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Foreword

The African Journal of Computing & ICT remains at the nexus of providing a platform for contributions to discourses, developments, growth and implementation of Computing and ICT initiatives by providing an avenue for scholars from the developing countries and other nations across the world to contribute to the solution paradigm through timely dissemination of research findings as well as new insights into how to identify and mitigate possible unintended consequences of ICTs. Published papers presented in this volume provide distinctive perspective on practical issues, opportunities and dimensions to the possibilities that ICTs offer the African Society and humanity at large. Of note are the increasing multi-disciplinary flavours now being demonstrated by authors collaborating to publish papers that reflect the beauty of synergistic academic and purpose-driven research. Obviously, these developments will drive growth and development in ICTs in Africa.

The Volume 8, No. 3, September, 2015 Edition of the African Journal of Computing & ICTs contains journal articles with a variety of perspective on theoretical and practical research conducted by well-grounded scholars within the sphere of computer science, information systems, computer engineering, electronic and communication, information technology and allied fields across the globe. While welcoming you to peruse this volume of the African Journal of Computing and ICTs, we encourage you to submit your manuscript for consideration in future issues of the Journal

We welcome comments, rejoinders, replication studies and notes from readers.

Very best compliments for the season

Thank you

Longe Olumide Babatope PhD
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Secret Communication Using Image Steganography

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ABSTRACT

Information security is one of the major concerns in this era of IT. The world now depends more and more on the computer and the related systems directly or indirectly for living. Cryptography and steganography are the most popular or widely used information security scheme or techniques. Steganography as a subject of consideration was born out of information security research as the previous mathematical techniques were vulnerable, and were hacked by cryptanalysts as computing knowledge developed over time. Steganography is the act of covert communications, meaning that only the communicating parties are aware of the communication. LSB replacement is adopted as an approach for embedding a message in a cover image. The algorithms for hiding data or message in a cover image, and extracting a message from a stego-image were implemented using C# programming language. In this paper, only 24-bit RGB bitmap files that use 1 byte (8-bits) for each of the 3 colours are allowed. In this type of bitmap image file, each pixel in the image is represented by 3 bytes – a byte each for the Red (R), Green (G), and Blue (B) components of its colour. This paper presents an experimental application of image steganography in a secure communication between two parties.

Keywords: Least Significant Bit (LSB), Steganography, Information Security, Encryption & Decryption

1. INTRODUCTION

Information security is one of the major concerns in this era of IT. The world now depends more and more on the computer and the related systems directly or indirectly for living. IT application stretches its tentacles from marketing to businesses, agriculture, weather exploration, scientific research, security, health and communications. The social media, distributed systems, intelligent systems, expert systems, decision support systems, executive information systems, transaction processing systems etc, are heavily depended upon in the contemporary world in day-to-day life as they have become part of man’s life, especially in the developed countries. Steganography is the act of covert communications, meaning that only the communicating parties are aware of the communication. To accomplish this, the message is typically hidden within innocent-looking stego-image. Thus, the most important attribute of steganography is un-detectability, means that no algorithm exists that can determine the existence of a hidden message in an object [1].

Steganography as a subject of consideration was born out of information security research as the previous mathematical techniques were vulnerable, and were hacked by cryptanalysts as computing knowledge developed over time. According to [2] one example is the Vigenere cipher, historically known as the chiffre indechiffreable (undecipherable cipher) for centuries until it was cracked by Charles Babbage in 1854 and in a more general form by Kasiski in 1863. Despite the fact that the Vigenere cipher was not broken for 300 years, it is actually quite easy to cryptanalyze and recover the key that has been used.

Within the first week of July 2013 in Nigeria, complaints by bank customers were reported in [3] across the country and banks of details of personal account information demanded by scammers pretending to be their bankers over the internet. Once a customer gives such information he or she becomes vulnerable to fraud by such miscreants. Recently, American newspapers as reported in [4] carried the news about hackers who stationed themselves at ATM machines in different parts of the world and within cities in America and made away with money estimated forty five million ($45m) US dollars.
They made an ATM card that ATM machine security doesn’t need to authenticate nor restrict amount to withdraw per day and smart enough to make away with such huge amount of money in hours.

2. RELATED WORK

Neil et al [5] on the subject Exploring Steganography: Seeing the Unseen, he referred to steganography as a ‘covert writing’ and that cryptography and steganography are cousin in the spycraft. In his research, he paid more attention to the selection of cover image as there is the tendency for some cover images ending in broadcasting the hidden message. He said that images are array of numbers representing light intensities at various points. He also noted that JPEG is lossy and most steganographers neither use them nor encourage its use but the 24 bit image format such as BMP image file formats does the job well. In his experiment, 25 files and 2 message files were carefully selected.

The first message file was 518 kb text message while the second was an image file. Using s-tools in the experiment he found out that there is a limitation of data size to hide in the cover image. He also laid emphasis on the need of security on the stego-image so as to protect the innocent looking stego from being intercepted, so there is a need to encrypt and decrypt in the source code when planning any stego project. They also asserted the need for hiding top secret project-device, aircraft, covert operation, using some steganographic method on an ordinary audio cassette tape. The alterations of the expected contents of the tape cannot be detected by human ears and probably not easily by digital means. Part of secrecy is of course in selecting the proper mechanisms.

Luis et al in their paper [6] a public-key steganography protocol allows two parties, who have never met or exchanged a secret, to send hidden messages over a public channel so that an adversary cannot even detect that there are being sent. Unlike previous settings in which provable security has been applied to steganography and introduce computational security conditions for public-key steganography that is secure from the adversaries that have access to decoding oracle. Here the two parties communicate without prior exchange of secrets. The paper try to see how a passive adversary who only watch if steganography is used in the communication or not, and show secure exchange of key under Integer Decisional Diffie-Hellman (DDH) assumption. Trapdoor one-way permutations in mathematical function that is a probabilistic polynomial-time algorithm. The attack for the research was the chosen-message attacks, the adversary here may influence the embedded message but has no access to the algorithms for encoding and decoding and research is also subjected to passive attacks. The security that was targeted at achieving was perfectly, statistically and computationally secure steganography. Algorithms were developed for both input and output for the computationally secure steganography while the other two are more of theory than application.

3. ALGORITHM FOR STEGANOGRAPHY

As stated in [8], LSB substitution is the process of adjusting the least significant bit pixels of the cover image. It is a simple approach for embedding message into the image. The Least Significant Bit insertion varies according to number of bits in an image. For an 8 bit image, the least significant bit i.e., the 8th bit of each byte of the image is changed to the bit of secret message. For 24 bit image, the colours of each component like RGB (red, green and blue) are changed. LSB is effective in using BMP images since the compression in BMP is lossless. But for hiding the secret message inside an image of BMP file using LSB algorithm it requires a large image which is used as a cover. The simple algorithm for OPA explains the procedure of hiding the sample text in an image. This is the reason we employ using it.
Step 1: A (LSB) are substituted with the data to be hidden.
Step 2: The pixels are arranged in a manner of placing the hidden bits before the pixel of each cover image to minimize errors.
Step 3: Let n LSBs be substituted in each pixel.
Step 4: Let \( d = \) decimal value of the pixel after the substitution.
\( d_1 = \) decimal value of last \( n \) bits of the pixel.
\( d_2 = \) decimal value of \( n \) bits hidden in that pixel.
Step 5: If \( (d_1 - d_2) \leq 2^\left\lfloor \frac{n}{2} \right\rfloor \) then no adjustment is made in that pixel
Else
Step 6: If \( d_1 < d_2 \)
\[ d = d - 2^n \]
If \( d_1 > d_2 \)
\[ d = d + 2^n. \]
This ‘\( d \)’ is converted to binary and written back to pixel. This method of substitution is simple and easy to retrieve the data and the image quality better so that it provides good security.

4. METHODOLOGY

In this paper, LSB Replacement technique was adopted as the embedding method. The LSB replacement technique was used because of its simplicity. The researchers used RSA encryption algorithm to encrypt the message before embedding it in a cover-image. RSA was chose as an encryption technique because of its encryption and decryption speed, and also its minimum storage requirement for the cipher text. C# was chosen as the programming language used to develop an application that demonstrates the use of image steganography in a secure communication. The paper used only BMP images as the only cover image, and the data or document to be hidden inside the cover image are limited to not more than 35% of the size of the cover image. The algorithms for hiding data or message in a cover image (section 3.1), and extracting a message from a stego-image (section 3.2) were adopted in this paper.

4.1 Algorithm for Hiding the Secret Message as in [9]

Then procedure involved here includes:
1. Read the original image and the image/message which is to be hidden in the original image.
2. Shift the image to hide in the cover image by \( X \) bits.
3. Hide the original image or cover image with 240 which is \( 11110000 \) so four MSB’s set to 0. Because of this, only four LSB’s are considered further.
4. The shifted hidden image and the result of step 3 are bitored. This makes changes only in the \( X \) LSB bits so that the image is hidden in the original image [10].

4.2 Algorithm for Extracting the Secret Message as in [8]

a) The stego-image is bit shifted by 4 bits since it was shifted by 4 bits to insert it into the original image.
b) This image is then ANDED with 255 i.e. 11111111, which gives the original image. It is ANDED with 255 because initially all the LSB’s were made 0. Now it is recovered back.
c) To get the unit8 format we convert it back to unit8 which is the extracted image.
4.3: RSA Algorithm
We adopted this technique as the encryption technique to encrypt the message before embedding it. This algorithm is an asymmetric cryptographic algorithm that uses both private and public keys. The public key is used for encryption while the private is for decryption. The Key generation, encryption, and decryption algorithms are as follows:

4.3.1: Key Generation Algorithm
1. Generate two large random prime integers “p” and “q” of approximately equal size such that their product is the required bit length (e.g. 1024 bits) but p should not be equal to q i.e. p ≠ q
2. Compute: n = p × q
3. Compute phi φ(n): φ(n) = (p – 1)(q – 1)
4. Choose an integer “e” between 1 and φ(n) such that “e” and φ(n) are coprime i.e. 1 < e < φ(n) such that: gcd(e, φ(n)) = 1
5. Compute the secret exponent “d”:
   i.e. 1 < d < φ(n) such that: e · d ≡ 1 (mod φ(n))
   Meaning de % φ(n) = 1 or d = e⁻¹ mod φ(n)
6. The public key is K_P = (n, e)
7. The private key K_S = (n, d)

Where
“n” is the system modulus or simply modulus
“e” is the public or encryption exponent
“d” is the private or decryption exponent
“p, q and φ(n)” are kept private
After the keys are generated, the HOD can publish the public key K_P = (n, e) to the public and keep his private (Secret) key K_S = (n, d) secret. The DEAN can now encrypt his message with the HOD’s public key using the below algorithm:

4.3.2 Encryption Algorithm
1. The DEAN obtains the HOD’s public key K_P = (n, e)
2. Represents his message M_i as positive integer such that M_i < n
3. Compute the cipher C_i = M_i^e mod n
4. The cipher C_i is then reconverted from number to text (cipher text)

4.3.3 Decryption Algorithm
1. The HOD obtains the DEANS ciphered text C_i
2. Represent the ciphered text as a positive integer
3. Use his private key K_S to compute M_i = C_i^d mod n
4. The plain number M_i is then reconverted from number to text (plain text)
5. SYSTEM FLOWCHART
This section presents the steps or procedure the application runs through in form of a flowchart as shown in figure 3. The flowchart in figure 3 shows how the application allows secret communication using image steganography.
6. IMPLEMENTATION

The algorithms for hiding data or message in a cover image, and extracting a message from a stego-image were implemented using C# programming language. In this implementation, only 24-bit RGB bitmap files that use 1 byte (8-bits) for each of the 3 colours are allowed. In this type of bitmap image file, each pixel in the image is represented by 3 bytes – a byte each for the Red (R), Green (G), and Blue (B) components of its colour. The application was tested and found to be working without errors and enables secret communication using image steganography. The result of the implementation is discussed in section 6.1.

6.1: Test Result

This section presents the test result of the application. Figure 4 allows users (Senders) to hide data or a message in a cover image in order to have a secure communication. Figure 5 allows users (Receivers) to extract the hidden data or message from the cover image (stego-image) in order to see the actual message embedded in the cover image.

Figure 4: Interface for Hide Operation

The Hide operation user interface consists of the following elements:

a) Operation drop-down list: this is used to indicate which operation to perform. The possible options are (i) Hide (ii) Extract.

b) Bit Position drop-down list: this is used to indicate the bit position in the image pixel bytes where the data will be hidden.

c) Data File name: this field is used to select the data file we wish to hide in the image. The Browse button next to this field can be used to open a File Dialog box containing files on the computer from which the data file can be picked from.

d) Original Image: this field is used to select the image file in which data will be hidden. The Browse button next to this field can also be used as stated above.

e) Final Image: this field is used to indicate the name of the file to store the modified image after the data is hidden in it.

f) A progress bar to indicate the progress of the Hide or Extract operation depending on the selection made.

g) Start button: this button is used to fire the start of the selected operation.

h) View Images button: this button is used to open a window that displays the Original input image and Final output image side by side for comparison.

Figure 5: The extract operation interface
The extract operation interface consists of the following components:

a) Operation drop-down list: this is used to indicate which operation to perform. The possible options are (i) Hide (ii) Extract.

b) Data File name: this field will be disabled as it is not used by this operation.

c) Modified Image: this field is used to select the image file that contains the hidden data or message. The Browse button next to this field can be used to open a File Dialog box containing files on the computer from which the modified image file can be picked from.

d) Output file: this field is used to indicate the name of the file to store the data or message after its extraction from the modified image.

e) A progress bar to indicate the progress of the Hide or Extract operation depending on the selection made.

f) Start button: this button is used to fire the start of the selected operation.

g) View Images button: this button will be disabled as it is not used by this operation.

6.2 Cover-images in BMP File and Their Corresponding Stego-images Used in the Experiment.

In this experiment, data files were hidden in the original images. In the first image which is the trademark logo of an Apple, a data file of 12.8kb was hidden, while in the second image which is the picture of Miss Godiya, a data file 45.1kb was hidden. Data file position in the images were tweaked in the RGB of the original images, hence introducing levels of noise in the original images proportional to the significance of the bits they are placed.

Figure 6: Apple original or cover image is 148Kb and Stego-image is also 148Kb, but the LSB replaced is the 3\textsuperscript{rd} index or 6\textsuperscript{th} MSB.

Figure 7: Miss Godiya’s image or Cover image is 1.08Mb and the Stego-image or final image is also 1.08 Mb, LSB used is the 3rd index or 6th MSB.
7. CONCLUSION AND FUTURE WORK

Steganography is one of the techniques used for securing data or information over the internet. In this paper, an experimental implementation of image steganography in securing data or information over a communication channel was carried out by using various types of input images as cover images and we discovered that:

(i) JPEG is not friendly with our program because the stego-image decreased in size by more than 50% of its original cover image. And when message is to be extracted from the stego-image the message is nowhere to be found it has evaporated.

(ii) The PNG files run well but the corresponding stego-images increase size to the original cover image.

(iii) BMP files when used: the files were stable i.e. the size of their corresponding stego-image was same with original images and extracted hidden-data were not in any way changed, meant the message successfully delivered.

This conforms to the literatures reviewed that discouraged the use of JPEG files as cover images in image steganography.

The researchers recommend that the message should be compressed in order to reduce the size of the message before embedding it in a cover-image.

REFERENCES


Achieving Modified Bloom’s Taxonomy with the Zolla Class Management and Learning Software

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ABSTRACT

This paper presents critical implementations that can help characterize modern classroom delivery, ensure active student participation with possibility for interactive evaluation based on e-learning tools. The authors achieved full cognitive plausibility in teaching intent based on their teaching of STEM subjects with the Zolla software. The presentation and class management software which was designed and built by the authors and which is comparable to a fusion of MS PowerPoint and Windows executable or program file was designed for attainment of the modified Bloom’s Taxonomy in a science classroom. As present day students’ distraction to learning and the fact that students are exposed to an avalanche of materials and contents online, thus necessitating the dependence of teachers on ICT based tools in knowledge delivery in the classroom. Also, as today’s world is permanently and uniquely a challenge to all facet of everyday life, pedagogues are always under pressure to develop and deliver adequate course contents, teach, research, publish, socialize and maintain a family life, thus making this tool a valuable source to aid teaching intent given the little available time for learning. A paradigm shift from unrealistic and unachievable goals of traditional teaching methods to a result focused and interactive model for teaching and learning was achieved by this work, with the model verifiable by the modified Bloom’s taxonomy of cognitive domain. This work fulfills a need in modern learning and enhanced teaching practice.

Keywords: Modified Bloom’s Taxonomy, Zolla Software, Hybrid Learning, Flipped Classroom, Triple Helix, Teaching STEM, Pedagogic goals.

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1. INTRODUCTION

Learning in the 21st century has indeed taking new turns as what can be referred to as “knowledge explosion” has taken centre stage in today’s world. Modern tools based on the various advantages available in the use of the internet for creating better support to pedagogues abound. Traditional methods of classroom delivery which involves teachers taking centre stage and controlling the flow of conversation while students depend on them for guidance, direction and feedback are gradually given room for newer methodologies. Tools such as the flipped classroom which allows the intentional shifting of instructions and learning through a student-centric model to create more meaningful and better learning opportunities mostly online have evolved. Today’s knowledge explosion has been necessitated by the easy access of information from the internet through computers and smart phones. This easy access of information online may mere teachers’ intent if not properly managed. This is because the organization, sorting and management of several terabytes of information available online by inexperienced and sometimes lazy students could overwhelm them.

The ability to generate proper searching and sieving criteria for huge data available online do not follow a standard process rather depends on heuristics. Due to the foregoing, teachers’ intent may be compromised as students who may already possess some idea of a new topic which could have aided understanding during class work may end up impeding students understanding of the new topic as knowledge flow is based on a bit-by-bit model that allows the biological reasoning processes of the human brain to accommodate information. The modified or enhanced Bloom’s taxonomy which emphasized more on previous knowledge possessed by the student as a platform for teachers to teach is better at achieving pedagogical goals in a classroom delivery. Furthermore, improving class participation becomes a daunting task for teachers as he or she has to deal with student’s inapt attention, lack of concentration and indifference even to simple and reasonable explanations. This is caused by student’s poor background or foundation, lack of interest or motivation, dependence on the internet for what we consider as “emergency learning” rather than capturing the area of interest and scope of work from the teacher.
This context is however only applicable to mostly undergraduate learning and teaching and not for more mature learning involving working class adults with families and other commitments. Achieving pedagogical goals in the classroom for the latter may become difficult for students whose hitherto dependence on the internet or more appropriately distracted by the internet may have to besiege classes and even exams with information clearly ambiguously outside the intended scope of learning and syllabus but which was readily available from online sites. Today, it is uncommon for a student not to have access to a computer system such as a laptop or at least must possess a smart phone through with e-learning can take place. In fact, it is compulsory in some university programmes especially in science and engineering for undergraduate students to use or own a laptop for learning. Teaching Science, Technology, Engineering and Mathematics (STEM) subjects can indeed be aided or improved by the design and deployment of indigenous software able to combine core learning outcomes and edutainment interactivity.

2. BACKGROUND

Bloom’s Taxonomy according to [1], was developed or designed by Bloom et al as far back as 1956 to enable the achievement of higher order thinking and then learning in a classroom environment. According to the authors, “the expressed purpose of the taxonomy was to develop a codification system whereby educators could design learning objectives that have a hierarchical organization.” In its most general form, Bloom’s Taxonomy of the cognitive domain outlines six hierarchical levels of cognitive processes: these are Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

From the figure, it can be seen that more student participation in the learning process is achieved as students tend to begin a new topic by first remembering a relationship from previous experience, trial or error, induction or inferences drawn. This is then followed by understanding based on the teacher’s explanations or relating knowledge to remembered experiences of students. This modification of the Bloom's taxonomy tends to be in line with the pedagogical goals proponents of the flipped classroom claim to be achievable if students were to be allowed more participation in the learning process [3], [4], & [5]. In the flipped classroom model according to the authors, pedagogues depend on a variety of methods and multiple technologies or tools.

Bloom’s Taxonomy proved to be a powerful tool for objectives-based evaluation in that it allowed for a level of detail in stating goals that had not previously been readily attained and thus it stood as the de facto standard for achievement of educational goals having withstood the test of time. The major idea of the taxonomy according to [2] was that what educators wanted students to know (which was encompassed in statements of educational objectives) can be arranged in a hierarchy from less to more complex level. The levels are understood to be successive, so that one level must be mastered before the next level can be reached. The taxonomy which was designed for the cognitive domain was received with scepticism by the educational community but however was implemented by various educators. However, critics of the scheme claim that it did not capture the more difficult aspect of students understanding of teachers’ intent thus necessitating the development of an improved version called the improved or modified Bloom’s Taxonomy, MBT. Though other taxonomies where developed for the affective and psychomotor domains as noted by the author in [2], but much emphasis is on the cognitive domain as it captures the more difficult process of acquiring knowledge by the use of reasoning, intuition and/or perception.

The modified version according to [1] was able to capture more students’ participation in the learning process of the classroom allowing more precise goals to be stated, delivered and evaluated in an outcome-focused modern educational process. In comparison with the original Bloom’s cognitive Taxonomy, the modified version switched the names of the levels from nouns to active verbs while reversing the order of the highest two levels; as shown below.

![Figure 1: The original Bloom’s taxonomy and the modified version](image)

These include recorded lectures in audio, video or both formats, screen captures, live classroom sessions, multimedia, online podcasts, e.t.c to teach students before they arrive the classroom. According to this model which delivers its instructional contents and materials mostly through the internet, students after accessing the contents are ready to immediately engage the discussion or practical aspect of the lecture intent as they arrive in class for the lecture after spending more time on remembrance. Conversely however, the traditional model of classroom delivery involving students having to be present all through the lecture session with majority of the classroom time consumed by the lecturer with a brief Q&A period which critics say is less effective as most of these classes may even drift from focus is less productive.
Though students can work outside the classroom during activities such as homework, proponents of the flipped classroom believe that more student involvement will be achieved using the flipped over the traditional classroom thus leading to the achievement of higher pedagogies. The use of modern technologies and Bloom's taxonomy in the study of the Direct Current Simple Circuit was carried out by [6] in which the author used equations such as Ohms law, power equations, plotting techniques and evaluation questions to teach and access students grasp of the aim and objectives of the topic. The students who remained in each level of Bloom’s taxonomy were documented with the students who remained in the level of synthesis having the highest number of 9 students from a total of 30 students in the research and the lowest number of 1 student remained in the first level of Knowledge.

According to the author the stress in teaching students should not be gear towards finding the perfect student, but rather on attracting as many students as possible towards perfection. Teachers must find suitable ways to get more and more students to reach level 6 in Bloom's taxonomy using modern teaching and learning methods.

A review of current practice in eliciting, presenting and amalgamating knowledge from multiple expert systems with emphasis on the use of graphical representations was carried out by [7]. The author pointed out that graphical representations are well established and flexible means of modelling and structuring knowledge as could be found in casual models, influence diagrams, semantic networks, Bayesian networks, knowledge maps, cognitive maps thus allowing for mathematical precise methods of analysis that can aid students’ grasp of teacher’s intent. Summarization according to the author is also a fundamental property of intelligence which in the face of overwhelming information allows an intelligent agent (the student) to focus on the most important issues while evaluation is a necessary and critical step in the formation of knowledge and transforming information to knowledge.

The author in [7] also identified knowledge management as the “formal management of knowledge to facilitate the creation, identification, acquisition, development, distribution, utilization and preservation of an enterprise’s knowledge using advanced information technology”. As the body of science continue to enlarge and various processes becoming so complex to the extent that new graduates will find significant differences in school work and working in the industry. It becomes imperative that dependence on ICT based tools and the internet is a necessity for transformation of today’s learning classrooms to tomorrows work office or plant floor. Also, in other to allow for pushing information technology tools and techniques to new frontiers, impacting knowledge and management of knowledge must continue to be refined.

If knowledge delivery were to be modeled to be similar to the objectives set aside for a research then the Corporate Academic Research Structuring System (CARESS) as developed by [8] for an integrated framework for designing innovative research topics and building teaching careers can be employed in a classroom environment where the aim and objectives of the topic transposes to becoming the aim and objectives of the research. According to the author, “CARESS thinking (by academics and researchers) motivates uncommon boldness, perseverance and optimism on the part of academics to institute deep and broad programmes of excellent research, teaching and community service”.

To ensure functional knowledge delivery that can bring about real future development, it is necessary for stakeholders that include academia, industry, governments/civil society – (a Triple Helix structure as coined by the author) to work together and implement policies that will encourage proper knowledge dissemination to help shape citizens of today and the future through capacity building, training workshops, seminars, and socio-economic development goals. Introducing the objectives of triple helix skills to students will help inculcate a broader sense of direction and set better goals and learning objectives as students understanding of new concept will be enhanced if there is a direct linking of learning outcomes with industry or government.

In the classroom, student’s engagement happens as a result of a teacher’s careful planning and execution of research-based strategies. The author in [9] established the following as consistent in arousing students’ engagement in the classroom: students engage in Emotional tasks such as “How do I feel?”, they arouse Interest: “Am I interested?”. Perceive importance: “Is this important or necessary?”, and also engage in Perceptions of efficacy: “Can I do this?”. Teacher’s awareness of the reasoning processes of the students can help model the classroom to be highly engaging according to the author.

The role of academia-industry cooperation to enhance the software integration process for engineering and science education in Nigeria was elucidated by [10]. The author who identified the fact that there has been a considerable improvement in access levels to ICT, also pointed out that problems such as lack of proper funding/management, staff training (especially in ICT), curricula review and students’ involvement abound to today’s poor delivery of engineering education in most undergraduate programmes. In an elaborate study of various foreign and local software available, [10] pointed out that local efforts in the development and usage of software packages relevant for the engineering profession in Nigeria are generally inadequate to meet up with today’s learning. Skepticisms to the adoption and use of ICT and e-learning by lecturers was investigated by [11], to include the “lack of confidence on the part of the academic users, the lack of provision of adequate skills and training programme, the inadequate technology infrastructure, planning and program deficiencies, the lack of human capacity and expertise, inadequate economic resources, the lack of recognition of knowledge or educational equivalence, and the neglect of learning conditions and cultural aspects to some extent.”

Aside these lamentations, researches in the dependence of ICT based tools on learning especially for science subjects according to [12] and [13] have witnessed considerable improvements over the past decades with children from homes with interactive edutainment materials or belonging to schools with rich syllabus embedded-content software recorded better academic performances at school especially in science related exams and perform excellently in computer related assessments. However, [14] gave a note of caution in the deployment of ICT based learning stating that these interactive tools and virtual environments require a clear understanding of their place in a curriculum and their potential to facilitate the comprehension of the course topics and the attainment of the course objectives.
Borrowing the guidelines from [15] in the summary of this background literature, it can be seen that pedagogues must continue to look for ways to impact knowledge to their students and continue to improve the process of the impact by constantly researching, placing the student at centre at all times and asking the questions “how can teaching or learning be done better?”, “what tools should I deploy or jettison?”, “how can delivery be better?”, “how convenient will it be for the student?”, e.t.c.

3. METHODOLOGY

The achievement of pedagogical goals in resource constrained environment and the accompanying issues to be contended with for a proper class session can be better obtained by dependence on ICT tools. Highly interactive models which are able to marry the in-depth and rigorous attention to detail of knowledge acquisition and the obvious distractions available in today’s environment have been obtained by the Zolla class management, learning and evaluation software. In order to achieve almost 100% learning outcome in a classroom session giving the available time, the software fuses both traditional methods of classroom delivery with the current trend of digitization where most people sit in front of TV screens to view electronic programme content and young people (mostly undergraduates) constant presence on the internet through social media sites (e-presence) with the help of smart phones other digital devices.

The Zolla software allows teachers to embed their lecture notes, materials or teaching intent in a computer executable program such that the contents of lectures are presented using more interactive slides which include student specific needs and lecture focus. Areas identified by the teacher for more focus during the lecture can be more thoroughly edited by the teacher in a customizable way. This software which requires little or no programming skills from the pedagogue for preparing modules can have the modules embed with videos, audios or both. Lecture content in text formats, screenshots images, e.t.c can be converted to short video files format with the following extensions .avi, .mpeg, .mpg, .mpe, .m1v, .mp2, .mpv2, and .vob. Specific activities such as quiz, test, practice questions tailored for each individual student and obtained from a pool of questions using randomization command in programming can be embedded in the module to improve higher pedagogical goals in an interactive manner. A synergy between the traditional methods of lecture delivery and use of e-tools is created by this method which is aimed at mostly undergraduate students with emphasis on minimal dependence on the internet. Screenshots of the highly interactive software which is executable on any MS Windows® operating system’s platform is shown in the figures below.

Figure 2: The welcome screenshot

The lecture content can be displayed in the form of a video file or with the help of slides that can be forwarded to view next content or rewinded to view previous content. Students can then select a topic from the list of available topics from the option’s menu. Clicking on Yes button then loads the content of that topic into the computer memory.

Figure 3: The topic selection screen

For illustration, the figures below shows screenshots of the content students will view if the topic on Electromagnetic Waves and Radiation, i.e if EM Radiation were to be chosen from the topic options menu in figure 3 above for a particular semester, then the educontent for that topic will appear on clicking ‘Yes’.
Figure 4: Screenshot for the introduction and attainable objectives slide

Figure 5: Screenshot for achieving remembering based on familiar experience.
Here, in order to achieve the first layer of the modified Bloom’s taxonomy: Remembering; slides such as figure 5 were designed to aid students’ recall of applications of electromagnetic waves in everyday life in the form of indoor antennas on phones, radios and TVs and outdoor antennas in radio and TV broadcasting stations, GSM Masts, metal detectors in banks, military, e.t.c. Students understanding of the lecture intent or learning objective is triggered with the introduction/recall of previous familiar knowledge, thus achieving the second stage in the modified taxonomy, see figure 5.

The application (stage 3 of MBT) of the remembered knowledge and the subsequent understanding triggered can then be used to analyse new concepts to be introduced by the teacher and then help attain more knowledge on that topic. For example, the slide above in figure 6 & 7 can be used for analysis sake based on teachers’ explanations and relation to the recalled or remember experiences.

However, it should be noted that in this analysis, emphasis is on the method proposed by this work and not on the topic: Electromagnetic Waves and Radiation which have been chosen arbitrary for illustrative purposes. Also, students in computer, chemistry and engineering who are included in this analysis have access to Zolla software for other topics not necessary the topic chosen for this writing. The stage of evaluating students based on MBT stage 5 was achieve in the topic under analysis by the screenshots below. Based on the present approach to evaluation, students spend more time tinkering over the evaluation questions outside the stress.
Individual needs of students or more appropriately, students with special attention such as slow learners, gifted students, e.t.c can be identified and given students’ specific exercises instead of the traditional method of taking an average evaluation of the whole class. Figure 9 above shows a specific student’s test or evaluation question for the topic under review. Thus due to robustness in the dependence of software, students’ evaluation is based on more goal specific individual strength and not on generalized assessment which most times lead to malpractice involvement by students.

Finally, in achieving the creating stage of the MBT, students are allowed to use the knowledge acquired to produce, revaluate or design prototypes through laboratory experiments and isometric projection or drawing. For example, from this analysis students were able to design a Yagi antenna which is a multi-dipole antenna that allows electric component of the EM wave to gain a pre-amplification.

4. RESULTS AND DISCUSSION

The results of the analysis in the methodology section above was achieved by the analysis of respondents’ questionnaires that had been previously administered to students you have used the Zolla software in at least one semester for learning in a STEM based course.

The Zolla software which has been developed and used in teaching students since the year 2013 from selected universities in Nigeria, has witnessed several improvements and transformations as noticed by the students respondents from collated questionnaires. Analysis of administered questionnaires to undergraduates showed that their attraction to interactive and indigenous ICT content was high with over 80% of 174 respondents affirming in the positive. 70% of the respondents which spanned undergraduates from Levels 100 to 300, agreed that the software allowed more time for tinkering over problems than the conventional teaching methods normally provide. 85% of the respondents noticed that the Zolla slides provided much more summary of lecture content than most power-pointed notes.

While 95% of the respondents believe that software based evaluation will help curb exam malpractices only about 40% where ready for such a paradigm shift. On the whole, the sampling method which ensured that students did not enter their names or other traceable biometrics on the questionnaire revealed that this effort should be encouraged to produce more lecture content materials for other topics in STEM based courses as agreed by 95% of the undergraduates. A graphical illustration of the sampling survey is shown in the figure below.

5. CONCLUSION

Several models aimed at making learning more meaningful have been developed and implemented with these models most time achieving their intended purpose given other constrains in the educational system and daily living. The constant change in information and communication technology, ICT has created the dependence of education on its tools over the past decades. The Zolla software developed for student’s interactive e-learning and active classroom participation has demonstrated higher pedagogical attainment in today’s learning when x-rayed with the modified Bloom’s taxonomy of the cognitive domain. Indigenous and highly interactive syllabus-enriched edutainment software is a major tool for teachers conquering of today’s classrooms.

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Towards a Practical Framework for Successful Change Planning and Implementation

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ABSTRACT

Identify how many variables both constants and the dynamics deliverables within a change project is likely to pose the needs for constant review in delivery and ordering priority of when the variables are indeed available. Change leaders motivate themselves by increasing the pace of change within the overall change plan. The focus on few constants and more variables could help in understanding the trend for more opportunities, more changes, shorter lifespan, and less stability in planning and implement change. This paper aims at a practical framework for successful change planning and implementation by focussing on the need for an agile approach in implementing change. It introduces the reader to the evolving concept of agile change management thinking. It explores some approaches to plotting and implementing change and gives practical tips embedded in a pocket guide for implementing change. Concepts are part of critical analysis of the significant benefits to change in society, government and organisations.

Keywords: Change, Management, Thinking, Model, PESTE.

INTRODUCTION

Due to today’s society of rapidly changing technologies and various market forces dynamics, change has entirely fit itself into the management agenda. Research has shown that working for success entails a considerable need for expertise on how to change what you do today to keep fit with pace with global approach to change that takes place everywhere [4][5]

It is not about would it happen, but when is it going to happen. Some managers will experience change once in their management lifetime while others possibly in multiple times. It is easier to predict the imminence of change experience than denying it, affording the system the understanding that change management is not a specialist role [[1][6][8]

However, research outcomes imply that many, if not most, change endeavours fail to obvious extent; though few got things right eventually. Notably, the current trend suggests that managers either in strategic or operational level should pay close attention to successive process of implementing change. In practice, it pays high dividends in terms of the strength for achieving objectives and upholds an overall organisational success. There are different focussing techniques on this far group integral part of the management agenda.

Effective handling of the external forces driving change like economic or market trends differ to effective implementation of the in-house challenges, in likes of underpinning holistic value-added activities that culminates to making effective change. It is intrinsically dynamic, and whatever it entails, it has to be monitored explicitly to map an effective change paradigm; each stage must be often communicated responsibly. Although, change correctly presented to be normal, continuous and ubiquitous, and not for humans and managers in particular to initiate but the facts emerging that much change self-initiate below the surface when emerging forces punctuate organisations to self-right and improve.

Performance ego places the normality of change to be carried along without any serious implication, i.e., changes only become challenge when it is striking. Change could bring success or failure depending on the realm of emphasis and implementation. Therefore, managers need to take control of change that is dramatic, especially when potentially disastrous. Most change has direct impact on people; they will support it if it is their idea and they have control over it but oppose it otherwise thus a change management programme has a greater chance of succeeding if it can call attention to individual initiative and individuals are in charge of the stages.
Understanding the dynamics of this subject and managing it are the dominant themes within the management framework and implementation today. Consequentially, adapting to the unpredictable factors of change like unnatural and volatility of the market trends present it as an essential part of management agenda for the overall success of business objectives in the volatile future.

2. WORKING DEFINITION OF CHANGE

In whatever approach taken in defining the subject of change, an in-depth definition could provide overwhelming evidence for the dynamic nature of the subject. Considering the effective dexterity of a well-configured transition period and content, of an organisation from state A to state B achieving lasting status or brand could be an essential need for change within an establishment. The reasons for change range from dynamic improvement within the organisation and external forces outside the same organisation to little-portable updates towards current procedures, to essential and extensive change relating to business tactic. The ever-growing expectation for change has duly informed the growing need for and shortage of management skills in handling the change that faces business in the current economic situation.

Effective definition of change is as efficient as meeting the need for effective implementation of change programme both in time of crisis and day-to-day management of business in the overall interest of meeting targets and achieving the objectives of the organisation. Wherever change is constant, managing it could be dynamic, as handling the constancy of its occurrence. Change managing could be either upbeat or spontaneous; prompted through feedback about an activity far from the immediate objective of the business. This could be either economical, political, governmental legal framework/policy, or issues inside the management tasks structure, community and the respective measures regarding the internal context of the business. In addition, this could exist as a down to business expecting perhaps unfavourable economic downturn in the end.

2.1 The triggering indicators of Change

Cause factors place enormous responsibility of effect that needs clarity of purpose in line with paradigm shift of dynamics. Recognising these factors help in managing and acquiring the relevant skills embedded in change management. This has direct link to clarification of the outcome, successful planning, and implementation of the needed change, safeguarding the successes made for overall effectiveness, and efficient change management processes. Research shows that change management typically tags on the following: appreciating change needed; clarifying expected outcome, or the destination; scheduling the tasks in attaining the underlined goals of the change; successful implementation of the change; and ensure that the change is in overall interest of the organisation, i.e., sustaining that the change is enduring [9][10][13].

On personal level, it engages various adjustments that include a change in outlook or job schedules promoting human resources managing skills, thus the needs for motivation, to successful implement essential processes of the change programme. In addition, within the same encyclopaedia, are paramount influences of management approach, such as, leading people and change management, to an integrated optimistic mind-set for the planned alteration within the workers. Business re-branding is an example of change activity involving system re-designing, which could raise performance even beyond one’s wildest imagination. As emphasising on the external forces of change, greater proportion of driven factors as the people within the organisation are the change agents. They are to be initiators and influencers of every stage evolving within the change agenda. They are the leaders and direct receivers of change impact. People within the organisation should receive appointment as the influential and campaigners; the game changers, to dictate the velocity required within the change processes and actualisation. Business survey of the last two decades shows direct link between the swiftness of needed change within the organizational context, and any acceptable reality of business life in relation to the dynamic matter of today’s, many management authors and practices.

2.2 PESTEL. (Political Economical Sociological Technological Ecological Legal):

Apparently, many essential changes are reshaping the global economy today. In this new template of change, business location is less relevant when irrelevancy is far approaching. The new approach levels on the stage field on which business operates, and frequently eliminates barriers via globalisation. Labour mobility is fast sprouting into career development mobility. High level of youth unemployment and frequently evolving new technologies are in full participation in management and the frequent need for adapting and implementing successive change programme becomes pressing.

“The new ‘borders’ are between people who have skills and those who don’t, who speak the right language and those who don’t, and who are flexible and those who resist change. These factors will separate success from failure in the future. There is no room for complacency in the ‘information society’.” [1][12]. There is a direct connection between countrywide monetary struggling, and the advancement of information and communication technologies. This provides candidly the evidence that there is a greater demand on managers to maintain the involving between businesses and the developmental value added through emerging technologies.
In the last four years, there are hundreds of UK government laws and regulations frequently demanding immediate change to business activities and thus promoting change management skills in the current economic situation. These policies are undoubtedly driving the need for change. John Browett answered ‘yes’ when asked, “Should the CEO assume responsibility for change?” He continues as follows:

“I would say that without the unswerving support of the chief executive and the executive committee, there is absolutely no chance that you can get transformation done and what I see in most businesses is that the chief executive is not at work on this kind of stuff (change and transformation). They may talk about it, they may even make presentations to the City about it, but they are not prepared to get their hands dirty. They are not prepared to intervene in order to get what they want. They are not prepared to put the best people on it. They don’t really understand it and they don’t like it.” (CMI, op cit)

Between 2005 and 2008, seventy-four percent of IT projects failed because change management skills are in shortage and Chief Executives grossly failed in responding competently to the needs for change due to competitiveness and the new technologies driven the business platform. (Source: Standish Group and Gartner)

In addition, the growing large quantity of information and the accompanying knowledge is a challenge to managers for change, and this demands for better way of managing information and the accrued knowledge. Professional discussions across the spectrum have recently grown in the field of knowledge management, and how change management playing performance roles within organisations of enormous knowledge growth. Strategic intelligent into resolving crisis and conflict of interest within multi-national organisations have also provided valuable checklist into mapping an effective change programme (Appendices 1 & 3). It means change management cuts across every aspect of today’s management agenda. Climate change, if one believes in its evolution could be a force, but undoubtedly, the positive response provisions by the disaster management skills, which have dramatically, invoke change to businesses where natural disasters had dramatically driven changes.

3. PLOTTING AN EFFECTIVE CHANGE PROGRAMME

Organisations, which have undertook change for its practical meaning adopted model for effective change programme. Although, different problems might arise from achieving the outcome of change but these are usual and surmountable when appropriate actions and don’ts are in place. Continuous existence of some organisations and their branding has helped managers’ understanding of the dynamics of change management.

This furthers the reason for the increasing interest for managers who have change management skills. There is higher success rate for organisations involving in a transitional programme of effective change to handling problems, which arise within the organisation.

Figure 1: present an action checklist and don’ts in carrying out an effective change programme. The composition of the dos and don’ts explicated in the figure relies on the Lewin’s three-step approach to Change (Check the Lecture Manual on Managing Human Capital Combined, 2012:231-233). The first step of Lewin’s approach presents an unfreezing stage of change programme. Changes needed are to be prepared for, focussing on the Lewin’s force field analysis of Figure 2. However, Lewin’s steps of changing and refreezing presents reasons why managers are to prepare for the change.

Usually there are opponents to the change. Plotting the programme of change must effectively handle both the hidden and the otherwise opponents positively in the overall interest of the change programme been pursued. It is been noted that hidden forces give addition force value only to the change but do not actually support it. This could be a further evidence of the dynamics of this subject and whilst most management dictionaries do not present a clear divergent definition of change from the one given by the Concise Oxford Dictionary; change defined as ‘making or becoming different.’ (CMI, Checklist 038:1)

3.1 Implementation of an Effective Change Programme

Furtherance to plotting an effective change programme is managing change. It includes achieving outcome of difference from a switch to another, handling effectively various problems emanating from the plot. Plot for change within an organisation, should have been mapped and ready for implementation. Many factors included as well as equipments. It includes implementing many procedures as well as many updates to policies. It involves moving people around or people moving on. It could also involve organisation structures be altered as well as inevitable alteration to infrastructures. Changing an element of a live organisation could cause inescapable change to other elements, particularly, in a multi-national organisation; most of the nodes are inter-related and involve complex systems.

Figure 3 Appendices) present a thoughtful and an organised checklist in undertaking this implementation. Requirements for change management thoroughly engaged with, since change varies from organisation to organisation, subject to type, size, and the type of change been plotted.
4. CONCLUSION

Having considered few aspects of change management, the dynamic of the subject is not in doubt. However, both mapping and managing effective change programme challenges the mind and preoccupy the schedule of managers because change in organisations usually could lead to change in lifestyle of employees and perhaps in employers. It has a knock-on-effect throughout the entire system, most importantly on people; therefore, effective plan and implementation are not to be over-emphasized. However, change leaders have different models and resources to tap into, which include the work of Bernard Burnes; Elisabeth Moss Kanter; John Kotter; Kurt Lewin; and other related works and models in modern approach to agile change management. [2] [11]

References:

Internet Sources:
Appendix 1

Figure 1: Plotting an Effective Change Programme- Dos Versus Don’ts Checklist

<table>
<thead>
<tr>
<th>Dos</th>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Think the change through</td>
<td>1. Forget that change management needs to have a vision, a purpose, a</td>
</tr>
<tr>
<td>2. Being open to change</td>
<td>2. rationale, with a direction, and a time bound (i.e., SMART)</td>
</tr>
<tr>
<td>3. Build a culture that sustains change</td>
<td>3. Overlook the need to ‘celebrate’ and ‘reward’ successful change</td>
</tr>
<tr>
<td>4. Appoint champions for change</td>
<td>4. management as people need to feel good about their achievements, but</td>
</tr>
<tr>
<td>5. Build the right team for change</td>
<td>5. even if small or modest are small.</td>
</tr>
<tr>
<td>6. Build the case for change</td>
<td>6. Think small: many change programmes fail to deliver the expected</td>
</tr>
<tr>
<td>7. Define the scope of change</td>
<td>7. results because their ambitions are too narrow, or not</td>
</tr>
<tr>
<td>8. Draw up an outline plan</td>
<td>8. radical enough</td>
</tr>
<tr>
<td>9. Cost the change programme</td>
<td>9. Fail to take account of stakeholders: seek the views of</td>
</tr>
<tr>
<td>10. Analyse your management competencies</td>
<td>10. customers, suppliers and other stakeholders as well as those</td>
</tr>
<tr>
<td>11. Cultivate curiosity: try to become</td>
<td>11. within the organisation</td>
</tr>
<tr>
<td>12. Seeing the effects of change</td>
<td>12. Expect rapid change: be patient and persistent, as change takes</td>
</tr>
<tr>
<td>13. Identify the driving and restraining</td>
<td>13. time</td>
</tr>
<tr>
<td>14. Think before following the same</td>
<td>14. Underestimate the cost of change: build in costs for repeated</td>
</tr>
<tr>
<td>15. Understand the causes of change</td>
<td>15. communications and training efforts</td>
</tr>
<tr>
<td>16. Respond to rivals</td>
<td>16. Embark on a major change programme without the absolute</td>
</tr>
<tr>
<td>17. Respond to contexts</td>
<td>17. support of the top management team</td>
</tr>
<tr>
<td>18. Analyse change</td>
<td>18. Bulldoze through resistance to change- instead listen and persuade</td>
</tr>
<tr>
<td>19. Outline the change programme to</td>
<td></td>
</tr>
<tr>
<td>20. Communicate</td>
<td></td>
</tr>
<tr>
<td>21. Identify change agents</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Chartered Management Institute Checklist O38 & Dk Essential Manager’s Manual, pgs. 698-715.

Appendix 2: Figure 2: Lewin’s Force Field Analysis (Extracted from the Course Manual on Human Capital Management Combined.ppt).
Figure 3: Plotting An Effective Change Programme; Dos Versus Don’ts

<table>
<thead>
<tr>
<th>Dos</th>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agree the implementation strategy</td>
<td>1. Fail to plan for natural resistance</td>
</tr>
<tr>
<td>2. Agree the timeframe</td>
<td>2. Cost in terms of additional training</td>
</tr>
<tr>
<td>3. Draw up detailed implementation plans</td>
<td>and communications</td>
</tr>
<tr>
<td>4. Set up a team of stakeholders</td>
<td>3. Become lost in the detail</td>
</tr>
<tr>
<td>5. Establish good programme management</td>
<td>4. Lose sight of the vision</td>
</tr>
<tr>
<td>6. Communicate clearly</td>
<td>5. Facilitate change without</td>
</tr>
<tr>
<td>7. Promote comradeship among change</td>
<td>facilitating effective</td>
</tr>
<tr>
<td>8. Give change agents stretching tasks</td>
<td>communication</td>
</tr>
<tr>
<td>9. Encourage people to form and</td>
<td>6. Keep information secret unless it is</td>
</tr>
<tr>
<td>10. Listen to what change agents say</td>
<td>essential to do so</td>
</tr>
<tr>
<td>11. Personalise the case for change</td>
<td>7. Assume that older employee are</td>
</tr>
<tr>
<td>12. Ensure participation</td>
<td>too set in their ways to be change</td>
</tr>
<tr>
<td>13. Help to minimise stress</td>
<td>agents</td>
</tr>
<tr>
<td>14. Be prepared for conflict</td>
<td>8. Discourage others by singling out</td>
</tr>
<tr>
<td>15. Be willing to negotiate</td>
<td>change agents for preferential treatment</td>
</tr>
<tr>
<td>16. Create a sense of purpose</td>
<td>9. Prevent change agents from using their</td>
</tr>
<tr>
<td>17. Create urgency to help in tackling</td>
<td>initiative</td>
</tr>
<tr>
<td>18. Motivate</td>
<td>10. Create an atmosphere of secrecy</td>
</tr>
<tr>
<td>19. Build skills</td>
<td>for its own sake</td>
</tr>
<tr>
<td>20. Build in capability for learning</td>
<td>11. Forget that real change often comes through</td>
</tr>
<tr>
<td>21. Remember change is discontinuous</td>
<td>a simple breakthrough</td>
</tr>
<tr>
<td>22. Monitor and evaluate</td>
<td>12. Fail to publicise all successes to</td>
</tr>
<tr>
<td></td>
<td>build up momentum and support</td>
</tr>
<tr>
<td></td>
<td>13. Go ahead without gaining employee</td>
</tr>
<tr>
<td></td>
<td>involvement at every stage of design and</td>
</tr>
<tr>
<td></td>
<td>implementation</td>
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<tr>
<td></td>
<td>14. Go ahead without top management</td>
</tr>
<tr>
<td></td>
<td>sponsorship of, and commitment, to the</td>
</tr>
<tr>
<td></td>
<td>agreed implementation</td>
</tr>
</tbody>
</table>

*Sources: Chartered Management Institute Checklist O40 & DK Essential Manager's manual, pg. 739.*
Multi Disease Analysis System Using Content Based Image Retrieval

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ABSTRACT

Content based image retrieval is a mainstay of image retrieval systems. This technique is incorporated in the analysis of disease identification in the medical field. Incorporating content based image retrieval with the medical field in the identification of multiple diseases is the main motto of this paper. Usually doctors take scan report which is in the form of DICOM format, to identify the diseases. In order to make conformation, they look after previous patients records. If there are multiple diseases in the single part, say brain, heart, lungs, kidney etc, there is a need to search various type of patients records to conform the type of disease affected in the particular part of the body. In order to avoid this difficulty we propose the project work of “Multi Disease Analysis System Using Content Based Image Retrieval” which provides high efficiency in multi disease identification from our medical images database. Content Based Image Retrieval (CBIR) is a technique that searches the similar type of images based on colour, size, texture etc. This techniques proves to be high efficient than other image retrieval techniques. Large type of diseased images taken from the patient are stored in the database. If the scan report with multiple disease are given as the input, it analyse the type of the disease and produces the report. In addition to that, this system also provides the description about the effort taken to cure this disease and also its prescription about the disease. This is the added advantage.

Keywords: Query by image(QBIC), Content-Based Image Retrieval(CBIR), Query by Example(QBE), Relevance Feedback Algorithm, Navigation Pattern Based Relevance Feedback (NPRF), Query-Point Movement(QPM), Query Reweighting(QR), Query Expansion(QEX)

1. INTRODUCTION

Data mining is the process of identifying valid, novel, potentially useful and ultimately understandable patterns in data. It is the set of activities used to find new, hidden patterns in data. It can also be defined in short as “Discovering hidden value in your data warehouse”. Data Mining is a part of the overall process of Knowledge Discovery in databases (KDD). There are many types of mining text mining, image mining, video mining etc. Image analysis tools find its applications in all the fields like Science, Medicine, Research etc. The various types of techniques are available in the image analysis system. They are Query by text, Query by description, Content Based Image Retrieval. These are the methods available to retrieve the data from the data base.

2. CONTENT BASED IMAGE RETRIEVAL

Content Based Image Retrieval (CBIR) is the main technique used in this paper. CBIR operates on a totally different principle from keyword indexing. Primitive features characterizing image content, such as colour, texture, and shape, are computed for both stored and query images, and used to identify similar images matching the query and thus retrieve the data from the database related to that query. The Query-by-Image-Content was one of the first prototype systems. It was developed at the IBM Almaden Research Center. It allows queries by color, texture, and shape, and introduced a sophisticated similarity function.
Advances in data storage and image acquisition technologies have enabled the creation of large image datasets. It is necessary to develop appropriate information systems to efficiently manage these collections. The commonest approaches use the so-called Content-Based Image Retrieval (CBIR) systems. Basically, these systems try to retrieve images similar to a user-defined specification or pattern (e.g., shape sketch, image example). Their goal is to support image retrieval based on content properties (e.g., shape, color, texture), usually encoded into feature vectors.

One of the main advantages of the CBIR approach is the possibility of an automatic retrieval process, instead of the traditional keyword-based approach, which usually requires very laborious and time-consuming previous annotation of database images. The CBIR technology has been used in several applications such as fingerprint identification, biodiversity information systems, digital libraries, crime prevention, medicine, historical research, Web searching.

3. MOTIVATION

The main motto of this paper is to make the medical treatment in effective manner. This project helps to avoid the manual searching for the identification of diseases and the treatment diagnosis. This paper provides suggestion to the doctors about disease. This paper helps to identify the multi diseases in the scan report without the need to pull out records individually. Generally doctors used to take scan reports of the patient to identify the disease affected in the patient. In order to make it confirm, they used to analyze previous patients records. In case, if there are multiple disease in any part of the body, they used to analyze various number of records to conform all those multiple disease. Incorporating the best efficient technique of content based image retrieval in this problem helps to reduce the burden of retrieval of images.

4. EXISTING SYSTEM

There are many image retrieval softwares available in the medical field. They are

1. Image Retrieval for Medical applications (IRMA)
2. Image Map
3. Automatic Search and Selection Engine with Retrieval Tools (ASSERT)
4. WebMIRS

5. IMAGE RETRIEVAL FOR MEDICAL APPLICATIONS

IRMA (Image Retrieval in Medical Applications) is a cooperative project of the Department of Diagnostic Radiology, the Department of Medical Informatics, Division of Medical Image Processing and the Chair of Computer Science VI at the Aachen University of Technology.

The IRMA project aims at goals in two research fields:
- Automated classification of radiographs based on global features with respect to imaging modality, direction, body region examined and biological system under investigation.
- Identification of image features that are relevant for medical diagnosis. These features are derived from a-priori classified and registered images that are stored in the database.

The resulting system must retrieve images similar to a query image with respect to a selected set of features.

6. IMAGE MAP

It is possible to create image maps by hand using a text editor. It requires web designers to know how to code as well as how to enumerate the coordinates of the areas they wish to place over the image. As a result, most image maps coded by hand are simple polygons. Because creating image maps in a text editor requires much time and effort, many applications have been designed to allow web designers to create image maps quickly and easily, much as they would create shapes in a vector graphics editor.

7. AUTOMATIC SEARCH AND SELECTION ENGINE WITH RETRIEVAL TOOLS (ASSERT)

To archive an image into the database, a physician delineates the PBRs and any relevant anatomical landmarks. This interaction takes only a few seconds for a trained domain expert (a radiologist). In the meantime, a lung region extraction algorithm is applied to the image to determine the boundary of the lungs.

The system then executes a suite of image processing algorithms to create attribute vectors that characterize the PBRs individually and the portion of the image that consists of just the lung regions. These attributes are subject to a sequential forward selection algorithm to reduce the dimensionality of the attribute space while retaining the ability to accurately classify each image as belonging to its associated disease pattern.

8. WEBMIRS

Through the selection of relevant medico-diagnostic features locally derived from the registered image data, a content-based database query can be specified. By mapping the medical diagnosis to each respective image, features can be extracted that describe and discriminate relevant image content. This includes the identification of diagnostically relevant regions of interest. By local image analysis, a hierarchical blob representation is obtained describing the image structure.
9. **DRAWBACKS**

The drawbacks of the existing system,
1. Especially for the compound and complex images, the users might go through a long series of feedbacks to obtain the desired images for confirmation,
2. Manual searching should be made leads to time complexity,
3. Need of prescription for the cure of the diseases.

10. **PROPOSED SYSTEM**

We propose a novel “Multi Disease Analysis System using Content Based Image Retrieval”. First we used to collect the image data composed of single diseases images. The RGB color code is generated for the disease affected images. The collection of these RGB code is named as “Navigation Pattern”. Then for all kind of image in data base we used to measure the disease affected area of parameter (x,y) of that image as well as the height and width of the disease affected area.

In addition to that , the name of disease identification based on the image color present in disease affected parameter area in image and all the description will be store with appropriate image with in the data base. This tends to construct “Multi Disease Analysis System” (back end). User can give any kind of medical related image input for disease identification, then our system will accept the input and analysis the input image by making and interact with the back end data base. We used Navigation pattern algorithm to classify the input image is which kind of classified image. After analyzing input image the description of medical image will be given to the user. Using our proposed system we achieve the high efficiency of multi disease identification from our medical images data base.

11. **OVERVIEW OF THE PROJECT**

The proposed approach deals with content based image retrieval techniques in the Medical field. This technique is implemented as the application in medical field. First we used to collect the image data composed of single diseases images. The RGB color code is generated for the disease affected images. The collection of these RGB code is named as “Navigation Pattern”. Then for all images the disease affected part alone is marked. This tracks the number of the occurrence of the similar RGB colour code for the images. User can give any kind of medical related image input for disease identification. Many number of disease affected part can be given as the input for the disease identification.

We used “Navigation Pattern Mining” algorithm to classify the input image. The probability of number of occurrence of the code values are tracked and stored in the data base. It founds out the how many similar occurrence of these RGB code are found out. After analyzing input image the description of medical image will be given to the user.

12. **MODULE DESCRIPTION**

The modules for the project is as follows,
- Construction of multi disease system
- Image description
- Searching and view description of disease

13. **CONSTRUCTION OF MULTI DISEASE SYSTEM**

The database of SQL Server is used as the back end for this paper. First we used to collect the image data composed of single diseases images. The RGB color code is generated for the disease affected images. The RGB code is generated by the predefined function. The collection of these RGB code is named as “Navigation Pattern”.

14. **IMAGE DESCRIPTION**

Then for all kind of image in data base we used to measure the disease affected area of parameter (x,y) of that image as well as the height and width (h,w) of the disease affected area. Next the disease affected is alone marked separately as “Disease affected “ as “yes”. In addition to that , the name of disease identification based on the image color present in disease affected parameter area in image and all the description will be store with appropriate image with in the data base. This tends to construct “Multi Disease System” (back end). This tracks the number of the occurrence of the similar RGB colour code for the images. The type of the diseases is also tracked separately. The count values for this occurrence of the codes and the diseases corresponding to those images are also mined.

15. **SEARCHING AND VIEW DESCRIPTION OF DISEASE**

User can give any kind of medical related image input for disease identification. The area of the disease affected part is marked by x axis, y axis , height and width of the affected area. Many number of disease affected part can be given as the input for the disease identification. In this paper, we did to analyse the two disease affected areas. Then our system will accept the input and analysis the input image by generating the code values. We used “Navigation Pattern Mining” algorithm to classify the input image is which kind of classified image. We used naive Bayes classifier algorithm to classify the input image is which kind of classified image.

It founds out the how many similar occurrence of these RGB code are found out. After analyzing input image the description of medical image will be given to the user. The description of the disease is listed order wise. The priority is allocated to top relevant descriptions as proposed in the normal content based image retrieval techniques. Using our proposed system we achieve the high efficiency of multi disease identification from our medical images data base.
16. SYSTEM IMPLEMENTATION

This paper need NetBeans, Java, SQL server for implementation. The java coding got run in the platform of NetBeans. The data base connectivity is generated by means of JDBC- ODBC connectivity. This connection is made established with the SQL Server. The images are handled in the data base with their path and name of the image. The construction of the database is done by generating the RGB code values for each image. The images are the MRI scan report from the scan center. The images are mostly grey scale images. Each grey scaled images are diseases marked. In this paper, the images of brain are taken into account. The various types of disease like cancer, brain stroke, coma stage, meningitis, brain tumour, dementia etc. These diseased images are put in the database as their code values. The RGB code values are taken for each pixel. The generation of code depends upon the dimensions of each images. The most repeated code values in these images are tracked in these aspects. Hence, the number of their occurrence are also tracked in these aspects. The disease affected area are marked by getting the input of the x axis, y axis , height , width etc. The description and their diagnosis specification are also given. These values are also stored in the separate table.

INPUT :   Multi diseased image
OUTPUT :  Type of disease and description about the image

PSEUDO CODE :
1. Input the sample image to store in the dataset
2. Store the path of the image.
3. Compute the height and width of the image
4. For i=0 to height do
5.  For j=0 to width do
6.   Generate the RGB code for each pixel
7.   Insert the code in the training dataset
8.  End for
9. End for
10. Input the x axis, y axis, height, width of disease affected area
11. Update that area pixels as disease affected area in the training dataset
12. Track the number of occurrence of the pixels and store in the table
13. Input the multi diseased image
14. Input the x axis, y axis, height, width of disease affected area
15. For i=0 to height do
16.  For j=0 to width do
17.   Generate the RGB code for each pixel
18.  End for
19. End for
20. Count the number of occurrence for the disease affected area
21. While (count)
22.  Do
23.  Compare the occurrence with the dataset and identify the type of disease
24.  End while
25. Match the description and display the output

The doctors can give the multi diseased images as input to this system. First the RGB color code for this entire image is generated. Then the disease affected part is marked with the parameters of x axis, y axis, height, width. Now the disease affected part is alone tracked and compared with the number of occurrence of the RGB code in the data set as per in the Navigation Pattern Mining algorithm. Finally the output is disease description of the multi diseased images. The code values are compared to each RGB code stored in the dataset. It corresponds to dataset and find those occurrence. Finally the system matches with the those images corresponds to those images. The name of the disease and their corresponding description of those images are generated as the output. This is the view of our project “Multi disease analysis system “ which predicts the multiple diseases in analysing the single scan report. This provides full benefit in the medical field.

Fig 1: Multi disease analysis system
17. PERFORMANCE EVALUATION

The performance evaluation of this paper Multi disease analysis system depends upon the size of the input image. The processing speed of the project depends upon the size of sample images given to the system. The RGB color code is generated for every pixel with correspond to the x axis and y axis is generated. The processing time depends upon the generation of these code values.

The time taken for the generation of pixel values of image in the size of 100*100 dimensions is two seconds, and for the image in size of 200*200 dimensions is five seconds, and for the image in size of 500*500 dimensions is nine seconds. This is demonstrated in the following graph as shown below. The size of the images in terms of dimensions are taken in x axis and the time in terms of seconds are taken in y axis. The performance evaluation graph is drawn. The accuracy of the disease identification in this paper is examined in the following graph as shown as below,

Fig 3: Performance evaluation graph

18. CONCLUSION

Hence this paper has been implemented in the way to make benefit in the medical field. This application will surely give profit to the users especially the doctors for the identification of multiple diseases in analyzing the single scan report. The type of MRI scanned images will be easily converted into the format of .jpg file. The storage of images in the data base tends to be much easier and efficient.

19. FUTURE ENHANCEMENTS

The project so far implemented is only for the single part of the body, i.e for brain. All the possible disease affected in the brain can be stored in this paper. This paper can be enhanced in such a way that the diseased images of all the parts of the body say kidney, lungs, heart, can be stored, so that it can be able analyze the disease in all the parts of the body. It is important to consider the storage of all the images. The separate type of table should be stored for each type of parts in the body. This type of separate storage helps to make the searching process to be very efficient. The enhancement is also made to reduce the processing time. The processing time for the image depends upon the size of the project. Hence it can be reduced.

REFERENCES


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Audiokrypt: Application of Blowfish for Audio File Encryption

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ABSTRACT

Much as blogging has made journalism accessible to everyone, podcasting has introduced a more democratic form of radio broadcasting. A podcast is a digital audio file that resembles a radio talk show although not live. Podcasts are created with audio software and can be played on a computer or portable media player. This means that they can be accessible to anyone, anytime, anywhere. In cases where the contents are sensitive and confidential such as court exhibits, police interviews, criminal records, company’s business meeting recording, unpublished/exclusive interviews, such recordings need to be protected. The traditional login authentication and authorization to media servers is not enough to guarantee information security, because media streams in transit can still be sniffed. This means that the publisher of a podcast must ensure that only the genuine subscribers to a podcast get to playback these files correctly when they are downloaded. There is need therefore to secure these audio files and this can be achieved through cryptography. In this work, we successfully employed a traditional text cipher algorithm, blowfish, in the encryption of audio streams in a real-time scenario.

Keywords: Cryptography, Audio security, Blowfish algorithm, Podcast.

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

Cryptography is the study of techniques related to all aspects of data security [1] and it ensures: confidentiality, data integrity, entity authentication and data origin authentication. The purpose of cryptography is to render information unintelligible to all but the intended receiver. The sender enciphers a message into unintelligible form, and the receiver deciphers it into intelligible form. Cryptography is the enciphering and deciphering of messages into secret codes [2] by means of various transformations of the plaintext, while Cryptanalysis is the process of deriving the plaintext from the ciphertext, without being in possession of the key or the system. There are two processes involved in Cryptography: Encryption and Decryption and these can be respectively represented with the functions:

\[ y = f(x) \quad \text{and} \quad x = g(y) \]  \hspace{1cm} (1)

Where f(x) is the encryption function, x is the cleartext (or the text to be encrypted); y is the ciphertext (or the encrypted text); and g(y) is the decryption function that returns the ciphertext back to the original cleartext.

Cryptography algorithms generally come in two forms, symmetric and Asymmetric. Symmetric algorithms use the same key for both encryption and decryption [3] and this key must be kept secret from everyone except the sender and receiver of the message. However, Asymmetric key algorithms use two keys, one for encryption and another for decryption [4]. The key used for encryption, the “public key” need not be kept secret. The sender of the message uses that public key to encrypt their message, and the recipient uses their secret decryption key, or “private key”, to read it. In a sense, the public key “locks” the message, and the private key “unlocks” it: once encrypted with the public key, nobody except the holder of the private key can decrypt the message. There are several cryptography techniques which include: the Caesar substitution cipher, Monoalphabetic substitution, Polyalphabetic substitution (the Vigenere cipher), Transposition ciphers, the Wheatstone disc, Vernam cipher and blowfish algorithm [5, 6, 7, 8, 9].

2. BLOWFISH ALGORITHM

Blowfish algorithm was developed by Dr. Schneier in 1993 and was defined for static scenarios and primarily for text inputs [9]. It employs an encryption function known as the Feistel network, which iterates 16 times to produce the encrypted data. Figure 1 depicts how the blowfish algorithm works. Primarily, a 64 bit plain text which is an input to the algorithm is taken and divided into two 32 bits data and at each round the given key (another input to the algorithm) is expanded and stored in 18 p-array [10]. The function F in the diagram is to divide a 32-bit input into four bytes and uses those as indices into an S-array. The lookup results are then added and XORed together to produce the output. At 16th round, the output of this algorithm should be 64 bit cipher text.
Blowfish uses a block size of 64 bits (the chunk size of cleartext encrypted as a unit); the key can be any length up to 448 bits. Each $x$ and the corresponding $y$ from the functions $y = f(x)$ and $x = g(y)$ constitute a chunk.

This algorithm was studied and re-engineered to create a full-fledged audio encryption engine for the standard audio file formats covering a range of applications with emphasis on podcasts.

3. METHODOLOGY

The steps taken to achieve this work include:

1. Create a clear audio buffer from the ensuing audio stream (damming).
2. Iteratively read 64bit blocks (8 byte block needed by blowfish) from the buffer (framing).
3. Encrypt each frame in each iteration using blowfish.
4. Convert the encrypted frame into audio format and queue it up in a cipher audio buffer.
5. From the cipher audio buffer the transmission may then continue to a designated audio stream.

The public key encryption policy was applied. This allows only the genuine possessors of the designated key to listen to the actual content of the encrypted files. The Electronic Code Block (ECB) mode was also used. This is an operation mode for block ciphers, where each plaintext block is encrypted independently of other blocks so that errors in each block are not transferred to the next block [1]. The ensuing engine was called “AudioKrypt”.

Figure 1: The Blowfish algorithm
In Figure 2, framing refers to the process of aligning the contents of the clear audio buffer to the 64 bit chunk required for blowfish algorithm. This may involve padding of the buffer contents with zeros. Reversal of this action is what occurs in the reverse framing stage as shown in figure 2 also. For this work, we limited the audio file formats to WAVE, AU, and Audio Interchange File Format (AIFF) and thereby studied their various specification. In order to maintain the fluidity of the audio stream – in order words their playability, we decided not to encrypt the header information in each of the audio files. The encryption rather begins from the data section. This enables any audio player to be able to read off header information correctly even when the actual data is encrypted and so determine the format of the file and how to play it, thus being able to stream the data even though the sound is rubbish.

The header information for WAVE files occupies the first 44 bytes of the file [11]. For AU file, the header information occupies the first 28 bytes of the file and for AIFF files they occupy the first 124 bytes at least. Some implementations place this header information at the end of the file rather that at the beginning but our implementation adopts the method of having the header information at the beginning of the file so that in a network scenario, a player that is receiving the audio file from a remote server may already know the format of the file before even the file is fully downloaded. The encryption process starts with the initialization of the blowfish engine, using the BlowfishJ package [12, 13]. This initialization consists of the blowfish self test and the loading of the key into the blowfish engine. First, the file containing the key is opened and read from, the blowfish encryption object is constructed and then the strength of the key is tested.

The following line of code shows the construction of a blowfish ECB object.

```
BlowfishECB bfe = new BlowfishECB(key, 0, key.length);
```

The key is any sequence of bits with length anywhere from 32 bits to 448 bits.

After the initialization process, comes the actual encryption which involves creating the file input stream and file output stream. The file input stream is the source file from which we read the stream to be encrypted. The file output stream is where we store the stream after encryption. Next, we determine the format of the file so as to know the length of the header. We then read off the header from the file input stream and write it immediately to the output stream. After this, we read the rest of the data from the file input stream into a buffer defined to be the exact same size as the data to be read into it. The blowfish encryption is then run on this buffer; the stream in the buffer is encrypted and written back to the buffer. Finally we write the encrypted data from the buffer to the file output stream, appending it to the header information which we had previously written. The decryption process tows the same path more or less. We first carry out the initialization of the engine as done for the encryption process. Next we open the file input stream of interest (now encrypted). We determine the file format and use this information to read off the header information (which was never encrypted), placing it immediately to the destination stream. Next we read off the data section of the stream into a buffer and pass it to the blowfish decryption engine to be decrypted. Finally we write back the decrypted stream from the buffer to the file output stream.

Figure 2: A Graphical Model of the Application Design
4. AUDIOKRYPT IMPLEMENTATION

The implementation of the entire AudioKrypt application is in two distinct modules:

1. The **AudioKrypt Server** which in turn is subdivided into two as follows:
   a. **Audio Recorder** that provides users with the utilities to capture audio from microphone attached to the PC and save it in a selected audio format [14]
   b. **Encrypt Audio** interface which enables the users to encrypt audio files and store them in a specified folder.

2. The **AudioKrypt Client** which integrates the functions of a regular audio player with the encryption functionality, enabling the end user to leverage the capabilities of the AudioKrypt engine.

4.1 AudioKrypt Server

Figure 2a, b & c are snapshots of some of the interfaces of AudioKrypt server. They enable the user to record audio in any of WAVE, AU or AIFF format. When the audio file has been successfully recorded and saved the user is notified of the status. It is typical for users to save audio files in the default audio server if they have one available.

![Figure 2a](image1.png)
![Figure 2b](image2.png)
![Figure 2c](image3.png)

Figure 2: (a) this window allows a user to select the format of choice for recording the audio file from the format drop down list (b) this window shows the selection of a path and a name for the audio to be recorded (c) The audio recorder interface showing the successful status. When the audio file has been successfully created, the Encrypt Audio tab allows the user to select a previously recorded audio file for encryption. This is referred to as the Target Audio File. The path and name to which to save the encrypted audio – this is called the Destination Audio File. In the Destination Audio File, a name is created for the encrypted version, and the file containing the symmetric key employed in the encryption process. The key is unique to each encrypted file as the same key is used to decrypt the file. The selection of the key is very important because it is only by the use of the key that the encrypted version can be transformed back into its intelligible form. Without the key, the encryption will take place but the encrypted file becomes useless as there will be no key to decrypt it back into its original form. Note that key.txt is the text document containing the key needed. See figure 3.
From the figure 3 above, the name ‘decompose’ is chosen for the encrypted version of the audio file. This is the unintelligible version of the recorded audio file. Having clicked the encrypt button, the AudioKrypt engine attempts the encryption using the supplied parameters.

4.2 AudioKrypt Client
The client side of this application is the customer end, a media player that incorporates our solution of blowfish audio encryption. We call this the AudioKrypt client. It shows a list of files automatically loaded from the audio server or any chosen location on a PC.

The AudioKrypt client embodies a set of controls used to control the “Play”, “Pause” and “Stop” activities respectively of the audio file. It also has a timer set for counting up during playback. The ‘key’ button enables the client to browse for the key for the selected encrypted audio file. This key is then loaded into the application and used to decrypt the audio file. The audio file is deciphered only when the loaded key matches the key with which the encrypted file was ciphered on the server side – because blowfish is a symmetric key cipher.

It is important to note here that although the client downloads the file in question, it is actually unintelligible without the right key file. We have the option of deleting the file once the playback finishes or leaving it still unencrypted henceforth after the playback.
5. CONCLUSION

In this work we have implemented a basic model for audio encryption using the Blowfish algorithm. The model is for an on-demand delivery system of audio files with digital and contract rights agreement. This was implemented using the Java technology. Specifically we employed the BlowfishJ package and the Java Sound API towards the realization of our model. The final solution is in two parts: a server side where the audio files are recorded and encrypted and a client side where the contract right agreement is enforced. The agreement is informed of “no key, no access”. Thus we have realized a working and practical system for a real-time application.

Success of the methodology lies in being able to correctly encrypt the audio files, not in such a way as to destroy the audio file, making it incapable of being played back by any media player, but in altering the sound beyond intelligibility of the sound albeit retaining the internal sound file structure. Thus the audio file can still be played, but it is useless or meaningless. AudioKrypt provides audio encryption using traditional text-based encryption schemes. Since the Blowfish algorithm has so far defied cryptanalysis as we have been able to extend its functions to encrypt audio file and not only text, it has become possible to introduce the strength of this algorithm into the scenario of audio applications especially for on-demand, over the network, access.

The performance of the AudioKrypt engine is exactly the same for the new audio inputs as for text inputs. The reason for this is that our model compels the blowfish engine to handle the audio material as text with minimal overhead. Additionally, the AudioKrypt application requires no rigorous installations as it runs on the Java platform. This also makes it very portable across several network and server platforms, making it ideal for real internet applications.

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Invoking .asm Codes In Object Oriented Programming Platform for Embedded Systems

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ABSTRACT

Presently, most programmers are scared about writing the cumbersome assembly codes for device independent systems (embedded systems). This article explains the techniques of inline Assembly language programming by linking or invoking the Central Processing Unit-dependent Native Assembly 32-bit code or 64-bit code to any object oriented programming platform of all the .NET framework. It also explains how non assembly language programmers can easily manipulate high level language codes to match assembly language mnemonics. Normally, the .NET framework doesn’t support assembly code execution explicitly via their compilers. With the help of this proposed inline assembler, object oriented programmers can easily integrate any C#, VB or C++ methods in its scope due to its convenient nature.

Keywords: Object oriented programming, device independent systems, .asm, dynamic link library

1. INTRODUCTION

Despite the complicated nature of this process, it will be useful in some scenarios where faster optimized code matters, because a larger calculation must be completed fast and C++ or C# code are relatively slow to process a complicated algorithm. Apart from program improvement, inline Assembly code will also assists to control hardware (device independent systems or embedded systems) and reduce memory leaks in a better way rather than .NET languages. At the end of this research, we will be able to demonstrate assembly code invoking into a genuine C# code by presenting a graphics user interface (GUI) application which renders some math and central processing unit (CPU) information gathering functionality by calling an ASM code library [1][2]

The example scenario we will illustrate in this article requires comprehensive working experience for manipulating both managed and unmanaged DLL (dynamic link library), and moreover the knowledge of MASM (micro Assembler) programming code syntax is very important because the DLL is going to contain methods definitions in the form of Assembly language. Our workstation must be configured with these software:

- Visual C++
- Visual C#.NET
- MASM (optional)

2. LITERATURE REVIEW

2.1 Assembly language

An assembly language (or assembler language) is a low-level programming language for a computer, or other programmable device, in which there is a very strong (generally one-to-one) correspondence between the language and the architecture's machine code instructions [4]. Each assembly language code is specific to a particular computer architecture, in contrast to most high-level programming languages, which are generally portable across multiple architectures, but require interpreting or compiling. Assembly language is converted into executable machine code by a utility program referred to as an assembler; the conversion process is referred to as assembly, or assembling the code.

Assembly language uses a mnemonic to represent each low-level machine instruction or operation. Typical operations require one or more operands in order to form a complete instruction, and most assemblers can therefore take labels, symbols and expressions as operands to represent addresses and other constants, freeing the programmer from tedious manual calculations. According to Armstrong,[1], Macro assemblers include a macroinstruction facility so that (parameterized) assembly language text can be represented by a name, and that name can be used to insert the expanded text into other code.
Many assemblers offer additional mechanisms to facilitate program development, to control the assembly process, and to aid debugging.

2.2 Object-oriented programming
Object-oriented programming (OOP) is a programming paradigm based on the concept of "objects", which are data structures that contain data, in the form of fields, often known as attributes; and code, in the form of procedures, often known as methods. Krüger [6]. A distinguishing feature of objects is that an object's procedures can access and often modify the data fields of the object with which they are associated. According to Meyer [7] in Object-oriented programming computer programs are designed by making them out of objects that interact with one another. There is significant diversity in object-oriented programming, but most popular languages are class-based, meaning that objects are instances of classes, which typically also determines their type.

Many of the most widely used programming languages are multi-paradigm programming languages that support object-oriented programming to a greater or lesser degree, typically in combination with imperative procedural programming. Significant object-oriented languages include Python, C++, Objective-C, Smalltalk, Delphi, Java, Swift, C#, Perl, Ruby and PHP.

2.3 Embedded system
An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints [5] [9]. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today. Example is the programmable speed control system in figure 1.

Fig.1 programmable speed control system
(Ezekwe et al, 2013)

Properties of embedded computers compared with general-purpose ones are low power consumption, small size, rugged operating ranges and low per-unit cost. Modern embedded systems are often based on microcontrollers (i.e. CPUs with integrated memory or peripheral interfaces) but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also still common, especially in more complex systems. In either case, the processor(s) used may be types ranging from general purpose to those specialized in certain class of computations or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced and this makes them to benefit from economies of scale. Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, and largely complex systems like hybrid vehicles, and avionics. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

2.4 Dynamic-link library
According to Petrusha [8], Dynamic-link library or DLL, is Microsoft's implementation of the shared library concept in the Microsoft Windows and OS/2 operating systems. These libraries usually have the file extension DLL, OCX (for libraries containing ActiveX controls), or DRV (for legacy system drivers). The file formats for DLLs are the same as for Windows EXE files – that is, Portable Executable (PE) for 32-bit and 64-bit Windows, and New Executable (NE) for 16-bit Windows. As with EXEs, DLLs can contain code, data, and resources, in any combination. Data files with the same file format as a DLL, but with different file extensions and possibly containing only resource sections, can be called resource DLLs. Examples of such DLLs include icon libraries, sometimes having the extension ICL, and font files, having the extensions PON and FOT.
2.4.1 Features of DLL

1) The following are the features of DLL files by Petrusia, 2005
   - Since DLL files are essentially the same as EXE files, the choice of which to produce as part of the linking process is for clarity, since it is possible to export functions and data from either.
   - It is not possible to directly execute a DLL, since it requires an EXE for the operating system to load it through an entry point, hence the existence of utilities like RUNDLL.EXE or RUNDLL32.EXE which provide the entry point and minimal framework for DLLs that contain enough functionality to execute without much support.
   - DLLs provide a mechanism for shared code and data, allowing a developer of shared code/data to upgrade functionality without requiring applications to be re-linked or re-compiled. From the application development point of view Windows and OS/2 can be thought of as a collection of DLLs that are upgraded, allowing applications for one version of the OS to work in a later one, provided that the OS vendor has ensured that the interfaces and functionality are compatible.

DLLs execute in the memory space of the calling process and with the same access permissions which means there is little overhead in their use but also that there is no protection for the calling EXE if the DLL has any sort of bug.

2.4.2 Functions of DLL

Memory management

In Windows API, the DLL files are organized into sections. Each section has its own set of attributes, such as being writable or read-only, executable (for code) or non-executable (for data), and so on. The code in a DLL is usually shared among all the processes that use the DLL; that is, they occupy a single place in physical memory, and do not take up space in the page file. If the physical memory occupied by a code section is to be reclaimed, its contents are discarded, and later reloaded directly from the DLL file as necessary.

In contrast to code sections, the data sections of a DLL are usually private; that is, each process using the DLL has its own copy of all the DLL’s data. Optionally, data sections can be made shared, allowing inter-process communication via this shared memory area. However, because user restrictions do not apply to the use of shared DLL memory, this creates a security hole; namely, one process can corrupt the shared data, which will likely cause all other sharing processes to behave undesirably. For example, a process running under a guest account can in this way corrupt another process running under a privileged account. This is an important reason to avoid the use of shared sections in DLLs.

Import libraries

Like static libraries, import libraries for DLLs are noted by the .lib file extension. For example, kernel32.dll, the primary dynamic library for Windows' base functions such as file creation and memory management, is linked via kernel32.lib. Linking to dynamic libraries is usually handled by linking to an import library when building or linking to create an executable file. The created executable then contains an import address table (IAT) by which all DLL function calls are referenced (each referenced DLL function contains its own entry in the IAT). At run-time, the IAT is filled with appropriate addresses that point directly to a function in the separately loaded DLL.

Symbol resolution and binding

Each function exported by a DLL is identified by a numeric ordinal and optionally a name. Likewise, functions can be imported from a DLL either by ordinal or by name. The ordinal represents the position of the function's address pointer in the DLL Export Address table. It is common for internal functions to be exported by ordinal only. For most Windows API functions only the names are preserved across different Windows releases; the ordinals are subject to change. Thus, one cannot reliably import Windows API functions by their ordinals. Importing functions by ordinal provides only slightly better performance than importing them by name: export tables of DLLs are ordered by name, so a binary search can be used to find a function. The index of the found name is then used to look up the ordinal in the Export Ordinal table. In 16-bit Windows, the name table was not sorted, so the name lookup overhead was much more noticeable.

Explicit run-time linking

DLL files may be explicitly loaded at run-time, a process referred to simply as run-time dynamic linking by Microsoft, by using the LoadLibrary (or LoadLibraryEx) API function. The GetProcAddress API function is used to find and load the DLL through LoadLibrary and FreeLibrary – to unload the DLL. These functions are analogous to dlopen, dlsym, and dlclose in the POSIX standard API.

Delayed loading

Normally, an application that was linked against a DLL’s import library will fail to start if the DLL cannot be found, because Windows will not run the application unless it can find all of the DLLs that the application may need. However an application may be linked against an import library to allow delayed loading of the dynamic library. In this case the operating system will not try to find or load the DLL when the application starts; instead, a stub is included in the application by the linker which will try to find and load the DLL through LoadLibrary and GetProcAddress when one of its functions is called.
If the DLL cannot be found or loaded, or the called function does not exist, the application will generate an exception, which may be caught and handled appropriately. If the application does not handle the exception, it will be caught by the operating system, which will terminate the program with an error message. The delay-loading mechanism also provides notification hooks, allowing the application to perform additional processing or error handling when the DLL is loaded and/or any DLL function is called.

2.4.3 Compiler and language considerations

Microsoft Visual Basic

In Visual Basic (VB), only run-time linking is supported; but in addition to using LoadLibrary and GetProcAddress API functions, declarations of imported functions are allowed. When importing DLL functions through declarations, VB will generate a run-time error if the DLL file cannot be found. The developer can catch the error and handle it appropriately. When creating DLLs in VB, the IDE will only allow you to create ActiveX DLLs, however methods have been created to allow the user to explicitly tell the linker to include a .DEF file which defines the ordinal position and name of each exported function. This allows the user to create a standard Windows DLL using Visual Basic (Version 6 or lower) which can be referenced through a "Declare" statement.

C and C++

Microsoft Visual C++ (MSVC) provides several extensions to standard C++ which allow functions to be specified as imported or exported directly in the C++ code; these have been adopted by other Windows C and C++ compilers, including Windows versions of GCC. These extensions use the attribute __declspec before a function declaration. Note that when C functions are accessed from C++, they must also be declared as extern "C" in C++ code, to inform the compiler that the C linkage should be used.

Besides specifying imported or exported functions usingdeclspec attributes, they may be listed in IMPORT or EXPORTS section of the DEF file used by the project. The DEF file is processed by the linker, rather than the compiler, and thus it is not specific to C++. DLL compilation will produce both DLL and LIB files. The LIB file is used to link against a DLL at compile-time; it is not necessary for run-time linking. Unless your DLL is a Component Object Model (COM) server, the DLL file must be placed in one of the directories listed in the PATH environment variable, in the default system directory, or in the same directory as the program using it. COM server DLLs are registered using regsvr32.exe, which places the DLL's location and its globally unique ID (GUID) in the registry. Programs can then use the DLL by looking up its GUID in the registry to find its location.

3. METHODOLOGY

Invoking hard core Assembly code into managed .NET code is a rather complicated task because CLR typically doesn’t execute ASM instructions. But as we know, C# can consume the methods of an unmanaged code which could be located in any VC++ or C++ DLL and more interestingly, C++ or VC++ can execute or integrate Assembly code. So here is the technic, VC++ can become a mediator between Assembly code and C#.NET source code, and we can invoke the ASM code into C# code indirectly. However, we will first write some functionality for specific operations in the form of Assembly code and export them by marking _declspec in VC++ code, which produces an unmanaged DLL library which has the definitions for all methods. Finally, we will import these methods into a C#.NET code file to consume the in-built methods into the DLL as described in figure 2.
4. ACTIVITIES OF SYSTEM DESIGN

4.1 Inline ASM Code

Here, we are integrating the Assembly code routine which later will be called in the C#.NET program. This mechanism is performing some typical mathematical operations as well as calculating the CPU accuracy by writing logic in ASM code. This section illustrates the process of exporting the ASM code to Win32 VC++ via DLL which has inline Assembly code as in figure 3. Now let’s come to one of the routines which can do simple arithmetic operations (addition, subtraction, division and multiplication) with two integers through Assembly code. 

This article doesn’t intend to teach Assembly programming but to show how assembly codes made to run in MASM MIDEs for particular processor or controller can still work in high level language platform.

Assuming that integer one = a, Integer two = b, Result = z.

Therefore, z = a+b, z = a-b, z = a/b, z

Assuming that we are programming for intel 8088, the assembly language codes for adding the two integers will be;

Mov ax, 0000h; initialize the accumulator
Mov ax, a; move a into the accumulator
Add ax, b; add b to the content of the accumulator
Mov z, ax; move the content of the accumulator to z
End

For subtraction;

Mov ax, 0000h; initialize the accumulator
Mov ax, a; move a into the accumulator
Sub ax, b; subtract b to the content of the accumulator
Mov z, ax; move the content of the accumulator to z
End

For multiplication;

Mov ax, 0000h; initialize the accumulator
Mov ax, a; move a into the accumulator
Imul b; multiple b with the content of the accumulator
Mov z, ax; move the content of the accumulator to z
End

For division;

Mov ax, 0000h; initialize the accumulator
Mov ax, a; move a into the accumulator
Idiv b; divide b with the content of the accumulator
Mov z, ax; move the content of the accumulator to z
End

Just place simple opcodes for simple arithmetic operations for two numbers and store results into an integer type variable through _asm block, which invokes the inline assembler and can appear in C or C++ statement anywhere as follows:

Once we are done with the coding for all routines, we will debug the program. But before this, it is mandatory to perform some slight configuration. Since it is a DLL file, it doesn’t have an entry point so we have to tell the compiler manually that it’s a library project as in figure 3.

The second important setting is that all VC++ DLL will be recompiled with the /clr option by default by choosing “no common language runtime support”, which can cause a loader lock issue and deadlock situation to occur non-deterministically. The loader lock MDA typically identifies efforts to execute managed code on a thread that holds the Microsoft OS loader lock, and utilizing DLL before its initialization by OS is illegitimate and could lead to a deadlock situation. If this option is enabled, our DLL is compiled successfully.
Finally, after compilation of the project and the file AsmCodeLib.dll (unmanaged DLL) is created in the solution Debug folder, which will be referenced in the C#.NET GUI application, invoking process sets in.

4.2 Invoking ASM Code
After the creation of the unmanaged DLL file, asmcode.lib.dll is finally done by inline assembly coding with VC++. This library contains routine definitions to perform operations which will be exported to C# Windows application. The next design activity is the invoking of the dll file through DOS platform using Dumpbin.exe utility as in figure 4, which enumerate the routine and other metadata:

Figure 3. the process (inline assembling) of choosing DLL in visual C++
When this file is through the invoking process in the dumpbin.exe utility, it is ready to be added into C# reference as dllimport “asncodelib.dll” as in figure 2. At this point the file becomes managed file that can be handled by visual C#. After making the entry for each DLL method in the DllImport attribute in the C# file, invoke each corresponding routine related to the math operation and processor type by calling the method name directly and storing the return value on the designated Windows form text box as shown in figure 5.

4.3 Result

When each routine for each arithmetic operation is in place run the project and a Windows form in C# will automatically appear as shown in figure 5, in which two sections will be highlighted, one for performing math operation and other is for retrieving CPU information. We entered any two integer type values (200 and 25) and performed any operation such as addition, division, subtraction and multiplication; the result appeared in a textbox. In the other section of the form, we can obtain significant information about CPU such as speed, type, family and model by hitting the Retrieve button.
5. CONCLUSION

In the course of this research, we have discovered a special mechanism in which we can invoke the Assembly code into the C# source code file even if it is not supported by CLR without writing codes in C# code window. We have used Win32 VC++ DLL, which has inline definitions for Assembly code because VC++ supports or can execute ASM code, unlike .NET code to produce unmanaged DLL file named AsmCodeLib.dll. The unmanaged dll file was converted to dllimport “asmcodelib.dll” via the Dumpbin.exe utility. When the project was run from VC++ DLL, we successfully achieved running of .asm codes in Object Oriented program platform. Second achievement of this research is the automatic creation of C# design form and the implementation platform with the controls in the proper position without writing any C# code. So VC++ bridges the gap between Assembly language codes and C# codes.NET to achieve this functionality.

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A Hybrid Cryptosystem Using Elgamal Algorithm and Matrix Encryption

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ABSTRACT

The increasing use of electronic means in data communication from one point to another, coupled with the growth of networking comes with a corresponding increase in vulnerability of privacy. Modern cryptography entails the study of mathematical techniques of encryption and decryption to solve security problems in communication. This research work harnessed the advantage of speed of implementation in a secret cryptosystem and the component advantage that allows strangers to exchange messages in a public key cryptosystem, thereby forming a suitable hybrid cryptosystem which guarantees a secure communication between communicating parties. This is achieved by integrating the Elgamal public key algorithm and matrix encryption technique to achieve the hybrid cryptosystem. This hybrid cryptosystem combines advantages of ‘speed of implementation’ over typical public key cryptosystems, as well as the advantage of ‘secure key distribution’ over typical secret key cryptosystems. A network bandwidth analysis showed the practical limitation of the typical Elgamal algorithm as a public key encryption scheme. The hybrid cryptosystem provides an alternative to this limitation as it utilizes its matrix encryption component to step down to a secret key scheme after the first contact of intending users, thereby showing a superior advantage over typical implementation of the Elgamal and matrix encryption schemes as separate entities.

Keywords – Encryption; decryption; key, Network; bandwidth.

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1. INTRODUCTION

More than ever before, people are connected in one way or the other, such that even the entire world has become a single community. The increasing use of electronic means in data communication from one point to another, coupled with the growth of networking comes with a corresponding increase in vulnerability of privacy for the communicating persons [Goshwe, 2013]. A principal goal of cryptography is to allow two people to exchange confidential information, via a channel that is being monitored by an adversary [Adewumi and Garba, 2003]. A typical example of such insecure environments that may require the technique of cryptography to guarantee privacy is the well-known internet.

Although the use of cryptographic systems (cryptosystems) in achieving communication security has been in existence, the two broad categories of cryptographic systems viz: secret key cryptography (SKC) and public key cryptography (PKC) have evolved along with their limitations in the implementation front, viz ‘secure key distribution’ and ‘speed of implementation’ respectively [Goldreich, 2004]. This paper presents a method which harnessed the advantage of speed of implementation in a secret cryptosystem and the component advantage that allows strangers to exchange messages in a public key cryptosystem, thereby forming a suitable hybrid cryptosystem which guarantees a secure communication between strangers and yet makes up for the respective limitations stated above.
2. METHODOLOGY

According to [Hoffstein et al, 2008], Cryptographic methods are aimed at applying an encryption scheme by a message sender to a plaintext to transform it into a ciphertext before sending, and the reverse process of applying a decryption scheme by the receiver to the ciphertext in order to recover the original plaintext as illustrated in the figure below:

![Figure 1: Schematic illustration of a Cryptosystem showing Encryption and Decryption in an unsecure channel.](image)

For the purpose of this paper, we considered the methods of matrix encryption from the family of secret key cryptosystems, the Elgamal algorithm from the family of public key cryptosystems to form a hybrid method that is made of the combination of Elgamal algorithm and matrix encryption [Yan, 2013]. Also, taking into cognizance, the fact that these three methods require that the message to be encrypted is converted into an integer before it is made suitable for the mathematical operations embedded in these algorithms, we hereby consider the first twenty six English alphabets, the number digits from zero through nine, and some characters which we deem as most frequently use (our arbitrary choice) to form a character to numeric value transformation figure as shown below:

2.1. The Elgamal Algorithm

According to (Yan, 2013), The Elgamal public key cryptosystem can be described as follows:

1. A prime $q$ and a generator $g \in \mathbb{F}_q$ is made public.
2. BOB chooses a private key at random $a \in \{1, 2, ..., q - 1\}$
   This $a$ is the private decryption key. The public encryption key is,
   $$[g^a, g^a \mod q]$$
3. Suppose now that ALICE wishes to send a message to BOB, he chooses a random number $b \in \{1, 2, ..., q - 1\}$ and sends to BOB the following pair of elements of $\mathbb{F}_q$:
   $$g^b, M g^{ab}$$
   where $M$ is the message.
4. Since BOB knows the private decryption key $a$, he can recover $M$ from this pair by computing $$M \equiv (g^b)^{a^{-1}} (\mod q)$$
   and divides this result into the second element. That is,
   $$M \equiv (g^b)^{(a^{-1})} (\mod q)$$

The mathematical basis for the security of the Elgamal public key cryptosystem is rooted in the discrete logarithm problem of finding the private key $a$, by solving the DLP:

$$a \equiv \log_g x (\mod q - 1),$$

such that

$$x \equiv g^a (\mod q).$$

Anyone who can solve the discrete logarithm problem in $\mathbb{F}_q$ breaks the cryptosystem by finding the secret decryption key $g^a$ [Yan, 2013]. In theory, there could be a way to use knowledge of $g^a$ and $g^b$ to find $g^{ab}$ and hence break the cipher without solving the discrete logarithm problem, but there is no known way to go from $g^a$ and $g^b$ to $g^{ab}$ without essentially solving the discrete logarithm problem and hence, the security basis of the Elgamal public-key cryptosystem.
2.2. Matrix Encryption

According to [Yan, 2013], the matrix encryption method utilizes the block enciphering method to achieve the process of encryption. The block enciphering method suggests that the plaintext to be encrypted be broken into groups of letters, and performing the encryption and decryption on the blocks of letters, as compared to other monographic methods where the encryption is done on the single letters of the plaintext. This principle of splitting the plaintext into groups before performing encryption is called block ciphering [Stallings, 2005]. The matrix encryption is a process of performing an encryption on each of these blocks (groups of letters) using any arbitrarily chosen matrix.

We carry out this process using the procedure outlined below:

(i) Split the message M into blocks of n-letters, say $M_1, M_2, ..., M_j$, each block $M_i$, for $1 \leq i \leq j$, is a block consisting of n letters.

(ii) Translate the letters into their numerical equivalents and form the cipher-text:

$$C_i = (C_{i1}, C_{i2}, ..., C_{in})^T$$

$$M_i = M_{i1}, M_{i2}, ..., M_{in}$$

Using matrix encryption, we shall consider an arbitrary matrix $A$, and perform $C_i = AM_i (mod 52)$ as the encryption algorithm. To decrypt the message, we use the decryption function: $M_i = A^{-1}C_i (mod 52)$, where $A^{-1}$ is the inverse of the arbitrarily chosen encryption matrix $-A$. We shall consider $-A$ the decryption function:

$$M_i = A^{-1}C_i (mod 52)$$

2.3. The Hybrid Cryptosystem

In this section, we put up an encryption algorithm that combines the Elgamal public-key cryptosystem and the matrix encryption. This hybrid cryptosystem combines advantages of 'speed of implementation' over typical public key cryptosystems, as well as the advantage of 'secure key distribution' over typical secret key cryptosystems. The Algorithm is given below:

Algorithm 1: Mathematical Description of the Hybrid Cryptosystem

1. An arbitrary prime $p$ and a generator $g \in \mathbb{F}_p^*$ are first published.

2. BOB chooses a private key at random: $a \in \{1, 2, ..., p - 1\}$. This $a$ is the private decryption key. The public encryption key is $(g, p, g^a mod p)$

3. Suppose now that ALICE wishes to send a message to BOB, she chooses a random number $b \in \{1, 2, ..., p - 1\}$ and sends to BOB the following pair of elements:

$$g^b, Mg^a$$

where $M$ is precisely the matrix encryption formla:

$$E = AM, D = INV(A)C$$

4. Since BOB knows the private decryption key $a$, he can recover M from this pair by computing:

$$M = Mg^a / (g^b)^a (mod p)$$

5. Having recovered $M$ ($E = AM, D = INV(A)C$), ALICE and BOB can now proceed to exchange messages using the algorithm described in $M$ as follows:

6. Split the message $M$ into blocks of $n$-letters, say $M_1, M_2, ..., M_j$; each block $M_i$ for $1 \leq i \leq j$, is a block consisting of $n$ letters.

7. Translate the letters into their numerical equivalents and perform the Encryption:

$$C_i = AM_i (mod 52), i = 1, 2, ..., j$$

$A$ is the key, and is an invertible $n \times n$ matrix.

8. Decrypt encrypted messages by performing the reverse operation:

$$M_i = A^{-1}C_i (mod 52)$$

where $A^{-1}$ is the inverse of the arbitrarily chosen encryption matrix $-A$. 
Example

Given that \( p = 14197 \) and \( g = 137 \). The following operation is an example of the communication between ALICE and BOB using the mathematical algorithm of the hybrid cryptosystem:

- Suppose BOB chooses \( a \in \{1,2,\ldots,p-1\} \). This \( a \) is the private decryption key. The public encryption key is \( \{g^a \mod p\} \).

Take \( a = 5 \), the Bob’s message to Alice is:

\[
2550 = 137^{14197} \mod 14197 = \frac{163659045491434123011}{1696^{14197}} = 597113404879142213
\]

Cryptanalysis on 2550 without the knowledge of \( a = 5 \) is as follows:

\[
\alpha = \log_{137}(2550) \mod (p-1), \text{ such that } \alpha = 16865426302211 \mod (14197-1) = 2550 = M^a \mod (14197)
\]

- Suppose ALICE chooses \( b \in \{1,2,\ldots,p-1\} \).

And sends

\[
M = M^{b^a \mod p} \mod p = 597113404879142213
\]

Upon receiving Alice’s message, BOB recovers \( M \) by computing

\[
M = M^{\alpha^b \mod p} \mod p = 597113404879142213
\]

With \( M \) being successfully exchanged, Alice and BOB can exchange encrypted messages using the knowledge of \( M \), which is now the secret key component of the hybrid cryptosystem.

3. RESULTS AND DISCUSSION

We used the C# programming language to code the hybrid cryptosystem and we tested it on a campus area network (CAM) of the University of Agriculture Makurdi which follows a hierarchical design topology and runs on a network bandwidth of 45mbps (megabits per seconds) uplink and downlink as at the time this test was conducted.

Figure 3: Capture of the bandwidth manager before commencement of public key exchange.
Alice makes a choice of a private decryption key which is kept secret, and computes and sends her first message to Bob, using the knowledge of the known published prime number for the public key procedure:

![Figure 4: Capture of Alice’s choice of a secret decryption key and the first computed message to Bob.](image1)

In a similar fashion, Bob makes a choice of a private decryption key which is kept secret, and computes and replies Alice’s message, using the knowledge of the known published prime number for the public key procedure:

![Figure 5: Capture of Bob’s choice of a secret key together with the message reply to Alice.](image2)

Upon receiving Bob’s reply, Alice clicks the ‘decrypt Bob’s reply’ to get the message which is the key to be used for the secret Key cryptosystem, -a component of the hybrid cryptosystem that utilizes matrix encryption for message encryption and decryption.

![Figure 6. Capture of the message reply from Bob to Alice.](image3)

![Figure 7: Capture of Alice’s decryption of Bob’s Public key message.](image4)
Figure 8: Capture of the bandwidth manager at the completion of public key message exchange.

The table below shows a measure of the change in network speed before the commencement of the public key exchange procedure and after the completion of the key exchange procedure. We notice a speed drop of about 6mbps. This is exposes the practical implementation challenge with typical public key schemes.

Table 1: Table Showing the Change in Network Link Speed during Public Key Exchange.

<table>
<thead>
<tr>
<th>Change in the link Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1mbps</td>
</tr>
</tbody>
</table>

Source – [Field Survey]

Secret Key cryptosystem established after a successful exchange of the secret key using the public key procedure. Subsequent exchanges of messages using the cryptosystem now uses this established secret key system, which depends on very little or no bandwidth resources as compared to typical public key schemes.

Figure 9: Capture of the established Secret-key Cryptosystem after a successful key exchange message.
Messages are either typed or copied and pasted into the message field of the established secret key system and clicking the ‘encrypt’ button executes the secret key component of the hybrid cryptosystem.

![Figure 10. Capture of the secret key cryptosystem with a sample plaintext for encryption.](image)

Figure 10: Capture of the secret key cryptosystem with a sample plaintext and the corresponding encrypted ciphertext.

Clicking the ‘decrypt’ button upon receiving and encrypted message recovers the original message (plaintext):

![Figure 12. Capture of the secret key cryptosystem showing the decrypted message from the ciphertext.](image)

Figure 12. Capture of the secret key cryptosystem showing the decrypted message from the ciphertext.

Cryptanalysis of the hybrid cryptosystem first poses the challenge of solving the discrete logarithm problem during the public key exchange procedure:

\[ a \equiv \log_{2} x \pmod{q-1}, \]

such that

\[ x \equiv 2^a \pmod{q}, \]

followed by computing:

\[ M_1 = A^{-1}C_1 \pmod{N = 52}. \]

where \( A^{-1} \) is the inverse of the arbitrarily chosen encryption matrix –A.
3.2 Analysis of Implementation Speed for the Hybrid Cryptosystem

We begin this analysis with reference to Table 1 (showing the change in network link speed during public key exchange). It is note-worthy that because the public-key process of this hybrid cryptosystem depends largely on network factors (such as bandwidth and throughput) other than just the computing power of the local host, we observed the link speed before the commencement of the exchange of key, as well as the link speed at the completion of the exchange of keys.

This is critical because the Elgamal public key component of the hybrid cryptosystem which guarantees a secure contact between intended users who may not have met before requires a network resource to ride on. Consequently, a fast and reliable network link only translates to speed and guarantee respectively, of a successful completion of the key exchange process, and hence, the relative speed of the hybrid cryptosystem. Figure 3 (capture of the bandwidth manager before commencement of public key exchange) shows this link speed on ether1_skanet to be 32.4mbps (megabits per second).

Figure 8 (Capture of the bandwidth manager at the completion of public key message exchange) shows the link speed on the same ether1_skanet to be 26.3mbps (megabits per second). Column three of Table 1 shows the change in the link speed to be 6.1mbps (megabits per second). Like many other typical implementations of public key cryptosystems, the Elgamal algorithm known to have the challenge of slow implementation. However, the stepping down to matrix encryption (by design) of this hybrid cryptosystem limits the challenge to only the first contact of communicating parties, after which subsequent encryptions and decryptions of messages are handled by the matrix encryption component of the hybrid cryptosystem shown in Figure 9 (Capture of the established Secret-key Cryptosystem after a successful key exchange message) and hence, showing the unifying advantage of the hybrid cryptosystem.

4. CONCLUSION

In this paper, a hybrid cryptosystem was presented. It was successfully implemented and tested on a campus area network, with which message encryption and decryption can be achieved. An attacker who intercepts a message for malicious reasons is faced with the challenge of solving a discrete logarithm problem together with accompanying function to find meaning to the message. This cryptosystem - which combines the advantages of ‘secure key distribution’ and ‘speed of implementation’, guarantees secure exchange of messages (like emails, and text messages) in insecure network environments like the internet or intranets which has become a part of our daily routine, and therefore provides a viable option to maintaining communication privacy even in insecure communication environments.

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An Analytical Study of Various Ad-hoc Network Routing Protocols Under Certain Parameters using Qualnet-7.1

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ABSTRACT

The Ad hoc network is the different kind of mobile wireless network where a set of mobile nodes form an impermanent network without using any backbone such as base station or infrastructure. However, numbers of routing protocols are there for the ad-hoc network environment, but it is not an easy task to decide which one routing protocol is efficiently best for particular situations. This paper attempts to identify the best routing protocols based on some Quality of Service (QoS) metrics. Here, the research article is subjected to the three different on-demand routing protocols (DYMO, AODV, and DSR) and two different Zone Routing Protocols (IARP, and IERP) with IEEE 802.11 MAC layer protocol in Random Way Point Mobility Model and 50 numbers of fixed nodes. These five different routing protocols have been analysed and their performances are compared in this paper. The comparative performance evaluation has been done with the help of performance measuring metrics such as jitter, average end-to-end delay, throughput and packet delivery ratio (pdr) by using MAC and physical layer model. The simulation has been performed for the number of times with different values of pause time such as 0, 20, 40, 60, 80, and 100 seconds for all taken routing protocols. Experimental results have been carried out by using simulation tool QualNet (version-7.1). Further, the excel sheet has been used for preparing the graphs from the collected data for different metrics.

Keywords- Ad-hoc network, IERP, IARP, AODV, DSR, DYMO, QualNet-7.1, PDR, MANET.

1. INTRODUCTION

The presented research work is based on the performance comparison of five routing protocols, out of which four are reactive or on-demand in nature and remaining one is IARP which is a proactive nature. Similar work has been accomplished with another set of routing protocols. The performance evaluation and comparison between DYMO, AODV, and DSR has already been done using QualNet (version 7.1) network simulator. Normally AODV performs better than other routing protocols, although DYMO also performs satisfactorily in terms of throughput and PDR performance metrics. For the performance metrics such as jitter and end-to-end delay IARP gives better than all remaining protocols, although AODV and DYMO also perform satisfactorily for jitter and end-to-end delay. The paper compares the various routing protocols with varying pause time from 1 to 100 seconds in the regular interval of 20 seconds in the network. It is observed that the throughout the range of pause time, the AODV performs better than all other routing protocols for throughput and PDR and also second best for jitter and end-to-end delay. Similar results as above have been obtained in which compare AODV, DSR, OLSR and DSDV in [1].

The results may vary from other similar studies due to difference in simulation setup and different parameter conditions. Although in general, results obtained by this paper are very similar to the other research results done for above routing protocols. This paper can evaluate the performance under different performance metrics in addition to the PDR, end-to-end delay, throughput, jitter as in

2. AN OVERVIEW OF MANET

The applications in which there is little or no communication infrastructure or the infrastructure is not possible to use or not cost efficient, wireless mobile users may still be able to communicate through the formation of a network known as “Mobile Ad-hoc Network (MANET)”. In a mobile ad-hoc network, each mobile node operates as a host as well as a router and in turn forwarding data packets to other mobile nodes in the network that may or may not be in the direct wireless communication range of each other. Each mobile node participates in an ad-hoc routing protocol that allows it to find multihop paths from one node to any other node in the network.
The mobile ad-hoc network may also be identified as infrastructure-less networks [15], as mobile nodes in the network are able to set routing among them to form their own network temporarily. The possible applications of ad-hoc networks may be in disaster management, military application, etc. Thus, from the above discussion, it can be said that the wireless communication may be infrastructure based or ad-hoc type. Hence, wireless networks may be of two kinds, namely infrastructure based wireless network and ad-hoc or infrastructure-less wireless network. Infrastructure based wireless networks have a fixed network topology whereas infrastructure-less networks do not have any fixed network topology but dynamic topology. The infrastructure networks have base access points from which wireless nodes are connected. All the access points are linked to the network via wired links like fibre optic cable, coaxial cable or wireless links. A wireless node is able to communicate any one of the access points in its range. As network topology is dynamic nature, the routes change very frequently. Therefore, the competent routing protocols play the important role in handling this problem [2, 4].

3. AN OVERVIEW OF ROUTING PROTOCOLS IN MANETs:

The routing protocols are a conventional method or standard rule according to which it is to be determined that how a node decides that which way to forward the data packets from one host to another host in the mobile ad-hoc network environment [3]. The topology of the mobile ad-hoc network is not ascertained, it is the dynamic in nature. So, the node takes a decision about a possible topology in the ad-hoc network. Generally a fresh node in network announces its presence and then acknowledges the announcement broadcast by its neighbours. Every node looks for its neighbours and finds the method to reach them and also it may advertise that how to reach for it [5, 6]. There are various routing protocols available in ad-hoc network for performance under different conditions and environments. The routing protocols in mobile ad-hoc networks can be classified as below:

- Proactive routing protocols.
- Reactive routing protocols.
- Flow-oriented routing protocols.
- Hybrid routing protocols.
- Hierarchical routing protocols.

3.1 Proactive Routing Protocols

In this kind of proactive routing protocol, each and every wireless mobile node in the ad hoc network maintains a fresh routing table in which all the possible destinations within the network from one host to another host and the number of hops towards the each destination are to be stored for further predictions. Every entry which is recognized by the destination node is given a sequence number. The sequence number facilitates a mobile node to differentiate old routes from new ones. It also avoids the creation of routing loops. The routing table is transferred to its current neighbors from time to time. The information transferred to the neighboring node contains a new sequence number along with following information for every new route: address of the destination, hops number required to reach the destination, etc. For keeping the regularity of routing tables in a random network topology of ad-hoc networks, the routing tables keep updating periodically transmitted information. Some examples of proactive algorithms are; Destination Sequence Distance Vector (DSDV), Optimized Link State Routing Protocol (OLSR), Intra-zone Routing Protocol (IARP).

3.2 Reactive or On-demand Routing Protocols

This type of routing protocol keeps the routing information for active routes only. Whenever a source node needs a route then routes will be formed or routes are determined here only one the basis of on demand. That is why these routing protocols are also called as on-demand routing protocols. A route discovery procedure has to initiate before the data transmission, which in turn gives rise to high latency. An additional route maintenance procedure is required here to adjust to link state changes. Here, no need of sending routing advertisement messages and so in turn saving the network bandwidth overhead [6]. Few examples of reactive routing protocols are; Dynamic Source Routing (DSR), Ad-hoc On-Demand Distance Vector (AODV), Dynamic MANET On-Demand (DYMO) etc.

3.3 Flow Oriented Routing Protocols

The flow oriented routing protocol has the property that it uses the prediction based mechanism for choosing and maintaining its routes. The FORP keeps the ability to predict the link expiration time for a given link. And in turn FORP is able to predict a route expiration time for a given path also. The ZRP reactive component is an example of this type of routing protocol. FORPs require less control overhead. These protocols determine a route on demand or by reactive mechanism.

3.4 Hybrid Routing Protocols

These kind of routing protocol takes the benefit of both proactive and reactive routing. For example, in Zone Routing Protocols (ZRP) [5], it combines both IARP and IERP to improve performance over routing. The first routing is done by the IARP i.e. proactively and then IERP acts which serves the demand of additionally activated nodes by the flooding method as done in reactive routing protocols. The selection of one method out of two depends on a predetermination of case arises. The example includes ZRP which combines IARP as proactive component and IERP as a reactive component in the functioning of the routing.
3.5 Hierarchical Routing Protocols

The hierarchical routing protocol is also similar to the hybrid routing protocol, it uses the proactive and reactive routing approaches. But in this case the selection of proactive and reactive routing is decided based on the hierarchy level of the nodes in which nodes reside. The routing is initially done for proactively oriented routes after that, this routing protocol serves the requirement of additionally activated nodes by on-demand flooding on the lower levels. Thus, the selection of the proactive or the reactive method needs proper recognition for individual levels. The Cluster Based Routing Protocol (CBRP) and Fisheye State Routing (FSR) protocol are the examples of hierarchical routing protocols.

4. ROUTING PROTOCOLS USED IN CURRENT ANALYSIS AND EVALUATION

In this research work, five different routing protocols have been considered for the analysis. Out these five routing protocol one is a proactive type routing protocol, i.e. IARP which is somehow related to the ZRP hybrid routing protocol and the remaining four is reactive or on demand kind of routing protocol that are; IERP, AODV, DSR, and DYMO. The brief introduction about these routing protocols are given below:

4.1 Intrazone Routing Protocol (IARP)

The Intrazone Routing Protocol (IARP) is some degree of the proactive routing protocol and it is used to enhance the performance of readily available globally reactive routing protocols [7]. Here, the global route discoveries to the local destinations can be avoided by observing the node monitoring changes in their surrounding R-hop neighborhood i.e. routing zone. Whenever the route search is needed globally in the network. This routing protocol can be utilized efficiently to guide route queries among the nodes in an outermost zone rather than blindly relaying queries from neighbor to neighbor. Moreover, the attribute of ascertained routes are being improved all the time, with the help of proactive maintenance of routing zones, by making them more and more vigorous to changes of the network topology. Once the routes have been revealed, then it offers the enhanced, real-time, and route maintenance quality in the network. The best features of this zone routing protocol is that the link failure issues could be minimized or bypassed by multiple hop paths within the routing zone. In the same way, other sub-optimal routes can be recognized and the traffic could be re-routed along with shorter paths [8].

4.2 Inter Zone Routing Protocol (IERP)

IERP is the type of the Zone Routing Protocol (ZRP), but its a reactive routing component rather than proactive [9]. It acquires key concept of the exiting reactive routing protocol to get the benefit of the well known topology of each node which is surrounded by R-hop neighborhood, i.e. Routing zone, provided by the IARP. The availability of routing zone routes, permits the IERP to suppress route queries for local destinations. Here, whenever a route discovery is required globally, the routing zone based border cast service can be utilized efficiently to direct route queries outward, more willingly than blindly relaying queries from neighbor to neighbor. Once a route is searched in the network, then this zone routing protocol is able to use routing zones to automatically re-direct data packets around the unsuccessful links. Again, here, other sub-optimal route segments may be point outed and traffic could be re-routed along with shorter paths. The IERP is the universal reactive routing component of the ZRP.

4.3 Ad-hoc On-Demand Distance Vector Protocol (AODV)

The AODV is a distance vector routing protocol in Mobile Ad-hoc Networks (MANETs) [8]. It works on the basis of on-demand routing approach which indicates that there is no periodic exchange of routing information. It also indicates that the incase of AODV routes is determined towards any destination whenever it is required. AODV provides rapid adjustment to the dynamic link behavior and changes, low processing in functioning, lower memory overhead and finds unicast routes to destinations within MANETs. In AODV routing protocol there are mainly two phases [10]: Route Discovery Procedure and Route Maintenance Procedure. Whenever any nodes need to send the message to any nodes in the network, then route discovery process is initiated. On the network when any router or intermediate node receives a request to send a message, it checks its routing table to see whether a route exists or not. If a route exists, then it will simply acknowledge the source nodes that forward the packets otherwise it rebroadcasts the route request packet to its neighbor. The following fields are comprised by each routing table; Destination address, Next hop address, Destination sequence number, Hop count, etc.

4.4 Dynamic Source Routing (DSR)

The DSR protocol is the efficient and easy to approach. It has particularly been designed for implementation in multi-hop wireless mobile ad hoc networks [12]. The dynamic source routing facilitates the network to be entirely self-organizing, self-configuring, and there is no need of any existing network infrastructure or in other words, no need of supervision in this process. This protocol also works according to the two main mechanisms that are; Route Discovery Procedure and Route Maintenance Procedure. In the case of the DSR routing protocol, these both mechanisms work together to facilitate nodes for discovering and maintaining routes to random destinations in the wireless mobile ad-hoc network environment [1]. All functions of the protocol are entirely based on the on-demand.
Hence, it is facilitating the routing packet overhead of DSR to scale involuntarily to only what has been required to respond to changes in the routes presently in use. The DSR protocol offers multiple routes or paths to any destination in the network. And DSR also allows every sender node to choose and control the routes used in the routing of its packets. Also, DSR protocol has favorable features like guaranteed to loop-free routing, useful in networks containing unidirectional links and quick recovery whenever route in the network changes. The DSR protocol has generally been drafted for ad-hoc networks having maximum two hundred nodes. Its design is very suitable to work with, very high mobility rates of mobile nodes.

4.5 Dynamic MANET On-Demand (DYMO)

The DYMO is a reactive, multihop, unicast routing protocol [11]. It is a memory concerned, routing protocol and stores minimal routing information. Therefore, the control packets are generated whenever a node receives the data packets and also it does not have any valid route information. This routing protocol facilitates reactive, multihop, and unicast routing among participating DYMO routers. Like as AODV, and DSR its basic operations also consist two phases that are route discovery and route management process [13].

5. SIMULATION EXPERIMENT AND PARAMETER SETUP

In this paper, the QualNet 7.1 simulation tool has been used for the analytical studies of various ad-hoc network routing protocols [14]. The presented paper uses the following parameters which are tabulated in table 1:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation tool</td>
<td>QualNet (Version 7.1)</td>
</tr>
<tr>
<td>Area</td>
<td>1500 m * 1500 m</td>
</tr>
<tr>
<td>No. Of nodes</td>
<td>50</td>
</tr>
<tr>
<td>Nodes Placement Strategy</td>
<td>Randomly</td>
</tr>
<tr>
<td>Nodes Maximum Speed</td>
<td>10 mps</td>
</tr>
<tr>
<td>Data Traffic Type</td>
<td>CBR</td>
</tr>
<tr>
<td>Packet Size</td>
<td>512 bytes</td>
</tr>
<tr>
<td>Data Rate</td>
<td>2 Kbps</td>
</tr>
<tr>
<td>Channel Bandwidth</td>
<td>2 Mbps</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>500 seconds</td>
</tr>
<tr>
<td>Pause Time</td>
<td>0, 20, 40, 60, 80, and 100 seconds</td>
</tr>
<tr>
<td>Transmission Range of Nodes</td>
<td>200 m</td>
</tr>
<tr>
<td>Transmission Powers</td>
<td>15dbm</td>
</tr>
<tr>
<td>PHY Layer Model</td>
<td>IEEE 802.11b</td>
</tr>
<tr>
<td>MAC Layer Protocol</td>
<td>IEEE 802.11</td>
</tr>
<tr>
<td>Antenna Model Type</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Random Way Point</td>
</tr>
</tbody>
</table>

6. COMPARATIVE PERFORMANCE ANALYSIS AND RESULTS

6.1 Analysis of the Jitter

Jitter is the variation of time of packets at the receiving point. In other words, network with constant latency has no variation or no jitter. A presence of jitter in any IP network is caused by network congestion, timing drift, or route changes. It is one of the important metric for any routing protocol. From figure it could be clearly observed that the DSR acquires the highest jitter for lower values of pause time such as 0, 20 and 40 seconds and for higher values of pause time it gives good performance whereas, IERP performance is worst at higher values of pause time. AODV and DYMO have satisfactory jitter and it is almost constant throughout the range of pause time. Among all routing protocols, IARP gives the lowest jitter value throughout the pause time variation.

Figure 1 Jitter (seconds) as a function of the Pause Time

6.2 Analysis of the Average End-to-End Delay

The average end-to-end delay is the difference of time moment at which packets are actually transmitted from the source point and at what moment it are actually received by the receiving point. In other words, it is an overall average time taken by the packets to reach the receiving point from the source point. It comprises the all-possible delays, which are happening due to buffering during the route discovery process, retransmission at the MAC layer, queuing at the interface point, propagation, and transfer times, etc. Here, figure 2 depicts that the IERP has a higher end-to-end delay almost all over the range of variation of pause time, followed by a second higher end-to-end delay value, which corresponds to DSR. AODV and DYMO both have very low values of an end to end delay over the range of pause time variation. Although AODV has slightly lower values than DYMO. At last, an IARP is one that has lowest average end-to-end delay variation throughout the range of pause time.
6.3 Analysis of the Throughput

Throughput is related to the channel capacity of the network and is the maximum number of data packets that can be delivered successfully over a communication channel under ideal circumstances in a particular time interval. In other words, it is the average rate of successfully delivered message over a channel of communication per unit time. Figure 3 reflects that the throughput as a function of the pause time. From the figure it is concluded that the in terms of throughput DYMO achieves better than the other remaining routing protocols for the middle range of pause time values. But at the same time, for lower and higher values of pause time AODV gives better throughput than the other remaining routing protocols. The other than AODV and DYMO routing protocol, the DSR and IARP has nearly comparable throughput values. Although, on average the DSR has a somewhat more throughput overall than the AODV. IERP is one which offers least throughput value all over the range of pause time.

6.4 Analysis of the Packet Delivery Ratio (PDR)

PDR is the ratio of the total packets received by the receiving nodes to the total packet sent by the sending nodes. The better PDR offers the most complete and correct routing path in the networks. This metric is very important because it evaluates the route discovery ability of any protocol. The PDR shows how successful a protocol performs delivering packets from source to destination.

\[
\text{Packet\_Delivery\_Ratio\ (PDR \%) = (Received\ Packets/\ Sent\ Packets) \times 100}
\]

Figure 4 demonstrates that the AODV acquired the highest PDR value and it is nearly followed by the DYMO. DYMO has satisfactory PDR value.

Further, it is also observed, the IARP has a lower value, but higher than IERP, which has lowest PDR value among all the routing protocols. The above-discussed results have been summarized in tabular form that is shown in table 2:

<table>
<thead>
<tr>
<th>Performance Metrics</th>
<th>Jitter</th>
<th>End to End delay</th>
<th>Throughput</th>
<th>PDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>IERP</td>
<td>IERP</td>
<td>AODV</td>
<td>AODV</td>
</tr>
<tr>
<td>High</td>
<td>DSR</td>
<td>DSR</td>
<td>DSR</td>
<td>DSR</td>
</tr>
<tr>
<td>Medium</td>
<td>DYM O</td>
<td>DYM O</td>
<td>DSR</td>
<td>DSR</td>
</tr>
<tr>
<td>Low</td>
<td>AODV</td>
<td>AODV</td>
<td>IARP</td>
<td>IARP</td>
</tr>
<tr>
<td>Lowest</td>
<td>IARP</td>
<td>IARP</td>
<td>IERP</td>
<td>IERP</td>
</tr>
</tbody>
</table>

Figure 3 reflects that the throughput as a function of the pause time.
7. CONCLUSION

An analytical study based this research paper evaluates the performance of different routing protocols for four different performance metrics, i.e. jitter, average end to end delay, throughput, and packet delivery ratio. From the above analysis, the paper concludes that the AODV gives better than the other remaining routing protocols throughout the range of variation of pause time. Although, it performs satisfactorily in terms of jitter and average end-to-end delay performance metrics, after IARP for pause time variations. DYMO also performs satisfactorily for pause time variation after AODV. Here, it can be noted that the IARP and IERP are proactive and reactive components of the ZRP respectively and have limited proactive and reactive features. Hence, their performance is poorer than the other remaining routing protocols, i.e. DYMO, AODV, and DSR. So further, we can see their cumulative performance in order to get idea about ZRP’s performance with varying conditions and the environment. Further, the new routing algorithm can be designed by using performance details obtained through this analysis or work can be done for improving the different features of routing protocols.

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A Comparative Study of ICT Maturity Measurement Models

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ABSTRACT

Over the last few years, several maturity models have been developed to support ICT management. They address a broad range of different application areas, comprising holistic assessments of ICT management as well as appraisals of specific subareas. In the service industry, ICT Maturity models are valuable instruments to service expert and managers as they are used for the assessment of the current state of its firms as well as the identification of reasonable improvement measures. However, how to measure the maturity of ICT is not only strange to service expert and managers of service organization but also confront them with the problem of choice of the appropriateness of existing ICT maturity measurement tool(s). This paper attempts to be a one stop shop to service experts and managers of service organisation by identifying and explicating among the several maturity measurement tools that are particularly suited to ICT maturity measurement, exposed their features, strengths and weaknesses.

Keywords: Service Science, ICT, Maturity Measurement Tools, Service Industry

African Journal of Computing & ICT Reference Format:


1. INTRODUCTION

ICT support of business processes has become indispensable for a lot of companies [2]. Moreover, innovative ICT systems generally offer great opportunities to improve a company’s competitiveness [3, 4, 5]. The responsibility for effective and efficient design and use of IT lies with the company’s IT management. The main goal here is to continually improve ICT performance with regard to its economic efficiency. ICT management therefore needs supportive tools to assess the as-is situation of a company, derive and prioritize improvement measures and subsequently control the progress of their implementation. Continual improvement requires the company’s positioning with regard to its ICT capabilities and the quality of its goods and services. As a rule, this positioning involves a comparison with the company’s goals, external requirements (e.g. customer demands, laws or guidelines), or benchmarks. To achieve an objective assessment of a company’s position, however, often proves to be a difficult task.

For each aspect of the company’s ICT under investigation, the questions arise what needs to be measured and how, and what to compare it with, in order to assess the as-is situation of a company and to assign it a specific quality or degree of maturity. Maturity models are helpful tools for addressing these issues [5]. A maturity model consists of a sequence of maturity levels for a class of objects. It represents an anticipated, desired, or typical evolution path of these objects shaped as discrete stages. Typically, these objects are organizations or processes.

The bottom stage stands for an initial state that can be, for instance, characterized by an organization having little capabilities in the domain under consideration. In contrast, the highest stage represents a conception of total maturity. Advancing on the evolution path between the two extremes involves a continuous progression regarding the organization’s capabilities or process performance. The maturity model serves as the scale for the appraisal of the position on the evolution path. It provides criteria and characteristics that need to be fulfilled to reach a particular maturity level. During a maturity appraisal, a snap-shot of the organization regarding the given criteria is made. The characteristics found are evaluated to identify the appropriate organization-individual maturity level. The application of maturity models can be supported by predetermined procedures, e. g. by questionnaires. Based on the results of the as-is analysis, recommendations for improvement measures can be derived and prioritized in order to reach higher maturity level [7].

Studies have shown that more than a hundred different maturity models exist [6]. The constant publication of new maturity models for often fairly similar applications however suggests certain arbitrariness. This often get service experts and managers of service organisation confused when it comes to which of the model(s) to employ; for it is not only irrational but it is also impossible in a given context or organisation, to use all the existing maturity measurement models.
In particular, knowing which of these models or tools is suited for ICT maturity measurement in their organization is another issue. Consequently, this paper identified and explicates among the several maturity measurement tools those that are particularly suited to ICT maturity measurement; exposed their features, strengths and weaknesses, so that services science researchers, consultants and managers may have a single document that can guide them on which measurement tool(s) is appropriate for ICT maturity measurement in a given service organization.

2. MODELS FOR MEASURING ICT MATURITY

The distinction on maturity models can be related to the ICT Maturity Models as a benchmark for comparison and as an aid to understanding the comparative assessment. The use of these ICT maturity models allows an organization to have its methods and processes assessed according to management best practice, against a clear set of external benchmarks. The paper identified ten notable models for measuring ICT maturity: Nolan ICT Maturity Model, UNESCO’S Model of ICT Maturity, Cloud ICT Maturity Model, Knowledge Management Maturity Model (KMM), Interoperability ICT Maturity Model, TOBI Maturity Model, Sustainable ICT Capability Maturity Framework (SICT-CMF), Accessibility Maturity Model, Green ICT maturity model and ICT Maturity Model of SMEs.

A. Nolan Stages of Growth ICT Maturity Model

Developed by Richard Nolan in 1979, Nolan Stages of Growth Maturity Model was the first ICT model which established a relationship between the growth phase of an EDP (Electronic Data Processing) department and the proportion of money spent on Data Processing. According to this model, an organisations involved in the adoption of Information Technology (I.T.) go through similar stages of organisational growth. The model was developed to actually looked at I.T. expenditure and noticed it followed a common ‘S’ shape which had three identifiable change points which in turn allowed them identify four different stages of growth in the life of I.T. introduction. The Nolan Stages of growth model initially identified four different stages;

1. Initiation (often referred to as the ‘ad-hocracy’ stage)
2. Contagion (later expressed as expansion)
3. Control (later expressed as formalisation)
4. Maturity

In [8] Nolan’s initial model is enhanced to include two additional stages; Integration and Data Administration, and the revised model characteristics were re-expressed as follows:

- Initiation (introduction of IT) - this is the initiation phase often described ‘adhocracy’ phase during which there is little control and I.T. issues are not that well understood.
- Contagion (proliferation of IT) – during this phase there is expansion of I.T. systems to meet an increasing demand. There is a lack of business involvement in I.T. during this phase.
- Control (a need to contain costs) – as the cost of I.T. spirals and a perceived unsatisfactory service from the I.T. Department, formalisation is introduced with an increase of central control and an increased scrutiny of I.T. from management.
- Integration – this phase is characterised by an increase in cooperation and discussion where lessons are learned and the I.T. and business functions come closer together.
- Data Administration – this phase examines entrepreneurial opportunity which can add value to the business through effective use of I.T.
- Maturity (the mature phase) – this phase is described as an integrated harmonious phase where lessons are learned and there is an emphasis on integrating internal and external data and bringing I.T. into the mainstream of the organisation.

The deficiencies identified in the original Nolan model is the lack of organisational or management focus.

B. Unesco’s Model of ICT Maturity

This model was developed in 2002 to measure indicators of Information and Communication Technologies (ICTs) in educational institutions. In the model, issues forming successful ICT integration were identified stage by stage according to competencies stated by UNESCO (2002). These stages are:

1. The emerging stage;
2. The applying stage;
3. The infusing stage and
4. The transforming stage.

The Emerging Stage: is the beginning stage of ICT development demonstrated in that sector. It involves the purchase of computing equipment and other ICT infrastructure. In this stage, administrators are just starting to explore the possibilities and consequences of using ICT in that sector. Sectors at this emerging stage are still firmly grounded in traditional centred practice, although there might be in an increase in basic skills and there is an awareness of ICT.

The Applying Stage: there is a new understanding of the contribution of ICT that has developed past the emerging stage. Here ICT is used for tasks already carried out in that sector; leaning of the uses of ICT usually goes on in this environment. Sectors in this stage adapt to the use of ICT in various areas with specific tools and software and prepares for movement to the next stage if so desired.

The Infusing Stage: involves integrating or embedding ICT across the services provided or managed by that sector and it is seen in sectors that now employ a range of computer based technologies in their laboratories, administrative offices and so on.
The Transforming Approach: here the sector uses ICT in creative ways, which leads to invention and innovations. ICT becomes an integral though mostly invisible part of daily personal productivity and professional practices. Here ICT is incorporated into all areas of that sector. The model was developed purposely for educational sector and is very difficult to be implemented in other sector of the service organization.

C. Cloud ICT Maturity Model
Cloud maturity model developed by Oracle in 2011 was based on collective experience and best practices. A Cloud Computing Maturity Model (CCMM) is a model that was developed to define, analyse and measure the progress of an organization’s ability to deliver cloud services in key areas such as capabilities, domains, maturity and adoption. A CCMM, like all maturity models, is a matrix laid out in rows and columns. The criteria to be evaluated is listed in the left-hand column and each column’s corresponding row has cells that describe, in a few words, the typical behaviour exhibited at each level of development -- beginning with entry level.

The Cloud Maturity Model measures Cloud capability against six defined maturity levels. The maturity levels progress from ‘None’ up to ‘Optimized.’ These levels define the path an organization usually takes moving toward Cloud Maturity. Cloud computing by its very nature, requires coordination, cooperation, and a common vision to be successful; therefore, it is necessary to define the strategy before it is possible to be truly successful at repeating it and then ultimately optimizing it. The six levels of maturity used in the Cloud Maturity Model from lowest to highest are:

None - There is no Cloud approach being taken. No elements of Cloud are being implemented.

Ad Hoc – Awareness of Cloud Computing is established and some groups are beginning to implement elements of Cloud Computing. There is no cohesive Cloud Computing plan being followed.

Opportunistic – An approach has been decided upon and is being opportunistically applied. The approach has not been widely accepted and redundant or overlapping approaches exist. It may be informally defined, or if documented, may exist primarily as “shelf ware”.

Systematic – The approach has been reviewed and accepted by affected parties. There has been buy-in to the documented approach and the approach is always (or nearly always) followed.

Managed – The capability is being measured and quantitatively managed via some type of governance structure. Appropriate metrics are being gathered and reported.

Optimized – Metrics are being consistently gathered and are being used to incrementally improve the capability. Assets are proactively maintained to ensure relevancy and correctness. The potential for market mechanisms to be used to leverage inter-cloud operations has been established. The maturity model is primarily designed for cloud technology driven organization. It is still a relatively new unpopular approach.

D. Knowledge Management Maturity Model (KMM)
KM Maturity Model was developed by C.J Kruger in 2008. According to him, there are six (6) levels/phases of maturity in an organization toward Knowledge Management (KM) and these include:

Phase 1: ICT and Information management enablers for knowledge management
Before any endeavour in knowledge management commences, a certain amount of ICT and information management (as enablers of effective knowledge management) needs to be present in the organization [9]. According to [10], ‘at a basic operational level, knowledge that helps an organisation to conduct its day-to-day operations is necessary, without which work would grind to a halt’. The mere fact that organizations exist and survive indicates that a certain amount of knowledge is available within the organization. Primarily, all knowledge resides in the head of the knower, and if it is being shared, this is done in an informal manner. The following aspects are characteristic of this phase:

* Organizations are not yet made aware of the power vested in knowledge, and/or the importance of knowledge as a strategic resource.
* ICT (if it is present within the organization) is not managed in an effective and efficient manner. Organizations are getting to grips with the way they handle data and information. There is a need to develop an understanding of existing ICT systems, ICT technology, where information resources are situated and what the capabilities of technical personnel, etc., are.

During these preliminary phases,’ organizations should progress to an ICT maturity level where they are capable of knowing and managing what constitutes data and information. At me end of this stage, organizations should be capable of shifting data and information by means of ICTS in support of business operations. ICT-related relationships should be of a sound nature. In order to aid in these endeavours, it is proposed that simple system maps and lists can be used to clarify ICT issues- Although ICT and information management can be considered enablers of knowledge management, due to the data-to-information cycle, a certain amount of ICT should be in place in order for information management to function optimally. In a similar manner the information-to-knowledge cycle dictates that certain information management practices can be regarded as prerequisites to successful knowledge management.
In order to launch this phase it is proposed that the level of organization [1]. formal knowledge management function exists, and an proposed that While the preliminary technological platform is to inculcate a knowledge culture in the organization. It is orientation should be consciously turned into a commitment knowledge orientation of the organization, but this knowledge is regarded as a strategic resource, be assessed. be determined. It is imperative that the extent to which associated drive to instil this realization into the entire realization of the importance of knowledge, recognition that a During the second level of maturity, there must be a knowledge infrastructures should already be in place. During this phase, managers must become more than just aware of the power vested in knowledge. They must consciously begin encouraging endeavours in knowledge management. Typical of this phase will be the need of organizations to rely heavily on information systems to achieve and sustain competitive advantage. Decision support and strategic information systems should be available to support and even enable knowledgeable decision-making, as well as group decision-making, to take place.

Phase 2: Deciding on knowledge management issues
During the second level of maturity, there must be a realization of the importance of knowledge, recognition that a formal knowledge management function exists, and an associated drive to instil this realization into the entire organization [1].

In order to launch this phase it is proposed that the level of knowledge management orientation within the organization be determined. It is imperative that the extent to which knowledge is regarded as a strategic resource, be assessed. Emphasis should not only be placed on assessing the knowledge orientation of the organization, but this orientation should be consciously turned into a commitment to inculcate a knowledge culture in the organization. It is proposed that While the preliminary technological platform is put in place (as proposed in Phase 1), endeavours in knowledge management should start off by identifying issues, success factors and elements that will promote the institution of a culture of knowledge and knowledge management architecture within the organization.

Phase 3: The formulation of an organization-wide knowledge management policy
This level constitutes a realization among business managers that knowledge is of extreme importance. In essence plans and policies to establish a knowledge culture within At this level, efficient and effective ICT architectures and knowledge infrastructures should already be in place. During this phase, managers must become more than just aware of the power vested in knowledge. They must consciously begin encouraging endeavours in knowledge management. Typical of this phase will be the need of organizations to rely heavily on information systems to achieve and sustain competitive advantage. Decision support and strategic information systems should be available to support and even enable knowledgeable decision-making, as well as group decision-making, to take place.

Phase 4: Formulating knowledge management strategy/strategies
The next level of maturity commences with a focus on determining to what extent organizations know what constitutes knowledge resources (both tacit and explicit), where knowledge resources are situated and why resources are strategic (i.e. organizational awareness of the power vested in knowledge, and/or the importance of knowledge as a strategic resource). In order to bridge the gap between current knowledge and knowledge needed (to base business strategy formulation on), organization at this level must be able (via the use of competitive intelligence and internal knowledge-sharing systems) to formulate a knowledge strategy and knowledge management strategies. In essence, this constitutes the ability to formulate strategies to explore, create, acquire, transfer, capture, codify, share and distribute knowledge. Of importance is the realization that strategies include ICT, information management, human resource and other organizational aspects.

Phase 5: Implementation of knowledge management strategies
Kazimi, Dasgupta and Natarajan (2004) state that 'Investment in technology, and, improvement in culture is not enough. It is the currency of knowledge creation that matters most for organizations seeking sustained knowledge advantage'. At this level strategists start perceiving ICT, information management and knowledge management as interdependent entities, entities irreplaceable in the quest, to sustain competitive advantage. The emphasis in ICT and knowledge management shifts to streamlining processes and procedures. Where the knowledge strategy is insufficient to supply answers to strategic knowledge gaps, and/or if strategists (functional owners) point out that 'new and more' knowledge and intellectual capital are needed in order to institutionalize future business strategies, there is a necessity to either leverage the power of existing internal knowledge resources, or increase knowledge in a particular area.

A checklist to determine whether or not this level of maturity has been reached should not only focus on questions to determine if strategists can formulate strategies to increase knowledge in a particular area, and/or leverage existing knowledge, but should also assess whether or not the organization is capable of formulating efficient and effective plans to change the organization's knowledge structure and supporting ICT structure from the 'as is' to the 'required should be' structure. At this level the goals of ICT management and knowledge management converge in a quest to continually improve processes, i.e. optimize the use of ICT with regard to maximizing the value gained from knowledge.
Phase 6: Ubiquitous Knowledge
As soon as organizations are capable of continually enhancing and formulating strategies to further create and/or to process knowledge internally, the next evolutionary step involves utilizing the knowledge of the organization's partners and extended partners. To emphasize this point, [10] state that knowledge maturity will in the end be determined by how well the organization can manage knowledge across all segments. During this phase ‘knowledge management needs to seamlessly integrate with the enterprise eco-system’, an eco-system consisting of customers, business partners, (shareholders, alliances, etc), operations and vendors. This mindset requires that the organization’s ICT architecture be capable of transcending the borders of the organization, i.e. capable of not only sharing data and information, but also knowledge and expertise with all stakeholders in the organization’s extended value chain.

However, due to cost and technological restrictions, most organizations will not easily reach or pass this point of knowledge management maturity. A checklist to determine whether or not this level of maturity has been reached should not only focus on determining if knowledge is being shared among value chain partners, but more specifically to what extent knowledge management has become institutionalized, between partners. If this level has not been reached, then organizations must return to Phase One of the maturity model.

Advantages of Knowledge Management Maturity Model
1. It is a knowledge driven model that extensively defines ICT knowledge management that can help companies in assessment of their ICT captured data and information.
2. It level is well defined for easy understanding and generally provides accurate result.

Disadvantages of Knowledge Management Maturity Model
1. It is quite difficult to implement in other sector that are not ICT knowledge driven in their entirety.
2. Owing to it complex nature, the model is quite unpopular in its usage and thus research materials in this domain is very scarce.

E. Interoperability ICT Maturity Model
Nowadays, Information Technology (IT) as well as human systems evolve in a worldwide heterogeneous environment and work in network. For enterprises, operating in such environment requires flexibility and co-operations between other enterprises, sharing their core competencies in order to exploit the market opportunities. It is now admitted that a major issue in global collaboration and co-operation is the development of interoperability between enterprise systems. This model was developed by C4ISR as a universal reference resources to define interoperability among organizations. The model deals with the ability of organizations to interoperate and assess organizational issues at business / company interoperability level. Five levels are identified in the model. OIM aims at assessing the systemic interoperability of an organization, considering the quality of its components inter-operations. OIM does not explicitly propose a specific approach to solve interoperability problems but within each level, there are some guidelines mainly focusing on the use of common terms and structures. In an enterprise context, OIM covers business area of concern: with its strong focus on organizational issues, it does not address technical, semantic or syntactical aspects.

Table 1: Interoperability Maturity levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Unified</td>
<td>The organization is interoperating on continuing basis Command Structure and knowledge basis are shared.</td>
</tr>
<tr>
<td>3</td>
<td>Integrated</td>
<td>Shared value systems and goals, a common understanding to interoperate. However there are still residual attachments to a home organization.</td>
</tr>
<tr>
<td>2</td>
<td>Collaborative</td>
<td>Recognised interoperability frameworks are in place. Shared goals are recognised. Roles and responsibilities are allocated but the organizations are still distinct.</td>
</tr>
<tr>
<td>1</td>
<td>Ad hoc</td>
<td>Some guidelines to describe how interoperability will occur but essentially the specific arrangements are still un-planned. Organizations remain entirely distinct. Organizations work without any interaction. Arrangements are unplanned and unanticipated.</td>
</tr>
<tr>
<td>0</td>
<td>Independent</td>
<td>No formal frameworks in place. Organizations are able to communicate e.g. via phone, fax and face-to-face meetings.</td>
</tr>
</tbody>
</table>
F. Tobi ICT Maturity Model
TOBI or Technology Operations and Business Integration Framework Maturity Model is a framework acting as the glue between IT operations and business operations, developed by Access Consulting Services (ACM) in 2009. The model, is designed to be flexible, robot and agile to meet all aspects. The framework can provide a high level maturity focus and at the same time drill down into the individual solution detail. A maturity model acts as a measurement or barometer of the current operational level of a solution, technology, department or the entity as a whole. The TOBI maturity model has five distinct levels. Each level has defined operational characteristics.

The goal of an organization will be to move from a lower to higher maturity level. Reaching the top maturity level may not be optimal for a particular organization. This is determined by requirements and business objectives.

LEVELS
The level concept is the level of maturity. TOBI maturity model define five levels of maturity. Maturity level can be used to gauge single solution entities, multiple solutions, areas, layers and the whole business entity. The maturity levels are defined as follows:

- **Reactive Mode**: organizations, solutions or processes that are in this mode are reacting to circumstances and the general direction to fire fight current issues.
- **Foundation**: organizations at this level of maturity are starting to formulate plans, procedures and process.
- **Intermediate**: at this stage of maturity, the organization and the supporting solutions are able to have some benefits of the strategic value.
- **Managed**: at this level of maturity has many of the benefits of a strategic partnership, but there are still some aspects that prevent full interpretability.
- **Strategic Partner**: organizations at this level will have the benefit of being a strategic asset to the business.

The levels are depicted below:

![Technology Operations and Business Integration (TOBI) Model (Tobias, 2011)](image)

Advantages of TOBI maturity model
It is designed to be agile and flexible to incorporate the frameworks and the model allows for these processes to be incorporated. It enhances the overall functionality. The TOBI framework is the glue to hold all the pieces together, but it is aided by the industry frameworks, standards and compliance structures.

Disadvantages of TOBI maturity model
It is expensive to design and implement.

G. Sustainable ICT Capability Maturity Framework (SICT-CMF)
The Sustainable ICT Capability Maturity Framework gives organizations a vital tool to manage their sustainability capability. This was developed in 2011 by a consortium of leading organizations from industry, the non-profit sector, and academia has developed and tested a framework for systematically assessing and improving SICT capabilities.

The Innovation Value Institute (IVI; http://ivi.nuim.ie) consortium used an open-innovation model of collaboration, engaging academia and industry in scholarly work to create the SICT-Capability Maturity Framework (SICT-CMF). The framework provides a comprehensive value-based model for organizing, evaluating, planning, and managing SICT capabilities.

Using the framework, organizations can assess the maturity of their SICT capability and systematically improve capabilities in a measurable way to meet the sustainability objectives. The IT-Capability Maturity Framework (IT-CMF) is a high-level process capability maturity framework for managing the IT function within an organization to deliver greater value from IT by assessing and improving a broad range of management practices.
The framework identifies 33 critical IT processes and describes an approach to designing maturity frameworks for each process.

A core function of the IT-CMF is to act as an assessment tool and a management system with associated improvement roadmaps that guide senior IT and business management in selecting strategies to continuously improve, develop, and manage the IT capability in support of optimized business value delivery. The framework focuses on the execution of four key actions for increasing SICT’s business value:

1. Define the scope and goal of SICT;
2. Understand the current SICT capability maturity level;
3. Systematically develop and manage the SICT capability building blocks and Access and manage SICT progress over time.

The framework defines a five-level maturity curve for identifying and developing SICT capabilities:

1. **Initial**: SICT is ad hoc; there’s little understanding of the subject and few or no related policies. Accountabilities for SICT aren’t defined, and SICT isn’t considered in the systems life cycle.
2. **Basic**: There’s a limited SICT strategy with associated execution plans. It’s largely reactive and lacks consistency. There’s an increasing awareness of the subject, but accountability is not clearly established. Some policies might exist but are adopted inconsistently.
3. **Intermediate**: A SICT strategy exists with associated plans and priorities. The organization has developed capabilities and skills and encourages individuals to contribute to sustainability programs. The organization includes SICT across the full systems life cycle, and it tracks targets and metrics on an individual project basis.
4. **Advanced**: Sustainability is a core component of the IT and business planning life cycles. IT and business jointly drive programs and progress. The organization recognizes SICT as a significant contributor to its sustainability strategy. It aligns business and SICT metrics to achieve success across the enterprise. It also designs policies to enable the achievement of best practices.
5. **Optimizing**: The organization employs SICT practices across the extended enterprise to include customers, suppliers, and partners. The industry recognizes the organization as a sustainability leader and uses its SICT practices to drive industry standards. The organization recognizes SICT as a key factor in driving sustainability as a competitive differentiator.

Table 2: Green ICT Maturity Level Description

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 No intension</td>
<td>Never thought about it, no awareness</td>
</tr>
<tr>
<td>1 Initial</td>
<td>Some awareness considered, but not implemented</td>
</tr>
<tr>
<td>2 Replicable</td>
<td>Some ad hoc implementation, but no strategy</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Formal programs have been defined, but implementation is immature</td>
</tr>
<tr>
<td>4 Managed</td>
<td>Methodical implementation of programs, with adequate measurement and management</td>
</tr>
<tr>
<td>5 Optimized</td>
<td>All activities are monitored and managed for optimal performance.</td>
</tr>
</tbody>
</table>

The advantage of Green ICT maturity model is that, is implemented as a web application, enabling company’s self-assessment via internet, but not popular.

I. ICT Accessibility Maturity Model (AMM)
The AMM is a self-assessment model, designed to help improve the accessibility of ICT systems, products and services. The approach enables an organisation to make an informed choice about the legal risks of overlooking accessibility. Using the AMM does not guarantee an organization from legal risk. The model is designed by the Technology Taskforce for Business Disability Forum. Technology Taskforce is committed to ensuring that all its products and services are as accessible as possible to everyone, including the disabled persons which are the major focus area of the model. The model has five levels, as shown in Table1.4.
Table 3: ICT Accessibility Maturity Model Level Description

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Poor understanding of disability related legal requirements / issues</td>
</tr>
<tr>
<td>Level 2</td>
<td>Understanding of disability related legal requirements</td>
</tr>
<tr>
<td>Level 3</td>
<td>Disability awareness across all ICT Staff</td>
</tr>
<tr>
<td>Level 4</td>
<td>Accessibility targets met (e.g. for recruitment and retention of disabled staff, take up of on-line services by disabled customers, disabled user satisfaction)</td>
</tr>
<tr>
<td>Level 5</td>
<td>Disabled staff / customers role (e.g. in setting and reviewing direction and policies) formalised and well established – regular events, documented actions and outcomes, mature feedback process</td>
</tr>
</tbody>
</table>

AMM can be used by public and private sectors in different ways. For example it will help the public sector meet their obligations under the ‘Disability Equality Duty’ by working towards level 5.

J. ICT Maturity Model of SMEs
This is a model for measuring ICT maturity of Small and Medium Enterprises. This model was designed by Australian Communication Authority in 2008. It is based on four main factors: Infrastructure, Application, Human Resource and ICT Policy. The ICT maturity of an enterprise is a solid foundation for successful implementation of knowledge management. According to a report of (Australian Communications & Media Authority, 2008) about ICT development trend, there are top six trends as follows:

TREND 1: An accelerating pace of change in ICT,
TREND 2: Diversity in the development of physical infrastructure,
TREND 3: Continuing spread of distributed connectivity,
TREND 4: Enhanced content and network management capabilities,
TREND 5: The emerging social web and
TREND 6: Continuing scientific and technological innovation.

Based on above classification [12] of ICT development in SMEs, with consideration of recent development trends as well as conditions for knowledge management maturity, the ‘Sophisticated’ phase is suggested to be divided into two (2) stages: Web-based and Knowledge-oriented. Which result to the five (5)-stage road-map of ICT development includes:

Ø Inactive – no current use of ICT in company,
Ø Basic – including word processing and other desktop packages,
Ø Substantial – extending into the networking of PCs and several applications,
Ø Web-based – extending to e-commerce with many web-based services,
Ø Knowledge-oriented – integration of applications and using ICT tools for innovation and knowledge management.

Each of maturity levels is characterized by certain observable capabilities of four (4) major factors: Policy, Infrastructure, Application and Human Resource. Based on trend analysis of ICT use in SMEs, table 1 maps above five (5) stages of ICT maturity in SMEs with its specific features.
### Table 4: ICT Maturity Stages and Its Features

<table>
<thead>
<tr>
<th>Maturity level</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>Inactive</td>
<td>Basic</td>
<td>Substantial</td>
<td>Web based</td>
<td>Knowledge Oriented</td>
</tr>
<tr>
<td>Trend</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectivity &amp;</td>
<td>Telephone</td>
<td>PC, laptop</td>
<td>Network</td>
<td>Internet</td>
<td>Wireless</td>
</tr>
<tr>
<td>Mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT HR</td>
<td>Unskilled</td>
<td>Business skills</td>
<td>Technology</td>
<td>MIS skills</td>
<td>Learning skills</td>
</tr>
<tr>
<td>Sophisticated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp; Innovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Integrated</td>
<td>No application</td>
<td>Office,</td>
<td>MIS</td>
<td>E-commerce</td>
</tr>
<tr>
<td></td>
<td>applications</td>
<td></td>
<td>E-mail</td>
<td>applications</td>
<td></td>
</tr>
<tr>
<td>Policy</td>
<td>Flexibility &amp;</td>
<td>No policy</td>
<td>Standardize</td>
<td>Modernize</td>
<td>Cooperation</td>
</tr>
<tr>
<td></td>
<td>Mobility</td>
<td></td>
<td></td>
<td></td>
<td>Outsourcing</td>
</tr>
</tbody>
</table>

Certainly, above five (5) stages do not exclude, but include each other. Any SME must pass through this road-map on the way to be fully maturity in ICT. So, the ICT maturity of an SME could be known based on getting information about its ICT use according to four (4) main factors and comparing with above classification.

### 3. CONCLUSION

We have identified and explicated ten ICT maturity measurement tools that are particularly suited to measuring the maturity of ICT in a service organisation. This was necessitated by the difficulty in making a choice on the appropriateness of maturity measurement tools for ICT maturity measurement by services science experts and managers of service organisations.

### REFERENCES


Comparative Analysis of Association Rule Mining Techniques for Monitoring Behavioural Patterns of Customers in a Grocery Store

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ABSTRACT

The amount of data being generated and stored is growing exponentially, due to the continuing advances in computer technology. This presents tremendous opportunities for those who can unlock the information embedded within this data, but also introduces new challenges. The primary challenge is how to discover the hidden knowledge or pattern from the large sets of data in order to be able to make intelligent decisions that would shape the future of the store and also to determine the best tool to use in mining. This study proposed to use two different algorithms in association rule mining. The main motivation for carrying out this study is to compare the two algorithms and determine the time complexity of the two algorithms in mining association rules. In this paper, association rule techniques were compared and analyzed for monitoring behavioural pattern of customers in a grocery store. The FP-growth Algorithm and Apriori Algorithm were applied on sixty three (63) datasets from a grocery store. The time complexity of the two algorithms were considered and it was observed that FP-growth Algorithm is more efficient within the resource constraints than Apriori Algorithm. The comparison and analysis were implemented using Weka tool. The results revealed that FP-growth Algorithm is currently one of the fastest approaches for frequent data item set mining.

Keywords: Time Complexity, Fp-growth, Apriori, Association rule mining, Grocery store.

1. INTRODUCTION

Across a wide variety of fields, data are being collected and accumulated at a dramatic pace. There is an urgent need for a new generation of computational techniques and tools to assist humans in extracting useful information (knowledge) from the rapidly growing volumes of data. These techniques and tools are the subject of the emerging field of Knowledge Discovery in Databases (KDD) [1]. The amount of data being generated and stored is growing exponentially, due to in large part to the continuing advances in computer technology. This presents tremendous opportunities for those who can unlock the information embedded within this data, but also introduces new challenges [9]. Worldwide enormous amounts of data is being produced and stored at an amazing pace.
Meanwhile, the steadily dropping prices for storage devices and the increasing capacity of each unit have made it into a simple choice to postpone the decision on what to do with all this data being produced. With hardware now having these sophistication, capability and capacity to store almost unlimited amount of data, we are rich in data but poor in information, the biggest challenge now confronting data analysts is how to use this large pool or quantity data to gain business advantage. Through knowledge discoveries in databases, interesting patterns could be discovered and analyzed from different dimensions to gain useful insight into the vast amount of data. Companies can use these discoveries to gain a competitive edge or advantage over their competitors, and thereby creating an opportunity to make higher profit. With the advancements in information technology and database technologies, data warehouses have emerged as a powerful tool to build decision support systems (DSS). Along with data mining, the power of data warehouses to support organizational decision making has increased vastly. The data warehouse provides opportunities for performing data mining tasks.

Data mining tools actively search for previously unrecognized patterns in the data. The patterns identified by these tools gives data analyst useful and unexpected insights that can be more carefully investigated subsequently, perhaps using other decision support tools. It is therefore a general expectation that data mining tools should be able to identify or find these patterns in the data with minimal user input. Data mining is related to the sub-area of statistics called exploratory data analysis, which has similar goals and relies on statistical measures. It is also closely related to the sub-areas of artificial intelligence called knowledge discovery and machine learning. The last important distinguishing characteristic of data mining is that the volume of data is very large.

One of the major challenges faced by most grocery stores is the issue of business intelligence as a result of their movement from manual storage of their records to automated storage. These challenges became more pronounced with the great rate at which data continue to grow. In this wise the primary challenge is how to discover the hidden knowledge or pattern from the large sets of data in order to be able to make intelligent decisions that would shape the future of the store and also to determine the best tool to use in mining. It has been observed over time that customer buying pattern in a shopping trip can lead to multiple product usually purchased from multiple categories. Efforts have been made by researchers to analyze the multi-category purchase information in order to plan marketing activities accordingly so as to maximize profit.

The main aim of this study is to carry out a comparative analysis of association rule mining techniques for monitoring behavioural patterns of customers in a grocery store and the objectives are to:

1. Investigate the two techniques (algorithms) of association rule mining by applying them to actual data.
2. Study how data mining technique works while mining the data from data warehouse.
3. Determine the data mining technique that is most effective, efficient, and accurate by comparing their results.

2. RELATED WORKS

Association rule mining represents a data mining technique and its goal is to find interesting association or correlation relationships among a large set of data items. With massive amounts of data continuously being collected and stored in databases, many companies are becoming interested in mining association rules from their databases to increase their profits. This process analyzes customer buying habits by finding associations between the different items that customers place in their “shopping baskets” [8].

The abundance of data generates the appearance of a new field named data mining. Data collected in large databases become raw material for these knowledge discovery techniques and mining tools for “gold” were necessary. The current expert system technologies, which typically rely on users or domain experts to manually, input knowledge into knowledge bases. This procedure contains errors, and it is extremely time-consuming and costly. Data mining tools which perform data analysis may uncover important data patterns, contributing greatly to business strategies, knowledge bases, and scientific and medical research [6].

Data is one of the valuable resources for organization, and database management systems are gradually becoming ubiquitous in many small and medium scale companies. Although, some of the benefits of database management systems have been explored, however, many companies have not been able to exploit the advantages of gaining business intelligence from their databases. This has led to inadequate business decision making based on the data contained in the databases. In this study, association rule mining also known as market basket analysis using Apriori algorithm is presented for extracting valuable knowledge embedded in the database of a supermarket [2].

Data stream is a continuous, real time, ordered sequence of items. In data stream, data arrives endlessly and the volume of data can be potentially infinite. In recent years advances in hardware and software technologies have resulted in automated storage of data from a variety of process. Data mining techniques are applied in data streams to find out the significant knowledge.
The term data mining refers to finding relevant and useful information from large databases. Some of the important techniques in data mining are association rule, classification, clustering, frequent episodes, and deviation detection. Frequent pattern mining is used to find important frequent patterns from the large dataset. Click stream analysis, market basket analysis, web link enquiry, genome study, network monitoring, and medicine designing are some of the important areas where frequent pattern mining is used. Most commonly used frequent pattern mining algorithms are Apriori, partition algorithm, pincer-search algorithm, fp-growth algorithm, dynamic item set counting algorithm and so on.

Association rule learning is a popular and well researched method for discovering interesting relations between variables in large databases. With wide applications of computers and automated data collection tools, massive amounts of transaction data have been collected and stored in databases. Discovery of interesting association relationships among huge amounts of data will help marketing, decision making, and business management. Therefore, mining association rules from large data sets has been a focused topic in recent research into knowledge discovery in databases [3].

One of the currently fastest and most popular algorithms for frequent item set mining is the FP-growth algorithm [4]. It is based on a prefix tree representation of the given database of transactions (called an FP-tree), which can save considerable amounts of memory for storing the transactions. The basic idea of the FP-growth algorithm can be described as a recursive elimination scheme: in a pre-processing step delete all items from the transactions that are not frequent individually, that is, do not appear in a user-specified minimum number of transactions. Data mining is a new concept and an exploration and analysis of large data sets, in order to discover meaningful patterns and rules. Many organizations are now using the data mining techniques to find out meaningful patterns from the database.

3. METHODOLOGY

Association rule mining has proven to be an effective method in mining market basket analysis to determining the relationship between products bought by individual (transaction done) in grocery stores. To establish the effectiveness of association rule mining we have proposed to use two different algorithms in association rule mining. The main motivation for carrying out this study is to compare the two algorithms and determine the time complexity of the two algorithms in mining association rules.

According to [5], an association rule is an implication expression of the form X \(\Rightarrow\) Y, where Xl and Yl and X and Y are disjoint item sets, i.e. X \(\cap\) Y = \(\emptyset\). X is called antecedent while Y is called consequent, the rule means X implies Y. The strength of an association rule can be measured in terms of its support and confidence. The rule X \(\Rightarrow\) Y holds in the transaction set D with confidence c and support s, if c% of the transactions in D contains X also contains Y, and s% of transactions in D contains XY. Both the antecedent and the consequent of the rule could have more than one Item. The formal definitions of these two metrics are:

Support(s) of an association rule is defined as the percentage/fraction that contain X \(\cap\) Y to the number of records in the database.

Support, s (X \(\Rightarrow\) Y) = \(\sum\) (X \(\cup\) Y)/N………………..(1)

Confidence of an association rule is defined as the percentage/fraction of the number of transactions that contain X \(\cap\) Y to the total number of records that contain X, where if the percentage exceeds the threshold of confidence an interesting association rule X \(\Rightarrow\) Y can be generated.

Confidence, c (X \(\Rightarrow\) Y) = \(\sum\) (X \(\cup\) Y)/\(\sum\) X………..(2)

Association rule mining is to find out association rules that satisfy the predefined minimum support and confidence from a given database [6]. The problem is usually decomposed into two sub-problems. One is to find those item sets whose occurrences exceed a predefined threshold in the database; those item sets are called frequent or large item sets. The second problem is to generate association rules from those large item sets with the constraints of minimal confidence. Suppose one of the large item sets is \(L_x\), \(L_{x} = \{I_1, I_2, I_{k-1}, I_k\}\), association rules with this item sets are generated in the following way: the first rule is \(\{I_1, I_2, ..., I_{k-1}\} = \{I_k\}\), by checking the confidence the rule can be determined as interesting or not. Then other rule are generated by deleting the last items in the antecedent and inserting it to the consequent, further the confidences of the new rules are checked to determine the interestingness of them. Those processes iterated until the antecedent becomes empty. Since the second sub-problem is quite straightforward, most of the researches focus on the first sub-problem.

Association rule mining process could be divided into two main phases to enhance the implementation of the algorithm. The phases are:

1. **Frequent Item Generation:** This is to find all the item sets that satisfy the minimum support threshold. The item sets are called frequent item sets.

2. **Rule Generation:** This is to extract all the high confidence rules from the frequent item sets found in the first step. These rules are called strong rules. According to [7], association analysis is based on the rule that is specified in the form: If item A is part of an event then X % of the time (confidence factor) item B is part of the same event.

This study is based on two different algorithm use in mining association rule. The algorithms are Apriori algorithm and frequent pattern growth (fp-growth) algorithm.
Apriori algorithm

Apriori algorithm [3] is the most fundamental and important algorithm for mining frequent things. Apriori is used to find all frequent things in a given database, that is, it provides a way to find association rules on large scale. The importance of Apriori algorithm is to produce multiple searches over the database. It uses a repetitive approach called a breadth-first search (level-wise search) through the search room, where \( K \)-things are used to explain \((K+1)\)-things. Apriori is designed to operate on databases containing transactions. Each transaction is seen as a collection of items or data known as item sets. Given a threshold \( C \), (confidence) the Apriori algorithm identifies the item sets which are subsets of at least \( C \) transactions in the database [6].

Apriori Principle:

i. If an item set is frequent, then all of its subsets must also be frequent, or

ii. If an item set is infrequent then all its supersets must also be infrequent

Apriori principle holds due to the following property of the support measure:

\[ \forall X, Y : (X \subseteq Y) \Rightarrow s(X) \geq s(Y) \]

i. Support of an item set never exceeds the support of its subsets.

ii. This is known as the anti-monotone property of support.

General Process

Association rule generation is usually split up into two separate steps:
1. First, minimum support is applied to find all frequent item sets in a database.
2. Second, these frequent item sets and the minimum confidence constraint are used to form rules.

While the second step is straightforward, the first step needs more attention. Finding all frequent item sets in a database is difficult since it involves searching all possible item sets (item combinations). The set of possible item sets is the power set over \( I \) and has size \( 2^n - 1 \) (excluding the empty set which is not a valid item set). Although the size of the power set grows exponentially in the number of items \( n \) in \( I \), efficient search is possible using the downward-closure property of support (also called anti-monotonicity) which guarantees that for a frequent item set, all its subsets are also frequent and thus for an infrequent item set, all its supersets must also be infrequent. Exploiting this property, efficient algorithms (e.g., Apriori and Eclat) can find all frequent item sets.

Apriori Algorithm Pseudocode

procedure Apriori \((T, \text{minSupport})\) //\( T \) is the database and minSupport is the minimum support

\[ L_1 = \{ \text{frequent items} \}; \]

For \((k = 2; L_{k-1} \neq \emptyset; k++)\) {

\[ C_k = \text{candidates generated from } L_{k-1} \]

//that is cartesian product \( L_{k-1} \times L_{k-1} \) and eliminating any \( k-1 \) size itemset that is not frequent

for each transaction \( t \) in database do{

//increment the count of all candidates in \( C_k \) that are contained in \( t \)

\[ L_k = \text{candidates in } C_k \text{ with minSupport} \]

}//end for each

}//end for

Return \( U_k L_k; \)

As is common in association rule mining, given a set of item sets (for instance, sets of retail transactions, each listing individual items purchased), the algorithm attempts to find subsets which are common to at least a minimum number \( C \) of the item sets. Apriori uses a "bottom up" approach, where frequent subsets are extended one item at a time (a step known as candidate generation), and groups of candidates are tested against the data. The algorithm terminates when no further successful extensions are found.

3.1 Frequent Item Generation

Apriori algorithm for frequent item generation is a two-step process of join and prune as follows:

JOIN STEP: Let the set of frequent item sets of size \( k \) be \( f_k \) and their candidates be \( C_k \). Apriori first scans the database and searches for frequent item sets of size \( 1 \) by accumulating the count for each item and collecting those that satisfy the minimum support requirement. It then iterates on the following three steps and extracts all the frequent item sets.

1. Generate \( C_{k+1} \), candidates of frequent item sets of size \( k+1 \), from the frequent item sets of size \( k \).
2. Scan the database and calculate the support of each candidate of frequent item sets.
3. Add those item sets that satisfies the minimum support requirement to \( F_{k+1} \).
**PRUNE STEP:** Check if all the item sets of size k in \( f_k \) are frequent and generate \( C_{k+1} \) by removing those that do not pass this requirement from \( f_k \). This is because any subset of size k of \( C_{k+1} \) that is not frequent cannot be a subset of a frequent item sets of size k + 1. This step removes a candidate if it contains any infrequent k-pattern.

Method (level-wise search):

i. Initially, scan DB once to get frequent 1-itemset.

ii. For each level k:

- Generate length (k+1) candidates from length k frequent patterns
- Scan DB and remove the infrequent candidates
- Terminate when no candidate set can be generated

### Table 1: Transactional Table

<table>
<thead>
<tr>
<th>Transaction id</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apple, chocolate</td>
</tr>
<tr>
<td>2</td>
<td>Apple, Biscuit, Chocolate</td>
</tr>
<tr>
<td>3</td>
<td>Biscuit, Black Jam, Cream Soda</td>
</tr>
<tr>
<td>4</td>
<td>Cream Soda, Apple, Chocolate, Blue Band</td>
</tr>
<tr>
<td>5</td>
<td>Apple, Cream soda</td>
</tr>
</tbody>
</table>

Step 1 scan the database and generate the frequent item set as shown in Table 1 above

### Table 2: C1 (candidate table)

<table>
<thead>
<tr>
<th>Items</th>
<th>Frequency or support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>4</td>
</tr>
<tr>
<td>Chocolate</td>
<td>3</td>
</tr>
<tr>
<td>Biscuit</td>
<td>2</td>
</tr>
<tr>
<td>Black Jam</td>
<td>1</td>
</tr>
<tr>
<td>Cream soda</td>
<td>3</td>
</tr>
<tr>
<td>Blueband</td>
<td>1</td>
</tr>
</tbody>
</table>

From table 2 assuming the set min. support is 2, apriori would generate, L1 (large dataset of frequent item sets) that meet the set min. support and prune out the items that does not meet the min. support as shown in table 3 below

### Table 3: L1 (large dataset)

<table>
<thead>
<tr>
<th>Items</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>4</td>
</tr>
<tr>
<td>Chocolate</td>
<td>3</td>
</tr>
<tr>
<td>Biscuit</td>
<td>2</td>
</tr>
<tr>
<td>Cream soda</td>
<td>3</td>
</tr>
</tbody>
</table>

From the large dataset, the apriori generate another candidate set C2 and its min. support as shown in table 4 below.

### Table 4: L2 (large dataset)

<table>
<thead>
<tr>
<th>Item sets</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple , Chocolate</td>
<td>3</td>
</tr>
<tr>
<td>Apple , Biscuit</td>
<td>1</td>
</tr>
<tr>
<td>Apple , Cream soda</td>
<td>1</td>
</tr>
<tr>
<td>Chocolate, Biscuit</td>
<td>0</td>
</tr>
<tr>
<td>Chocolate, Cream soda</td>
<td>0</td>
</tr>
<tr>
<td>Biscuit, Cream soda</td>
<td>0</td>
</tr>
</tbody>
</table>

Since no more candidate set can be generated again from the table, Terminate when no candidate set can be generated

#### 3.2 Rule Generation

From the above frequent item generated and based on the min. support. We now proceed to determine if the 2-itemset \{Apple, Chocolate\} lead to association rules with required confidence of 75%. Every 2-itemset \{X, Y\} can lead to two rules \( X => Y \) and \( Y=>X \), if both satisfy the required confidence. As defined earlier, confidence of \( X => Y \) is given by the support for \( X \) and \( Y \) together divided by the support for \( X \).

The study therefore have two possible rules and their confidence as follows:

- Apple => Chocolate with confidence of \( \frac{3}{4} = 75\% \)
- Chocolate => Apple with confidence of \( \frac{3}{3} = 100\% \)

Therefore, both rules have confidence of minimum of 75% required and qualify. Rules that have more than the user-specified minimum confidence are called confident.

#### 3.3 FP-Growth Algorithm

FP-GROWTH takes a clear different approach to discovering or finding frequent item sets. The algorithm does not align to the GENERATE AND TEST model of the APRIORI, instead, it forms a compact datasets using a data structure called FP-TREE and then extract the frequent item sets directly from this structure. It compresses large database into a compact Frequent-Pattern tree (FP-tree) structure highly condensed, but complete for frequent pattern mining and avoid costly database scans. The divide-and-conquer methodology is used by FP-GROWTH in arriving at its result. The FP-growth algorithm mining frequent patterns without candidate generation was proposed by [4].
Fp-growth Algorithm Pseudocode

Input: FP-tree constructed based on Algorithm 1, using DB and a minimum support threshold $\xi$.

Output: The complete set of frequent patterns.

Method: Call FP-growth (FP-tree; null), which is implemented as follows.

**Procedure FP-growth (Tree; $\alpha$)**

```
IF   Tree contains a single path P
THEN FOR EACH combination (denoted as $\beta$) of the nodes in the path P DO
   generate pattern $\beta \cup \alpha$ with support = minimum support of nodes in $\beta$;
ELSE FOR EACH $a_i$ in the header of Tree DO {
   generate pattern $\beta = a_i \cup \alpha$ with support = $a_i$.support;
   Construct $\beta$'s conditional pattern base and then $\beta$'s conditional FP-tree $Tree_\beta$;
   IF $Tree_\beta \neq \emptyset$
   THEN Call FP-growth (Tree$\beta$; $\beta$)
}
```

3.3.1 Frequent Item Generation

FP-growth algorithm allows frequent item sets generation without candidate item sets generation. FP-growth uses a two-step approach known as:

- **Building The FP-Tree:**
  - The Fp tree is constructed with two passes over the database
    - **Pass 1:**
      - i. Scan data and find support for each item.
      - ii. Discard infrequent items.
      - iii. Sort frequent items in decreasing order based on their support.
      - iv. For our example: $a$; $b$; $c$; $d$; $e$ Use this order when building the FP-Tree, so common prefixes can be shared.
    - **Pass 2:** construct the FP-Tree
      - i. Read transaction 1: $a$; $b$, then create 2 nodes $a$ and $b$ and the path null ! $a$ ! $b$. Set counts of $a$ and $b$ to 1.
      - ii. Read transaction 2: $b$; $c$; $d$, then create 3 nodes for $b$, $c$ and $d$ and the path null ! $b$ ! $c$ ! $d$. Set counts to 1. Note that, although transaction 1 and 2 share $b$, the paths are disjoint as they don't share a common prefix. Add the link between the $b$'s.
      - iii. Read transaction 3: $a$; $c$; $d$. It shares common prefix item $a$ with transaction 1 so the path for transaction 1 and 3 will overlap and the frequency count for node $a$ will be incremented by 1. Add links between the $c$'s and $d$'s.
      - iv. Continue until all transactions are mapped to a path in the FP-tree.

- **Extraction Of The Frequent Itemsets From The Tree:**
  - FP-Growth extracts frequent item sets from the FP-tree.
  - Bottom-up algorithm from the leaves towards the root
  - Divide and conquer: First look for frequent item sets ending in $e$, then $de$, etc. . . then $d$, then $cd$, etc. First, extract prefix path sub-trees ending in an item(set). (hint: using the linked lists)
3.5 METHODOLOGY FLOW CHART

Figure 2: Flow Chart showing the step follows in the methodology

4. RESULTS AND DISCUSSION

The study proposes to use an open source data mining tool - Weka. Weka (Waikato Environment for Knowledge Analysis) is a popular suite of machine learning software written in Java, developed at the University of Waikato. WEKA is free software available under the GNU General Public License. The Weka workbench contains a collection of visualization tools and algorithms for data analysis and predictive modelling, together with graphical user interfaces for easy access to this functionality.

Figure 1: Pre-processing of data sets. The pre-processing stage serves as the editing and loading of data in the Weka platform.

Figure 2: This phase is the result of data set implemented using Apriori Algorithm. The result revealed the relationship between data items.
Future research will involve comparing the two Algorithms and their time complexity and further refining the method presented. This study would help in generating the efficient Algorithm for frequent data item set mining. Other data mining techniques and tools can also be explored and comparing their results would also be a promising area in future works.

REFERENCES


5. CONCLUSION

This study focused on comparison and analysis of association rule mining for monitoring behavioural pattern of customer in a grocery store. Two association rule techniques were used, FP-growth Algorithm and Apriori algorithm were implemented on sixty three (63) data sets in a Weka tool. It was observed that FP-growth Algorithm took faster time of execution as compared to Apriori Algorithm. This indicates that the amount of time it requires to run to completion is less than the amount of time required in Apriori algorithm. The study supports the fact that FP-growth algorithm is the fastest approach for frequent item set mining.
Broadband infrastructure using Fiber Optic: The State of things in a Developing Economy

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ABSTRACT

Nigeria is presently experiencing an influx of fiber optic operators into the country but minimal “last mile” deployment to users. The influx might be closely related to the huge potential in the country’s ICT market and its importance in the world economy. With these advancements, the country still has a low penetration of fiber optic network even though there are a lot of fiber optic backbone cables landed on the shores of the country. The last mile deployment of the cables is expected to enhance the much expected ubiquitous broadband in the country. This work gives an assessment of fiber optic operator’s activities in terms of coverage, capacity and utilization. This research work also examines the relationship between major players using the broadband ecosystem model to analyze the relationships between the different tiers of the system in terms of competitions, information and symbiosis. Challenges militating against broadband penetration in Nigeria were also investigated and solutions proffered.

1. INTRODUCTION

ICT has been seen in Nigeria as a necessary foundation for long-term economic development. The importance of ICT cannot be over emphasized in national development given the trends of ICT development in advanced countries [1]. Nigeria the most populated country in Africa with over 167 million people has being described as the largest growing market in Africa ICT market in terms of internet usage and mobile/fixed line subscriptions. Despite these large market share in the industry, ICT development in the country is still a far cry compared to the advanced countries. While it had been very successful in increasing access to basic voice communications, there has been no comparable improvement in broadband connectivity. The broadband access gap between Nigeria and the rest of developed world is getting wider just as the gap in basic voice communications is getting smaller [1,2]. Nigeria is quoted by the Nigerian Communications Commission (NCC) to have 6% broadband penetration, when the country has interestingly 10Tbps bandwidth capacity of submarine optic fiber at the shores of the country [3].

High cost of internet facilities, inadequate bandwidth capacity supply to the end users, low penetration of internet in rural areas, lack of pragmatic ICT National Policy and failing infrastructure amongst other factors affects broadband penetration. Therefore increasing access to broadband connectivity is therefore emerging as a high priority for policy makers across the country [4, 5].

According to the Nigerian broadband plan; 2013-2018, broadband is an internet transmission capacity with a minimum speed of 1.5Mbits/s [6], the International Telecommunication Union (ITU) defines it to have a capacity between 1.5Mbits/s – 2.0Mbits/s. Broadband is very important and synonymous with the economical growth of any nation [7]. The internet, which is the ultimate wide area network, relies on backbone infrastructure to transmit and carry data over long distances, across countries, continents and all over the world.

The inability of satellite communications and microwave to provide the needed internet capacity to carry the ever growing traffic demand necessitated the emergence of submarine fiber optic cable. Submarine fiber optic cable is a cable laid under the sea between land-based stations to carry telecommunication signals across stretches of ocean. It is designed to provide high speed, reliable and unlimited bandwidth capacity for communications [8, 9].

Before the landings of undersea cables on the shores of the country, the high cost of internet was attributed to a lack of cable infrastructure and total dependence on satellite. Sat-3 cable was then laid, linking the South and Western parts of Africa to Europe and Asia. Other alternatives were later laid such as the MainOne, Glo1 and WACS and potential ones are ACE, SAex, WASACE and SACS.
Domestic Fiber Optic backbone network lie at the heart of most communication service; supply chain, it also serves as the integral component in the provision of broadband connectivity. In Nigeria, most Internet traffic passes in and out of the region, since little Internet content is hosted within the country itself. A wired backbone network is essential for high traffic between network nodes. The hierarchical nature of communications networks means that the volumes of traffic carried on the backbones are very high, even if the customer base is small.

Limited availability of high-capacity of domestic fiber optic backbone network in Nigeria is one of the factors underlying the limited growth of broadband in the country. Fiber Optic based broadband networks operators have focused on the most profitable geographical areas, primarily major urban areas and capital cities and intercity routes. The majority of the population living outside major urban areas is unlikely to benefit directly from fiber optic backbone infrastructure. Current Fiber Optic backbone network infrastructure in Nigeria is characterized by widespread, networks generally owned and operated by vertically integrated operators focusing on voice services. The underlying causes of this pattern of network and market development in Nigeria might be due to high cost of network construction and operation [9].

This paper focuses on investigating the reasons why Nigeria has a low penetration of fiber optic network even though there are lots of fiber Optic backbone cables landed on the shores of Nigeria. Factors influencing the choice of network for broadband penetration in Nigeria and methods of enhancing the penetration are also presented.

2. BROADBAND BACKBONE

This backbone infrastructure gets into Nigeria through many means mainly satellite and fiber optics cable [7]. The increase in the highway of information from and to the country has assisted increasing information and communication technology (ICT) penetration in the country. Some major factors have made fiber optic the choice broadband deployment method over satellite network in Nigeria according to [10]. These and other factors are presented in this section.

Market and Cost

Nigeria has big broadband market with many users and the demand for fast connection is high, thus a high traffic is generated. Fiber optic has the advantage of overall cost reduction with an increase in volume of traffic. Perhaps the main disadvantage of satellite communication is their high cost relative to fiber optics communication. While the initial cost of a continental fiber optic network for Africa may appear too high, the long term cost savings over satellite transmission are overwhelming.

Location

Considering that Nigeria is located on the coast, affords her great privilege to access fiber optic backbone network as she is not a landlocked country. Nigeria is bounded to the southwest and south by Atlantic Ocean making it easily accessible to undersea fiber optic cable.

Weather and Climate

Weather rarely affects fiber optic cable communication unlike satellite communication which is affected by weather (cloud, rain, fog, wind, etc). Nigeria is a country with heavy rain at some part of the country throughout the year and the northern part is known for its cyclic wind. These conditions are not good for satellite communications all year round.

Higher Bandwidth

The bandwidth available using a single fiber optic cable and a laser beam is much greater than can be obtained from a single satellite radio channel. Higher frequency and shorter wavelength of light compared to microwaves results in higher bandwidth; the higher the frequency, the larger and better the bandwidth of transmission. An undersea cable is a bundle of many (92 pairs) fiber optic cables; bandwidth offered is therefore high and appropriate for Nigeria to be in the forefront of the IT revolution.

Latency

Latency refers to any delay incurred in processing network data, low latency result in small delay time while high latency result in long delay time. In fiber optic cable communication there is low latency compared to satellite form of communication. For satellite transmissions, signals travel more than 50,000 miles and this result to delay of up to 600 milliseconds during transmission while transmission on submarine fiber optic cable and coaxial cable networks is about 100ms.

Replaceable

Fiber cable can be fixed if damaged or broken though most submarine fiber optic cables are built to be resilient and adequate provision is made for its Right of Way, damage sometimes occur. Unlike satellite that can’t be fixed physically once it is launched, it can only be fixed remotely or the satellites falls out of the orbit and disintegrates with time.

Security

Wireless communication is much more vulnerable to trust issues when confidential information is being transmitted; this is because it is vulnerable to interception and corruption. Although several data encryption algorithms are available for IP over wireless, the high bit error rate may cause failures in the encryption systems. Fiber optic transmission by its characteristics makes hacking a difficult process thereby offering undoubtedly much better confidentiality and security of data transmitted.
Scalability and expansion
In order to address increasing traffic demand, it is relatively easy to increase the capacity of fiber optic networks during their lifetime by means of wavelength division multiplexing technology. For example, the SAT-3/WASC/SAFE system has been upgraded in several fold. At inception, it was cut out to be 2.5 x 4 Gbps presently; it is operating at 920 Gbps [11]. It is impossible to do a similar upgrade on satellite systems.

Environmental safety
Fiber optic is much more environmentally friendly. The light signal used for transmission is fully contained within the fiber. It uses substantially less energy than wireless and does not expose wildlife and vegetation to radiation [12]. Chronic exposure to RF radiation causes symptoms variously known as Radio Frequency Sickness, Radio Wave Sickness, and Microwave Sickness. Alzheimer’s disease, multiple sclerosis, autism, diabetes, asthma, ADHD, and numerous other health conditions appear to be linked to exposure to radio frequencies, either from transmitted and electrical pollution origin [13, 14].

Spectrum Shortage
It is a known fact all over the world that allocation and increase in the use of spectrum for hosting new wireless technologies. To enhance increase in performance, increase in speed and coverage more frequency spectrum has to be utilized. Unfortunately, spectrum is a finite resource and wireless broadband is approaching a crises point already, fiber optic provides limitless opportunity and expansion option.

3. MOTIVATION
In Nigeria, a major factor responsible for limited growth in broadband is the low penetration of domestic backbone network. Present backbone networks are mainly in urban areas where most providers have established networks and providing the same or similar service to the same set of broadband operators. Clients in rural areas and other towns are often neglected. An established backbone network is essential to ensure fast internet connectivity, because of the hierarchical nature of communication networks backbone networks are required to carry high traffic even in an environment with low customer base [9]. Furthermore, availability of adequate domestic backbone network will result in significant saving for users. This research is timely at a period when Nigeria begins to experience influx of Submarine Fiber Optic Cable operators due to the huge potential in the country’s ICT market especially in the telecoms industry and yet an undeveloped domestic backbone network.

4. BACKBONE INFRASTRUCTURE IN NIGERIA
Mobile subscribers in Nigeria were placed at 116,601,637 active lines at the end of February 2013. Second generation (2G) mobile coverage was at 98% while 3G coverage which is mostly concentrated in urban areas is very limited at less than 35%. Internet penetration is quoted at 33% and Broadband penetration is at 6% [3]. Nigeria’s ICT penetration and teledensity are as shown in Figure 1.

Nigeria currently boasts of primary fiber optic backbone infrastructure presence in all the 36 state capitals and the Federal Capital Territory (FCT), with most fiber infrastructure concentrated in state capitals and a few urban centres. Of the 774 existing local government headquarters very few are connected on the route of the primary fiber backbone. Metropolitan networks only cover part of Lagos, Port Harcourt and Abuja [6].

After about 43 years, the Nigerian Telecommunication Plc, NITEL had about half a million lines available to over 100 million Nigerians. The President Olusegun Obasanjo administration in 1999 initiated the complete deregulation of the telecom sector, which led to the privatization of NITEL by giving licenses to GSM service providers. This proactive approach by the government to the telecom sector made it possible for over 114 million Nigerians to have access to the only form of modern communication available to them, mobile devices. About 34,471,520 of phone users in Nigeria used data on the internet in the first quarter of year 2013[15].

The licensing, rollout and upgrade of mobile networks based on GPRS, UMTS, HSPA, HSPA+, HSDPA, CDMA and EVDO technologies, easier access to affordable smart mobile devices by clients provides seamlessly connectivity to the internet. These wireless networks are responsible for the growth in internet access and usage recorded in Nigeria. With a roll out of 3G networks across the country, more subscribers are expected to have access to broadband internet using mobile devices [16]. The current backbone network infrastructure in Nigeria, though extensive in its reach is predominantly characterized with low-capacity, wireless based infrastructure designed to carry voice communications traffic majorly.

Presently, Nigeria has over 9 Tbit/s combined capacity of submarine cable landings on the shores of the country. All the landing points are in Lagos and other parts of the country are distributed from there. The provision of broadband connectivity to end users requires several elements. A problem in any of these elements will affect the delivery of affordable broadband services. In Nigeria, the inadequacy of domestic backbone networks is one of the factors underlying the limited growth of broadband in the country.

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Current backbone network infrastructure in Nigeria is characterized by widespread, low-capacity networks generally owned and operated by vertically integrated operators focusing on voice services. Incumbent network operators have much less extensive networks than in other part of the world.

Communications networks usually operate by channeling traffic from a geographically dispersed customer base to local switching or routing nodes; traffic is thus directed either to other customers (in the case of local voice and data communications) or to the Internet. In the case of Nigeria, most Internet traffic passes in and out of the region, since little Internet content is hosted within the country itself [9].

Nigeria’s International connectivity landscape has come a long way from a single international submarine cable system with 340 Gbit/s total capacity installed in 2001 with SAT-3. There was an expansion of the sector in 2008 by the first Submarine Fiber Optic Cable Company founded by Main One Cable Company commenced operations and sales of both domestic and international capacity in Nigeria. GloI owned by Globacom, Nigeria’s second national operator was the second carrier in Nigeria. Both companies have been in operations since 2010 while WASC owned by MTN also became active in 2011.

The communication bandwidth they provide has relatively yielded improvements in the Nigeria ICT sector. The four cables have a bandwidth of 10.34 Tbit/s bandwidth capacity and it is expected that by the end of 2014 the addition of four more cable would boost it bandwidth capacity to about 97Tbit/s.

International Fiber Optic Broadband Network Connectivity

SAT-3/WASC undersea cable system was cut over in the year 2002 and it was designed and implemented by Alcatel. It links Europe to Africa via the west coast from Portugal and Spain, and serving the Canary Islands, Senegal, the Ivory Coast, Ghana, Benin, Nigeria, Cameroon, Gabon, Angola and South Africa. It utilizes Dense Wavelength Division Multiplexing (DWDM) technology and it supported transmission at 4 x 2.5 Gbit/s [17]. The recent upgrade of the optical fiber cable went live during the first half of 2014 and it was upgraded from 420 Gbit/s to 920 Gbit/s in the northern segments, north of Ghana, and from 340 Gbit/s to 800Gbit/s in the southern segments [11]. Presently, Nigeria has a capacity of 800Gbits/s from the SAT-3/WASC submarine cable system. Figure 2 depicts the undersea cables landing on the shores of Nigeria and Table 1 shows the capacity of the fiber optic landed in Nigeria.
GLO1, owned and operated by Globacom with minimum capacity of 640 Gbit/s, the second largest telecom operator in Nigeria with a total capacity of 2.5 Tbit/s covering distance of 10,000 km from Lagos to UK, connecting 17 African and European countries, landed on the shores of Nigeria in 2009, while Main One covers a distance of over 7,000 km from London, with initial landing stations in Nigeria, Ghana and Portugal with total capacity of 4.92 Tbit/s.

MTN’s West African Cable System (WACS) commenced operation in 2011, and was delivered to Nigeria by MTN. It has links from Europe, West Africa and South Africa, with bandwidth capacity of over 5.12 Tbit/s and spanning a distance of 14,530 km. WACS has the mandate to deliver international connectivity and provide International Private Leased Circuits (IPLC) to any location across the globe, with an extensive terrestrial Internet Protocol (IP) and broadband infrastructure to deliver connectivity anywhere in Nigeria. Proposed Fiber Optic Broadband International Connectivity is summarized in Table 2. When all the proposed cables are installed Nigeria will be able to boast of 97.92 Terabits of fiber optic broadband bandwidth capacity on her shores.

Table 1: Nigerian cable landed capacity [6]

<table>
<thead>
<tr>
<th>CABLE</th>
<th>CAPACITY (Gigabits)</th>
<th>TERMINATION LOCATION</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT3/SAFE</td>
<td>340</td>
<td>Lagos State</td>
<td>Active</td>
</tr>
<tr>
<td>MainOne</td>
<td>1920</td>
<td>Lagos State</td>
<td>Active</td>
</tr>
<tr>
<td>GLO-1</td>
<td>2500</td>
<td>Lagos State</td>
<td>Active</td>
</tr>
<tr>
<td>WACS</td>
<td>5120</td>
<td>Lagos State</td>
<td>Active</td>
</tr>
<tr>
<td>TOTAL-IN SERVICE</td>
<td>9880</td>
<td>Lagos State</td>
<td></td>
</tr>
</tbody>
</table>

National and Metro Fiber Optic Broadband Network Connectivity

Though extensive in capacity, concentration is mainly in major cities of the country as rural areas are left out. Development of fiber-optic backbone networks has occurred predominantly within state capitals and on inter-state routes. All the 37 state capitals including FCT are covered. Within metropolis fiber networks is largely limited to few state capitals in the country and these are Lagos, Abuja and Port Harcourt. Table 3 depicts the metro network within the country. However, Nigeria’s backbone network infrastructure although extensive in many parts of the country as discussed earlier; consists of islands of infrastructure that
are not linked to each other. Figure 3 shows the national and metro fiber optic connections within the country.

Table 2: Proposed Additional Cable Systems [6]

<table>
<thead>
<tr>
<th>Cable</th>
<th>Capacity (Gigabits)</th>
<th>Termination Location</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE</td>
<td>5120</td>
<td>?</td>
<td>Planned 2012</td>
</tr>
<tr>
<td>SAex</td>
<td>12800</td>
<td>?</td>
<td>Planned 2014</td>
</tr>
<tr>
<td>WASACE</td>
<td>40000</td>
<td>?</td>
<td>Planned 2014</td>
</tr>
<tr>
<td>SACS</td>
<td>40000</td>
<td>?</td>
<td>Planned 2014</td>
</tr>
<tr>
<td>TOTAL-IN SERVICE</td>
<td>97920</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Estimated Coverage of Fiber infrastructure [6]

<table>
<thead>
<tr>
<th>Category</th>
<th>Area Description</th>
<th>Estimated coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>Fiber backbone to all state capitals and FCT</td>
<td>100% (37 of 37)</td>
</tr>
<tr>
<td>Category 2</td>
<td>Metropolitan Area network in cities</td>
<td>10% (mostly Lagos, Abuja and Port Harcourt)</td>
</tr>
<tr>
<td>Category 3</td>
<td>FTTB. Fiber to the base station</td>
<td>10% of all base stations</td>
</tr>
<tr>
<td>Category 4</td>
<td>FTTC, Fiber to the cabinet, buildings or states</td>
<td>Unknown (e.g. 744 local governments)</td>
</tr>
</tbody>
</table>

National and metro coverage hasn’t been too extensive as they only include major cities. Taking GLO1 network as a case study, Globacom initiated its fiber ring project across the nation and so far a good number has been completed: Abuja to Kano, Minna, Enugu-Owerri-Uyo, Lagos-Benin, from Ibadan to Ilorin, Ife-Osogbo, Enugu to Abakaliki, Ogomosho to Saki etc. Other operators and ISPs are neither left out as network as predominately focused these areas and have embarked on similar projects.

While some of these routes have being observed to have multiple cables installed, vast expanses of rural areas are left out. For example, there are about seven fiber optic laid networks between Lagos and Abuja alone; while other routes especially rural areas in the country have none.

MTN initiated a project called Blaze network, Blaze was implemented in four phases; phase1 and phase 2 includes the southern and the eastern rings covering a distance of 2,422km. Phase 3, northern ring spans 1,116km and phase 4 Niger-Delta ring with a total distance of 347km all found in the major cities. Though two of the operators are still rolling out fiber infrastructure over power lines which by their nature run through rural areas, this situation requires government intervention so as to extend to include regional networks and links to most of the rural and un-served communities.

Though difficult to get the facts on utilization, it can be deduced that utilization is still very low, owning to the fact that the CEO of MainOne cable Mrs. Funke Opeke said “Nigeria is yet to utilize 5 per cent of its cable capacities” in 2012 [18], same with other cable operators and the report released by the NCC in the first quarter 2013 which also shows that less than 35 million Nigerians uses data on the internet in the confinement of the country in the three months under consideration [15]. This implies that over 100 million Nigerians still do not use or have access to broadband services; an issue of accessibility.
However, studying Figures 2 and 3 one is bound to ask; why low utilization of these huge capacities at the shore of the country and thus high cost of internet access in the country. Some reasons will be highlighted in the next couple of paragraphs on challenges affecting fiber optic network penetration despite the arrival of Main One, Glo1 WACS in addition to SAT3 cables.

Operators like MainOne and others have focused in urban areas because of the existing infrastructures in these areas. This might be as a result of inadequate power supply at other underdeveloped areas leading to high cost of fueling and maintenance of generators. Other challenges amongst many others include poor transportation network which involves the movement of people, goods and services to implement the development of backbone networks all missing in the rural areas, the areas have low average revenue per user (ARPU).

One of the major reasons for the low utilization is the cost of taking it to end users which is usually higher than the cost of taking the fiber from Europe to the country. This is because, already existing pre-agreement between different organizations or governments in the cable’s landing countries are all responsible for the total cost of landing the cable at the shore. Now each organization is solely responsible for the distribution of its bandwidth in her respective countries. For example, SAT3 is jointly owned by NIGCOMSAT for Nigeria and sixteen other organizations, in those countries that it has it landing point.

The total cost of laying the cable from Europe to those countries is collectively shared by those organizations that would have made a pre-agreement before the laying. But the cost of distributing the bandwidth within the country is wholly taken care of by those individual organizations as the case of NIGCOMSAT. The cost of transmitting traffic on SAT3 network to all parts of the country, from Lagos to Sokoto, Lagos to Abuja etc will all be taken care of by NIGCOMSAT, meaning more expenses compared to the cost of landing it.
Fiber optic is also more labour intensive as it requires underlying fiber optic cable beneath the earth from the landing point to the intended destination. Digging from Lagos to Kano for example will be very tedious and consumes more money and time.

**Last Mile Fiber Optic Broadband Network Connectivity**

Delivery of broadband access in Nigeria to last-mile users is still largely carried out using wireless technology. Mobile network rollout in Nigeria is majorly based on 2.5G (GPRS), EDGE, UMTS, HSPA, HSPA+, HSUPA, HSDPA AND CDMA EV-DO technologies. With the increase in penetration of smart phones and mobile devices the major method of connectivity to the internet by subscribers is through their mobile devices and modem using mobile operators’ networks. 3G networks have also been deployed in major cities of the country resulting in much better internet connectivity [6].

### 5. FIBER OPTIC BROADBAND ECOSYSTEM

Ecosystem refers to a number of organisms that interact within an environment at a particular time. In relation to ICT, ICT ecosystem can simply be said to be all that makes up the information communication technology environment. These include information, strategies, policies, processes, technologies, applications and all the stakeholders including: individuals, who create, buy, sell, regulate, manage and use technology. Martin Fransman, perhaps the leading scholar of the ICT sector, has made persuasively the case that “it is fruitful to understand the ICT sector as an ecosystem [19].

There are four major players making four layers also called tiers in Fiber Optic broadband ecosystem namely: core network, distribution network, access network and the customer as shown in Figure 4. All the players involved are interconnected and are closely related for better delivery and conducive environment. This relationship can either be competitive or symbiotic and it can exist in six different forms. The relationship between major players of the ecosystem is shown in Figure 5.

**Tier 1 (Core Network)**

The core network also referred to as international connectivity provides the basic element necessary to implement the fundamental requirements to startup access to broadband. As the name implies they are core network provider, making it work from the scratch and supplying networked elements like routers, switches, servers and the core personnel. The layer includes in addition to all the hardware components also the necessary software.

**Tier 2 (Distribution network)**

There are basically integrated in the layer 1, although originally separated; these two layers are increasingly interconnected as in the case of MainOne which can be seen as tier1 and tier2 in another angle also included are some telecom operators like GLO and MTN. They employ several channels to provide services; provide content distribution which might also include interstate optical cable. They are at times referred to as network operator who peers with some networks, but still purchases IP transit or pays settlements to reach at least some portion of the Internet broadband.

**Tier 3 (Metropolitan access links - Access)**

This tier provides platform, content and application. Platforms are product or technologies that can run and host a variety of services and applications. They provide connection to internet service providers (ISP), link together base stations (BS) for mobile access and wireless service providers. Content and applications refer to final products, such as dedicated service websites, mobile phone services, these services could be generic. Tier3 are ISPs that solely purchase transit from other networks to reach the Internet.

**Tier 4 (Consumers)**

These include the users of broadband network which includes individual people, organizations, such as firms, associations, government parastatal.

**Ecosystem Model**

Though it has been partly explained that innovation lies at the heart of very level of the broadband ecosystem and relationship between these layers but with the model below it better explains how innovation can be achieved. Figure 5 shows the six symbiotic relationships between the four players in broadband ecosystem.
Relationship One
Relationship between core network and network distributor involves close cooperation and mutual dependence. Currently, one of the issues in IT is impending stress on this symbiosis, as some of the network distributors are attempting to capture business from core network operators, and vice-versa.

Figure 5: Symbiotic relationships between the four players of broadband ecosystem (adapted from Fransman 2007)

Relationship Two
Relationship between network distributor (network operators) and content and applications providers is presently strained. This is where the bulk of the penetration in the country stops. Optic fiber network has penetrated state capitals in the country including the Federal capital Territory but to very few internet service providers. Internet service providers in the country rely more on wireless connections and linkages especially for the provision of last mile access. Presently in the country there is an overlap between the two providers, although they should be separated. MainOne, GLO and MTN are both network distributors and also metropolitan distributors. They are at times referred to as network operator in some quarters and also metropolitan distributors in others.

Relationship Three
This depicts the relationship between access distributor and the final consumers. There are currently no known last mile accesses (fiber to homes) in the country. With the coming together of some tertiary institutions in the country through Nigerian Network Operators Group (NgNOG), presently a number of tertiary institutions are linked together to ensure collaboration and improved research. The network operators in the country provide fiber links connecting their base stations to improve broadband access to mobile users with 2.5 and 3G coverage areas. Other operators provide fiber links to data centers, industries and establishments.

Relationship Four
Relationship Four is between international connectivity providers and final consumers. Example include GLO and MTN, these relationships are often black boxed. GLO have an increasing interest to learn about this relationship as it only sells directly to final consumers. Also considering that even though the customer base and final consumers might be small compared to developed countries, the hierarchical nature of communications networks means that the volumes of traffic carried on the backbones are very high. Therefore there is a need for higher bandwidth for the backbone network.

Relationship Five
Relationship between core network provider who provide international connectivity and metropolitan access distributor (platform, content and application provider) as indicated in Figure 4. Example include, SAT3 regulated in Nigeria by NICOMSAT to galaxy backbone who sells directly to the final consumers and equally provide a platform for hosting content and applications for Ministries Departments and Agencies (MDAs).

Relationship Six
Relationship six relates network distributors (network operators) and final consumers. This has been traditionally fixed voice service to final consumers, but is assuming increasingly new forms. Today, these include a wide array internet access from mobile operators who buy or have access to broadband from core network.
6. CHALLENGES AND POSSIBLE SOLUTION TO NIGERIAN BROADBAND PENETRATION

The island of fiber infrastructure in Nigeria and lack of an established metropolitan network is due to many reasons some of which will be presented in this section and possible solutions.

**Government Involvement**

Failure on the part of Government to put proper policies and legislatures in place, created gap between a balance and conducive atmosphere for competitions and symbiosis among the players of the broadband system. The lack of not putting the adequate infrastructure in place and for the fact that access to data in the country is always cumbersome is a fault on the government. Institutions (government owned universities, polytechnics and colleges of education), research organizations etc have no proper access to broadband and funding, thus, knowledge and collaboration can’t be harnessed fully. As a result of little or no access to right information has resulted in poor local content which equally tell on the price and challenges militating against broadband at large.

Policy toward backbone network development in Nigeria must address critical areas and proper enforcement needs to be implemented. Successful policy will have to include key elements like: stimulating rollout in underserved areas, as in the case of rural areas and small towns and to allow aggregation of traffic onto higher-capacity networks.

It also entails providing the basic necessary infrastructure for all the levels of players ranging from networked elements to last mile that is the final users. This might encompass proper funding of the public institutions, scholarship to students in order to alleviate the high illiteracy predominance within the region, restricting regulation should be proper tailored to boost indigenous companies and also attract some foreign investors. Incentives and grants could also be provided for the three intermediate players in the system to boost the sector.

**Lack of competition**

Relationship could either be competitive or symbiotic within and between the players of the broadband system. The competition in the domain is low in the real sense as a result of backbone networks are typically owned by vertically integrated operators that have built end-to-end networks [7]. Competing downstream operators and service providers are unable to obtain access to affordable backbone capacity, so competition in the provision of broadband in this region of metropolitan access distribution has not developed as well as it has in other developed parts of the world.

Nigeria is also still relatively new in the market with SAT3 being the only international broadband connector for many year. GLO1 and MainOne cables just came onboard in 2010 and WACS in 2011. The country still has a lot of growing to do. The Government should however learn from the failure and success of countries and build a better resilient, effective and fast growing broadband network. Presently, backbone networks are mainly used by mobile network operators to provide backbone services to their own retail customers.

This encourages lack of competition and access and provision of needed market to metropolitan access distributors. The government should provide an enabling environment for open access infrastructure sharing among the different levels of providers.

**Local Content**

Using the fiber optic broadband ecosystem innovation should take place in the heart of every layer. However, the case has not been so in the country’s broadband ecosystem as little meaningful innovations have taken place at most levels. The local content (websites, web services and technologies) developed within the country are short of international standard, therefore most traffic is directly toward Europe and America attracting extra cost and very minimal local traffic.

Incentivizing content creation, innovation through application development and services, and bringing content closer to end-users (e.g., localizing information) are also key. This will help curb the increasing idle minds leading to inadequate local content in the country. This can be done by providing more and accessible incubation centers, research centers and digitalized libraries for both researchers (lectures, students, businessmen) and inventors.

**Lack of Expertise and Literacy Level**

There are only few experts in the broadband backbone industry in the country. Considering broadband penetration within the country, there is more interest in other things such as food, infrastructure, security etc while availability of broadband tails the long list. These have affected the system negatively, users and the country’s citizenry have critical role in pushing for the creation and implementation of an established broadband industry.

There is also scarcity of indigenous skills and expertise at all levels of the ecosystem, ranging from the policy makers to the rural users. Research and development also taking place within the country is geared mainly towards software development with no particular interest in hardware, maybe due to the fact that firstly, there is no company or industry within the country manufacturing ICT hardware from resistors to fiber optic cables. Secondly, the academic and research institutions are not well funded therefore there are no established hardware laboratories to effectively work on the sector.

The government should enact policies that will make Nigeria friendly to investors. Nigeria has enough human resources and large enough market base to take up the challenge. Research institutions should also be well funded to carry out hardware related research in this field to ensure well trained personnel and well established collaboration with the industry. The Government can commit to promoting basic literacy, connecting schools, training teachers and getting computer systems to school children. Governments can also look to adopt other initiatives that have proved successful in expanding digital literacy in other countries, such as linking national e-Gov portals to existing government services, programmes to increase the business use of digital applications by SMEs and integrating e-health into government services.
Infrastructure

Infrastructure has a lot to play in broadband ecosystem as it controls price and innovation naturally. The country is yet to be there in term of infrastructure, it was a good step to liberalize the sector in 2000 but the government failed to put the proper infrastructure then in place for the private investors. A central or nationwide backbone network was built in government institutions like universities, research centers and will have been appropriate before embarking on the deregulation process. The government should have also have a planed network which can be implemented a step at a time. Instead the government handed over her responsibility to the private sector who are more interested in their capital base than the growth and interest of the country even if they are indigenous firms. A well planned network and a government owned nationwide backbone would have assisted the private sector in consolidating on already existing platform and allowed them to run at a determined low cost. It will also provide a framework in which they are to work and expand. This will also enable Internet Service Providers (ISPs) have equal access to available broadband capacities; and by so doing the government will be able to control the price and coverage fully.

Laws made in the country have not promoted low taxes on the prices of ICT equipments into the country which has been on the high price, thus affecting a healthy access to the necessary tools for creating innovations. Due to lack of adequate planning of the broadband network by the government, adequate right of way is not provided for operator’s cables. During construction of roads and infrastructures these cables are destroyed and have to be reinstalled again. Operators claim to spend millions of Naira annually on vandalized cables by activities of government contractors building roads, the much needed money to have gone into network expansion and provision of quality service.

The government should take up their responsibility and invest in the ICT sector. Not only investing money but also professional expertise to come together and chart a proper plan for the growth and penetration of broadband network within the country. Leading to policies and enacting laws to support these plans. Since 2003, the government of Spain required the construction of new buildings to include common passive communication infrastructure such as ducting, access points and building rises (William, 2010). Presently in Nigeria, newly built academic and research buildings do not even have such laws enacted, the country definitely have a long way to go.

ICT Infrastructure are critical to national interest and should be well protected. The security of licensed investors both in term of lives and properties greatly lies on the government and as such the proper protection of outdoor telecoms infrastructures should be well articulated for. This is imperative especially in term of vandalization and sabotage of fiber optic cable operators who had the necessary permit. And also the lives of the telecoms field staffs should be well protected from harassments from thieves and kidnapers as this is the only way to attract foreign investors.

Landing Point

Presently, all the landing point are in Lagos, Nigeria. All other parts of the country need to connect to Lagos leading to a choke and limited distribution to other parts of the country. Security of the cables are also compromised and it is important for the government to ensure that furthermore proposed landed points should be extended to other coastal states in the country. This will enhance faster metropolitan penetration of the fiber backbone.

7. CONCLUSION AND FUTURE WORK

The research confirmed that if Nigeria is to be a key player in the emerging information society there is the need to address the problem of infrastructure, ICT policy, illiteracy, research which deter ICT development. One of the aims of this research is to find out the main reasons behind the unavailability and inadequate access to bandwidth capacity despite the huge and extensive network backbone at the shores of the country. Challenges common to operators in the telecoms sector have been identified as; the high costs of right of way (the right of way are infringed upon by vandalizers and the government without appropriate compensation); long delays, bottle necks and corruption associated with the processing of permits; Lack of a common front by bodies representing the Federal, State, and Local Government leading to multiple taxation, regulatory bodies and policies; lack of essential infrastructure such as electricity, road and other ICT infrastructure.

As Nigerians’ demand for broadband connection increases, the existing source of bandwidth provision which is via satellite could not provide the much needed capacity to carry both local and international traffic. Hence, the promotion of undersea cable (fiber optic) is essential to ensure a cheaper, faster and more reliable source of capacity provision.

Further work is to be carried out on a detailed national economic importance of broadband in Nigeria and a comprehensive discussion of ICT ecosystem and information society in Nigeria.
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Harmonic Mitigation on a 33kV Distribution Line using Passive Filters

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ABSTRACT

The use of modern power electronic devices in circuits has made ‘power quality’ an increasingly important factor in the planning of both transmission and distribution systems. These devices are nonlinear loads such as office equipment like Central Processing Units (CPU), Plotters etc and most electronic home appliances such as TV, Video players, etc., that generate distorted harmonic currents and voltages, which get injected into the power system and leads to ineffective operation of the system. Harmonic mitigation scheme is therefore imperative in the design and planning of power system network. Consequently, this paper presents the control of harmonics in a 33kV Distribution line by using passive filters – a case of RLC and LC filters in both single and cascaded configurations were examined in order to study the net effects of their application in a distribution line. It involves the use of the distribution line (case study) results obtained from previous studies on power flow and harmonic analysis of the overall network that contains the distribution line of case study. These results serve as source data for this research. Only a distribution line of the network was used as a test case. The harmonic mitigation analysis was carried out using MATLAB/Simulink platform. The simulation results of mitigation harmonics are presented. Conclusions and necessary recommendations for future research are also discussed.

Keywords: Power quality, Harmonic mitigation, Passive filters, RLC filter, Passive LC filter, 33kV Distribution link

1. INTRODUCTION

In recent time, electrical power engineers, power utility companies and electric power end users have become a lot more concerned about power quality. The increasing number of nonlinear loads produces harmonic currents in transmission and distribution feeders and thus, distorts voltage waveforms [1]. A power quality problem exists if a variation in voltage, current or frequency results in a failure of customer’s equipment [2]. To ensure a better operation of a power system, it is imperative to get rid of the system harmonics. For this purpose, filters are often required. Both passive and active filters can be used to reduce harmonic currents. While passive filters provide low impedance paths to absorb harmonic currents, active filters give countervail harmonic components to purify load currents [3-5]. However, passive filters are usually a better choice for customers considering cost. The capacitors of passive filters also provide reactive power compensation to improve power factor. Very often, harmonic mitigations are achieved by applying power flow and harmonic analysis results to model network formulation for harmonic mitigation analysis. Consequently, the results of the previous researches on power flow and harmonic analysis of a 33kV Distribution network were used as the source data for this mitigation research. To avoid cumbersomeness in presentation, the results obtained on only one of the distribution lines were used as the case study.

In this paper, the harmonic mitigation on a 33kV line using passive filters is studied. Consideration for various filters of the type or form, Single RLC, Cascaded RLC, Single LC and Cascaded LC on a formulated model distribution line came to play. The mitigated harmonic results for each case are displayed and discussed. The various harmonic minimization methods using filters are highlighted in subsequent sections of this paper.
2. HARMONIC MINIMIZATION METHODS

Majority of large power (typically three-phase) electrical nonlinear equipment often requires mitigation equipment in order to attenuate the harmonic currents and associated voltage distortion to within necessary limits as stipulated by IEEE Standards 519-1992. Depending on the type of solution desired, the mitigation may be supplied as an integral part of nonlinear equipment (e.g., an AC line reactor or a line harmonic filter for AC PWM drive) or as a discrete item of mitigation equipment (e.g., an active or passive filter connected to a switchboard) [2]. There are many ways to reduce harmonics, ranging from variable frequency drive designs to the addition of auxiliary equipment. Few of the most prevailing methods used today to reduce harmonics include (but not limited to) the use of:

1. Isolation Transformers
2. Reactors
3. Passive (or Line) Harmonic Filters
4. Low Pass Filter
5. Phase Shifting Transformers
6. Active Power Filters
7. Power Factor Corrections

A number of researchers devoted their studies to filtering out the harmonic currents in a power system. Heydt and Grady [3] used a simple filter configuration of connecting a single branch of series RLC (or single tuned filter) connected to the Busbar system.

2.1 Passive Harmonic Filters for Harmonic Mitigation

Passive filters are combination of inductance, capacitance and resistance elements configured and tuned to reduce the impact of harmonics in the power systems [4]. Passive harmonic filter techniques are among the oldest and perhaps the most widely used techniques for filtering power line harmonics. Besides the harmonics reduction, passive filters can be used for the optimization of apparent power in a power network [5]. The classical solution for reducing current harmonic distortion is to connect a shunt LC-series filter nearby the harmonic source in order to drain the current harmonics generated by the load, trying to keep the main source current sinusoidal [6]. Passive harmonic filters are also known as harmonic trap filters and are used to eliminate or control more dominant lower order harmonics specifically 3rd, 5th, 7th, 9th, 11th, 13th and 15th and are the more severe examples of triplet harmonics that produce bigger problems to engineers because they possess more distortion in voltage [7]. Passive Harmonic Filter is comprised of a passive L-C circuit (and also frequently resistor R for damping) which is tuned to a specific harmonic frequency which needs to be mitigated (for example, 5th, 7th, etc).

Their operation relies on the “resonance phenomenon” which occurs due to variations in frequency in inductors and capacitors. The series tuned filters are used to compensate the dominant harmonics of the supply current. The cost of the passive filter is very low and it is easy to tune the particular frequency [8]. This filter acts as zero impedance at the tuning frequency that absorbs the harmonics. Passive filters are usually connected in parallel with nonlinear load(s) and are “tuned” to offer very low impedance to the harmonic frequency to be mitigated. In practical application, above the 13th harmonic, their performance is poor, and therefore, they are rarely applied on higher-order harmonics [8]. Passive filters are made of passive elements like resistors, capacitors and inductors.

Passive filters have a value-added function of achieving power-factor correction of inductive loads. This function brings an advantage to passive filters in many cases, but not in all cases [9]. However, the disadvantages of passive filter implementations to filter out the current harmonics include possibility of resonances with the source Impedance, Supply impedance dependent system performance and fixed compensation [10]. They are considered best suited for three phase four wire network [5]. Various kinds of passive filter techniques are given below [5]:

1. Series passive filters
2. Shunt passive filters
3. Low pass filters or line LC trap filters and
4. Phase Shifting Transformers

2.1.1 Series Passive Filters

Series passive filters are usually placed in series with the supply and the load. Series passive filters are considered good for single phase applications and specially suited to mitigate the third harmonics [5]. They do not produce resonance and offer high impedance to the frequencies they are tuned to. These filters must be designed such that they can carry full load current [5].

2.1.2 Shunt Passive Filters

Shunt Passive filters are also designed using passive elements and they offer good results for filtering out odd harmonics especially the 3rd, 5th and 7th harmonics. They provide low impedance to the frequencies they are tuned for. Since they are connected in shunt, they are therefore, designed to carry only harmonic currents [5]. Their nature of being in shunt makes them loads to the supply side and can carry 30-50% load current if they are feeding a set of electric drives [5]. Economic aspects reveal that shunt filters are always more economical than the series filters due to the fact that they need to be designed only for the harmonic currents. Therefore they need comparatively smaller sizes of L and C, thereby reducing the cost. Furthermore, they are not designed with respect to the rated voltage, thus making the components less costly than it is for series filters. However, these types of filters can create resonant conditions in the circuit.
2.2 Design of Passive Filters

The most common type of shunt filters used in harmonic mitigation is the Single Tuned Filter (STF), which is either a low pass or band pass filter [10]. This type of filter is the simplest to design and the least expensive to implement [11]. The basic principle of operating a passive filter is that at the tuned frequency, the filter will offer low impedance to current through which harmonic currents tends to divert in the system [12]. Secondly, passive filters come with the property of reactive power compensation. A very simple arrangement of single tuned filter is shown in fig 1, which also gives the connection arrangement used in the design of single tuned filter [13]:

![Single Tuned Filter](image)

Figure 1: Single Tuned Filter [14]

It can easily be seen in fig.1 that single tuned filters are the simple series connection R-L-C component and LC components. The equation of resonant frequency for a single tuned frequency is given by [15]:

\[ f_0 = \frac{1}{2\pi \sqrt{LC}} \]  

where,  
- \( f_0 \) = Frequency at resonance in Hertz  
- \( L \) = Inductance of filter in Henry  
- \( C \) = Capacitance of filter in Farads  

Another important term, which is necessary to consider, is the design of the filter Quality factor. The term “Quality factor” is the ratio of the reactance at resonant condition to the resistance of the circuit as follows [15]:

\[ Q_f = \frac{X_f}{R} \]  

Where,  
- \( Q_f \) = Quality factor (for a normal distribution system, typical value of \( Q_f \) varies between 15 and 80)  
- \( R \) = Resistance of the filter in Ohms  
- \( R \) = Resistance of the filter branch  
- \( C \) = Capacitance of filter branch  
- \( L \) = Inductance of filter branch

If \( h \) is the ratio between the fundamental and harmonic frequencies, then the value of capacitance and inductance can be obtained using the following equations that relate the harmonic and electronic component of filters [15]:

\[ X_{Lh} = h \times 2\pi f \]  
\[ X_{Ch} = \frac{1}{h \times 2\pi f} \]  

Again, at the tuning of the filter, the impedance value of the filter must be low; for which purpose, if we inspect the simple circuit of filter and find that the only way to minimize the impedance of the filter is to make both of the reactance cancel out, this can be made possible through the resonant condition viz:

\[ X_{Lh} = X_{Ch} \]  

Now, when we put the value of \( X_{Ch} \) and \( X_{Lh} \) in equation (6), another relationship between harmonic and passive components which is important for filter design, will be achieved:

\[ h = \frac{X_h}{X_L} \]  

Again, if \( X_h \) is the reactance of the capacitor, or filter reactor at its tuning frequency,

\[ X_h = \omega_h L = \frac{X_h}{\omega_h} = \sqrt{C} \]  

but,

\[ Q = \frac{X_h}{R} = \frac{X_L}{R} \]  

The pass band is bounded by frequencies at which [16]:

\[ |Z_f| = \sqrt{2R} \]  
\[ f = \frac{\omega - \omega_h}{\omega_h} \]  

The sharpness of tuning is dependent on \( R \) as well as \( X_h \) and reducing these can reduce the impedance of the filter at resonant frequency.

Note that, at parallel resonance, the equation of a resonant frequency for a single tuned frequency is given as:

\[ f_{0 \text{ (parallel load)}} = \frac{1}{2\pi \sqrt{\frac{R}{LC}}} \]  

\( f_{0 \text{ (parallel load)}} \) = Frequency at resonance for networks involving nonlinear loads in Hertz
$$L_s = \text{Inductance present in the network (source inductance) before connection of filter in Henry}$$

$$L = \text{Inductance of filter in Henry}$$

$$C = \text{Capacitance of filter in Farads}$$

In this condition, the total source impedance will be so much and have an impact such that the resonant condition of the system will be just before the tuning frequency, usually about $3 - 6\%$ of its desired value [17]. Also, when there are multiple harmonic filters connected in the system, the resonance of the filter circuit will be affected for all the harmonic filters.

### 3. MODELLING OF ALAGBON – FOWLER DISTRIBUTION LINE FOR HARMONIC MITIGATION

A 33kV distribution network of Island Business District, Eko Electricity Distribution Plc, from which one of the 33kV Distribution lines (line between Alagbon and Fowler Busbars) was selected for the study, and is shown in fig. 2 below. A power flow and harmonic analysis researches for scenario hours of feeder restoration had been previously carried out on the line and some of the results obtained from these analyses serve as the source data for this research work.

Fig. 3 shows the model of the initial setup of ALG – FOW Distribution line of case study, before the process of mitigation was initiated. Also, $\pi$-modelled diagram or circuit was considered suitable for the display of harmonics flowing between two buses. The circuit comprises of the source, which is the input, and the output electrical parameters such as resistance, reactance, and susceptance. It also has two oscilloscopes placed at Fowler (FOW) and Alagbon (ALG) Busbars to measure the input and output voltage variation due to harmonic flow on the line. A reactor is connected for power control, while a current source is included to act as non-linear loads which generate harmonics.

![Figure 3: Model of the Initial setup of the ALG – FOW Distribution Line](image)

Fig 2: 33kV Network of Islands Business Unit, EKEDP

Generally, transmission or distribution lines are modelled using any of these networks: $\pi$ - network, $T$ – network and $\pi$ & $T$ networks, depending on the distance of the line. Since the distribution route length of Alagbon (ALG) – Fowler (FOW) D/L is 3.00km, a $\pi$ distribution line modelling approach was adopted using the MATLAB/Simulink environment.
The Amplitude of source voltage at the sending end (Alagbon Bus) of ALG – FOW Distribution line is 33kV. When the simulation is done, the 4 harmonics generated on the line are shown in the Impedance/Frequency characteristic graph in fig. 5. To start with, an RLC filter is inserted at Alagbon end of the line as shown in fig. 4:

The values of electronic components; Resistance \( R = 1 \Omega \), Inductance \( L = 1 \text{ mH} \), and Capacitance \( C = 150 \mu \text{F} \) are MATLAB/Simulink default values, while the component values used in fig. 4 above were obtained using passive filter design equations illustrated in equations (1) to (10). MATLAB simulations were carried out for an RLC filter implemented within ALG – FOW Distribution line as shown in fig 4. The other configurations of filters introduced to the model include: 2 RLC filters in cascade; an LC filter and two LC filters in cascade. These configurations are illustrated in figures 4b to 4d.

Figure 4a: Model showing the Introduction of an RLC Filter into the Existing ALG - FOW Distribution Line

Figure 4b: Model showing the Introduction of two RLC Filters in Cascade into the Existing ALG - FOW Distribution Line
Figure 4c: Model Showing the Introduction of a Passive LC Filter into the Existing ALG - FOW Distribution Line

Figure 4d: Model Showing the Implementation of two Passive LC Filters in Cascade on ALG- FOW Distribution Line
4. MITIGATION RESULTS AND DISCUSSION

Fig. 5 below shows the harmonics generated on the ALG – FOW Distribution Line before mitigation. It can be seen that 4 harmonics were generated on the line namely: 2nd, 6th, 15th and 24th harmonics at impedance levels of $10^{1.985}\Omega$, $10^{2.508}\Omega$, $10^{2.268}\Omega$, and $10^{2.198}\Omega$ respectively, for a range of frequencies between 0-1500Hz.

![Figure 5: Harmonics of the ALG – FOW Distribution Line](image)

Upon implementation of the RLC filter, the harmonics generated on the line were visibly reduced from 4 to 3 as shown in the impedance magnitude/frequency graph fig. 6a:

![Figure 6a: Mitigation Result on Application of an RLC Filter to ALG - FOW Distribution Line](image)

The value of output voltage after the simulation using an RLC filter in the line (i.e. voltage at FOW end of the line) is about 32.99kV as shown in fig. 6b below:

![Figure 6b: Output Voltage at FOW Bus after applying RLC filter](image)
The peak impedance magnitude from the harmonic result shown in fig 6a is about $10^{2.24}\Omega$ as clearly shown in fig. 6c below:

![Figure 6c: New Impedance Magnitude / Frequency Characteristic of Reduced Harmonic on ALG - FOW Line](image)

The percentage reduction in magnitude of harmonic impedance (% HR) from the initial impedance magnitude of $10^{2.508}\Omega$ to that value after applying an RLC filter is illustrated as follows:

$$\% HR = \frac{10^{2.508} - 10^{2.24}}{10^{2.508}} \times 100\% = 44.05\%$$

When two RLC filters were applied in cascade as shown in fig. 4b, simulation shows that the number of harmonics still remains 3 as shown in fig. 7a and the impedance magnitude/frequency characteristic plot shown in fig. 7b. However, the peak impedance magnitude of the harmonics further reduced from $10^{2.24}\Omega$ (shown in fig. 6c) to $10^{0.585}\Omega$ as shown in fig 7b.

![Figure 7a: Mitigation Result on Application of two RLC Filters in Cascade to ALG - FOW Line](image)

![Figure 7b: New Impedance Magnitude / Frequency Characteristic of Reduced Harmonic on ALG - FOW Line after Applying two RLC Filters in Cascade](image)
However, the value of output voltage at FOW Bus with the implementation of 2 RLC filters in cascade is about 73.80V as shown in fig. 7c:

![Figure 7c: Result showing the Output Bus Voltage at FOW with the implementation of 2 RLC Filters in Cascade](image)

The total percentage reduction in harmonic impedance in this case, from the initial peak value of $10^{2.508}\Omega$ to the new value of $10^{0.585}\Omega$ is,

$$%HR = \frac{10^{2.508} - 10^{0.585}}{10^{2.508}} \times 100\% = 98.31\%$$

Furthermore, with the application of an LC filter in ALG – FOW line as shown in fig. 4c. The results obtained are shown in figures 8a and 8b, which illustrate the harmonic pattern and harmonic impedance characteristics respectively:

![Figure 8a: Mitigation Result after Applying an LC Filter on ALG - FOW Line](image)

![Figure 8b: Plot of Impedance / Frequency Characteristic of Reduced Harmonics on ALG - FOW Line with application of an LC Filter](image)
The value of output Bus voltage at FOW Bus with the implementation of a passive LC filter is about 870V as shown in fig. 8c.

However, with 2 LC filters in cascade on ALG - FOW D/L as shown in fig. 4d below, simulation results obtained are also shown in figures 9a and 9b. Only one harmonic is eliminated. The output voltage in this case is 6.80V and this is shown in fig 9c.
Generally, the Impedance /Frequency Characteristic plots show that the number of harmonics on ALG – FOW D/L reduced from 4 to 3 in all the cases for which the 4 configurations of filters were implemented. The only visible variations were observed in their peak harmonic impedance values and the output voltage at the receiving end (FOW) Bus. The value of percentage reduction in harmonic impedance magnitude when single RLC and LC filters were implemented on the line model were estimated to be approximately the same value of 46.05%.

The value for the cases where 2 RLC and 2 LC filters were separately implemented in cascade configurations, was estimated to be about 98.81%. This value is approximately 100% and therefore, implies that using these configurations on a 33kV D/L has a net suppressive effect on the impedance magnitude of harmonics generated when the D/L is in service. However, when the single RLC filters was introduced on the line, the voltage at the receiving end Bus at FOW was 32.99kV as shown in fig. 6b. with the addition of a second RLC filter on the D/L, the value of voltage at FOW Bus plummeted very significantly to 73.80V.

By changing the filter configuration on the D/L to a single passive LC filter, the voltage on FOW Bus was raised to 870V; whereas, with the addition of a second passive LC filter, the voltage drop across FOW Bus was observed to be about 6.80V as earlier mentioned.

5. CONCLUSION

It can therefore be inferred from the simulation results that although the overall harmonic level (or number of harmonics present) on the D/L gave the same result upon filter implementation, increasing the number of RLC or passive LC filters on a D/L would result in a reduction in the value of impedance magnitude of the harmonics on a D/L. However, this would result in an undesirable reduction in the output voltage at the tail-end of the line. It is also worthy of note that based on the results of the simulation, the RLC filter is preferable to the LC filter of the same configuration, for the purpose of harmonic control on a 33kV distribution line with harmonic-generation tendencies, as the RLC filters give higher output voltages.

It is therefore, highly recommended that in future studies related to this research work, a voltage boost converter can be introduced in the power system to resolve this undesirable effect of voltage drop. It should be noted also that the poor output voltage results were never a surprise as literature has it that passive filter approach to harmonic mitigation is often recommended for three phase four wire networks [5] (usually low voltage). Consequently, active filters may be applied to the same distribution line and then observe the difference in harmonic mitigation level, compared to passive filter applications.

6. CONTRIBUTIONS TO KNOWLEDGE

Research on previous work done on harmonic mitigation reveals that passive filter approach to harmonic mitigation was mostly applied to low voltage distribution networks, i.e. 3-phase-4-wire networks. This research, however, has successfully presented passive filter approach to harmonic mitigation on a high voltage network (i.e. a 33kV distribution network).
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On the Adoption and Implementation of a Cashless Economy in Nigeria

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ABSTRACT

Vision 20:2020 is an embraced policy of Late President Umaru Musa Yar’adua to transform Nigeria into one of the world’s top 20 economies by the year 2020, after taking office in May 2007. As a way of achieving this vision, the federal government of Nigeria through the Central Bank of Nigeria (CBN) has in 2012 proposed the adoption of cashless economy; and Lagos State was allowed to pioneer the project. The study examines the requirements, opportunities and feasibilities of the policy in Nigeria. To be able to achieve this, the study used structured questionnaire as a means of data collection. Data collected were analyzed using simple percentage procedure (SPSS). The results indicate that the policy is promising in that it will assist in fighting against corruption and money laundering. It will also reduce the risk of carrying cash and foster economic growth. However, the challenges still lie with the key issues that any policy faces when it newly introduced, these include culture and government policies, literacy level and ICT status of users, cultural/religious beliefs, bank willingness, inadequate ICT infrastructure, trust/language issues and users awareness.

Keywords: Cash-less policy, Nigeria; ICT; Infrastructure; economy

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1. INTRODUCTION

The Federal Government of Nigeria through the Central Bank of Nigeria (CBN) has in recent times in other to increase the overall performances of the nation’s banking industry has engaged in different kind of reformations aimed at both making the Nigerian financial system formidable. Osinupebi, (2005) reported that Charles Chukwuma Soludo, the then CBN Governor was on July 6, 2004, announced new regulations for Nigeria banking industry. Soludo said that only banks with a minimum capitalization of N25 billion ($172,000,000 in 2005 dollars approximately) by the deadline of December 31, 2005 would be permitted to operate. By December 31, 2005, 64 banks out of the formerly existing 89 banks were declared illiquid, uncompetitive on the international market, and unprofitable.

He added that it was risky for Nigerians to deposit their income with such banks. These eventually led to the merging of many weak banks in order to reach reserve requirements of N25 billion (Adeyemi, 2006). The strong banks also absorbed the weak ones to be able to reach minimum reserves. The objective of this exercise is to build strong and reliable banking industry where there is safety of depositors’ money, and reposition the banks to play active developmental roles in the Nigerian economy” (Adebaja and Olokoyo, 2008). However, the consolidation of the Nigerian banking system, in no doubt, has greatly improved the country’s economic outlook.

2. NIGERIA –A CASH-BASED ECONOMY

According to Nweke, (2012), Nigeria is a cash-based economy with most retail and commercial activities transacted primarily in cash and a huge amount of this is a share of income per capital of the country. He added, an estimated 215 million customer transactions in Nigerian banks; and an estimated 99% of their transactions were carried out over the counter and using the ATM (all cash related). Cash distribution also amounts for over 60% of cost overheads in the banking industry. When considering some of the limitations of a paper cash, for example, its limited durability, easy to steal, easy to destroy, and easy to counterfeit, one will commend the CBN for introducing cashless economy in Nigeria. Adoption of the e-transactions will definitely reduce the amount of physical cash and risks related to paper money such as fear of being attacked by robber. Now that we are finding ways of protecting ourselves from Ebola Virus Disease (EVD), a cashless economy will help in this respect, in that, it will prevent transferred of diseases and contaminations from one person to another. (Maitanmi, Awodele, Ogbonna, and Osundina, 2013; Siyanbola, 2013).

3. NIGERIA –THE NEW CASHLESS ECONOMY

The new policy implementation is from cash-based to cashless economy. Unlike in a cash-based economy, in which day-to-day payments and business activities are predominantly transacted in physical notes and coins, cashless economy is an economy where the physical cash circulating in the economy is minimized while other forms of
payment, especially electronic based payments, are used. Cash-less economy is a combination of the cash-based payment system and electronic payment systems (Ejirio, 2012; Odior and Banuso, 2013). Change is something people do not like no matter the beauty of what the change is bringing into the system. This came into play at the commencement of the cashless economy, the cash-based payment exceeds the e-payment system, with time; the former will then exceed the latter which evolves to a cashless economy.

The Central Bank of Nigeria released a circular on the introduction of ‘cash-less’ policy which sets cash deposit and withdrawal limits. The cash-less’ policy was introduced in April 2011 by the Central Bank of Nigeria to join the committee of nations that embrace the electronic means of payment and limit the use of cash to the very barest. According to CBN’s plan of 2011, the pilot implementation of the policy started in Lagos State and took effect from January 2012. The apex bank asserted the commencement of its “cashless policy” for other cities such as the Federal Capital Territory (FCT), Rivers, Anambra, Kano and Ogun states from the 1st of July, 2013 and the implementation became nationwide on July 1st, 2014 (Central Bank of Nigeria, 2011). The Cashless economy introduced by CBN will only lead to a reduction in the amount of physical cash transactions not an absence of cash as stipulated by many people (Akhalumeh and Ohiohka, 2011; CBN, 2011) and it is presently operational in every state of the federation.

4. THE NIGERIA VISION 20:2020 PROJECT.

After assuming office in May 2007, President Umaru Musa Yar’adua embraced a policy known as Vision 20:2020 to transform Nigeria into one of the world’s top-20 economies by 2020. Vision 2020 envisaged the enactment of a “Seven Point Agenda,” consisting of the following points: power and energy infrastructure; food security and agriculture; wealth creation and employment; mass transportation; and reform; security (including bringing stability to the Niger Delta); and education. The Nigeria Vision 20:2020 project is a challenging but achievable task, and one that must be done if Nigeria is to harness her natural endowment, empower her teeming population and elevate herself in world ranking. The Vision 2010 document aptly captures the project of re-orientation thus: “Broadly speaking, there is no doubt that Nigeria and Nigerians need to imbibe a mind-set change to prepare us to successfully cope with ever changing global realities”. This will require two major fundamental changes. They are as follows:-

a. The first is a need to re-examine the shared values which have been so essential to whatever successes might have been recorded in the past. These should be the lasting foundation upon which enduring future successes can be built. The values, of a rich heritage and strong sense of community, are essential for holding citizens together as a people and for providing the common principles which will guide the country in a rapidly changing world.

b. The second major change is to open the minds of citizens to select the best options the world has to offer and then devise together a truly Nigerian success formula which will enable a forging ahead to rapid success” (Vision 2010). A major thrust of the efforts to become one of the 20 largest economies by 2020, therefore, lies in aggressive ICT and social re-orientation.

5. IT: A MOTIVATOR FOR CASHLESS ECONOMY

It will not be a mistake if one says that the recent growth of Information Technology (IT) industry will help the newly introduced cashless policy. Looking back to a decade ago, it will not be a gain-saying that the number of users of Internet has greatly increased. Going by the records of International Telecommunication Union (ITU), (2014), the figure of the Internet users was 200,000 in year 2000 but it grew to 67,319,186 in year 2013 which represented 33,560% growth in Nigeria. Broadband satellite, very small aperture terminal (VSAT) (Fabio, 2004) and wireless telephony technologies have provided wonderful opportunities for Nigeria to leapfrog in the information society age. These technologies have been exploited in order to accelerate IT that leads to a cashless society development in Nigeria (Ajayi, 2002; Akinyede et al., 2008). In Nigeria, many state governments have accorded IT a priority. These states have information units directly under the control of and finance by the state governors. Presently, the Internet users in Nigeria are about 38.0% of her population (ITU, 2014). In the same manner, Nigeria being Africa’s largest mobile market with more than 125 million subscribers and a market penetration of around 75% in early 2014, has not been able to fully utilized the opportunities of mobile phones (Budde, 2014).

6. METHODOLOGY

In this research work, two phases of analysis are presented. In phase one, the challenges which are the key issues that any policy faces when it newly introduced. Challenges addressed include culture and government policies, literacy level and ICT status of users, cultural/religious beliefs, bank willingness, inadequate ICT infrastructure, trust/language issues and users awareness. In phase two, a survey was carried out via secondary data, questionnaires and one-to-one interview, to ascertain the readiness of banks and customers for the cashless policy. This paper is an extended version of (Dahunsi and Akinyede, 2014).

6.1 Phase One: Cashless policy framework

In this phase, we presented a framework for the cashless economy. Here, we considered the following seven key issues to be important, they are: culture and government policies, literacy level and ICT status of users, cultural/religious beliefs, bank willingness, inadequate ICT infrastructure, trust/language issues and users awareness. Figure 1 shows the cashless policy framework.
i. **Culture/Government Policies** - For anything to work anywhere culture and government policies must be considered. Most companies realize that the only way to do business effectively in other cultures is to adapt to those cultures. The phrase “think globally, act locally” is often used to describe this approach. In many occasions, local language of the people is needed to carry out the task. As we know that culture varies across national boundaries and, in many cases, varies across regions within nations, we need to consider it at the design stage if really we want this new cashless policy to work especially in the Northern Nigeria. Since in some parts of Nigeria, there are cultural environments that are extremely inhospitable to the type of online transactions that occurs on the Internet. These cultural conditions, in some cases, lead to government controls that can limit the development of cashless policy (Gary, 2011). Government policies should favour indigenous ICT services and products in form of software development. Since culture plays a major role in adopting anything new things in our society, government at all levels should educate people in towns/villages on the advantages of cashless economy.

ii. **Literacy level and ICT Status of Users** - ICT status/infrastructure remains the major focus of the cashless policy, government at all levels must be ready to support it. In ITU, (2014), it was reported that a total of 70,300,000 Nigerians are accessing the Internet through telecommunications networks. This means that out of the estimated population of 177,155,754 only 70 million Nigerians have access to the Internet as at December 31st, 2014. That is, 39.7 per cent of the population is dependent on the Internet. Statistics provided by the Nigerian Communications Commission showed that as at February 28, 2013 32,335,478 Internet subscribers depended on Global System for Mobile Communications networks while 177,783 Internet users depended on Code Division Multiple Access networks (Amaefule, 2013). According to her, among GSM subscribers, MTN Nigeria Communications Limited had the biggest proportion of Internet users – 21,308,725 or 65.5 per cent of the total number of Internet users that depend on GSM networks. The closest network was Airtel, with 5,870,670 or 18.1 per cent of the GSM Internet users. Etisalat had a total of 4,354,845 or 13.39 percent while Glo had 801,218 or 2.46 percent. Among the CDMA operators, Visafone had 87,691 or 0.27 percent Internet users; Starcomms had 63,198 or 0.19 percent users while Multi-Links had 26,894 or 0.08 percent. Figure 2 below is a graphical representation of the penetrations. The report of Amaefule in 2013 revealed that as at June 30, 2012, Visafone had 82,029 subscribers; Starcomms had 110,438; while Multi-Links had 47,517 Internet users. Airtel had 3.2 million Internet users and MTN had 16,135,672. Glo had 1,014,166 while Etisalat had 5,031,019. This showed a reduction in the subscribers of CDMA in 2013 as compared to what happened in 2012. It was Visafone that was able to move upward during the time in question.
Several reasons account for the increasing dependence of Internet users in the country on mobile telecommunications networks. One of the reasons is the near absence of fixed networks that carry data. Other reasons could be as result of any of the following:- cost, trust, availability of ICT infrastructure, government policies and regulations and others (Irefin, Abdul-Azeez and Tijani, 2012).

iii. Cultural/Religious beliefs - According to Ottuh’s report, Nigeria is presently battling with lots of in-house conflict and most of these are religious oriented. (Ottuh, 2013). For example, a set belief that western education for women is a sin. As a result, cultural and religious belief is an important consideration when talking about the adoption of cashless economy. When we talk about culture, we talk about language and customs. Researches have shown that culture varies across national boundaries and, in many cases, varies across regions within nations.

iv. Bank Willingness - The CBN must ensure that banks are ready to comply and also that they must maintain proper and accurate database of all their account holders and be willing to share it other financial institutions according to the lay down rules.

v. Infrastructure - Businesses that successfully meet the challenges posed by trust, language, and culture issues still face the challenges posed by variations and inadequacies in the infrastructure that supports the Internet throughout the world. Technology is very expensive and is ever changing at a very fast pace, as a result, banks must be ready to invest in e-banking infrastructure to make an optimal cash-less economy possible. However, Internet infrastructure includes the computers and software connected to the Internet and the communications networks over which the message packets travel (Gary, 2011). The financial ICT infrastructure in Nigeria is insufficient to adequately carry the load of a cash-less society (Emmanuel and Adebayo, 2011; Agwu, 2012). Erratic power supply has been a major challenge facing every industry in Nigeria (Subair and Oke, 2008) and the demand for electricity in Nigeria continue to increase despite the slow growth in economic activities, unfortunately there is no commensurate growth in the power supply sector. This has plunged the country into expensive and unreliable power supply provision destroying equipments in its wave of multiple and unpredictable power cuts (Subair and Oke, 2008). For an optimal penetration and sustainable cash-less economy, the power supply provision has to be adequately addressed. Another one is the low broadband penetration; this has also affected optimal utilization of the available ICT infrastructure and internet usage in Nigeria (Dahunsi, 2013).

vi. Trust/Language Issues - It is important for all businesses to establish trusting relationships with their customers. Financial institutions with established reputations in the physical world often create trust by ensuring that customers know who they are. On language issue, most banks realize that the only way to do business effectively in other cultures is to adapt to those cultures. The phrase “think globally, act locally” is often used to describe this approach. The first step that a Web business usually takes to reach potential customers in other countries, and thus in other cultures, is to provide local language versions of its Web site. This may mean translating the Web site into another language or regional dialect.

vii. User Awareness - Most financial institutions are familiar with two general ways of identifying and reaching customers: personal contact and mass media. These two approaches are often called communication modes because they each involve a characteristic way (or mode) of conveying information from one person to another or communicating (Gary, 2011). In the personal contact model, the firm’s employees individually search for, qualify, and contact potential customers. This personal contact approach to identifying and reaching customers is sometimes called prospecting. In the mass media approach, firms prepare advertising and promotional materials about the firm and its products or services. They then deliver these messages to potential customers by broadcasting them on television or radio, printing them in newspapers or magazines, posting them on highway billboards, or mailing them. Some experts distinguish between broadcast media and addressable media.

6.2 Phase 2: Survey Analysis

The survey, which aimed at examining the ICT penetrations and nation’s readiness in ensuring the smooth and effective take-off of the cashless policy in Nigeria, comprises of banking customers and bank officials. Over 300 banking customers and 15 bank officials were considered. The study also made use of both primary and secondary data.

6.2.1 Data Analysis (Questionnaire Analysis)

Questionnaires were administered to over 300 banking customers and 20 bank officials to get the primary data. The data were analysed using descriptive statistics. In the same manner, secondary data were derived from interviews, CBN electronic banking guideline and other relevant literature.
6.2.2 Data Analysis of the Respondents
From the analysis, figure 3 shows that 58% of the respondents were male 42% were female. Figure 4 shows the respondents according to their qualification; 36% of the respondents were students while 38% were civil servants, Artisans and farmers makes up 3% of the respondents. Finally, the data collected indicated that 68% of respondents are graduates, 21% are undergraduate students while about 11% have other qualifications (Figure 5). Therefore, it could be inferred that majority of the customers are graduate.

The survey was also extended to Internet users and the following results were gotten. Figure 6 shows that 43% of the respondents were expert users of the Internet, 38% were casual users, and 13% were beginners while 6% constitutes others. In figure 7, we have 67% to be excellent users of the internet, 23% were good users, 7.5% were average while 2.5 constitutes fair which implies that majority of the respondents have a good understanding of the internet. Figure 8 shows that 43% always visit internet, 34% visit internet often, 21% rarely visit internet while 2% never visit internet at all. This implies that majority of the respondents do visit internet always. Finally, figure 9 revealed that 63% of the respondents connect to the internet via mobile phone, 17% connect to the internet via modem and 20% connect via cybercafé. This shows that majority of the respondents connects to the internet using mobile phone.

Figure 3. Respondents according to Gender

Figure 4. Respondents according to Occupation

Figure 5. Respondents according to Qualifications

6.2.3 Data Analysis by Internet usage
6.2.4 Types of e-banking information of customers
Respondents are also analysed according to the type of banking they operate Figure 10 shows that 64.8% of most of the respondents operate saving account while 33% operates current bank accounts. Fixed deposit was 1.7% while others were about 0.6%.

6.2.5 Bank transactions carried out by customers
Analysis shown in Figure 11 shows the type of bank transactions carried out by the respondents. For example, (49%) used Automated Teller Machine (ATM), while 24% of them use cheque and tellers, 8% make use of internet banking, 6% use money transfer and another 6% use point of sales (POS), also 4% fall into credit card category and 3% use mobile banking. The analysis shows that most used ATM while few of them used mobile banking.

6.2.6 Usage pattern of some e-banking transactions
In Nigeria, most people use ATM as reflected in the analysis as cash withdrawing machine (Figure 12). Figure 13 shows how the respondents rate the banking services. However, the respondent made the following complaint as reflected in Figure 13. In Wada and Odulaja, (2012), it was reported that cybercrime is going to be the major challenge in the cashless economy in Nigeria.

7. BENEFITS OF CASHLESS ECONOMY
The following are some benefits of a cashless economy, especially to a developing economy:
   i. It creates employment
   ii. It reduces cash related robbery
   iii. It attracts foreign investment
   iv. It reduces corruption in terms of cash
   v. It is very convenient to operate.
   vi. It saves time for individual customer.
   vii. It brings about economic uniformity in the world.
   viii. It enhances globalization that characterizes our present time.
   ix. It reduces the amount of paper trail.
   x. It replaces paper cash with cashless credits and/or e-money transfers can at least minimize crime, illegal drug trade, terrorism, illegal immigration, human trafficking, and corruption.
Figure 12: Pattern of Automated Teller Machine (ATM) usage by the respondents.

Figure 13: Respondents’ Rating of the Banking Services
8. PAYMENT SYSTEM STATISTICS

According to CBN, (2014), the payment statistics for 2009 January to 2014 June as presented Table 1. The table considered the Number is Transactions and Value of transactions in Billions of Naira. There had been a steady increase in the use of ATM compared to cheque transactions from the year 2009 till June 2014. From the advent of cash-less banking in most States of the Federation in 2013 and latter in all States, there has been an increase in POS and mobile transactions where as there has been reduction in others. This reduction in transaction especially in Web transaction might be as a result of the fear of cyber-crime.

<table>
<thead>
<tr>
<th>Year</th>
<th>No of Transactions</th>
<th>Value of Transactions (Naira Billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>29166780</td>
<td>29436.03</td>
</tr>
<tr>
<td>2010</td>
<td>33973919</td>
<td>19675.51</td>
</tr>
<tr>
<td>2011</td>
<td>37718585</td>
<td>22302.63</td>
</tr>
<tr>
<td>2012</td>
<td>12045833</td>
<td>7461.63</td>
</tr>
<tr>
<td>2013</td>
<td>14145839</td>
<td>7674.86</td>
</tr>
<tr>
<td>2014</td>
<td>7144340</td>
<td>3710.69</td>
</tr>
</tbody>
</table>

*Data is from January 2009 – June 2014. (Source: CBN, 2014)*
9. CONCLUSION

The Survey has revealed the opinion of people on the present banking services. Amongst all, ATM happens to be the best means of operation of cashless banking. Although, most of the services accessed with ATMs are cash withdrawals, this indicates that bank customers do not patronize other banking e-services. Therefore, Federal Government, CBN and Commercial Banks have lots to do in the area of education and enlightenment of the customers on the available products that can facilitate the adoption and widely used of the newly introduced cashless economy. Lastly, tackling the challenges such as culture and government policies, literacy level and ICT status of users, cultural/religious beliefs, bank willingness, inadequate ICT infrastructure, trust/language issues and users awareness must be immediate because all these are major requirements for the smooth operation of the cashless economy.

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4th Generation (4G) Technological Infrastructure and Enhanced Mobile Learning: An Effective Tool for Open and Distance Education

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ABSTRACT

There is a widely accepted vision of a system that enables an “Always Best Connected (ABC)” mode of communication. This concept, generally accepted as 4G (Fourth Generation), presupposes a heterogeneous communication landscape comprising different wireless access systems integrated on a platform, where the user enjoys undeterred connectivity and ubiquitous access to applications and services. Such features and services can be incorporated in an educational environment to foster the realization of educational objectives. The use of 4G devices for educational purposes, have enormous benefits: access to volumes of information just anywhere and at anytime; promotion of mobile collaboration among tutors and students, and so on. The 4G features, if integrated with mobile learning capabilities can go a long way in enhancing distance education schemes. This study explores the 4th Generation (4G) Technological Infrastructure and Enhanced Mobile Learning; seeing an integration of both technologies as an effective tool for Open and Distance Education. An extensive review of related literatures was also done. The study proposes that M-learning integrated on 4G platforms provide the best learning method, not just for Open and Distance Education, but also for conventional classroom oriented mode of learning, to make learning more exciting and interactive.

Keywords: Seamless Mobility, Global Mobility, Wireless Standards, Mobile Learning, Circuit Switching, Packet Switching, Bandwidth, Broadband

1. INTRODUCTION

The mobile communication technology is one of the many technologies that are incremental in nature: they provide room for incremental developments (that is, more features can be added to the previous technology to develop a more advanced one). The advancement is necessary in order to cope with increasing number of users of mobile networks, increasing level of traffic, and increasing level of sophisticated, but useful, applications on mobile devices. The quest for higher bandwidth, faster connection time, and seamless handoffs are some of the factors that lead to the search for better solutions. Various standardization organizations have taken efforts to work on specific agenda, providing an open forum for ideas, contributions, and convergence to agreed technical specifications. The ITU (International Telecommunications Union), IEEE (Institute of Electrical and Electronics Engineers), 3GPP (3rd Generation Partnership Project), WWRF (Wireless World Research Forum), and so on, held regular meetings to address these issues. Those meetings were mostly well attended by key industry players. Their deliberations resulted in the establishment of several standards for the telecommunication industry, including the 4G (Fourth Generation) wireless framework.

The term 4G, which refers to the ‘Fourth Generation’ of wireless communication standards, focuses on, not one defined technology or standard, but on a collection (an integration) of technologies and protocols expected to provide a comprehensive and secure all-IP based packet-switched networks, optimized for data [1]. 4G networks are expected to provide higher data rates: projected data speeds of 100Mbps for mobile terminals such as users of cell phones or smart phones, and 1Gbps for stationary terminals such as WLANs (Wireless Local Area Networks). They are also expected to provide access to large volumes of information anytime, anywhere. Being an ultra fast technology, it is getting more attention day by day. The 3G, 2G, and 1G family of communication standards are its predecessors.

The 1G (First Generation) framework of wireless technology was preceded by a radio telephone system. 1G wireless technology encompassed numerous incompatible analog standards introduced in the 1980s and continued until it was replaced by 2G digital cellular technologies. The 2G was basically about a shift from the then existing analog systems to a digital communication technology. The Third Generation Wireless Communication (3G) came into being in the 1990s with a view of eliminating previous incompatibilities and become a truly global system.
The 3G system provides higher quality voice channels, ability to transfer voice data and non-voice data (music downloads, emails, and instant messaging) over the same network simultaneously, as well as broadband data capabilities, up to 2Mbps. The delivery of broadband capacity and support for greater number of voice and data customers by 3G networks are done at lower incremental costs than 2G. The data transfer rates for 3G technologies are 2Mbps for fixed spots (when user is stationary) and a minimum of 384 Kbps when the user is moving. The 3G standards are: W-CDMA (Wideband Code Division Multiple Access) and EVDO (Evolution-Data Optimized).

However, the demand for higher access speed in multimedia communication in our today’s society led to the evolution of the Fourth Generation (4G) standards in wireless communication. 3G performances are not sufficient to meet the need for future high-performance applications like multimedia, full-motion video, and wireless teleconferencing. This created a need for a wireless network technology that extends 3G capabilities. The 3G has some limitations that also served as drivers for the 4G framework:

- **a)** There are multiple standards for 3G making it difficult to roam and interoperate across networks. This created the need for an infrastructure that supports global mobility and service portability.
- **b)** The 3G concept is based on, primarily, a wide-area concept. This limitation established the need for hybrid networks that utilize both wireless LAN (hot spot) concept and cell or base-station wide area network design.
- **c)** The need for wider bandwidth
- **d)** Researchers have come up with spectral more efficient modulation schemes that cannot be retrofitted into 3G infrastructures.
- **e)** There is a need for all digital packet networks that utilizes IP, in its fullest to converge with voice and data capability.

The 4G infrastructure provides higher data rates and enables an “Always Best Connected” mode of communication: a communication system that sketches a heterogeneous network infrastructure comprising different wireless access systems (example, GSM(Global System for Mobile)/GPRS(General Packet Radio System), UMTS, DVB-T, HAPS, WLAN) in a complementary manner, where the user, supported by his/her personal intelligent agent, enjoys undeterred connectivity and ubiquitous access to applications over most efficient combination of available system. The goal of 4G wireless communication systems is to incorporate and integrate different wireless access technologies and mobile network architecture in a complementary manner so as to achieve a seamless wireless access infrastructure.
Can the 4G infrastructure be applied within educational circles? Focusing on how the 4G framework impacts on educational processes will leave us with questions as regards what it has to offer to the field of education. One might ask if there are educational benefits that can be derived from the 4G wireless communication standard. Can it be seen or considered as one of the educational technologies? In more specific terms, since the concept of seamless mobility is a key factor in the 4G technology, the best logical application of the infrastructure within educational circles will be in the area of mobile learning. Exploring the correlation between the 4G infrastructure and enhanced mobile learning; focusing on how it can be used to foster ‘Open and Distance Education’, is what this study is about.

Open and Distance Learning (ODL) has been defined in different ways and at different points in time: According to the Commonwealth of Learning (COL), ODL is a learner-oriented system that allows greater flexibility in learning while students continue with their regular work. ODL is founded in view of the physical limitations imposed by the traditional mode of delivery. In the words of the former Vice-Chancellor, National Open University of Nigeria, [3] ODL provides education for all, promotes lifelong learning, and improves on the economies of scale in education management. These definitions have three things in common: flexibility, cost-effectiveness, and learner-centered. It can thus be said that at its best, Open and distance learning can be defined as a flexible, cost-effective, and learner-centered educational system. It is learner-centered as it aims at providing answers to academic questions and problems of learners, not the other way round. [4]

A definition of open and distance education cannot be too precise. It would be as precise as the concept of distance itself is or as precise as the concept of education can be, both of which are within the province of subjectivity. In an attempt to define open education, Burge [5], states that it is a situation in which the learner uses resources in a flexible way to achieve their goals. The resources here could be print, audio, computer based; used at home, at a study center, in the work place, with or without the guidance of a tutor or mentor. On the other hand, Mujibul [6] sees distance education as situations in which learners are physically separated from the educational provider, and communicate in writing (using letters, e-mail, fax or computer conferencing) verbally (by telephone, audio, conferencing, videoconferencing), or in face to face tutorial sessions.

From the above definitions therefore, open and distance education is a form of education and training in which using learning resources rather than attending classroom sessions, is the central feature of learning experience. It is a field of education that focuses on the pedagogy, technology and instructional system designs that aim to deliver education to students who are not physical “on site” in a traditional classroom or campus. It is a process used to create and provide access to learning when the source of information and the learners are separated by time and distance or both. In other words, distance education is the process of creating an education experience of equal quality for the learner to best suit their needs outside the classroom situation. It is worthy to note that there is a considerable overlap between the two terms, open and distance learning and they are often used together to refer to the whole range of leaning approaches as described above. Open and distance education courses that require a physical onsite presence for any reason, including taking examination is considered a hybrid or blended course of study and it is the most popular in Nigeria today. [7]

With the above understanding of the concept of Open and Distance Education, considering the fact that it emphasizes flexibility in the learning process, and that students are not confined to a particular location (classroom or campus), but are expected to use multimedia learning resources wherever they are at their convenience and pace, a very vital consideration that can facilitate the quick realization of the objectives of the ODL methodology is the mobile learning (M-Learning) scheme.

M-learning provides access to educational environments and resources, alongside interactions with other learners without being limited by time and space. M-learning, according to Boyinbode O. K. and Akinyede R. O. [8], is a combination of mobile technologies and appropriate pedagogy to allow learners to interact with learning environments, and other learners, at any time from any location. Mobile learning is effectively a sub-category of the larger concept of e-Learning. According to them, Clark Quinn proposed that mobile learning is “the intersection of mobile computing and e-learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance based assessment - e-learning independent of location in time and space”. So they defined M-learning as the intersection of Mobile Computing and e-learning. E-learning offers new methods for education based on computer internet technology. M-learning provides students the ability to learn everywhere at every time without permanent physical connection to cable networks.

To highlight the advantages of M-Learning over e-Learning a comparison by Boyinbode O. K. and Akinyede R. O. [8] is given in the table below:

<table>
<thead>
<tr>
<th>M-Learning</th>
<th>E-Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessible resources anywhere</td>
<td>Accessible resources only certain locations</td>
</tr>
<tr>
<td>Strong search capabilities</td>
<td>Limited search capabilities</td>
</tr>
<tr>
<td>Rich interaction</td>
<td>Limited interaction</td>
</tr>
<tr>
<td>Powerful support for effective learning</td>
<td>Limited support for effective learning</td>
</tr>
<tr>
<td>Performance based assessment</td>
<td>Limited performance based assessment</td>
</tr>
</tbody>
</table>

The table above shows the comparison between M-Learning and E-Learning.
Table 1: Comparison of M-learning with E-learning

<table>
<thead>
<tr>
<th>M-learning</th>
<th>E-learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>It can be used everywhere at every time.</td>
<td>It cannot be used everywhere at every time</td>
</tr>
<tr>
<td>Most mobile devices have lower prices than Desktop (PCS).</td>
<td>Desktop (PCS) are more expensive than mobile devices.</td>
</tr>
<tr>
<td>Mobile devices are smaller in size and lighter in weight than Desktops. Hence they are portable.</td>
<td>Desktops are not portable. They are not easily carried around due to their heavy weight.</td>
</tr>
<tr>
<td>M-learning can provide location dependent education using GPRS technology</td>
<td>E-Learning cannot provide location dependent education.</td>
</tr>
<tr>
<td>It is flexible to engage by learners on the move.</td>
<td>It is not flexible.</td>
</tr>
<tr>
<td>One learner to more than one mobile device.</td>
<td>One learner to one computer.</td>
</tr>
</tbody>
</table>

Source-[8]

In considering the implementation of mobile learning, Attewell [9] suggests five broad categories of technology that should be considered, namely transport, platform, delivery, media technologies, and development languages, as seen in the figure below:

Figure 2: Technology Selection - [9]

The 4G wireless infrastructure, which offers higher data rates, broader bandwidth, seamless mobility, a convergence of heterogeneous networks, access to information anytime, anywhere, and ability to receive large volume of information, data, pictures, and videos; alongside the possibilities of enhanced mobile gaming experience, personal media repository, virtual presence, mobile TV, high definition videos, broadband access in remote locations, and so on, provides a unique platform and sophisticated functionalities for enhancing mobile learning initiatives. The 4G infrastructure, integrated with mobile learning schemes, if applied within open and distance learning framework, has the capacity to effectively and efficiently engender the quick and easy realization of set objectives.

1.1 Motivation

Every emerging technology undergoes a process, viz. maturity, adoption, and social application of specific technologies. The 4G is not an exception. With the obvious invasion of 4G systems in our world today, and considering the projected capabilities; alongside the understanding that mobile learning is the future of education, it becomes very imperative to study how 4G systems can be integrated with mobile learning applications to foster the realization of educational objectives, especially within open and distance learning circles where it is more relevant. Also, the understanding that the open and distance learning ideology deemphasizes location-based teaching, but encourages studying anywhere and anytime, at the pace and convenience of the student, with provisions for mobility, is enough to stimulate every student to seek to explore how mobile learning facilities can be placed on 4G platforms to
provide a very effective and efficient tools to foster the realization of these objectives.

2. LITERATURE

2.1 Key Attributes and Applications of 4G
Shah, I et al. [10] proposed that based on the requirements for seamless interaction between networks, 4G is characterized by the following key attributes:

Support for Multiple and Efficient Applications and Services: 4G provides support for unicast, multicast and broadcast services and the applications that rely on them. Prompt enforcement of Service Level Agreements (SLA) along with privacy and other security features.

Quality of Service: Consistent application of admission control and scheduling algorithms regardless of underlying infrastructure and operator diversity leads to an increased quality of service (QoS) to the users.

Network Detection Selection: A mobile terminal that features multiple radio technologies or possibly uses software defined radios if economical, allows participation in multiple networks simultaneously, thereby connecting to the best network with the most appropriate service parameters (cost, QoS and capacity among others) for the application.

Seamless Handover and Service Continuity: A base station that features intra- and inter-technology handovers, assuring service continuity with zero or minimal interruption, without a noticeable loss in service quality.

According to Bandi [11], accessing information anywhere, anytime, with a seamless connection to a wide range of information and services, and receiving a large volume of information, data, pictures, video, and so on, are the keys features of the 4G infrastructures. The 4G infrastructures will consist of a set of various networks using IP (Internet protocol) as a common protocol so that users are in control because they will be able to choose every application and environment. Based on the developing trends of mobile communication, 4G will have broader bandwidth, higher data rate, and smoother and quicker handoff and will focus on ensuring seamless service across a multitude of wireless systems and networks.

Application adaptability and being highly dynamic are the main features of 4G services of interest to users. These features mean services can be delivered and be available to the personal preference of different users and support the users traffic, air interfaces, radio environment, and quality of service. Connection with the network applications can be transferred into various forms and levels correctly and efficiently.

The dominant methods of access to this pool of information will be the mobile telephone, PDA, and laptop to seamlessly access the voice communication, high-speed information services, and entertainment broadcast services. The fourth generation will encompass all systems from various networks, public to private; operator driven broadband networks to personal areas; and ad hoc networks. [11]

In summary, Bandi [11] proposed that the features of the 4G infrastructure include: Support for interactive multimedia, voice, streaming video, internet, and other broadband services; IP based mobile system; High speed, high capacity, and low cost-per-bit; Global access, service portability, and scalable mobile services; Seamless switching, and a variety of Quality-of-Service-driven services; Better scheduling and call-admission-control techniques; Ad-hoc and multi-hop networks (the strict delay requirements of voice make multi-hop network service a difficult problem); Better spectral efficiency; Seamless network of multiple protocols and air interfaces (since 4G will be all-IP, 4G systems will be compatible with all common network technologies including 802.11, WCDMA, Bluetooth, and Hyper LAN), and an infrastructure to handle pre-existing 3G systems along with other wireless technologies, some of which are currently under development.

2.2 Overview of the 4G Technology
Prateek [1] saw the 4G concept as a collection of technologies and protocols, not just one defined technology or standard, geared towards the creation of fully packet-switched networks optimized for data. In an attempt to state some of the 4G possibilities, the following where highlighted: Enhanced mobile gaming experience, Personal Media Repository, Virtual Presence, and Broadband Access in Remote Locations. He raised the issue of the loss of proper understanding of the 4G technology owing to the lack of clarity and overuse of the term. This, he suggested, could prove the biggest opportunity for the technology, or could spell its premature demise. In my opinion, to forestall the dangers that the loss of meaning of the 4G technology produces, in researches like this one should aim at stating the proper definition of the concept as stipulated by the International Telecommunications agencies approved by the United Nations.

Cole [12] upheld the idea of the 4G technology. He stated that the pre-4G and 4G technologies, which are clearly the next the-generation technologies, with their promise of greater speed and spectral efficiency is more appealing to the players involved in the ICT value chain. According to him, the success of the 4G proposition, even though it sounds promising, ultimately depends on the availability of new spectrum and wide coverage. He, however, warned that the many benefits of 4G may be wasted unless ICT companies find business models that help them to increase revenue, and also drive adoption.
Ibrahim, Jawad [13] outlined what he called “the key features of the 4G infrastructure”: access to information anytime, anywhere, with seamless connectivity, and ability to receive large volume of information, data, pictures, and videos; Stating that various networks using Internet Protocols (IP) as a common protocol, which puts the user in control, will constitute this 4G infrastructure. The 4G standard, he proposed, will have higher data-rate, broader bandwidth, smoother and quicker handoff; and will focus on ensuring seamless service across a multitude of wireless systems and networks. He made it clear that integrating the 4G capabilities with all the existing mobile technologies through advanced technologies, is the key concept. For those who are not really aware of what the 4G technology is about, a glance at the features he outlined, more especially the higher data rate, and the access to large volume of information, data, pictures, and videos, will raise the issue that the 4G technology will be more capital intensive for the end-users and service providers. A detailed analysis, however, brings to bare the fact that these features will be available at a lower cost for user, and a lower transmission cost for service providers.

Singh [14] mentioned that the 4G systems and its applications will result in a significant growth and developments in consumer services and business expectations; pointing out that 4G mobile phone technology supports IPv6-Internet protocol version 6, and provides faster communication speeds. The world is dynamic. The idea of faster communication speeds, improved services to the consumer, and enhanced business initiatives, is ideal for human existence. [15].

Laxini, V., Aggarwal, M., Batra, N. [16] outlined some of the prerequisite for the progress towards the attainment of the goals of being able to communicate everywhere, with everybody, and at anytime: Digitalization of communication systems, enormous progress in microelectronics, computer and software technology, inventions of efficient algorithms and procedures for compression, security and processing of all kinds of signals, and the development of flexible communication protocols. They also stated that the 4G systems will interoperate with 2G and 3G systems, as well as with digital (broadband) broadcasting systems.

2.3 ITU Requirements and 4G Standards
The Wikipedia [17] proposed that the IMT-Advanced (International Mobile Telecommunications Advanced) requirements for the 4G communication standard, was specified by the International Telecommunications Union (ITU) in 2009. According to the Union, an IMT-Advanced communication system must fulfill the following requirement:

Based on an all-IP packet switched network

Peak data rates of up to approximately 100Mbit/s for high mobility such as mobile access and up to approximately 1Gbit/s for low mobility such as nomadic/local wireless access, according to the ITU requirements.

- Dynamically share and use the networks resources to support more simultaneous users per cell
- Scalable channel bandwidth 5–20 MHz, optionally up to 40 MHz
- Peak link spectral efficiency of 15 bit/s/Hz in the downlink, and 6.75 bit/s/Hz in the uplink (meaning that 1Gbit/s in the downlink should be possible over less than 67 MHz bandwidth).
- System spectral efficiency of up to 3 bit/s/Hz/cell in the downlink and 2.25 bit/s/Hz/cell for indoor usage.
- Smooth handovers across heterogeneous networks.
- Ability to offer high quality of service for next generation multimedia support.

2.4 4G Wireless Standards
The Wikipedia [17] stated the fact that the 4G landscape is characterized by two co-existing standards:

- LTE Advanced, standardized by the 3GPP
- WiMAX (802.16) standardized by the IEEE.

LTE Advanced: LTE Advanced (Long-Term-Evolution Advanced) is a candidate for IMT-Advanced standard, formally submitted by the 3GPP organization to ITU-R in the fall of 2009, and expected to be released in 2012. It is an improvement on the existing LTE Network, which showed early implementation speed of up to 100mbps downloading speed and 50mbps uploading speed. The LTE Advanced aims at reaching and surpassing the ITU requirements. However, its release which currently supports up to 300Mbit/s download speeds still falls short of the IMT-Advanced standards.

WiMAX Advanced: The WirelessMAN-Advanced or the IEEE 802.16m evolution is under development. It aims at fulfilling the IMT-Advanced criteria. It is also, an improvement on the previous WiMAX mobile wireless broadband access (MWBA) standard. Cellular networks, are presently, using the Mobile WiMAX(IEEE 808.16e-2005) – mobile WiMAX that offers full mobility at true broadband speeds. However, there is a second application of WiMAX: fixed WiMAX (IEEE 802.16-2004) - fixed WiMAX application for point-to-point, enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL for homes and businesses.
2.5 A Correlation of LTE and WiMAX
Both LTE and WiMAX use the principle of Orthogonal Frequency-Division Multiple Access (OFDMA), which conceptually has been around since the 1960’s. OFDMA is based on the idea of frequency-division multiplexing, which is a method to transmit multiple data streams over a channel. In the case of OFDMA, a digital data stream that needs to be transmitted is split into multiple pieces, each of which is modulated onto a separate carrier. These sub-carriers are combined together at the end. The differentiating factor, between LTE and WiMAX lies in how they handle the channel for processing data. In case of Clearwire’s implementation of WiMAX, about two-thirds of the channel is used for downloads, while a third is used to upload data. LTE splits the channel into two parts using frequency-division multiplexing, so download and upload speeds are better balanced. [15]

2.6 Components of the 4G Framework
The Wikipedia [17] stated some of the major components of the 4G infrastructure: IPv6 support, Integration of access schemes, and adaptive antenna systems.

IPv6 Support: The 4G framework is based on packet switching only; unlike 3G which is based on two parallel infrastructures consisting of circuit switched and packet switched network nodes. Circuit switching refers to the technique in which a dedicated channel is used to transmit and receive voice or data. Packet switching (packetized data communication) refers to the digital signaling technique in which information is converted into binary codes and partitioned into short segments. These segments are then reassembled into the correct order and converted back into usable information at the destination. Packet switching is more desirable than circuit switching. The 4G concept involves using Internet Protocol version 6 (IPv6) to route data packets to the cellular device. Internet Protocol version 6, provides faster communication speeds, higher capacity, and diverse usage formats-formats that support other public networks such as optical fiber and Wireless Local Area Networks. In the context of 4G, IPv6 support is essential in order to support a large number of wireless-enabled devices. By the increase of the number of IP addresses, IPv6 removes the need for network address translation (NAT), a method of sharing a limited number of addresses among a large group of devices.

Integration of Access Schemes: As wireless communication technology continues to undergo tremendous change, various radio access technologies have been deployed all over the world. The 4G mobile system provides a platform for the integration of all these radio access technologies into a common net work called the Open Wireless Architecture (OWA) platform. The convergence of advanced mobile wireless communications and high-speed wireless access systems into an OWA platform, alongside the focus on data-rate increase, and new air-interface, is the core of the 4G mobile technology.

The overall 4G architecture tends to integrate, on the OWA platform, a broad range of systems: from satellite broadband to high altitude platform to cellular 3G and 3G systems to WILL (Wireless Local Loop) and FWA (Fixed Wireless Access) to WLAN (Wireless Local Area Network) and PAN (Personal Area Network), all with IP as the integrating mechanism. This convergence of different wireless access systems in a complementary manner provides the ABC (Always Best Connected) service, where users choose the best available access networks in a way that best suits their needs.

Adaptive Antenna Systems: The performance of radio communications in cellular systems depends on an antenna system, termed smart or intelligent antenna. In order to achieve the goal of 4G systems such as high rate, high reliability, and long range communications, multiple antenna technologies are emerging. MIMO (Multiple In Multiple Out) technology, a branch of intelligent antenna which uses spatial multiplexing-deploying multiple antennas at the transmitter and at the receivers, so that independent streams can be transmitted simultaneously from all the antennas-as one of such technologies to develop adaptive antennas.

2.7 Conceptualization of Mobile Learning
According to El-Hussein, M. O. M., & Cronje, J. C. [18], mobile learning as an educational activity makes sense only when the technology in use is fully mobile and when the users of the technology are also mobile while they learn. These observations emphasize the mobility of learning and the significance of the term “mobile learning”. Traxler [19] and other advocates of mobile learning define mobile learning as wireless and digital devices and technologies, generally produced for the public, used by a learner as he or she participates in higher education. Others define and conceptualize mobile learning by placing a strong emphasis on the mobility of learners and the mobility of learning, and the experiences of learners as they learn by means of mobile devices. The two terms under consideration in this article are therefore mobility and learning. On the one hand “mobility” refers to the capabilities of the technology within the physical contexts and activities of the students as they participate in higher learning’s institutions. On the other hand, it refers to activities of the learning process, the behavior of the learners as they use the technology to learn. It also refers to the attitudes of students who are themselves highly mobile as they use mobile technology for learning purposes. [18].

“Traxler [19] writes: “so, mobile learning is not about ‘mobile’ or about ‘learning’ as previously understood, but part of a new mobile conception of society”. Research and reflections on mobile learning should stimulate multidisciplinary and interdisciplinary thinking and methods in education. They should facilitate our understanding of outdated concepts and rigid assumptions about learning and what it may be in a society that has changed (at least from a technological point of view) out of all recognition in the past few decades. In this sense, it is impossible to attribute one
fixed meaning to the concepts of mobile learning. To fully understand this concept, it is critical to consider the relationships between each of the words used to describe the phenomenon of mobile learning.

The use of this premise to understand mobile learning presents an enormous challenge because there are many words and terms, which have been used to define and explain mobile learning as a phenomenon. Traxler [19] notes that there are some definitions and understandings of mobile education, which focus only on the technologies and hardware, whether it is a handheld and mobile device such as personal digital assistants (PDAs), Smartphones or wireless. These definitions undermine a proper understanding of the uses of mobile technology in learning by confining their explanations and descriptions to the actual physical way in which the technology operates. Other definitions place more emphasis on what learners experience when they use mobile technologies in education, while others inquire how mobile learning can be used to make a unique contribution to the advancement of education and other forms of e-learning.

Mobile learning values and defends in its own unique way the introduction of what is radically new in the technological, social and cultural spheres of human life and activity. We argue that human beings are obsessed by the desire to change, to explore, to learn, design and to introduce what is absolutely new into the framework of past conventions and protocols. Mobile learning opens our minds to the possibility of a radically new paradigm and encourages us to abandon the constraints of our habitual ways of thinking, learning, communicating, designing and reacting. This argument provides a strong theoretical framework for understanding how mobility and learning are manipulated in design paradigms.

However, the pedagogical view of collaborative learning can be regarded as the theoretical fundamental of design perspective and technology also supports the design view of the system. After students manipulate the mobile blogging system in a learning activity, the use of collaborative and technological perspective should be observed in the experimental process which can further influence the design aspect by evaluating the learning effect of students [20]. Traxler [19] again cautions that “the role of theory is, perhaps, a contested topic in a community that encompasses philosophical affiliations from empiricists to post-structuralists, each with different expectations about the scope and legitimacy of a theory in their work”. If we are to place the phenomenon of mobile learning within the context of the theories of instructional design, we need to “break down the walls to open up new spaces” [21]. This means examining some of the foundational assumptions and presuppositions on which all previous understandings of the term “higher education”, or post-school education, are constructed.

By using mobile communication devices to deliver higher education content, we are likely to reduce the physical walls of the classroom and replace them with other virtual barriers or constraints. However, it would support just in time learning and training in higher education context and “the results showed a significant correlation between planning and model quality, indicating an overall positive effect for the support tool” [22]. While the content of the education may remain the same, it is delivered by means of a radically new technology that combines the advantages of the Internet as a convenience of portability and education “at any time and in any place”. King [21] highlights how radically different the procedures connected with mobile learning are, when he writes: “by breaking down the assumptions and process behind writing and speaking, we can go beyond them and find new ways of thinking about the world” [18]

2.8 Mobile Learning in Higher Education

“The most important yet sophisticated concepts for designing instruction in this context are identifying the technology, learner and learning material as well as mobile technology such as portable devices. It also involves identifying learners who are nomadic and able to understand and interpret learning materials. In general, mobile learning – or m-learning- can be viewed as any form of learning that happens when mediated through a mobile device, and a form of learning that established the legitimacy of ‘nomadic’ learners [23]. These are the developments that have made mobile devices strategic tools with the capacity to deliver higher education instruction in a way that was never anticipated when the first prototypes of these devices were designed and marketed. Designers can deliver successful higher education products to the present generation of learners, by means of a technology, distinctively adapted for its own personal (mostly social) purposes. This makes technology a particularly potent tool for the delivery and reinforcement of content that would otherwise be identified with the higher education “establishment”. Devices “such as mobile phone and mp3 players have grown to such an extent over recent years and are gradually replacing personal computers in modern professional and social context” [24]. Modes of communication that were spontaneously developed by the younger generation have been subverted to serve the purposes of transmitting higher education. Such structural changes in the delivery of higher educational instruction add a powerful tool to the arsenal of available means that educators can use to make delivery more efficient, personal and culturally acceptable to those who pioneered these new modes of text delivery [25]. These fundamental changes pose new problems to the designers. What new design paradigms and meanings can be attributed to the use of mobile technology? How can we appreciate their full significance within the context of traditional instructional design theory? Before the development of new forms of information and computer technology such as the current mobile “smart” cellular telephones, the design paradigms by means of which the delivery of higher education was understood remained essentially static.
The extraordinary potential inherent in mobile devices, anticipate radical changes in the very structure of educational dynamics especially in the way in which people interact with one another in society. The kind of informal learning through the use of mobile devices makes it an even more potent tool of educational communication than the customary forms and modes of traditional education. These revolutionary changes developed out of the unforeseen significance of human social life generally more “mobile”, creative and opportunistic, than the formal modes of traditional education.” [18]

2.9 Sarah Kessler on Improving Education through Technology
Sarah Kessler [26] established eight ways that education is being improved via the application of various technologies:
1) Better Simulations and Modeling: The key issue she raised here is the development of free, open source software that teachers can use to model concepts. For instance, the development of software that aid students in the experimentation of virtual greenhouses in order for them to understand evolution.
2) Global Learning: The use of collaborative schemes like videoconferencing or social networks as tools to aid the acquisition of knowledge from teachers or other folks in different parts of the world.
3) Virtual Manipulative: The use of virtual manipulative sites where students can play with the idea of numbers and what numbers mean.
4) Probes and Sensors: Real-time data can be collected through probes and sensors. They have a wide range of educational applications. Dew point can be computed with temperature sensors, pH with ph probes, chemical changes in photosynthesis with pH and nitrate sensors.
5) More Efficient Assessment: Real-time assessment data can be gotten from students with the aid of technological applications.
6) Storytelling and Multimedia: she argued that asking children to learn via multimedia projects is an excellent form of project-based learning that teaches teamwork. It is also a good way of motivating students who are excited to create something that their peers will see, she added.
7) E-books: Electronic textbooks, usually in PDF formats, can aid education and reduce the stress involved in carrying many textbooks.
8) Epistemic Games: These are games that put students in roles like city planners, journalists, or engineers and help them in solving real-world problems. Fundamental ways of thinking can be learnt through these games.

2.10 Augustus, M.E [15] on “4G Systems and Education”
The technical development of wireless networks and its explosive penetration in practically all regions of the world have created opportunities not available before, to explore applications of communication devices in social, cultural, economic, and educational contexts. A lot has been achieved in this regard, with the 3G infrastructure. 3G performances, however, are insufficient in meeting the demands for future high-performance applications. This creates the need for a wireless communication technology that extends 3G capabilities. The 4G framework is intended to compliment and replace the 3G systems. The idea is to solve the problem of the 3G systems and provide a wide range of new services. This suggests that the 4G framework is not a radical shift from the previous technologies, but a product of an incremental process of decent with modifications. The new technology incorporates some features of the 3G standard. The differentiating factor between 3G and 4G is that 4G offers higher speed rates (in the order of 100Mbps compared to a peak 3Mbps of 3G) and enhanced quality of service and security. These and other features of the 4G facilitate learning and improve performances in educational environments.

4G Features: Education Perspective
4G is described as MAGIC- Mobile multimedia, Anytime anywhere, Global mobility support, Integrated wireless solution, and Customized personal service. This highlights the key features of 4G technologies. How then do they apply to education?

High Usability Anytime, Anywhere, and with Any Technology: The use of 4G systems gives one access to huge amount of information and services from anywhere, at anytime. The ease in accessing these information is achieved by increased bandwidth and higher data transmission rates that allow users, at anytime, anywhere, the ability to utilize high-definition videos, video conferencing features of mobile devices, and receiving large volume of information, data, pictures, and many more.

This feature is highly needed in distance education. The term distance education refers to a form of education and training delivery in which students are remote from the institution and rarely, if ever attend formal teaching sessions. Distance education is delivered through the use of various learning resources, and supported by teachers using a variety of communication technologies. Multimedia educational technologies such as CD-ROM, Internet applications and activities, radio, television, video materials, telepresence, fax machines, and computers, are employed. With 4G wireless devices, distance education will be given a major boost via the ability for students, anywhere in the world, to get connected and acquire information in real-time from live classes delivered through mobile collaborative schemes such as video conferencing, telepresence, and audio conferencing/communications and so on.
Students can actually receive High-definition television broadcasts on their mobile devices via mobile TV seamlessly - without noticeable disruptions. The academic goal of social constructivism can be achieved in distance education with the use of 4G wireless devices which give students access to mobile video calls or chatting, audio communications, and social networking sites, on the go. Social networking sites provide an avenue for students to interact in an asynchronous place-independent manner; enabling students to become a community of learners. With 4G devices, these features can be accessed at any moment, from any part of the globe.

**Support for Multimedia Services at Low Transmission**

**Cost:** The mobile access to these rich digital media services provided by the 4G technology is or will be achieved at lower cost/bit. This reduces the economic factor in the usage of the infrastructure, for both teachers and students.

**Global Seamless Mobility:** The 4G technology is expected to provide an all-IP based mobile broadband to cellular devices and wireless modems. The all-IP based broadband (a set of various networks using internet protocol–IP, as a common protocol) ensures that mobile servers can be reached as long as it is within the coverage area of any server. This fosters a seamless mobility-navigation between technologies with noticeable disruptions. Thus, an educational session is not interrupted in case a student carrying a mobile terminal moves from one base station coverage area to another, because of the smooth and quick handovers among access technologies such as ad-hoc, wired networks, wireless LAN, or cellular networks. As a result, various learning/teaching processes can be done without interruptions.

**Integrated Services:** In his article titled “4G Features”, Jawad Ibrahim [13], an RF engineer, who was, as at the time of the publication of the article, in the Design Department at Bechtel Telecommunications, stated that “The features of the 4G systems might be summarized with one word-integration”. He expressed the fact that “the 4G systems are about seamless integrating terminals, networks, and applications to satisfy increasing user demands”.

Alongside seamless mobility, 4G provides flexible interoperability of the various kinds of existing wireless networks, such as satellite, cellular wireless, WLAN, PAN and systems for accessing fixed wireless networks [17]. 4G provides an all-encompassing integrated perspective-integration with existing mobile technologies through advanced technologies which ensures the high dynamic nature and adaptability of terminals and applications. This feature aids mobile-learning significantly, in that it reduces the limitation of learning location with the mobility of general portable devices.

In educational context, these mobile devices can be used to perform the following:

- a) Deliver Education/Learning
- b) Foster Communication/Collaboration
- c) Conduct Assessments/Evaluations
- d) Provide Access to Performance
- e) Support/Knowledge
- f) Capture Evidence of Learning Activities.

**Personalized/Localized Information:** Services in the 4G framework are delivered and made available to the personal preference of users with a high level of security, and supports the users’ traffic, air interface, radio environment, and quality of services. Personalized/localized information services and applications with respect to an educational environment, can provide students with news on educational issues based on the profile stored by the user, which defines how the application should act with respect to available educational services.

### 2.11 Elements of a Comprehensive M-Learning (Mobile Learning) Framework

One of the major 4G possibilities from an educational point of view is mobile learning. Mobile learning, however, refers to a learning process experienced when the learner is not at a fixed predetermined location or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies, such as handheld computers, notebooks, and mobile devices. The following elements readily come to play in the development of a mobile learning framework [15]:

- The capacity of immediate communication: Making available a synchronous communication among tutors and students is readily available. This communication capacity in the form of voice or text messaging, mobile video and internet connectivity provides the needed access and establishes social networks with the potential of supporting the learning process via interactions with teachers and students, relatives and friends regarding academic or daily life concerns.
- Message size limitations: Mobile devices have limited processing capacities compared to laptops or other computers. This limitation associated with the screen size restrains the kind of content to install and manage by the devices. This should be given due consideration.
- Context Management: Context is a key factor associated with learning. Students and teachers can experience and relate with different types of information when moving during the length of a trip or in route to school or home. The management and understanding of interactions and interactivity with the contexts using mobile technology becomes crucial to establish a relevant framework for m-learning. Context personalization is another important factor to consider.
Spontaneity: The portability and accessibility of smart-phones provides immediate opportunity to communicate with other parties or to establish a social network for solving a specific academic need. It will be important to identify which applications are pertinent to take full advantage of this capacity.

Informal learning: The use of mobile devices in non-traditional academic environments using m-learning applications provides opportunities for informal learning experiences. There are many pilot projects all over the world that have exploited the technological benefits of m-learning in informal settings. These projects have created an important platform to identify the main challenges involved in developing relevant applications of m-learning in different academic environments.

Technology skills: In order to take advantage of the full potential of mobile devices, it is important for students and teachers to be informed and understand its main capacities, functions, and applications. The frequent contact of teachers and students with mobile devices allows the development of skills to properly operate such devices. Teachers who might experience the “mobile divide” perhaps reject the use of mobile technology and will face significant challenges to adopt or participate in educational efforts centered on m-learning concepts.

3. METHODOLOGY

3.2 Design Considerations for M-Learning Systems
M-learning is simply about learning with mobile devices. This implies that students are made to have access to educational materials/sessions on their mobile devices anywhere, at anytime. M-learning is collaborative. All the users of an M-learning scheme can share information almost instantaneously using the same content, which leads to the reception of instant feedback and tips. In developing mobile learning schemes, the following considerations need to be given proper attention.

Design Objectives
- Students Motivation: designed to motivate students in their various learning processes
- To serve as an efficient tool in distance education for the transmission of information
- Promotion of the development of personalized and flexible learning processes
- Reducing the difficulty experienced by students in accessing customized information
- Providing instant feedback to students about their performances and explanations of correct answers
- Delivery of educational materials
- Conduct assessments and evaluations, and capture evidence of learning activities
- Provide faster communication and collaboration

- Providing a platform for instants interactions of students using the scheme from anywhere and at anytime
- Provide a database backbone to save and track students records and academic activities
- Providing adequate content security, security of students details, and eliminating common piracy and hacking concerns

3.2 Design Principles
- It is visually simulative, flexible and easy to use
- Diversification of learning activities. Providing a blended approach to learning, where students can learn via different methods and in different formats
- Very interactive and well designed user interfaces
- Promotes engagement between the learner and the lesson content
- Develops and maintains user’s interest
- Facilitates lesson navigation and access to learning content
- Helps learner to find and organize information
- Proper design segmentations
- Adequate security of the platform
- Creating room for incremental development. This implies that the framework should be emerging in nature (It should be an emerging technology).

3.3 Benefits of M-Learning
The Wikipedia [27] proposed the following benefits of M-learning. These benefits apply to any m-learning scheme/approach.

- Relatively inexpensive opportunities, as the cost of mobile devices are significantly less than PCs and laptops
- Multimedia content delivery and creation options
- Continuous and situated learning support
- Decrease in training costs
- Potentially a more rewarding learning experience

3.4 M-Learning Technologies
- Handheld MP3, MP4 players,
- Notebooks, and Laptops
- Mobile phones (Camera Phones) and Smart-phones with Wi-Fi capabilities
- Tablets
3.5 Design Architecture/Framework

The educational materials/methodology for the proposed m-learning schemes on the 4G platform can come in the form of eBooks, audio and video recordings, access to streaming-life discussion sessions, access to radio broadcasts, HD TV educational sessions, communication (among students and lecturers) via SMSs (Short Messaging Services), emails, social networking sites, mobile blogging, video and audio conferencing, mobile collaborative schemes, and so on. These features will foster individual students independent learning; a group of students can also communicate and exchange ideas via group discussions; and a tutor can also communicate with all the students or via a mobile collaborative scheme received on their mobile devices. Students can also take online assessments and have access to their grades via their mobile devices.
Basically, with the m-learning scheme, users (students and lecturers) should be able to:

- Download, store, display text
- Download, store, display images
- Download, store, play audio
- Download, store, play video
- Download, store, play games and simulations
- Download, store, and play images, audio, video-enhanced e-books
- Take, store, share audio, video, text, images
- Receive and share instant messages (text, image, video)
- Make telephone calls
- Record, store, process, and share data (GPS, images, temperatures, pressure, etc.)
- Edit, modify, alter shared text and images

The student’s mobile device will communicate with the m-learning system using:

Wireless networks that are implemented by the telecommunication companies: mobile telecommunications companies in the country. Mobile carrier data connections over 4G that allows permanent connections in areas covered by a mobile carrier; these services imply supplemental costs for users but in many cases students benefit from different promoting programs that will lower the cost or offer limited transfer with the voice service; it allows almost anywhere connection and access to mobile learning services in places where conventional networks are unavailable; taking into consideration the cost impact that is directly related to the amount of transferred data, developers of m-learning applications must concentrate firstly on reducing this size.

Despite the fact that the m-learning process is not fully defined and it is in a continuous development, there are categories of applications that must be implemented and used:

- Standalone applications that provide standalone services or communicate with the system using WAP or Socket technologies; depending on the device operating system, these applications are developed in Java or in .NET Compact Framework;
- Web browsing using 4G technologies; it gives access to online resources as courses, suggested bibliography, multimedia presentations; taking into consideration the connection bandwidth, amount of transferred data and the device display, the Web content must adjust its size and quality dynamically; developers must set as objective an optimal level for the quality-cost balance;
- SMS Alert services must be provided by the mobile carrier as a request made by the m-learning provider; this solution is very cost effective and also has a great communication impact; as every student has a mobile device used also for voice communication this application type has a full coverage over its users; also, this service has the minimum time for data communication;
- IVR (Interactive Voice Response) services which offer support or useful information to users using voice communication technologies; it may be considered an alternative to the web based solutions;
- Email services for mobile devices has become possible as many Smartphones and PDAs come with POP3 email clients that use any available data connection to retrieve email messages from the server;
- PushToEmail is a service that will be offered by the m-learning provider with the mobile carrier; this application allows email transfer using the mobile carrier network; initially the technology was introduced by Blackberry devices but in recent time many vendors has implemented this facility in their mobile devices;
- Online Sharing of data or multimedia content; shared resources may be uploaded or accessed using the application.
- A Web based application that requires students to interact with it on a specific topic; this application implements an inquiry-oriented activity and allows students to access resources and to upload data.
4. IMPLEMENTATION

4.1 System Hardware Requirement
Mobile devices that can be used for the learning infrastructure should have the following hardware components. These are the minimum hardware components for such devices. They’re the basic hardware requirements for 4G phones and other mobile devices within the 4G framework.

- CPU: 1GHz Processor Speed and above
- Memory: 512 MB RAM and above
- Removable Storage: 4GD microSD and above
- Data Inputs: Multi-touch touch-screen display, Light Pen, Joy Stick
- Camera 1.3 mp, minimum
- USB cable to connect and to transfer data between mobile devices and a local computer
- Bluetooth hardware components for compatible devices
- Infrared data ports for mobile devices with infrared capabilities

4.2 System Software Requirement
The basic software requirements for the devices to be used are as follows:

- EBook Reader, Acrobat Reader for PDF Documents
- Android OS (Operating System), Blackberry OS, Windows OS
- Web Browsers
- Bluetooth technologies that allow communication between mobile devices, data transfer and access to different resources like shared printers and other Bluetooth compatible devices
- Infrared data transfer between mobile devices that incorporate an IR port
- Wi-Fi Capabilities
- FM Radio
- Audio and Video Media Players
- Mobile applications that will enable the receipt of Radio and Television broadcasts from anywhere in the world

4.3 Implementation Procedures
The implementation of the proposed infrastructure begins by developing a functional website with all the needed functionalities; from which mobile applications developed for the content delivery can be downloaded. Sharples [28] proposed that the general requirements for technologies to support contextual life-long learning are that they should be:

- highly portable, so that they can be available wherever the user needs to learn;
- individual, adapting to the learner’s abilities, knowledge and learning styles and designed to support personal learning, rather than general office work;
- unobtrusive, so that the learner can capture situations and retrieve knowledge without the technology obtruding on the situation;
- available anywhere, to enable communication with teachers, experts and peers;
- adaptable to the context of learning and the learner's evolving skills and knowledge;
- persistent, to manage learning throughout a lifetime, so that the learner's personal accumulation of resources and knowledge will be immediately accessible despite changes in technology;
- useful, suited to everyday needs for communication, reference, work and learning;
- easy to use by people with no previous experience of the technology.

These requirements provide initial constraints on the implementation of a mobile learning technology. The requirement for a highly portability means that the implementation of the technology/applications for m-learning should be light and capable of being carried and operated on the move by mobile devices. The technology should be able to capture sounds and images, and to communicate.

The requirement for it to be highly portable and available anywhere, indicates wireless communication, either through cellular telephone or wireless Local Area Network (LAN). To adapt to a learner’s changing skills and knowledge, the system must be able to maintain a profile or model of the learner which can determine the way in which the accumulated knowledge and learning material is stored and then presented back to the learner in new contexts. This presents a major research challenge. Most attempts at developing computer models of a learner’s knowledge have concentrated on specific topic areas and learning over a short period of time. A life-long aid must either be able to detect, model and support such reorganizations of knowledge, or provide tools for the learner to manage this process.

Lastly, for the system to be useful and easy to use, the technology must present an appropriate and intuitive system image. A system image is the combination of product design, interface, and interaction design that hides the complexity of the internal programming and presents a product which matches the user’s tasks and understanding.
5. EVALUATION

In evaluating the study, I make reference to the concepts proposed by [29] and [24]; which presents a proper evaluation about m-learning integrated with 4G capabilities. M-learning is the future of education. M-learning integrated on a 4G platform provides the best learning method, not just for open and distance education, but also for conventional classroom oriented mode of learning, to make learning more exciting and interactive. However, according to Libin He, Chengling Zhao [30], “4G mobile technology-based learning model will be the emergence of a strong impetus to mobile communications and the integration of the internet and mobile communications and education combined to make full use of educational resources, improve people's learning...This kind of mobile learning also has the following characteristics: embodied in portability, efficiency, and individual, low-cost.”

Portability: Learners can control their own learning time with portable mobile devices, via making voice, video, data and other information access during their study, and make exchanges among themselves in scattered time (‘scattered time’ implies having access to information and communication by the learners anytime and at anywhere: at home, on the road, in the office, and so on, without being restricted to specific periods as is the case with classroom learning mode). In the open and distance learning system, most of the students are assumed to have jobs. Mobile learning is more helpful to them because they are no longer restricted to a specific time, specific place to learn, but can organize their life, study and work better.

Efficiency: 4G technologies provide learners with intelligent networks. Learners can change ideas timely with other learners on the internet; they can study and have discussions. By this way we can enhance learners’ learning efficiency rapidly.

Individuation: Modern education advocacy opts for personalized learning; which case learners can be in accordance with their own actual conditions and needs, master learning processes, and align themselves with the learning content. Mobile learning provides a system for self-learners to develop the space and learning platform.

Low cost: With the anytime, anywhere, wireless connectivity, communication has been made flexible and easy. The use of wireless LAN can avoid the high cost of cable installation costs. In universities more than 90 percent of students have mobile phones, so schools don’t need to invest heavily in wired equipments for student again. Wireless systems provide lower cost of communication.

An analysis of 12 international case studies in [29] reveals that reasons given for using mobile technologies in teaching and learning relate principally to improving access, exploring changes in teaching and learning, and alignment with institutional or business aims, as illustrated by these examples:

Access:
- Improving access to assessment, learning materials and learning resources
- Increasing flexibility of learning for students
- Compliance with special educational needs and disability legislation

Changes in Teaching and Learning:
- Exploring the potential for collaborative learning, for increasing students’ appreciation of their own learning process, and for consolidation of learning
- Guiding students to see a subject differently than they would have done without the use of mobile devices
- Identifying learners’ needs for just-in-time knowledge
- Exploring whether the time and task management facilities of mobile devices can help students to manage their studies
- Reducing cultural and communication barriers between staff and students by using channels that students like
- Wanting to know how wireless/mobile technology alters attitudes, patterns of study, and communication activity among students

Alignment with Institutional or Business Aims:
- Making wireless, mobile, interactive learning available to all students without incurring the expense of costly hardware
- Delivering communications, information and training to large numbers of people regardless of their location
- Blending mobile technologies into e-learning infrastructures to improve interactivity and connectivity for the learner
- Harnessing the existing proliferation of mobile phone services and their many users.

A review of the 27 projects documented in the proceedings of MLEARN 2003 [24] shows a similar spread of objectives, with a predominance of objectives identifying or targeting changes in teaching and learning:
Access:
- enabling students to look at course information anytime and anywhere
- trying to ensure that every student can access content independently of the channel he or she chooses to use
- the use of a PDA as an assistive technology
- ensuring that classroom-based pupils benefit from the experience of a field trip being undertaken by their peers

Changes in Teaching and Learning:
- individualization:
- to explore the potential for individualized mobile learning - revision material tailored to the needs of the individual;
- to provide learners with a flexible context-awareness system that can react to their needs
- collaborative and active learning:
- immediate feedback through interactive tests: the user knows in real time if their choice is correct
- interactive screens encouraging art gallery visitors to respond to the art on view
- a set of innovative games, materials and activities which will motivate reluctant young learners
- a user-friendly m-portal that is powerful and empowering, and encourages active participation by its users
- enhancing interactivity and cooperation while preserving the traditional advantages of face-to-face encounters
- informal learning with multiple media:
- to investigate how self-produced videos, made with a digital video camera and later viewed on handheld mobile computers, can support informal learning
- to provide video and still images giving additional context for art gallery works on display, opportunities to listen to an expert talk about details of a work, with the details simultaneously highlighted on the screen
- enhancing the audio presentation of a multimedia museum guide by using the PDA screen to travel throughout a fresco and identify the various details in it
- using voice technology to provide rich media content for the user
- cognitive and behavioral change:
- to explore how context-dependent learners’ knowledge concepts are
- to evaluate fragmentation in mobile learning based on students’ deep and surface approaches to learning
- to capture learners’ thoughts, views and behaviors in a mobile learning setting

Alignment with Institutional or Business Aims:
- to remain at the cutting edge of educational technology by helping to shape a new generation of multimedia tours in art galleries
- to investigate whether an integrated set of learning tools would be useful, which tools would be adopted and the contexts in which the tools would be used
- development of a service model and new component concepts for lifelong mobile learning

6. CONCLUSION

Applying the 4G technology, with all its very impressive promises, in mobile learning context is the best for our educational system in a dynamic world like ours. The possibilities cover a wide range; only limited by the imaginations of the developers and the needs of the users. The world cannot afford to go back on this infrastructure. Its full implementation (strict implementation based on the specified ITU specifications) should be the goal of every one on various institutions of learning, more especially in mobile learning and distance education. This will bridge the divide created by time and space in learning processes at all levels of education.

To date, content for entertainment and communications captures the attention of students all over the world. With the mobile learning scheme integrated with 4G features and capabilities, students will be more willing to study; thereby fostering the realization of educational objectives. More educational content is necessary with adoption and usability suited for specific learning environments.
REFERENCES


Authors' Brief

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A Cognitive Load Theory-Based Framework for Designing an E-Learning Environment

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ABSTRACT

Learning has foundation in learning theories. The organisation of the learning contents to students and the linking of the related or similar contents in the same field of domain knowledge in an e-learning environment should be given a great consideration. From the literature, there are lots of factors that relate to cognitive learning theories that have been incorporated into the development of e-learning systems. Factors such as students’ learning styles models and motivational models have been used in e-learning environment as instruments that lead students in enhancing their learning performance. Hence, this paper presents a framework of an e-learning environment that takes into consideration the significance of cognitive load theory to instructional procedure or design.

Keywords: E-learning environment, cognitive load, learning theories, cognitive architecture

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1. INTRODUCTION

Learning is the acquisition and transferring of knowledge to solve similar problems within the contexts. There are several strategies and approaches to learning which most importantly focus on achieving successful learning performance on the part of the learners. The organisation of the learning contents and the modalities of transferring the contents to the learners to be processed by human cognitive memory unit should be greatly considered in educational settings. Human cognitive memory system should process information content for its transference into long-term memory for retention and recall. Often time, when learners need to access information on a similar subject matter or concept that requires several interfaces, there is tendency for cognitive overload and the rate of information loss to be high.

Cognitive load theory deals with the limitations of short-term memory and its interaction with an unlimited long-term memory [4]. Cognitive load is described by theorists as total amount of mental activity that short term memory must deal with simultaneously and that information complexity of learning materials is determined by the level of element interactivity [3].

Sweller and Chandler in [4] stated that the scenario of less skilled learners in the process of acquiring a new task or complex task requires processing the elements as units into a number of low-order schemas which are combined into higher-order schemas. With this, the reconstructed schemas for complex task also established that all the related interactions are incorporated in the schemas and the schema is treated as a single element by learners’ short-term memory, thereby reducing the load for short-term memory.

When considering the process of understanding, a new knowledge is significance to reconstruction of existing schemas to generate new higher order schemas which contains the new knowledge.

Human cognitive architecture requires a large information store in order to function which is established in long-term memory. The role of education is to increase knowledge held in long-term memory of particular discipline areas and how such knowledge is acquired is a concern of cognitive load theory. The processing capacity of working memory is considerably less than its storage capacity with no more than about three to four items of information being able to be processed at a time [9], [6].

The concept of heavy working memory load is a function of processing many elements simultaneously. The processing of information simultaneously or successively depends on element interactivity. Element interactivity is central to cognitive load theory and the cognitive load effects. When processing multiple and interacting elements in working memory simultaneously, then an excessive or inappropriate cognitive load may be generated [3].

2. OVERVIEW OF COGNITIVE LOAD THEORY

Wong et al [8] described cognitive load theory as a framework of educational design principles based on the attributes and relations between the structures of human cognitive memory model especially the working memory and long-term memory.
The theory has the notion that human cognitive architecture is a natural information processing system, similar to other systems such as evolution by natural selection. According to Wong et al [8] stressed that the theory can be identified by the following principles:

i. Long-term memory and the information store principle: Human cognitive architecture or systems requires a large information store that can be used to direct appropriate activity. The structure that provides this functionality is human long-term memory.

ii. Schema theory and the borrowing and reorganizing principle: The principle assumes learning is through borrowing information from the long-term memory. The borrowed information and the already stored information in the long-term memory are integrated together in such manner it is the new and reorganized information that is stored in the long-term memory. In nutshell, information is stored as schemas rather than as copies. Each schema stored is different from the schema held in the long term of the person from whom it was borrowed, because it is a combination of the borrowed information combined with the information already held in long-term memory.

iii. Problem solving and the randomness as genesis principle: Through learning, knowledge stored in long-term memory is acquired via the borrowing and reorganising principle. Knowledge is actually created through problem solving. When solving familiar problems, it requires human cognitive architecture to retrieve schematic information from long-term memory. That is, recognising a problem to a particular class of problems that require a particular solution. Mostly, this cannot generate new knowledge. Dealing with unfamiliar problems has the tendency to discover a new procedure or concept when solving the problems and this generates new knowledge. With unfamiliar problems and the lack of information held in long-term memory, it is expected to randomly choose a procedure and attempt to test that procedure for effectiveness.

iv. Working memory and the narrow limits of change principle: Working memory acts as a medium between the external environment and the long-term memory. The peculiar feature of working memory is its limitation in processing capacity and temporal when dealing with a novel information from the external environment using a random generate and test procedure. The narrow limits of change principle is important to instruction and central to cognitive load. Instructional procedures have to take into consideration the capacity and temporary limits of working memory because recommended procedures leads to increase in working memory load causes inability of students to learn.

v. Long-term working memory and the environmental organizing and linking principle: The operation of working memory differs when organizing novel information from the environment to when using environmental information to organize the information store. Working memory has its limitation in processing capacity when dealing with novel information from the external environment but with long term working memory, it has the capacity to handle previously learned information held in long-term memory. This automatically reduces the burden on working memory and decreases the cognitive load.

Alasraj et al [4] stressed that theorists of cognitive load have developed three distinct types that can affect learner during learning process such as intrinsic, extraneous and germane load. These types are to be considered by the instructor in deciding the most suitable instructional techniques for the learner in order to increase learning outcomes. These are discussed as follows:

i. Intrinsic Cognitive Load (ICL): Cognitive load theory describes that information complexity of learning materials is determined by the level at which the elements interact. The load on short-term memory during learning process depends on the number of elements that has to be processed simultaneously which is the function of the level of interactivity between the elements. The ICL varies on the degree of interactions between elements in the learning material. Learning materials that have single learning elements with the need to learn in isolation have a reflection of low level of element interactivity. With these materials, the short-term memory is low and the intrinsic cognitive load memory is low. When compare with complex materials that have higher degree of elements interactivity cannot be learned in isolation by the learners. It is expected that learners need to learn individual elements and understand the relationship between the individual elements.

ii. Extraneous Cognitive load (ECL): This is the resultant effect of poorly developed instructional materials. The way to reduce the effect of ECL is ruled by the instructional process through which the instructor is given the ability to vary the e-learning tool developed. Short term memory should not be flooded or exposed with an unnecessary ECL when the learner is in the process of constructing and acquiring schemas.

iii. Germane Cognitive load: This is the process of constructing and storing schemas in long-term memory.
The cognitive load effect is demonstrated when the theory is used fundamentally to propose the ways of altering the number of interacting elements which result in new instructional procedure and with enhanced assessment outcomes rather than traditional procedure.

The cognitive load effect generally depends on the elements interactivity of materials and how learners relate with this to achieve study and overall learning outcome. Sweller [3] described various load effects on cognitive that theorists developed in the face of instructional procedures which are depicted in Table 1.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Description</th>
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<tbody>
<tr>
<td>Variability</td>
<td>Under low intrinsic cognitive load, increased variability increases intrinsic load resulting in increased learning if working memory resources are available</td>
</tr>
<tr>
<td>Isolated elements</td>
<td>Under high intrinsic cognitive load, presenting interacting elements as though they are isolated can decrease intrinsic load</td>
</tr>
<tr>
<td>Goal-free</td>
<td>Eliminating a problem goal eliminates the use of means-ends analysis reducing extraneous cognitive load</td>
</tr>
<tr>
<td>Worked example</td>
<td>Demonstrating a problem solution reduces the extraneous cognitive load associated with problem solving</td>
</tr>
<tr>
<td>Split-attention</td>
<td>If mental integration is required, extraneous cognitive load may be reduced by physically integrating disparate sources of information</td>
</tr>
<tr>
<td>Modality</td>
<td>Mental integration can be facilitated by presenting material using audiovisual rather than a visual only format</td>
</tr>
<tr>
<td>Redundancy</td>
<td>Demonstrating a problem solution reduces the extraneous cognitive load associated with problem solving</td>
</tr>
<tr>
<td>Element interactivity</td>
<td>if intrinsic cognitive load is low, a high extraneous cognitive load may not exceed working memory capacity, reducing extraneous cognitive load effects</td>
</tr>
<tr>
<td>Expertise reversal</td>
<td>Information that is essential for novices may be redundant for experts reversing the relative effectiveness of instructional designs</td>
</tr>
<tr>
<td>Problem completion</td>
<td>Similar to the worked example effect based on partial worked examples and can be used during guidance fading</td>
</tr>
<tr>
<td>Guidance fading</td>
<td>Due to expertise reversal, as expertise increases, the guidance provided by worked examples should be decreased and eventually eliminated</td>
</tr>
<tr>
<td>Imagination</td>
<td>With sufficient expertise, imagining procedures or concepts can be more effective than studying</td>
</tr>
<tr>
<td>Transient information</td>
<td>The use of technology can transform permanent into transient information increasing extraneous cognitive load.</td>
</tr>
</tbody>
</table>

For the effective deployment of this theory connecting with technology, instructional designers or developers must place great consideration in the instructional procedures and strategy that promote or lead to successful learning performance. Cognitive load theory provides a platform where instructional designers can control the conditions of learning within an environment. E-Learning can achieve greater success by implementing the design to reduce cognitive load effect, so that learners will be able to learn within the context of their understanding without putting too much load on the memory.

3. RELATED WORKS

Sawicka [2] developed a simulation model of cognitive learning theory where certain features of instruction and the cognitive capabilities of learners are expresses formally and how the resultant model can assist in gaining insights into the learning dynamics that arise from these relationship and providing a new assistance for research teaching and practice in the field of instructional design.

Park et al [1] developed a theoretical framework using cognitive load theory to ascertain several studies with the notion that adding seductive details to instructional materials has detrimental effect. A 2 x 2 experimental design was set up in which a group of 100 high students was selected to learn biology with a multimedia environment that manipulated the presence of seductive details with or without and the modality of the verbal information with high load on screen text versus low load narration.
The research findings demonstrated that students learning performance was significantly higher when seductive details were presented under low load condition than the other conditions. The results suggested that seductive details may foster learning under a low load condition. Adding extraneous load in the form of seductive details fostered learning under the narration condition but not under the on-screen text conditions.

Wong et al [8] carried out an experimental study to explore the effects of transience due to the use of animation-based instructions and spoken information under audio-visual conditions in a cognitive load theory framework. The study was hypothesised in the form that the transient information presented in short sections; animations would be superior to static graphics due to innate ability to learn by observing. The transient information in long sections, animations should lose their superiority over static graphics due to working memory overload associated with large amounts of transient information. In the same way, the modality effect under which audio-visual information is superior to visual information should be obtained using short segments but disappear or reverse sing longer segments as a result of the working memory consequences of long, transient and auditory information. The results obtained supported the hypotheses.

Klüge et al [7] presented combined principles of cognitive load theory and diagnostic error analysis for designing job aids to determine the effects on motivation and diagnostic performance in a process control task. The researchers set up research questions which carried two studies on the design of a procedural aid and the impact of an additional decision aid for process control. Study one is a procedural aid that avoids imposing unnecessary extraneous cognitive load on novices when controlling technical system. Study two is the effect of a decision aid for use before the procedural aid was investigated which was based on the analysis of diagnostic errors committed in study one. The research findings in study one showed that procedural aid is positively affected germane load, attention, satisfaction, motivation, knowledge acquisition and diagnostic speed for novel faults. While in study two showed that novices are able to diagnose both novel faults and practiced faults; and to support novices in dealing with technical faults in process control.

Beserra et al [5] presented a survey methodology in measuring cognitive load in practicing arithmetic using educational video games on a shared displayed. The research study is on the effect of the position on the screen of displayed information and the amount of information received by each student that shared the workspace with respect to the acquired knowledge on the subject matter. The findings from the research study using experimental setup showed that students that worked with more objects and more neighbours improved significantly less in their learning outcome.

4. FRAMEWORK OF E-LEARNING ENVIRONMENT WITH' COGNITIVE LOAD THEORY

The emphasis on instructional design principles in an e-learning environment is to foster learning and encourage high level of information processing within a given learning materials that attract meaningful elements interactivity without loss of memory information (that relates to cognitive overload) and translates to high level of skill or knowledge acquisition. The Figure 1 depicts the framework of e-learning system based on cognitive load theory to stimulate high performance of learning outcome. The learning environment establishes organised learning materials that assist students in reaching minimum level of difficulty and complexity of the materials and tasks when engaged in the learning process. It incorporates the restructuring and simplification of the materials according to students’ learning abilities or skills. It provides a step-by-step procedure and guidelines to worked examples to assist students in solving similar problems within the context supported with hints, misconceptions, correct and wrong answers.

Through this, students’ level of understanding of the concepts might greatly be tracked and provide feedback to students on specific areas of their weakness and strengths during the course of engaging in the learning process. To reduce cognitive load, extraneous factors such as split-attention and redundancy are completely avoided by the way in which the learning material is organised. An autonomy-supportive teaching method is invoke to increase intrinsic motivation in order to increase germane cognitive load which in turn will increase learning success by providing supportive information to students instead of ready-made answers during students’ demand for answers to some questions. The successful students’ learning outcome is when students can bring up an appreciative knowledge and skill from relevant materials made available to them during learning process and with different teaching techniques deplore into such learning environment.
5. CONTRIBUTION TO KNOWLEDGE

The framework is a platform to assist instructional designers and educational technologists in designing e-learning systems that focus on reducing complexity of learning materials with respect to “elements interactivity” to avoid cognitive overload on the part of students. This would afford students to create effective learning experience and achieve optimal learning outcome.

6. CONCLUSION

The use of technology in educational setting has added a unique creativity to the learning environment. Connecting students’ understanding on cognitive learning theories and processes with technology would play a vital role in e-learning environment. Building instructional designs that can effectively reduce unnecessary cognitive burden on working memory would create enabling environment for students to learn and increase their participation in the learning process that leads to successful learning outcome.

The followings are recommended for post-primary and tertiary schools for quality education delivery in developing countries such as Nigeria:

(i) This framework should be deployed in schools across various levels for effective teaching and learning methods;
(ii) Teachers and lecturers must be well informed about the general knowledge of the underlined principles of the concept (cognitive load theory) for wider recognition and acceptance of the framework;
(iii) Schools should provide adequate and well enabling technological infrastructure for effective deployment
(iv) Instructors and students should be equipped and trained on the usage of e-learning devices and resources for knowledge acquisition and skills.
References


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Development of a Yoruba Language E-Tutor for Windows Phone

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ABSTRACT

This paper discusses the development of Windows mobile application for learning Yoruba language. The application was developed using C# on Visual Studio with XML for its database. The portable application offers a high degree of privacy through its password protection feature with the user having the ability to learn how to read alphabets, numbers and common words in Yoruba language. Self-assessment questions are also provided to test how much the user has learnt after every module. Thirty participants were recruited to evaluate the software by completing a questionnaire after using the application. The evaluation criteria included user friendliness, navigation flexibility and overall performance on a 5-point likert rating scale. Most of the participants rated the application as excellent; 26 out of the 30 users rated the user-friendliness as excellent. Similarly, 21 and 17 users rated the navigation flexibility and overall performance of the application as excellent, respectively. We intend to extend the Yoruba language E-Tutor by replicating the application on other mobile platforms such as Android and IOS.

Keywords – E-learning, E-tutor, Yoruba Language, Windows phone, Mobile app.

1. INTRODUCTION

One of the dominant and pervasive problems in Nigeria, and in Africa at large, is the language question. Language, being a potent vehicle of transmitting cultures, values, norms and beliefs from generation to generation, remains central factor in determining the status or nature of any nation. This informs the submission [1] [2] that “language is a nation’s most obvious and most important attribute”. The African indigenous languages are gradually being eroded due to emphasis on western education and English language as a vehicle for its dissemination [7] [18].

Yoruba language is spoken mainly by the natives of south western part of Nigeria with a population of over 20million [9]. However, the threat of extinction that looms over Yoruba language is increasing daily especially as more natives move to urban areas where most interactions are done in English language, Nigeria’s lingua franca [7]. It has therefore become imperative to provide a means whereby people living in the urban areas, especially the younger generation, can learn Yoruba language outside the school curriculum that are mostly English language oriented.

Technological advancement in electronic gadgets and information technology has led to E-learning as a veritable tool for dissemination educational materials outside the conventional classroom environment [10] [12] [15].

In this paper, we develop a Windows-based mobile e-learning application for teaching Yoruba language. Section 2 critically examines previous related work in the area of e-learning while our methodology is discussed in Section 3. Implementation details are given in Section 4 with Section 5 analyzing our evaluation results. Section 6 concludes the paper with pointers to future work.

2. RELATED WORK

The ability to learn and comprehend a new language takes considerable effort and time especially for adults. However, access to the right tools and materials can make a huge difference especially the use of technological tools through e-learning [1] [2] [14] [20]. Existing language-learning software applications [3] now have mobile apps [13] which can help a user to squeeze in some extra study time while commuting, waiting in lines, or anywhere one finds him/herself with a few minutes to spare. A mobile application consists of software or set of hardware programs that run on a mobile device and performs certain tasks for the user [4] [6]. Mobile applications are easy, user friendly, inexpensive, downloadable and runnable on smart phones [5].
The development of a standalone e-learning system for Igbo language was previously carried out [19] in order to provide opportunities for the younger generations to learn the language and arrest the threat of extinction that looms over it. The Igbo language e-learning system was developed using Java on the Netbeans IDE and Microsoft Access 2007 was used for developing the database. [18] also developed a mobile application for Yoruba proverbs. The application defined proverb as a simple and concrete saying, popularly known and repeated, that expresses a truth based on common sense or the practical experience of humanity. The application had a user-friendly interface with options for viewing of lessons, taking of quizzes, computing scores and displaying the ranking with respect to other users.

“Asa” [7] is also an interactive application for kids to get acquainted with the basics of Yoruba language. The application uses games, animation, voice, and colorful graphics to teach the Yoruba culture and contains topics including etiquettes and ethics in the language.

3. DESIGN METHODOLOGY

The architecture of the mobile E-tutor for Yoruba language consisted of three main components. These are the database design, software design with the use case diagram and the Windows mobile application development environment. These components are described in Sections 3.1 to 3.3.

3.1 Database Design

In designing the database with the entity relationship (E-R) diagram, all entities were identified and defined as well as the interactions between the entities and the cardinality of the relationship [8]. The identified entities include User, Profile, Alphabet, Phrase, Part of the Body, Number, Animal, Question, Answer and Result. Fig 1 shows the relationship between these entities as used in developing the Yoruba E-tutor. The User entity has attributes User ID, First name, last name, age, and password with the User ID as its primary key. This entity has relationship with the profile entity to create users and with the result entity to store each scores attached to the user ID.

The Profile entity contains the attributes Admin ID and user ID. It has relationship with user, question, alphabet, phrase, part of the body entities. The adminID attribute allows for management and updating of the library of the entities. The Alphabet entity is used to represent Yoruba alphabets. The Phrase entity represents common phrases and words in the Yoruba language. The Parts of the body entity denotes Yoruba names of the parts of the body and their description. The Number entity characterizes numbers in Yoruba language. The Animal entity symbolizes the Yoruba names of selected animals and their description. The Question entity contains the questions and relates with the profile entity. Users can take questions while the Admin updates the question library. The Answer entity contains attributes to store answers relating to questions as results. Each answer yields a result. The Result entity specifically functions as storage of test results taken by Users and attaches it to the user that took the question.

Fig 1: Entity Relationship Diagram of Yoruba Language E-tutor database
3.2 Use Case Diagram

There were two main actors identified in the E-tutor software. Fig 2 shows the use case diagram of the mobile electronic tutor for Yoruba language. The actors are the user and administrator. The functionalities captured include sign up, login/logout, manage profile, learning, and test activity among others. The Login/Log out functionality permits users to log on if they had previously created a profile successfully. Also, the administrator can also log on and log out to update and upgrade the software from his end. The Sign up/Create profile allows new users to create their profile by supplying any required information.

The functionality of Manage profile enables users to update their profile by changing their user ID appropriately. The administrator also has access to manage user profiles as well as adding new features. Learning Activity deals with users being able to select among different categories to learn from. During Test Activity, users have the option of examining what they have learnt so far with corrections shown. Users get to view the history of their scores with the Manage score functionality while the administrator has access to load up new words, categories, and more test questions using the Update Library function.

3.3 Windows Phone Application Development

Windows Phone (WP) is a mobile operating system developed by Microsoft for smart phones as the replacement successor to Windows Mobile. Unlike Windows Mobile, it is primarily aimed at the consumer market rather than the enterprise market and was first launched with Windows Phone 7 [REF NEEDED]. Windows Phone supports managed application development using the WP7.1, WP8.0 .NET and Win PRT APIs, native app development using Win PRT and Win32. It also supports games development using the WP7.1 XNA framework and Direct3D or DirectX. XAML UI with managed code is the most common way to build apps for Windows Phone which consists of user interface (UI) defined using XAML, codes (logic) written using Visual C# or Visual Basic, Microsoft Access for database and Windows Phone Run time APIs.

The Windows Phone application development environment uses an emulator that runs as a virtual machine on a Windows PC. It contains the same software as a “real” phone, but built for the Windows PC platform. The emulator is supplied with the Windows phone SDK must be used with a Windows phone. The Simulation Dashboard can be used in Visual Studio to manage the emulator environment, lock and unlock the phone and control the quality and availability of the network connection.

4. IMPLEMENTATION

The Yoruba language e-tutor for Windows phone was developed using Visual C# with an XML database. The modules in the application include the home page, signup/login and available menu items. Figure 3 shows the home page of the application through which users are introduced the software with the get started option to proceed into discovering what the software can do.

![Fig 2: Use case diagram of Yoruba Mobile E-tutor](image-url)
The Login/Signup module is wherein the user is granted access into the system once the application has been invoked. It requires the user to enter a username which is not currently being used by any other user. The login/signup page is shown as Fig 4.

The signup link gives room for new users to create a new profile for the first time. During signup, users provide their first name, last name, Age and a unique userName as indicated in Fig 5.

The menu module, shown in Fig 6, is where the user chooses the learning activity that he/she wants to learn after login. Learning activities include alphabets, animals, numbers and body parts. The log out and test activities (manage score and quick test) are also located in this module.
For each learning activity, there is an audio sound that plays with each item selected. For instance, each Yoruba alphabet can be heard to help the user with the correct pronunciation; ditto for other learning activities. Next and back buttons are also provided to learn more or to repeat any previously learnt materials. A test activity is presented to the user after each learning session to evaluate what is learnt. The test score is provided together with a correction of the test after this activity. Other navigation buttons are also available to allow the user access the menu page and other pages easily.

5. EVALUATION & RESULTS

Qualitative assessment [11] [16] [17] of the Yoruba language e-tutor mobile application was carried out by recruiting thirty (30) participants to test the application functionalities on a Windows phone and evaluate the app by completing a questionnaire. The questionnaire was designed using a 5-scale likert rating based on three criteria: user friendliness, navigation flexibility and overall assessment.

A summary of the user responses is shown in Table 1. Based on user-friendliness criterion, 26 out of the 30 users (86.67%) rated the app as excellent with 2 users (6.67%) apiece rating it as very good and average. Correspondingly, 21 users (70%) rated the app’s navigation's flexibility as excellent while 5 users (16.67%) rated as very good and 4 users (13.33%) rated it as average under the same criterion. Overall, 17 users (56.67%) rated the mobile app as excellent, 12 users (40%) rated it as very good and 1 user (3.33%) rated it as average.

<table>
<thead>
<tr>
<th>Table 1: User Evaluation results</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Friendliness</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Excellent</td>
</tr>
<tr>
<td>Very Good</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Poor</td>
</tr>
<tr>
<td>Very Poor</td>
</tr>
</tbody>
</table>

6. CONCLUSION

This paper has discussed the development of a Windows phone Yoruba language E-Tutor mobile application aimed towards providing an easier way of learning the language through our mobile phones. It is hoped that the application will enhance the Yoruba culture and encourage speaking of Yoruba language especially within the youth. We intend to add more beneficial Yoruba culturally-inclined features to the application in the future. The application will also be extended to other mobile platforms such as Android and IOS to reach a wider audience.

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Fuzzy Analytical Hierarchical Process Model and ICT Maturity Model of SMES for ICT Maturity Measurement of Nigerian Service Firms

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ABSTRACT

A key challenge within the service industry is how the benefits from ICT adoption and diffusion (ICT value) relate to the degree of adoption and diffusion of ICT (ICT maturity). This has resulted in the uncertainty of value generation from investments on ICT leading to ICT mis-planning and disaster. For sustainable improvement of ICT based service delivery in Nigeria therefore, the ICT maturity index of the Nigerian service industry has to be measured. The ICT maturity of selected service firms listed in the Nigerian Stock Exchange (NSE) has been measured adapting the ICT Maturity model of Small-and-Medium Enterprises (SMEs) by using the Fuzzy Analytical Hierarchical Process (FAHP) model to determine the weights of the four main factors that constitute the ICT maturity model against the original equal weighting of the factors. The result showed that the Nigerian service industry is web based in ICT maturity with an index of about 0.74.

Keywords: Service industry, Nigeria, ICT maturity, ICT maturity model and FAHP

1. INTRODUCTION

A key challenge within the service industry is to improve the understanding of how managers actually perceive the benefits from ICT adoption and diffusion (ICT value), and how this relates to the actual level of ICT adoption and diffusion (ICT maturity) reminiscent of the productive investments on ICT. This research work addressed this challenge. This is particularly important considering the fact that as with the developed nations of the world; the service industry is the largest contributor to the wealth of the Nigeria economy; presently the largest in Africa and 26th largest in the world. It accounts for about 51% of Nigeria’s gross domestic product – GDP [1].

ICT maturity models are increasingly being applied within the field of service science, both as an informed approach for continuous improvement and as a means of self or third-party assessment of service organization [2]. ICT maturity models when applied to service department(s) can show how structured, ordered and focused they are towards the provision of service(s) to their customer(s); using ICT facilities [3]. Furthermore, it can guide in the continuous improvement of ICT facilities and services of a service department(s) [4,5]. To this end, using the ICT maturity model of SMEs, this paper measured the ICT maturity of the Nigerian Service Industry as a possible panacea towards unravelling the uncertainty of value generation from investments on ICT.

Pham [6] did a similar work for some Vietnamese SMEs while Chan et al. [7] did also for selected companies in mainland China. This ICT maturity model as implemented by Pham [6] and Chan et al. [7], is very easy to implement but assign equal weights to the criteria involved in the decision making process (see equation 10). These weights play a vital role in decision making process and extremely affect the final decision [8]. In reality however, some criteria are more important than others towards determining the maturity of ICT in firms. Besides, possible respondent’s imprecision and uncertainty in filling the questionaire is not accommodated. Consequently, this paper uses the Fuzzy Analytical Hierarchical Process (FAHP) model to determine the criteria weights as against the use of equal weights as in Pham [6] and Chan et al. [7]. The FAHP is an extension of Analytical Hierarchical Process (AHP) to accommodate risk and uncertainty.

2. ANALYTIC HIERARCHICAL PROCESS (AHP) MODEL

Analytic Hierarchy Process (AHP) model was introduced by Saaty [9] to solve complicated multi-criteria decision problem. Besides, AHP is appropriate whenever a target is obviously declared and a set of relevant criteria and alternatives are offered [10]. AHP is an ideal method for ranking alternatives when multiple criteria and sub-criteria are present in the decision-making process [11]. AHP is a popular model to aggregate multiple criteria for decision making [12]. AHP allows the decision-maker to structure complicated problems in the form of a decision hierarchy.
The hierarchy usually consists of three different levels, which include goals, criteria, and alternatives as depicted in Figure 1.

![Figure 1.1: Structure of AHP](image)

The AHP process begins by determining the relative importance of the criteria in meeting the goals. Next, the focus shifts to measuring the extent to which the alternatives achieve each of the criteria. Finally, the results of the two analyses are synthesized to compute the relative importance of the alternatives in meeting the goal. Managerial judgments are used to drive the AHP approach [13]. These judgments are expressed in terms of pair-wise comparisons of items on a given level of the hierarchy with respect to their impact on the next higher level. Pair-wise comparisons express the relative importance of one item versus another in meeting a goal or a criterion. Each of the pair-wise comparisons represents an estimate of the ratio of the weights of the two criteria being compared. Because AHP utilizes a ratio scale for human judgments, the alternatives weights reflect the relative importance of the criteria in achieving the goal of the hierarchy [14].

The use of the AHP approach offers a number of benefits. One important advantage of AHP is its stability and flexibility regarding changes within, and additions, to the hierarchy. In spite of the benefit of AHP, it also has some weak points. One of these is the complexity of this method which makes its implementation quite inconvenient. A further disadvantage of this method is that it does not consider risks and uncertainties [14].

To make a decision in an organised way to generate priorities we need to decompose the decision into the following steps as proposed by Saaty [9]:

1. Define the problem and determine the kind of knowledge sought.
2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).
3. Construct a set of pair-wise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.
4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

2.1 Fuzzy Analytical Hierarchical Process (FAHP) Model

In spite of the benefit of AHP [10,11,15], it has been criticized due to its inability to adequately handle uncertainty and imprecision associated with the mapping of the exact numbers [16]. The conventional AHP approach does not reflect human thinking for the simple fact that decision makers feel more confident to give interval judgments rather than express their judgments in the form of single numeric values and so Fuzzy Analytical Hierarchical Process (FAHP) is capable of capturing a human's appraisal of ambiguity when complex multi-attribute decision making problems are considered [17]. A new approach to a precise theory of approximation and vagueness based on generalization of standard set theory to fuzzy sets was introduced by Zadeh [18]. Since fuzziness and vagueness are common characteristics in many decision-making problems, a fuzzy AHP (FAHP) method should be able to tolerate vagueness or ambiguity [19].
Fuzzy sets and fuzzy logic are powerful mathematical tools for modelling nature and humanity, uncertain systems in industry, and facilitators for common-sense reasoning in decision making in the absence of complete and precise information. Their role is significant when applied to complex phenomena not easily described by traditional mathematical methods, especially when the goal is to find a good approximate solution. Fuzzy set theory is an extension of classical set theory where elements have degrees of membership [18]. The theory of fuzzy set was a generalization of classic set theory which allows the membership functions to operate over the range of real numbers [0, 1]. The main characteristic of fuzziness is the grouping of individuals into classes that do not have sharply defined boundaries [20]. The uncertain comparison judgment can be represented by the fuzzy number. In the FAHP method, the pair-wise comparisons in the judgment matrix are fuzzy numbers and use fuzzy arithmetic and fuzzy aggregation operators. Triangular fuzzy numbers were introduced into the conventional AHP in order to enhance the degree of judgment of decision maker.

2.4.5 Triangular Fuzzy Number (TFN)
A triangular fuzzy number is a convex fuzzy set with a grade of membership between 0 and 1. It is a special class of fuzzy number whose membership is defined by three real numbers. In applications it is often convenient to work with TFNs because of their computational simplicity [21,22], and they are useful in promoting representation and information processing in a fuzzy environment [23]. Consequently, a succinct implementation of the FAHP model as given by [24] was adopted.

In the services science domain, ICT maturity is measured using standard models called ICT maturity models. The first ICT maturity model introduced was the Nolan’s model [25, 26] and since it was introduced in the 1970’s, several ICT maturity models are now in use. They include: (i) Nolan ICT Maturity Model; (ii) UNESCO’S Model of ICT Maturity; (iii) Cloud ICT Maturity Model; (iv) Organization Interoperability ICT Maturity Model; (v) TOBI Maturity Model; (vi) Sustainable ICT Capability Maturity Framework (SICT-CMF);(vii) Accessibility Maturity Model; (viii) Green ICT Maturity Model; (ix) Knowledge Maturity Model and (x) the ICT Maturity Model of SMEs. Due to limited paper size and to keep the paper in focus, a detailed review of existing ICT maturity models is reported separately.

3. MATERIALS AND METHODS
The quasi-experimental research methodology was adopted. After a critical review and consultation, some 23 service firms listed in the NSE and a model each for ICT maturity and value measurement, were selected. The research then took two independent paths which later coalesced into the third and final part of the research. After a successful informal consultation with several service firms listed in the NSE to seek for permission to use their firms as a research case study, a total of 33 service firms gave consent but only 28 of them was actually accessible for the field work exercise which took place during the periods of 14th of April through 15th of May, 2015. The 28 firms are: Expert Edge Software, Main Street Bank, Bank of Industry, Skye Bank PLC, Zenith Bank PLC, Keystone Bank Limited, Access Bank PLC, Guaranteed Trust Bank PLC, First Bank Nigeria PLC, Union Bank PLC, Fast Credit Limited, Information Technology Transfer, Petropoint Management Services, Digital Communication Company, CHAMS PLC, Computer Warehouse Limited, ETISALAT Nigeria, Visafone Communications Limited, Airtel Nigeria, MTN Nigeria, SMILE Communications, STACO Insurance PLC and Zenith Insurance.

The field work exercise was a questionnaire survey meant to capture the necessary data to measure the ICT maturity of these firms. The questionnaires were given to the protocol officers of the various firms for distribution. As a result of the very busy schedule of the respondents, the questionnaires could not be filled and collected immediately upon distribution; it sometimes took several days of series of attempts to get the distributed questionnaires back. A total of 252 questionnaires were distributed, nine questionnaires per firm. The firms were specifically instructed that the nine questionnaires should be distributed three each per levels of management namely operational, middle and top management levels. This is to avoid a possible pitfall of a related research by Chan et al. [7] for companies in mainland China where one questionnaire per firm was administered which may be to prejudice by the respondent’s position.

Distributing three questionnaires per managerial level did not only degrade the effect of position prejudice but also weakened bias within a managerial level. The average time a respondent spent on the questionnaire was about 15 to 20 minutes. Due to administrative protocols and the high traffic in Lagos, Nigeria, we could hardly visit five firms in a day. The second researcher carried out the questionnaire survey under the strict monitoring of the research leader via mobile phone calls and location tracking. A total of 156 questionnaires were validly returned.

The questionnaire modelled after the ICT Maturity Model of SMEs [6] is a three part document. The first part introduced and contained demographic data (name and type) of firm and respondents managerial position. The second part consist of 50 indicator questions grouped under the four major factors of observable capabilities of SMEs: Infrastructure (eleven indicator questions), Application (thirteen indicator questions), Human Resource (twelve indicator questions) and Policy (fourteen indicator questions). In addition, the last part of the questionnaire captured the respondents contact (mobile phone and e-mail address). Although questionnaires with similar connotations and indicator value have been used by Pham [6] and Pham [27], the research leader validated and approved this questionnaire for the research. Appendix A contains a sample questionnaire.
The questionnaires was then sorted and coded using the indicator stage value as proposed by Pham [6]. The ICT maturity index (ICTMI) was calculated using the formula in equation (1) as proposed by Pham [6].

\[\text{ICTMI} = \alpha I + \beta A + \gamma H + \delta P \]  

(1)

Where

\[0 \leq I, A, H, P, \text{ICTMI} \leq 1 \text{ and } \alpha + \beta + \gamma + \delta = 1; \text{ and} \]

\[\sum_{i=1}^{4} \frac{\text{H}_{i1}}{\text{P}_{i1}} = 4, \quad \sum_{i=1}^{4} \frac{\text{H}_{i2}}{\text{P}_{i2}} = 4, \quad \sum_{i=1}^{4} \frac{\text{H}_{i3}}{\text{P}_{i3}} = 4, \quad \sum_{i=1}^{4} \frac{\text{H}_{i4}}{\text{P}_{i4}} = 4 \]

(2)

(3)

\[A_k = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \ldots & a_{1m} \\ a_{21} & a_{22} & a_{23} & \ldots & a_{2m} \\ a_{31} & a_{32} & a_{33} & \ldots & a_{3m} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{41} & a_{42} & a_{43} & \ldots & a_{4m} \end{bmatrix} \]

(4)

The above process is repeated for each of the firms.

Step 2: Obtain judgement matrices \(A^L_{ij}, A^M_{ij}, A^H_{ij}\) based on pair-wise comparison of all \(A_k\)

\[A^M_{ij} = \sqrt[4]{A^L_{ij} \times A^H_{ij}} \forall \text{ } i \neq j \text{ otherwise } A^M_{ij} = 1 \]

(5)

where

\[A^L_{ij} = \min (A_k) \forall \text{ } A_k \]

(6)

\[A^H_{ij} = \max (A_k) \forall \text{ } A_k \]

(7)

Step 3: Normalize each column of matrices \(A^L_{ij}, A^M_{ij}, A^H_{ij}\) to get a new judgment matrix \(A^L, A^M, A^H\) respectively of the form:

\[A^N = a_{11} \quad a_{12} \quad a_{13} \quad \ldots \quad a_{1m} \]

\[a_{21} \quad a_{22} \quad a_{23} \quad \ldots \quad a_{2m} \]

\[a_{31} \quad a_{32} \quad a_{33} \quad \ldots \quad a_{3m} \]

\[\vdots \quad \vdots \quad \vdots \quad \ddots \quad \vdots \]

\[a_{41} \quad a_{42} \quad a_{43} \quad \ldots \quad a_{4m} \]

(8)

Step 4: Sum up each row of normalized judgement matrix \(A^N\) to get weight vector \(V\).
\[ V = \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ \vdots \\ v_m \end{bmatrix} = \begin{bmatrix} \sum_{j=1}^{n} \frac{1}{n_j} \\ \sum_{j=1}^{n} \frac{2}{n_j} \\ \sum_{j=1}^{n} \frac{3}{n_j} \\ \vdots \\ \sum_{j=1}^{n} \frac{n_j}{n_j} \end{bmatrix} \quad (9) \]

Do this for each of the matrices \( A_{1j}^L \), \( A_{1j}^M \), \( A_{1j}^U \).

Step 5: Concatenate matrices \( A_{1j}^L \), \( A_{1j}^M \), \( A_{1j}^U \) to form a new matrix \( RS \), the fuzzy number vector, of the form:

\[ RS = \begin{bmatrix} r_{s1} \\ r_{s2} \\ r_{s3} \\ \vdots \\ r_{sm} \end{bmatrix} = \begin{bmatrix} \sum_{j=1}^{n} \frac{1}{n_j} w_{1j} \\ \sum_{j=1}^{n} \frac{2}{n_j} w_{2j} \\ \sum_{j=1}^{n} \frac{3}{n_j} w_{3j} \\ \vdots \\ \sum_{j=1}^{n} \frac{n_j}{n_j} w_{nj} \end{bmatrix} \quad (1.10) \]

Step 6: Compute the fuzzy synthetic extent value vector \( S \):

\[ S = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ \vdots \\ s_m \end{bmatrix} = \begin{bmatrix} \min \{ V(1 \geq S) \} \\ \min \{ V(2 \geq S) \} \\ \min \{ V(3 \geq S) \} \\ \vdots \\ \min \{ V(n \geq S) \} \end{bmatrix} \quad (11) \]

Step 7: Get the non-fuzzy weight vector \( V \):

\[ V = \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ \vdots \\ v_m \end{bmatrix} = \begin{bmatrix} \min_{j=1}^{n} V(S_j \geq S) \\ \min_{j=1}^{n} V(S_j \geq S) \\ \min_{j=1}^{n} V(S_j \geq S) \\ \vdots \\ \min_{j=1}^{n} V(S_j \geq S) \end{bmatrix} \quad (12) \]

Step 8: Define the final normalization weight vector \( W \).

\[
W = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ W \end{bmatrix} = \begin{bmatrix} \frac{\min_{j=1}^{m} A_{j1}^U}{w_{1j}} \\ \frac{\min_{j=1}^{m} A_{j2}^U}{w_{2j}} \\ \frac{\min_{j=1}^{m} A_{j3}^U}{w_{3j}} \\ \vdots \\ \frac{\min_{j=1}^{m} A_{jn}^U}{w_{nj}} \end{bmatrix}
\]

Where \( V(S_i \geq S_j) \) =

\[
\begin{cases} \text{if } M_2 \geq M_1 \\ \text{if } L_1 \geq U_2 \\ (L_j - U_i)/((M_i - U_i) - (M_j - L_j)) \\ \text{Otherwise} \end{cases}
\]

Step 9: For each \( i = 1 \) to \( n \), compute matrix \( A' \):

\[ W_1 \times A'_{ij} = S_j \quad (15) \]

Step 10: Compute vector \( P_j = \frac{W_j}{\sum_{i=1}^{m} W_i' A'} \forall j = 1(1) m \quad (16) \]

Step 11: Compute vector \( R_j = P_j \sum_{i=1}^{m} P_j \forall j = 1(1) m \quad (17) \]

Step 12: \( R_j \) defines the ranking of the firms.

It should however be noted that for the purpose of getting the weights, it suffices to stop at step 8. Thereafter, the computed weights will now be used to get the resultant ICTMI. The results for ICTMI were then calculated using Microsoft Excel spreadsheet. Thereafter, the results of ICTMIs were mapped to the ICT maturity levels using the stratification proposed by Pham (2010) as follows: Inactive (0.0 – 0.2), Basic (0.2 – 0.4), Substantial (0.4 – 0.6), Web based (0.6 – 0.8) and Knowledge oriented (0.8 – 1.0).

This study made use of ICT maturity model of SMEs not only because it has been improved to be able to handle any category of enterprises but because it is simple, generic, quantifiable, popular, strongly aligned with modern business enterprises and yet powerful [6, 7]. Ralian Communication Authority in 2008. It is based on four main factors: Infrastructure, Application, Human Resource and Policy. It originally consists of four phases namely: (i) Inactive; (ii) Basic; (iii) Substantial and; (iv) Sophisticated.
However, based on the above classification of ICT development in SMEs, [6] in consideration of recent development trends as well as conditions for knowledge management maturity, the ‘Sophisticated’ phase is suggested to be divided into two stages: Web-based and Knowledge-oriented.

Thus, we now describe this model as consisting of five phases as highlighted:

1. Inactive – no current use of ICT in company.
2. Basic – including word processing and other desktop packages.
3. Substantial – extending into the networking of PCs and several applications.
4. Web-based – extending to e-commerce with many web-based services.
5. Knowledge-oriented – integration of applications and using ICT tools for innovation and knowledge management.

Each of the maturity levels is characterized by certain observable capabilities of four major factors: Policy, Infrastructure, Application and Human Resource. Based on trend analysis of ICT use in SMEs, Table 1 maps the above five stages of ICT maturity in SMEs with its specific features.

<table>
<thead>
<tr>
<th>Maturity level</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Trend</td>
<td>Inactive</td>
<td>Basic</td>
<td>Substantial</td>
<td>Web based</td>
<td>Knowledge Oriented</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Connectivity &amp; Mobility</td>
<td>Telephone</td>
<td>PC, laptop</td>
<td>Network</td>
<td>Internet</td>
</tr>
<tr>
<td>ICT HR</td>
<td>Sophisticated &amp; Innovation</td>
<td>Unskilled</td>
<td>Business skills</td>
<td>Technology skills</td>
<td>MIS skills</td>
</tr>
<tr>
<td>Application</td>
<td>Integrated applications</td>
<td>No application</td>
<td>Office, E-mail</td>
<td>MIS applications</td>
<td>E-commerce</td>
</tr>
<tr>
<td>Policy</td>
<td>Flexibility &amp; Mobility</td>
<td>No policy</td>
<td>Standardize</td>
<td>Modernize</td>
<td>Cooperation</td>
</tr>
</tbody>
</table>

In general, it is very difficult for an enterprise to build up a knowledge system without appropriate ICT infrastructure and previous ICT applications. Moreover, to strengthen the competitive capability of SMEs, it is very important to apply appropriate ICT applications at the right time rather than adopting latest information systems. Therefore, the SMEs model allows a plan for improving ICT maturity towards Knowledge-oriented in order to use the knowledge resource effectively for future development.
4. RESULTS AND DISCUSSION

Table 2 captures the firms’ type and managerial level of the respondents in the respective firms’ type that took part in the questionnaire survey for measuring the ICT maturity of the Nigeria Service Industry.

Table 2: Summary of Service Firms’ Type and Operational Levels of Respondents

<table>
<thead>
<tr>
<th>TYPE OF FIRM</th>
<th>OPERATIONAL LEVEL</th>
<th>MIDDLE MANAGEMENT</th>
<th>SENIOR MANAGEMENT</th>
<th>TOTAL TYPE</th>
<th>% Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSULTANCY AND SERVICES</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>5.77%</td>
</tr>
<tr>
<td>BANKING</td>
<td>31</td>
<td>24</td>
<td>16</td>
<td>71</td>
<td>45.51%</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>33</td>
<td>21.15%</td>
</tr>
<tr>
<td>TELECOMMUNICATIONS SERVICES</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>30</td>
<td>19.23%</td>
</tr>
<tr>
<td>INSURANCE</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>13</td>
<td>8.33%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>68</td>
<td>50</td>
<td>38</td>
<td>156</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Table 2 shows the spread of respondents across managerial levels and firms’ type. Most of the respondents are from the Banking sector (45.51%) and the respondents had a good spread across the three managerial levels with the operational level accounting for 43.59% of the respondents. Table 3 captures the ICTMI of the various firms of the 23 service firms denoted as $F_i, i=1(i)23$; using equation (1) to equation (3). The average of these ICTMI is also captured in the table. The result in Table 3 shows that $F_1$, for instance, has a total of 2.115162 of the maximum ICTMI index of 2.5. To map these ICTMIs indexes to the ICT maturity levels of SMEs, they were quantized by a factor of 2.5 to realize Table 4. From Table 4, it easy to see that the average maturity of service firms in Nigeria is 0.763256 which by [6] stratification is web based. Thus, we can state that the ICT maturity of the Nigerian Service Industry is 0.76 i.e. web based.

Table 3: ICTMI of Selected Service Firms in Nigeria

<table>
<thead>
<tr>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.115162</td>
<td>2.21875</td>
<td>1.521205</td>
<td>1.675347</td>
<td>1.927083</td>
<td>1.989583</td>
<td>2.284375</td>
<td>1.888021</td>
</tr>
<tr>
<td>F9</td>
<td>F10</td>
<td>F11</td>
<td>F12</td>
<td>F13</td>
<td>F14</td>
<td>F16</td>
<td>F17</td>
</tr>
<tr>
<td>1.651042</td>
<td>1.413411</td>
<td>1.99375</td>
<td>1.895544</td>
<td>2.167245</td>
<td>2.155382</td>
<td>1.828451</td>
<td>2.209491</td>
</tr>
<tr>
<td>F18</td>
<td>F19</td>
<td>F19</td>
<td>F20</td>
<td>F21</td>
<td>F22</td>
<td>F23</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>2.13831</td>
<td>1.466146</td>
<td>1.467708</td>
<td>1.957465</td>
<td>2.06033</td>
<td>2.243634</td>
<td>1.619792</td>
<td>1.90814</td>
</tr>
</tbody>
</table>

Table 4: The Quantized ICTMI of Selected Service Firms in Nigeria

<table>
<thead>
<tr>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.846065</td>
<td>0.8875</td>
<td>0.608482</td>
<td>0.670139</td>
<td>0.770833</td>
<td>0.795833</td>
<td>0.91375</td>
<td>0.755208</td>
</tr>
<tr>
<td>F9</td>
<td>F10</td>
<td>F11</td>
<td>F12</td>
<td>F13</td>
<td>F14</td>
<td>F16</td>
<td>F17</td>
</tr>
<tr>
<td>0.660417</td>
<td>0.565365</td>
<td>0.7975</td>
<td>0.758218</td>
<td>0.866898</td>
<td>0.862153</td>
<td>0.73138</td>
<td>0.883796</td>
</tr>
<tr>
<td>F18</td>
<td>F19</td>
<td>F19</td>
<td>F20</td>
<td>F21</td>
<td>F22</td>
<td>F23</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>0.855324</td>
<td>0.586458</td>
<td>0.587083</td>
<td>0.782986</td>
<td>0.824132</td>
<td>0.897454</td>
<td>0.647917</td>
<td>0.763256</td>
</tr>
</tbody>
</table>

Due to possible bias and uncertainty on the part of the respondents, the FAHP steps as presented by Ekuobase et al. [24] are faithfully implemented to get a more reliable weighting value: $\alpha, \beta, \gamma, \delta$ as against the equal weighting of 0.25 each used to realize the ICTMI in Table 1.4. The resulting weighting values are as captured in Table 1.5.
Table 5: ICTMI weighting Coefficient using FAHP

<table>
<thead>
<tr>
<th>Weighting</th>
<th>FAHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.419189</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.14882</td>
</tr>
<tr>
<td>$\Gamma$</td>
<td>0.278186</td>
</tr>
<tr>
<td>$\Theta$</td>
<td>0.15380</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
</tr>
</tbody>
</table>

Observe that weighting values for AHP also added up to 1. Table 5 shows that the various weighting values were not equally distributed using AHP which is actually more reasonable and reliable. These weighting values were now used to compute the ICTMIs for the various firms under investigation. The resultant ICTMIs are captured in Table 6.

Table 6: The Quantized ICTMI of Selected Service Firms in Nigeria using FAHP Weighting

<table>
<thead>
<tr>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.828547</td>
<td>0.857646</td>
<td>0.594981</td>
<td>0.688207</td>
<td>0.755234</td>
<td>0.752671</td>
<td>0.903828</td>
<td>0.741356</td>
</tr>
<tr>
<td>F9</td>
<td>F10</td>
<td>F11</td>
<td>F12</td>
<td>F13</td>
<td>F14</td>
<td>F15</td>
<td>F16</td>
</tr>
<tr>
<td>0.658058</td>
<td>0.497213</td>
<td>0.776618</td>
<td>0.711014</td>
<td>0.844994</td>
<td>0.860464</td>
<td>0.714779</td>
<td>0.888715</td>
</tr>
<tr>
<td>F17</td>
<td>F18</td>
<td>F19</td>
<td>F20</td>
<td>F21</td>
<td>F22</td>
<td>F23</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>0.839287</td>
<td>0.503019</td>
<td>0.629696</td>
<td>0.773922</td>
<td>0.824655</td>
<td>0.896351</td>
<td>0.601917</td>
<td>0.74535217</td>
</tr>
</tbody>
</table>

Observe the minor variations between the ICTMI in Table 4 and that of Table 6 which altered the ranking of the various firms by ICTMI and puts the ICTMI of the Nigerian service industry at 0.74 against 0.76 estimated using the original equal weightings for $\alpha$, $\beta$, $\gamma$ and $\theta$.

5. CONCLUSION

A critical corporate performance and investment policy index – ICT maturity index, hitherto not existing, for the Nigeria Service industry has been estimated. The ICT maturity index of the Nigerian Service Industry was estimated to be about 0.74 i.e. the Nigerian Service Industry is Web based in ICT maturity. Managers of the Nigerian service industry are now better positioned towards a sustainable improvement of ICT based service delivery in Nigeria.

REFERENCES


APPENDICES : Questionnaires

Information and Communication Technology (ICT) Maturity Assessment
Questionnaire

GENERAL INSTRUCTIONS
Please answer the questions by drawing a circle around an appropriate number or alphabet in the space provided.

Please use the code where appropriate:
Yes definitely (Y); Yes, but not Significantly (S); No, but Probably within the next 5 years (P); No (N).

Unless specifically instructed otherwise, please answer all questions, one answer per item.

1. What is the name of the organization on whose behalf you are answering this Questionnaire?

2. What is the type of organization being assessed?

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles/Transport</td>
<td>1</td>
</tr>
<tr>
<td>Banks</td>
<td>2</td>
</tr>
<tr>
<td>Capital Goods</td>
<td>3</td>
</tr>
<tr>
<td>Chemicals</td>
<td>4</td>
</tr>
<tr>
<td>Construction, Building, Materials and Steel</td>
<td>5</td>
</tr>
<tr>
<td>Consumer Goods</td>
<td>6</td>
</tr>
<tr>
<td>Insurance</td>
<td>7</td>
</tr>
<tr>
<td>Consultancy and Services</td>
<td>8</td>
</tr>
<tr>
<td>Oil and Gas</td>
<td>9</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>10</td>
</tr>
<tr>
<td>Technology</td>
<td>11</td>
</tr>
<tr>
<td>Telecommunications Services</td>
<td>12</td>
</tr>
<tr>
<td>Utilities</td>
<td>13</td>
</tr>
<tr>
<td>Retailers and Distributors</td>
<td>14</td>
</tr>
<tr>
<td>Other (please specify below)</td>
<td>15</td>
</tr>
</tbody>
</table>

3. Please specify the level of management being assessed?

<table>
<thead>
<tr>
<th>Level of Management</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational level</td>
<td>1</td>
</tr>
<tr>
<td>Middle management</td>
<td>2</td>
</tr>
<tr>
<td>Senior management</td>
<td>3</td>
</tr>
</tbody>
</table>

V1
V2
V3
SECTION 1: ICT INFRASTRUCTURE INFORMATION

1.1 Number of fixed telephone. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200
   (e) over 200
1.2 Number of business mobile devices (a) 1 – 10 (b) 11 – 50 (c) 51 – 100
   (d) 101 – 200 (e) over 200
1.3 Number of computers (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200
   (e) over 200
1.4 Type of Internet access. (a) No Internet (b) Dial up (c) ADSL (d) ISDN (e) cable modem (f) Leased line (g) Satellite
   (h) Others _________
1.5 Have Local area network (LAN). Y; S; P; N
1.6 Internet bandwidth (mbps). (a) Unknown (b) < 8mbps (c) < 16mbps (d) < 32mbps (e) >= 32mbps
1.7 Secure Internet Server/ Hosting. Y; S; P; N
1.8 Security & backup system. Y; S; P; N
1.9 Wide area network (WAN). Y; S; P; N
1.10 Wireless LAN/ wifi Internet. Y; S; P; N
1.11 Company information/services could be accessed through WAP/ i-mode access. Y; S; P; N

SECTION 2: ICT APPLICATION INFORMATION

2.1 Standard application software. (a) Not use (b) Office software (c) CAD/CAM (d) Database (e) others _____________
2.2 Using Internet for getting information. Y; S; P; N
2.3 Website presence. …………………….. Y; S; P; N
2.4 Internet Services which is used or provided (a) No service (b) Searching (c) Ordering (d) Purchasing (e) Marketing & sale
   (f) Customer support (g) intra-communications (h) inter-communications (i) Others
2.5 Online payment system. Y; S; P; N
2.6 Customer understanding/e-Marketing. Y; S; P; N
2.7 E-mail/ IM for communication. Y; S; P; N
2.8 Forum/ Social Network for cooperate use Y; S; P; N
2.9 Remote Meeting/ Voice Conference. Y; S; P; N
2.10 Using services through Intranet/ Extranet. Y; S; P; N
2.11 Management Information Systems. (a) No use (b) Finance-Accounting (c) Human Resource Management (d) Document Management (e) Assets Management (f) Inventory Management (g) Decision Support System (DSS)
2.12 Integrated Information Systems. (a) SCM (b) ERP (c) CRM (d) others________
2.13 Knowledge Systems (a) Business Intelligent (b) Knowledge Base/KMS (c) Expert systems (d) other________
SECTION 3: ICT HUMAN RESOURCE INFORMATION

3.1 ICT training. (a) Usually (b) Sometime (c) Rarely (d) Never
3.2 Number of employees using a computer. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.3 Number of employees using the Internet. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.4 Royalty payment & receipt. (a) No (b) The total amount is (NGN)__________
3.5 Patent/license application. (a) No (b) Number of application is__________
3.6 Company spending on R&D (NGN/year): __________
3.7 Capacity for innovation. Y; S; P; N
3.8 Number of IT specified employee. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.9 Separate IT department with Asst. Director/ Director. Y; S; P; N
3.10 Number of Business specified employee (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.11 Employees with self-learning skill (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.12 Capacity for Expertise Reuse. Y; S; P; N

SECTION 4: ICT POLICY INFORMATION

4.1 ICT investment budget/development budget (NGN/year): (a) 5% (b) 5% – 15% (c) 16% - 30% (d) over 30%
4.2 Quality policy. (a) No quality policy (b) ISO (c) CMMI (d) Others __________
4.3 Privacy policy. Y; S; P; N
4.4 Regulatory quality. (a) Good (b) Fair (c) Not Good (d) Bad
4.5 Security policy. Y; S; P; N
4.6 Piracy policy. Y; S; P; N
4.7 Upgrade ICT hardware/ software. (a) Annually (b) 2-year period (c) 3-year period (d) No policy
4.8 Assessment effectiveness. (a) Good (b) Fair (c) Not Good (d) Bad
4.9 ICT policy in company strategy. Y; S; P; N
4.10. your organization regards ICT and the management thereof as (a) An enabler of knowledge management (b) Knowledge management
4.11. In your organization, the following Information management tools and services have been institutionalized:

| 1 | Inventory of information entities | Y | S | P | N |
| 2 | Information management systems | Y | S | P | N |
| 3 | Databases | Y | S | P | N |
| 4 | Information service / Library | Y | S | P | N |

4.12. Knowledge Management based on ICT use is a priority. Y; S; P; N

Contact Name / Position _____________________________________________

Contact e-mail (to get survey result) ______________________________________

... Thank you very much for your cooperation, we are very grateful.
Problems Militating Against Computer Education and Its Effects on the Secondary School Curriculum in Umuahia North Local Government Area of Abia State, Nigeria

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ABSTRACT
The current study was undertaken in order to determine the problems militating against Computer Education and its effects on the secondary schools curriculum in Umuahia North Local Government Area of Abia State, Nigeria from the perception of principals and teachers in the L.G.A. The study adopted a descriptive survey method using random sampling technique from 350 respondents selected from 14 (fourteen) secondary schools. Data were gathered through the use of questionnaires and interviews. The use of these two instruments enabled data triangulation thus enhancing data validity and reliability. Major findings of the study reveal that there were no budgets for computer procurement in the majority of the schools. Funds were inadequate for computer procurement as various governments did not avail finances for computer procurement. However, stakeholders were willing to contribute for the purchase of computers for computer education. Other results show that there were not adequate qualified teachers to teach Computer Education in the schools. Those teachers who taught the subject were not willing to teach the subjects most likely due to shortages in equipment and unavailability of in-service computer training programmes. On a positive note heads of secondary schools and students had a positive attitude towards computer education. The study recommended that government should make compulsory for schools to offer computer education at all level through policy statements that should be enforced. Teacher training institutions should incorporate Computer Education into their curriculum. Teachers should be offered administrative and technical support through in-service training programmes.

Keywords: Computer Education, Curriculum, Effects, ICT, Problems.

1. INTRODUCTION
In the globalised world, technology has become the in-thing as countries and/or organizations devise means of gaining a competitive edge over the others. In view of this, education systems in individual countries need to be tailor-made to suit this endeavour. Information and Communication Technology (ICT) has played a major role in linking business and individuals far apart in terms of geographical distance. Transactions are being carried out in or outside offices, twenty-four hours a day. In pursuit of the objectives to ensure that the country advances its technology base, Nigeria, through the Ministry of Education, has introduced computer education in the secondary school curriculum. However, much as this innovation is applauded, the introduction of computer education has failed to take off in the majority of schools, primary and secondary, rural and urban. Given this scenario, it is necessary for this study to look into problems militating against computer education and its effects on the secondary school curriculum in Umuahia North Local Government Area of Abia State, Nigeria. In view of the fact that secondary schools are immediate sources of manpower for industries and commerce, it is hoped that computer education could be taught to students in preparation for employment.
This, however, has not been the case for the majority of secondary school graduates who have gone job seeking without any knowledge of computers despite its relevance for employment in many institutions.

Computer education refers to as the amount of knowledge and skills acquired by an individual to perform a given task using a computer system. Expectedly, the knowledge and skills acquired in this area may be very high, high, low or very low, depending on the individual’s exposure to computer facilities. Computer education is of paramount importance to national development and it is on this premise that the government of Nigeria sought to introduce computer studies in the educational system from primary through to tertiary institutions.

An attempt to popularise computer education in Nigeria evolved in 1988 when the Nigerian Federal Government launched the National Policy on Computer Education at primary, secondary and tertiary levels with the aim of equipping the individual or students with thorough understanding of the concept of computers in order to fit into the next century [1]. The objectives of the programme, as contained in the address of the then Federal Minister of Education, Professor Jubril Aminu, to the Ad-hoc Committee on Computer Education in Nigeria [4] are to:

1. Bring about a computer education society in Nigeria within a short period of time
2. Enable the present generation of school children at all levels to appreciate the potentials of the computer and to be able to use the computer in various aspects of life and later occupations

Subsequently, the state governments throughout Nigeria embraced the policy of the Federal Government by introducing computer education and literacy into secondary schools in 1997 [2], [3]. This was followed by the inauguration of the National Committee on Computer Education the same year. The functions of the committee include “planning for a dynamic policy in computer education and literacy in Nigeria as well as devising clear strategies and terminologies to be used by the federal and state governments in introducing computer education” [4].

The general objectives of the policy include:

1. Bring about a computer literate society in Nigeria by the mid-1990s.
2. Enable present school children to appreciate and use the computer in various aspects of life and in future employment.

According to the National Computer Policy [4], the first objective is to ensure that the general populace appreciates the impact of information and computer technology on today's society, the importance of its effective use, and the technologies that process, manage, and communicate the information.

The second general objective is to ensure that the people of Nigeria knows how to use and program computers, develop software packages, understand the structure and operation of computers and their history, and to appreciate the economic, social and psychological impact of the computer.

The modalities and the strategies for achieving the stated objectives include:

1. Training teachers and associated personnel
2. Provision of Hardware facilities
3. Curriculum development
4. Software developments and evaluation
5. Maintenance of hardware and peripherals

The policy recommends a continuous evaluation of progress. The starting point of this evaluation is to compare existing school practice with policy stipulations. This will provide a framework for policy revision. Furthermore, in order to adequately respond to the changing needs of the schools, it is necessary for the Ministry of Education, curriculum developers, and teacher trainers to understand existing practice as compared to national goals.

Information and communication technologies are essential tools in any educational system. They have the potentials of being used to meet the learning needs of individual students, promote equality of educational opportunities; offer high quality learning materials, increase self-efficacy and independence of learning among students, and improve teachers’ professional development. Furthermore, ICTs offer great potentials for revolutionizing school administration. The Milken Exchange on Educational Technologies had noted in her synthesis of research findings that ICT under the right condition has the following potentials in education.

First, it has the potential to accelerate, enrich and deepen basic skills in reading, writing, mathematics, and the sciences. Second, it motivates and engages students in learning as they are encouraged to be more independent and responsible for their own learning. Third, it helps to relate academics to the practices of today’s work as the influence of ICT is pervasive in every field. Furthermore, it is relevant in increasing the economic viability of tomorrow’s workforce, as students are prepared to be fluent in thinking with and using technology in ensuring efficiency and effectiveness in their work places, thereby increasing productivity

2. STATEMENT OF THE PROBLEM

In realization of the important role which education plays as an agent of National development and globalization, there has been agitation for more functional and qualitative education all over the world. This agitation has not been matched with commensurate effort aimed at bringing computer to the people. This gap has been in existence for a very long time.
Due to the fact that computer education has failed to take off in majority of schools, fears are that technological development may be a pipe dream for the country. Given this scenario, it is necessary for this study to look into problems militating against the computer education in secondary schools. The question to be answered by this current study is: What problems have impeded the implementation of computer education in schools?

2.1 Purpose of the Study

The main purpose of this study is to determine the problems militating against computer education and its effects on the secondary school curriculum in Umuahia North Local Government Area of Abia State. Specifically the study will determine:

- State and availability of computer resources in the schools.
- Budgetary and funding constraints militating against computer education in schools.
- Availability of trained manpower to teach the subject in the schools.
- Attitude of the school community towards the teaching and learning of computers in schools.
- Time adequate for the computer lessons to be incorporated on the timetable.
- Remedies can be put in place to make sure computer education is fully implemented in schools.

2.2 Research Questions

The Research questions raised for this study are:

1. What is the state and availability of computer resources in the schools?
2. Are there any budgetary and funding constraints militating against computer education in schools?
3. Are there trained manpower to teach the subject in the schools?
4. What is the attitude of the school community towards the teaching and learning of computers in schools?
5. Is time adequate for the computer lessons to be incorporated on the timetable?
6. What remedies can be put in place to make sure computer education is fully implemented in schools?

3. METHODOLOGY

The researcher adopted a descriptive survey design for this study. Descriptive survey design was used for this study because of its appropriateness in seeking to obtain relevant information that describes existing phenomena and to find facts that yields accurate information, Gay [5]. In a survey research method, large and small populations are studied by selecting and choosing the relative incidence, distribution, and interrelations of sociological and psychological variables.

The area of study for this research project is Umuahia North Local Government Area of Abia State, Nigeria. The population of this research consists of 60 categories of Principals - Principal I, II, III who are the Principals, Vice Principals and 350 teachers who were knowledgeable of problems militating against computer education in Umuahia North Local Government Area of Abia State, Nigeria. Fourteen (14) secondary schools in Umuahia North Local Government Area were selected.

The schools were stratified in urban and rural strata of schools. Nine (9) schools were deliberately selected in urban schools because of their near distance from the Local Government Area Headquarter while the other five schools were selected from rural schools because of their far distance for the Local Government Area Headquarter. A total of three hundred and twelve (312) respondents consisting of 258 teachers and 54 categories of principals were selected for this study through a stratified random sampling.

The researchers developed a questionnaire derived from the six (6) research questions of the study titled “The Problems Militating Against Computer Education and Its Effects on the Secondary School Curriculum in Umuahia North Local Government Area of Abia State, Nigeria” for the collection of data. To ascertain the reliability of the instrument, the test and retest method was used. The questionnaire was administered within a two week interval to the Principals and class teachers. The scores obtained were correlated and the results obtained indicated that the instrument used was reliable. The researcher personally administered the instrument on the respondents.

The completed questionnaires were collected immediately but those that were not completed immediately were collected later and followed by computation. The information collected through the questionnaire and relevant to the research questions were collected, organized and analyzed using simple percentages. The results were stated in tables and converted into their percentage equivalents. The quantitative data was analyzed using a simple tabulation that included frequency and percentages of the respondents on the items of the questionnaire. The score obtained were organized and statistically analyzed making use of mean scores and percentages.
4. RESULTS AND FINDINGS

Presentation of Results

Research Question 1: What is the state and availability of computer resources in the schools?

Table 1: Availability Of Computer Resources In The Schools.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Strongly disagree (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer laboratories available</td>
<td>30(9.6)</td>
<td>2(0.6)</td>
<td>220(70.5)</td>
<td>60(19.2)</td>
</tr>
<tr>
<td>Computer available in laboratories</td>
<td>32 (10.3)</td>
<td>5(1.6)</td>
<td>210(67.3)</td>
<td>62(20.8)</td>
</tr>
<tr>
<td>Computer functional</td>
<td>10(3.2)</td>
<td>9(2.8)</td>
<td>198(63.4)</td>
<td>95(30.4)</td>
</tr>
<tr>
<td>Computer adequate</td>
<td>39(12.5)</td>
<td>12(3.8)</td>
<td>186(59.9)</td>
<td>75(20.8)</td>
</tr>
<tr>
<td>Computer accessories available</td>
<td>42(13.4)</td>
<td>36(11.5)</td>
<td>178(57)</td>
<td>57(18.3)</td>
</tr>
<tr>
<td>Computer literature available</td>
<td>12(3.8)</td>
<td>23(7.3)</td>
<td>213(68.3)</td>
<td>64(20.5)</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>27.5(8.8)</td>
<td>14.5(4.6)</td>
<td>200.8(64.4)</td>
<td>68.9(22.2)</td>
</tr>
</tbody>
</table>

Table 1 reveals that the respondents strongly agreed that there are availability of computer resources with a mean value of 8.8%, agreed with a mean value of 4.6%, strongly disagreed with a mean value of 64.5% and disagreed with a mean value of 22.2%. Majority of the respondents strongly disagreed that there are availability of computer resources in the schools.

Research Question 2: Are there any budgetary and funding constraints militating against computer education in schools?

Table 2: Budgetary Constraints Militating Against Computer Education In Schools

<table>
<thead>
<tr>
<th>Variables</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Strongly disagree (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer procurement budget available</td>
<td>45(14.4)</td>
<td>34(10.8)</td>
<td>123 (39.4)</td>
<td>110 (35.2)</td>
</tr>
<tr>
<td>Computer procurement funds adequate</td>
<td>23 (7.3)</td>
<td>45 (14.4)</td>
<td>154 (49.3)</td>
<td>90 (28.8)</td>
</tr>
<tr>
<td>Government avails funds for computers</td>
<td>16 (5.1)</td>
<td>45 (14.4)</td>
<td>154 (49.3)</td>
<td>102 (32.6)</td>
</tr>
<tr>
<td>Computer accessories funds available</td>
<td>12.3(3.8)</td>
<td>15 (4.8)</td>
<td>214 (68.5)</td>
<td>71 (22.7)</td>
</tr>
<tr>
<td>Stakeholders willing to contribute funds for computer</td>
<td>134 (42.9)</td>
<td>121 (38.7)</td>
<td>34 (10.8)</td>
<td>71 (22.7)</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>46 (14.7)</td>
<td>52 (16.6)</td>
<td>105(33.6)</td>
<td>88.8 (34.9)</td>
</tr>
</tbody>
</table>

Table 2 reveals that the respondent strongly agreed that there are budgetary and funding constraints militating against computer education with mean value of 14.7%, agreed with a mean of 16.6%, strongly disagreed with a mean value of 33.6% and disagreed with a mean of 34.9%. Majority of the respondents strongly disagreed that there are budgetary and funding constraint militating against computer education in schools.
Research Questions 3: Are there manpower to teach the subject in the schools?

Table 3: Availability Of Trained Manpower To Teach Computers In Schools

<table>
<thead>
<tr>
<th>Variables</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Strongly disagree (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are teachers to teach computer education in the school</td>
<td>34 (10.8)</td>
<td>23 (7.3)</td>
<td>134 (42.9)</td>
<td>121 (38.7)</td>
</tr>
<tr>
<td>Teachers are willing to teach computer education</td>
<td>38 (12.1)</td>
<td>28 (8.9)</td>
<td>125 (40.0)</td>
<td>121 (38.7)</td>
</tr>
<tr>
<td>Are the teachers willing to teach the subject in the school</td>
<td>65 (20.8)</td>
<td>67 (21.4)</td>
<td>102 (32.6)</td>
<td>78 (25.0)</td>
</tr>
<tr>
<td>There are in service computer training programmes for teachers</td>
<td>39 (12.5)</td>
<td>12 (3.8)</td>
<td>186 (59.6)</td>
<td>75 (20.8)</td>
</tr>
<tr>
<td>The computer teachers adequate considering the student enrollment</td>
<td>68 (21.7)</td>
<td>31 (9.9)</td>
<td>124 (39.7)</td>
<td>89 (28.5)</td>
</tr>
<tr>
<td>Mean</td>
<td>48.8 (15.5)</td>
<td>26.6 (8.5)</td>
<td>134.2 (44.0)</td>
<td>96.8 (32.0)</td>
</tr>
</tbody>
</table>

Table 3 reveals that the respondent strongly agreed that there is availability of trained manpower to teach computer education with mean value of 15.5%, agreed with a mean value of 8.5%, strongly disagreed with a mean value of 44.0% and disagreed with a mean value of 32.0%. Majority of the respondents strongly disagreed that there is no availability of trained manpower to teach computer education in schools.

Research question 4: what is the attitude of the school community towards the teaching and learning of computer in school?

Table 4: Attitude Of School Community Towards Computer Education In School

<table>
<thead>
<tr>
<th>Variables</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Strongly disagree (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heads have a positive attitude towards computer education</td>
<td>109 (34.9)</td>
<td>135 (43.4)</td>
<td>34 (10.8)</td>
<td>34 (10.8)</td>
</tr>
<tr>
<td>Teachers have a positive attitude towards computer education</td>
<td>124 (39.7)</td>
<td>120 (38.4)</td>
<td>45 (14.4)</td>
<td>23 (7.3)</td>
</tr>
<tr>
<td>Students have a positive attitude towards computer education</td>
<td>109 (34.9)</td>
<td>98 (31.4)</td>
<td>38 (12.1)</td>
<td>67 (21.4)</td>
</tr>
<tr>
<td>Parents have a positive attitude towards computer education</td>
<td>176 (56.4)</td>
<td>119 (38.1)</td>
<td>12 (3.8)</td>
<td>5 (1.6)</td>
</tr>
<tr>
<td>All stakeholders are willing to have computer education succeed in the school system</td>
<td>154 (49.3)</td>
<td>87 (27.8)</td>
<td>37 (11.8)</td>
<td>34 (10.8)</td>
</tr>
<tr>
<td>Mean</td>
<td>134 (43.0)</td>
<td>111.3 (35.8)</td>
<td>33.2 (10.7)</td>
<td>32.6 (11.5)</td>
</tr>
</tbody>
</table>

Table 4 reveals that the respondent strongly agreed that positive attitude of school community can influence computer education in school with a mean value of 43.0%, agreed with mean value of 27.8% strongly disagreed with mean value of 10.7% and disagreed with a mean value of 11.5%. Majority of respondents strongly agreed that positive attitude of school community can influence computer education in schools.
Research Question 5: Is time adequate for the computer lessons to be incorporate on the time table.

Table 5: Adequate Of Time For Computer Lessons On The Time Table

<table>
<thead>
<tr>
<th>Variables</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Strongly disagree (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer education is on the timetable</td>
<td>109 (34.9)</td>
<td>135 (43.4)</td>
<td>34 (10.8)</td>
<td>34 (10.8)</td>
</tr>
<tr>
<td>Computer education is accorded the same number of hours per week as other subjects</td>
<td>124 (39.7)</td>
<td>120 (38.4)</td>
<td>45 (14.4)</td>
<td>23 (7.3)</td>
</tr>
<tr>
<td>Computer timetabling is given priority in the school</td>
<td>55 (17.6)</td>
<td>34 (10.8)</td>
<td>123 (39.4)</td>
<td>90 (28.8)</td>
</tr>
<tr>
<td>Mean</td>
<td>96 (30.7)</td>
<td>97.7 (30.8)</td>
<td>61.0 (21.5)</td>
<td>49.0 (15.6)</td>
</tr>
</tbody>
</table>

Table 5 reveals that the respondents strongly agreed that adequate time should be incorporated on the timetable for computer lessons in schools with a mean value of 30.7%, agreed with a mean value of 30.8%, strongly disagreed with a mean value of 21.5% and disagreed with a mean value of 15.6%. Majority of the respondents agreed that adequate time should be incorporated on the timetable for computer lessons.

Research Question 6: What remedies can be put in place to make sure that computer education is fully implemented in schools?

Table 6: Remedies to Make Sure Computer Education Is Fully Implemented In Schools

<table>
<thead>
<tr>
<th>Variables</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Strongly disagree (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government to make it compulsory for schools to offer computer education through policy statements that should be enforced.</td>
<td>267 (85.5)</td>
<td>45 (14.5)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Government to provide funding to schools for computer procurement.</td>
<td>309 (99.0)</td>
<td>3 (1.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Invigorating the training of manpower to teach computers in schools.</td>
<td>302 (96.7)</td>
<td>10 (3.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Teacher education institutions to incorporate computer education into their curriculum.</td>
<td>280 (89.7)</td>
<td>32 (10.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Teacher support through in-service for computer education teachers should be regularized.</td>
<td>278 (89.0)</td>
<td>34 (11.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Communities to be educated on the importance of computer education.</td>
<td>298 (95.5)</td>
<td>14 (4.5)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Efforts to be made to motivate the school community into accepting computers as a viable piece of technology.</td>
<td>306 (98.0)</td>
<td>6 (2.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Administrative support should be given by heads that should make sure gadgets for the purpose are available.</td>
<td>300 (96.2)</td>
<td>12 (3.8)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Mean</td>
<td>292.5 (93.8)</td>
<td>19.5 (6.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

Table 6 reveals that the respondents strongly agreed that remedies can be put in place to make sure that computer education is fully implemented in schools with a mean value of 98.8% and agreed with a mean value of 63.3%. Majority of the respondents strongly agreed that remedies can be put in place to make sure that computer education is fully implemented in schools.
5. DISCUSSION OF FINDINGS

Based on the result of this study, the following findings were made:

From table 1, majority of the respondents strongly disagree that there are availability of computer resources in school with a mean value of 65.5%, strongly agreed with a mean value of 8.8%, agreed with a mean value of 4.6%, and disagreed with a mean value of 22.2%.

In table 2, respondents strongly agreed that there are budgetary and funding constraints militating against computer education in schools with a mean value of 14.7%, agreed with a mean value of 14.1%, strongly disagreed with a mean value of 45.8% and disagreed with a mean value of 25.4%. Majority of the respondents strongly disagreed that there are availability of computer resources in schools. This finding is in contrast with [6] who established that budgets for computers were high in some schools and computer budgets were a major consideration.

From the data obtained from table 3, respondents strongly agreed that there are availability of trained manpower to teach computers in schools with a mean value of 15.5%, agreed with a mean value of 8.5%, strongly disagreed with a mean value of 43.0% and disagreed with a mean value of 31.0%. Majority of the respondents (43.0%) strongly disagreed that there are availability of trained manpower to teach computers in schools. This is in agreement with other researchers [7], [8], [9] who identified teachers’ lack of computer literacy as being an obstacle to their using computer education implementation in schools, teachers readiness to use ICT as a significant factor in the attempt to embrace on modern technology in the schools. While other researchers [10] noted that the qualifications of the majority of the teachers are far from being satisfactory due to lack of exposure to college curricular that does not cater for ICT training. The teachers have poor practical skills in ICT usage since the majority of them could not even use the basic software in computers for the delivery of their lessons and indication are that the teachers lack the necessary skills and knowledge of computers in basic software usage. This obviously militates against the implementation of computer education.

Table 4 respondents strongly agreed that positive attitude of school community will influence computer education in schools with a mean value of 43.0%, agreed with a mean value of 27.8%, strongly disagreed with a mean value of 10.7% and disagreed with a mean value of 11.5%. Majority of the respondents strongly agreed that positive attitude of school community would influence computer education in schools. This is in concurrence with the findings of some authors [11], [12], who established that some of the principles have supported computer labs by ensuring that money was made available for hardware and software.

From table 5, respondents strongly agreed that adequate time should be incorporated on the timetable for computer lessons in school with a mean value of 43.0%, agreed with a mean value of 27.8%, strongly disagreed with a mean value of 10.7% and disagreed with a mean value of 11.5%. Majority of the respondents strongly agreed that adequate time should be incorporated on the timetable for computer lessons. The time factor surrounding the implementation process is viewed by teachers as being a major barrier in the implementation of computer education in schools [13].

From table 6, respondents strongly agreed that remedies can be put in place to make sure that computer education is fully implemented in schools with a mean value of 93.8% and agreed with a mean value of 6.3%. Majority of the respondents (93.8%) strongly agreed that remedies can be put in place to make sure that computer education is fully implemented in schools. This is agreement with the findings of another author [12] who identified administrative support as enabling successful implementation of computer education in the school system. Lack of support by administrators is identified as a significant barrier toward implementation of computers in classrooms [14], [15].
6. CONCLUSION
This study focused on the problems militating against computer education and its effects on the secondary school curriculum in Umuahia North Local Government Area of Abia State. The study covered 14 secondary schools in the Local Government Area under consideration. The major areas covered in the study included the state and availability of computer resources in the schools, budgetary and funding constraints militating against computer education in schools, availability of trained manpower to teach the subject in the schools, attitude of the school community towards the teaching and learning of computers in schools, attitude of the school community towards the teaching and learning of computers in schools, time adequate for the computer lessons to be incorporated on the timetable and remedies can be put in place to make sure computer education is fully implemented in schools. Consequent on the research findings of this study the following challenges have impeded the implementation of computer education in schools:

- There are no budgets for computer education in most schools and where funds exist these funds are inadequate for computer procurement.
- Government do not avail funds for computer procurement in most cases.
- Majority of teachers and parents have a negative attitude towards computer education.
- There are few teachers qualified and trained to teach computers in the schools. The few teachers available are not willing to teach the computer in the school and computer teachers were inadequate considering the student enrolment.
- There are a negligible number of in-service computer training programmes for teachers in the schools.
- Phobia of computers is another significant factor for resenting the subject.
- Stakeholders are unwilling to have computer education succeed since they have not given any meaningful support to the implementation of the subject.

7. RECOMMENDATIONS
Based on the result and findings of the research study, the following recommendations are hereby made:

- Government should provide funds to schools for computer procurement and invigorate the training of manpower to teach Computer Education in schools.
- Teacher training institutions should incorporate computer education into their curriculum.
- Teachers should be offered administrative and technical support through in-service training programme.
- Communities should be educated on the importance of computer education with the hope of challenging them towards a paradigm shift.
- Authorities should motivate both the school and the local communities into accepting computers as a valuable piece of technology.
REFERENCES


Author’s Biographies

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Customer Churn Analysis In Banking Sector Using Data Mining Techniques

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ABSTRACT

Customer churn has become a major problem within a customer centred banking industry and banks have always tried to track customer interaction with the company, in order to detect early warning signs in customer's behaviour such as reduced transactions, account status dormancy and take steps to prevent churn. This paper presents a data mining model that can be used to predict which customers are most likely to churn (or switch banks). The study used real-life customer records provided by a major Nigerian bank. The raw data was cleaned, pre-processed and then analysed using WEKA, a data mining software tool for knowledge analysis. Simple K-Means was used for the clustering phase while a rule-based algorithm, JRip was used for the rule generation phase. The results obtained showed that the methods used can determine patterns in customer behaviours and help banks to identify likely churners and hence develop customer retention modalities.

Keywords: Customer, banking, data mining, churn analysis, WEKA, retention models & K-means.

1. INTRODUCTION

The regulatory framework within which financial institutions and insurance firms operate require their interaction with customers to be tracked, recorded, stored in Customer Relationship Management (CRM) databases, and then data mine the information in a way that increases customer relations, average revenue per unit (ARPU) and decrease churn rate. According to [23], churn has an equal or greater impact on Customer Lifetime Value (CLTV) when compared to one of the most regarded Key Performance Indicator (KPI’s) such as Average Revenue Per User (ARPU). As one of the biggest destructors of enterprise value, it has become one of the top issues for the banking industry. Customers churn prediction is aimed at determining customers who are at risk of leaving, and whether such customers are worth retaining.

Churn or customer attrition is a term adopted to define the movement of customers from one provider to another [15], and it is also regarded as the annual turnover of the market base, while recognizing the fact that it cost five (5) times more to acquire new customers than to retain existing customers’ database, as companies often spend fortune on advertisement to acquire new customers [17]. Therefore banks now need to shift their attention from customer acquisition to customer retention, provide accurate churn prediction models, and effective churn prevention strategies as added customer retention solutions to preventing churn [24]. And as [18] also observed better products, convenience and lower fees are not enough to prevent customer churn.

The banking industry needs to intensify campaign to deliver a more efficient, customer focused and innovative offerings to reconnect with their customers. The problem of churn analysis is not peculiar to the banking industry. Churning is an important problem that has been studied across several areas of interest [16], such as mobile and telephony [2]; [3]; [17], insurance [27], and healthcare [9], [4]. Other sectors where the customer churn problem has been analysed includes online social network churn analysis [20]; [1], and the retail banking industries [8]; [2]; [18].

1.1 Data Mining

Data mining is an important component of every CRM framework that facilitates analysis of business problems, prepare data requirements, and build, validate and evaluate models for business problems [32]. The data mining process and algorithms enable firms to search, discover hidden patterns and correlations among data, and to extract relevant knowledge buried in corporate data warehouses, in order to gain broader understanding of business. Data mining uses sophisticated statistical data search algorithms to find, discover hidden patterns and relationships, and extracts knowledge buried in corporate data warehouses, or information that visitors have dropped about their experience, most of which can lead to improvements in the understanding and use of the data in order to detect significant patterns and rules underlying consumer’s behaviours.
Data mining involves four tasks: classification, clustering, regression and association learning; which are classified into two types of data mining: verification-oriented (where the system verifies the user’s hypothesis) and discovery-oriented (where the system finds new rules and patterns autonomously). Data mining process compliment other data analysis techniques such as statistics, on-line analytical processing (OLAP), spreadsheets, and basic data access.

1.2 Data Mining Techniques

Generally, there are two types of data mining tasks: descriptive data mining tasks that describe the general properties of the existing data, and predictive data mining tasks that attempt to do predictions based on available data. Data mining applications can use different kind of parameters to examine the data. They include association (patterns where one event is connected to another event), sequence or path analysis (patterns where one event leads to another event), classification (identification of new patterns with predefined targets) and clustering (grouping of identical or similar objects) [14]. Decision tree is a symbolic learning technique that organizes information extracted from a training dataset in a hierarchical structure composed of nodes and ramification. The tree-like output of decision tree makes it easy to understand and interpret, making it the mostly widely used data mining algorithms in many domain such as supplier selection and email user churn analysis [13]. It is capable of building models based on numerical and categorical datasets.

Decision tree is also used for classification patterns or piecewise functions. Cluster analysis is an approach by which a set of instances (without predefined class attribute) is grouped into several clusters based on information found in the data that describes the objects and their relationships [30]. A cluster uses a collection of data objects that are similar to one another within the same cluster and are dissimilar to the objects in another cluster. While in classification the classes are defined prior to building the model, cluster analysis divides the data based on their similarities. There are different types of clustering from different point of view. The most common types divide them all into two types, partitional and hierarchical methods. Partitional clustering is a simple division of a set of data objects into non-overlapping segments such that each data object is in exactly one segment and if we permit clusters to have sub-clusters then we have hierarchical clustering.

1.3 Model Performance Evaluation

The performance of machine learning algorithms is typically evaluated using predictive accuracy. However, this is not appropriate when the data is imbalanced and/or the costs of different errors vary remarkably [6]. All classifier’s performance evaluation involves certain level of trade-off between true positive (TP) rate and true negative (TN) rate; and the same applies for recall and precision. Precision, Recall and F-Measure are commonly used in information retrieval as performance measure [5].

1.4 Related Works

Table 1 presents a listing of some of the techniques used in some of the related work on churn prediction in the banking domain.

<table>
<thead>
<tr>
<th>Researchers</th>
<th>Data Mining Techniques</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shao, J., Xi, L., &amp; Wenhuan, L.</td>
<td>Boosting Schemes (Real AdaBoost, Gentle AdaBoost, &amp; Modest AdaBoost)</td>
<td>Commercial Banking</td>
</tr>
<tr>
<td>Naveen, N., Ravi, V., &amp; Kumar, D. A.</td>
<td>fuzzyARTMAP (Neural Network Architecture)</td>
<td>Banking (Credit Cards)</td>
</tr>
<tr>
<td>Zhao, Y., Li, B., Li, X., Liu, W., &amp; Ren</td>
<td>Support Vector Machine</td>
<td>Banking</td>
</tr>
<tr>
<td>Dudyala, A. K., &amp; Ravi, V.</td>
<td>Ensemble System (Multilayer Perceptron Neural Network, Logistic Regression (LR), Decision Tree (J48), Random Forest (RF), Radial Basis Function (RBF) Network &amp; Support Vector Machine (SVM))</td>
<td>Banking</td>
</tr>
<tr>
<td>Farquad, M. A., Ravi, V., &amp; Raju, S. B.</td>
<td>Support Vector Machine (SVM), Naïve Bayes Tree (NBTree), SVM+NBTREE Hybrid</td>
<td>Banking (Credit Cards)</td>
</tr>
<tr>
<td>Teemu, M., Ahola, J., &amp; Nousiainen, S.</td>
<td>Logistic Regression</td>
<td>Retail Banking</td>
</tr>
<tr>
<td>Nie, G., Wang, G., Zhang, P., Tian, Y., &amp; Shi, Y.</td>
<td>Logistic Regression</td>
<td>Banking (Credit Cards)</td>
</tr>
</tbody>
</table>
2. MATERIALS AND METHODS

The methodology used for this study is illustrated diagrammatically in Figure 1.

![Research methodology flowchart](image.png)

**Figure 1: Research methodology flowchart**

2.1 Data Acquisition

The dataset used for this study for customer churn prediction was acquired from a major Nigerian bank. The raw data was extracted from the bank’s customer relationship management database and transactional data warehouse which contained more than 1,048,576 customer records described with over 11 attributes. Attributes such as customer name, account number, record start, record closed descriptor that do not affect the customer churn prediction, and or tend to violate the privacy and confidentiality status of the customer records were identified and removed. Also, attributes with a lot of missing values were removed due to the fact that it was difficult recreating values that can fit in for omitted attributes like date of birth (recorded as age), customer type and account type.

The input attributes descriptors used were those for:

1. Customer demographics is the geographic and population data of a given customer or, information about a group living in a particular area;
2. Account level is the billing system including charges; and
3. Customer behaviour is any behaviour related to a customer's bank account.
Error! Reference source not found. presents the descriptors. The customer demographics category included: age and gender. In the customer behaviour category, the descriptors used were dormancy date (dormcDate) and account balance (balance).

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Numeric</td>
<td>Customer’s age at the study time</td>
</tr>
<tr>
<td>Gender</td>
<td>Male or Female (Nominal)</td>
<td>Customer’s state of being male, female</td>
</tr>
<tr>
<td>Balance</td>
<td>Naira currency (Numeric)</td>
<td>Average balance in naira</td>
</tr>
<tr>
<td>dormStatus</td>
<td>Yes or No (Nominal)</td>
<td>State of account: active or inactive</td>
</tr>
</tbody>
</table>

The customer records had different account types like individual account and corporate account types. The corporate account type had a lot of missing values that concerns customer demographics such as date of birth, and gender. According to [22] customer demographics have been widely used to differential how a segment of customers differs from one another. In determining customer churn or switching in banking, customer demographics such as age, and job type were shown to have an effect on customers switching banks. Other studies proposed inclusion of additional demographics characteristics such as gender, race and occupation as they have great impact on customers switching behaviour in the banking industry. Hence the corporate account types were not used in the study.

2.2 Data Preparation
Data preparation tasks consider transforming acquired datasets to remove noise, inconsistencies, incoherence, bias and redundancies. The data preparation tasks includes table, record, and attribute selection as well as transformation and elimination of data for modelling, that can be performed multiple times, in no prescribed order. The preliminary diagnosis is conducted on the datasets to gain an insight into their properties by scaling or standardizing the data to reduce the level of dispersion between the variables in the datasets [19]. The dataset was pre-processed in Waikato Environment for Knowledge Analysis (WEKA) to clean, transform and establish relationship between the input variables and the output variables.

2.3 WEKA Machine Learning Workbench
The Waikato Environment for Knowledge Analysis otherwise known as WEKA, is a collection of machine learning algorithms for data mining tasks, which can either be applied directly to a desired dataset or invoked from within a java code. The WEKA machine learning workbench was developed by Machine Learning Group at the University of Waikato New Zealand and distributed under GNU General Public license. Embedded within the WEKA workbench are variants of machine learning tools such as data preprocessing and visualisation tools, classification and regression techniques, clustering and association rule mining techniques, which are well suited for developing new models and machine learning schemes. The WEKA machine learning workbench has a unique file format known as Attribute-Relation File Format (.arff) for converting and pre-processing datasets for analysis and evaluation. It also accept datasets saved in a command-separated value file format (.csv), using Load Converter function to convert (.csv) to (.arff), and can connect and load datasets into WEKA from database and website (url). Figure 2 shows part of the bank dataset in an attribute-relation file format (.arff).
3.0 RESULTS AND DISCUSSION

In this study churn prediction was modeled using K-Means clustering techniques and Repeated Incremental Pruning to Produce Error Reduction (RIPPER) also known as JRip algorithm in WEKA. The prepared data was used to generate clusters with similar attributes and to generate rule sets using JRip algorithm. The raw banking datasets acquired consists of 1,048,576 customer’s records, with 11 attributes descriptors. After rigorous data cleaning and transformation, customer’s records considered for final analysis consists of 4958 customers banking records with 8 attributes descriptors of which 500 customer records with four attribute descriptors were used for the study.

For the classifier that was used the datasets was divided into training, testing and cross validation datasets using percentage split and k-fold cross-validation to avoid training and testing on the same data that could leads to false result. The data was split as 66% for training and testing with the remaining 34%. 10-fold stratified cross-validation was used. The Sample data in Excel (.CSV) Format is presented in Figure 3.
3.2 Cluster Analysis

Due to the nature of the segment of the banking sector which was used which was non-contract based, it is important to give an appropriate definition of churn prior to building the prediction model. In almost all studies reviewed, bank customers are those customers who had relationship with the bank. Consequently, “churn” in such condition could be defined as the terminating of contract from the customer’s side or not reactivating an account(s) after going into dormancy. However, in the banks there is no contract between the bank and its customers. The customer through marketing or self-will can simply decide to open either individual or corporate account(s) type and automatically become a customer. On the other hand, at any time, customers can stop operating their accounts with the bank, and become a churner without leaving immediate trace. This implies that churn in such cases happens with no tracking point such as closing of account or inactive account this makes it difficult to recognize churners. For example if a customer database consisting of a number of customers with different transactional activities, some of which perform daily/weekly activity on their account either by walking into the banking hall or using the online banking system platform; and some who do not perform any transactional activity on their account, is considered. And if a churner is defined as “a person who has not used his/her account for 3 months”, then a considerable part of the customers who use their account occasionally, for instance every 2 months, would be mistakenly considered as a churner. If a longer time span is used for the prediction period and a churner is now defined as “a person who hasn’t used his/her account for a year”, the model may not be able to recognize the real churners. This will increase the number of False Negative (FN) and False positive (FP) and consequently lower the level of model’s accuracy.

In the first stage of the empirical analysis, K-Means clustering technique was applied the training set in WEKA. As a result, different numbers of clusters were generated, in order to choose the best number of clusters (that is: 2 clusters, 3 clusters or 5 clusters etc.) which models the problem. It was discovered that the result which gave five clusters was better than the others. In the second stage of the analysis, the chosen clusters were then analyzed using the RIPPER (JRip) classification algorithm. The clustering algorithm was therefore used to partition the customers into groups with similar clustering characteristics based on their attributes as shown in Table 3.
Table 3: Characteristics of 5 initially extracted clusters from the customer’s database

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Instances (%)</th>
<th>Age</th>
<th>Gender</th>
<th>Balance</th>
<th>DormtStatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>183(37%)</td>
<td>57</td>
<td>Male</td>
<td>6265.5100</td>
<td>Y</td>
</tr>
<tr>
<td>1</td>
<td>26(5%)</td>
<td>50</td>
<td>Female</td>
<td>25783.1569</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>117(23%)</td>
<td>62</td>
<td>Male</td>
<td>18139.4779</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>76(15%)</td>
<td>32</td>
<td>Female</td>
<td>10601.4605</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>98(20%)</td>
<td>34</td>
<td>Male</td>
<td>20712.7888</td>
<td>N</td>
</tr>
</tbody>
</table>

Table 3 shows that behavior of Female customers who were clustered in groups 1 and 3 while that of Male customer was clustered in groups 0, 2, and 4. The transactional characteristics of the customers in each of the groups are presented as follows:

a. Cluster 0 – Cluster Zero consists of 183 cluster instances, representing 37 percent of Male bank customers in their late 50’s with operating account balance above 6000 NGN, who are at high risk of Churn based on their account dormancy status identified as beingInactive;

b. Cluster 1 – Cluster One consists of 26 cluster instances, representing 5 percent of Female bank customers in their early 50’s with operating account balance above 25000 NGN, who are at no risk to Churn based on their account dormancy status identified as being Active;

c. Cluster 2 – Cluster Two consists of 117 cluster instances, representing 23 percent of Male bank customers in their early 60’s with operating account balance above 18000 NGN, who are at no risk of Churn based on their account dormancy status identified as being Active;

d. Cluster 3 – Cluster Three consists of 76 cluster instances, representing 15 percent of Female bank customers in their early 30’s with operating account balance above 10000 NGN, who are at no risk of Churn based on their account dormancy status identified as being Active; and

e. Cluster 4 – Cluster Four consists of 98 cluster instances, representing 20 percent of Male bank customers in their early 30’s with operating account balance above 20000 NGN, who are at no risk of Churn based on their account dormancy status identified as being Active.

One interesting way to examine the data in these clusters is to inspect the clusters visually through Visualize cluster assignments in WEKA. In order to demonstrate how the clusters are grouped in terms of Age and Dormancy Status, the chart was plotted with Age (Num) on the X axis, Dormancy Status (Num) on the Y axis, and the Color to Cluster (Nom) with the “Jitter” turned up completely to artificially scatter the Plot Points for enhanced visualization as shown in Figure 4.

Figure 4: Cluster Visual Inspection of Age(Num) against DormtStatus(Num)
3.3 RIPPER (JRip) Classification Analysis

In order to evaluate the developed model, RIPPER (JRip) classification rule based algorithm was used to generate sets of rules and performance evaluation metrics that define the goodness of fit of the developed model. At this stage of empirical analysis, two criteria are used based on the confusion matrix. Criteria one is based on the Accuracy rate represented by equation 5, which identifies the percentage of the total number of predictions that were correctly classified; while criteria two is based on the Actual Churners’ Rate which identifies the percentage of churners that were correctly identified. However, to provide more robust and better indication of how well the developed classification through clustering model will perform when trained on new data, 10-fold cross validation was applied. Figure 5 shows the WEKA Knowledge Flowchart for the JRip classifier algorithm.

![Figure 5: JRip algorithm Knowledge Flowchart](image)

Using 10-folds cross-validation, the dataset is split into 10 mutually exclusive subsets, and then each subset is used as test set while the remaining datasets are used as training set. This procedure is repeated 10 times, where one fold is used for pruning, and the other folds are used in growing the rules, example of which are shown in Table 5.

<table>
<thead>
<tr>
<th>#</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(age &gt;= 62) and (balance &lt;= 1357.282557) =&gt; dormtStatus=Y (111.0/18.0)</td>
</tr>
<tr>
<td>2</td>
<td>(balance &lt;= 22923.25813) and (balance &gt;= 1169.263145) and (gender = Male) and (age &gt;= 34) and (age &lt;= 45) =&gt; dormtStatus=Y (28.0/6.0)</td>
</tr>
<tr>
<td>3</td>
<td>=&gt; dormtStatus=N (361.0/85.0)</td>
</tr>
</tbody>
</table>

4. CONCLUSION

According to [24], customer churn analysis has become a major concern in almost every industry that offers products and services. In this study a data mining model that can be used to predict which customers are most likely to churn or switch their banks was developed. The model used K-Means clustering in the first stage and a rule-based algorithm (JRip) in the second stage. The model was developed using case data from one of the major banks in Nigeria. The developed model can provide banks with useful knowledge regarding customer transactional behavior, help banks to identify likely churners and hence develop customer retention modalities. Bank customer databases contain a lot of information which if appropriately analysed can further enhance banking practices and operations. Future work will also focus on fraud detection and marketing and enhancement of banking operations and practices.
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Delay Prediction in Wireless Sensor Network Routing Using ART1 Neural Network

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ABSTRACT

The main criteria communication in wireless sensor network is emphasized on routing packets in time. Data packets are not available to base station on time which may result in losing packets. Hence there is a need to analyze end to end delay among packets. Analysis end to end delay and energy consumption are required to optimize for good communication in routing. In this paper we have used an unsupervised learning technique i.e. adaptive resonance theory (ART) neural network. ART can be categorized in many categories such as ART1, ART2 etc. ART1 neural network can be used over various routing protocols such as direct diffusion (DD), lower energy adaptive clustering hierarchy (LEACH) and energy efficient source routing (EESR). These routing protocols are considered as quite energy efficient, however we may need more advance soft computing techniques to handle such situations. The simulation results show that the combination of ART1 neural network and EESR i.e. EESR-ART protocol performs better in finding average delay and total energy consumption as compared to other protocols.

Keywords- Wireless sensor network; end to end delays; LEACH; EESR algorithm; ART1 neural network

1. INTRODUCTION

Wireless sensor network (WSN) is a collective communication of hundreds or thousands of sensor nodes. These nodes communicate with each other via radio signals. These nodes have capability of sensing and forwards sensed data to base stations. This sensor network is totally depending on these sensor nodes. There exist many types of sensor nodes small scale to large one. They are chosen according to specific application purposes. Sensor nodes have large range of applications like environmental monitoring, military surveillance, chemical industries, weather forecasting etc. They are deployed at harsh environment to which human intervention is negligible. Due to a lot challenges faced by sensor nodes are prone to failures.

The topology of a sensor network is very frequently changed as to due to failure of sensor nodes. All of these sensors have common challenge of limited battery. As with the power constraint computational capabilities and memory are also major challenges. To make sensor network work efficient and also for a long period of time there is need to work upon routing techniques. Many routing techniques have been developed till date. Main consideration is energy dissipation during whole execution of communication process.

Another quality of services (QoS) parameter is end to end delay which also analyzed and helps to get better efficient network. So, we are considering delay analysis in this paper for different routing algorithms in addition to artificial neural network which gives best results.

2. RELATED WORK

There are many protocols have been designed, developed and implemented according to applications. All of these have to overcome the challenges face by the sensor network. In the starting ages of the sensor network, the concept of data aggregation and forwarded to base station has been emphasized. According to this requirement direct diffusion has gather to good response and have better performance. Directed Diffusion [13] is a multi-path routing protocol, in which the sink nodes initialize the routing process. The sink nodes have capability to generate interest message via network. This interest message has been flooded all the intermediate nodes. As the interest message is received by the nodes, the receiver node creates a gradient towards the node from which the message has been received. During this stage multiple paths can be discovered between each source-sink pair.
Afterwards, when a source finds an event matched according to existing data, it forwards the data. Based on the performance of the packet reception over each path the sink node selects a path, i.e. the path with minimum latency, the sink node reinforces the selected path by sending a low-rate reinforcement message towards the source. Then the source transmits the data through the selected path. Direct diffusion is a good option in the past time. But the energy and end to end are the major constraints still needs much better option. After that clustering concept is much better option. Clustering is the concept in which out of all the sensor nodes near about very few nodes are selected as clustered head node according to total energy remaining of a sensor node.

Cluster head node then announce as cluster head to their neighboring nodes. All non cluster head sensor nodes selected the particular cluster head for a particular time span and send its data. Cluster head nodes aggregate the information and forwards to base station through intermediate nodes. After that, cluster head selection process again takes place i.e. clustered head rotation process. This due to energy consumption in cluster head selection, data aggregation and data forwarded to base station is much higher. If we select same node as cluster head then it may die in between the routing data. All data would be lost. So cluster rotation is important to prolong life time of sensor network. This clustering concept has been implemented in LEACH [1] protocol. Leach protocol is one of big achievement in the sensor network to get better performance. As we consider delay analysis leach protocol have limitation. Then artificial neural network is introduced to get better performance implemented over leach protocol. This is used to solve complex real world problems.

There are lot techniques available under supervised and unsupervised learning. We have been adopted ART1 (adaptive resonance theory) [15-16] neural network which give better result after computation. Leach protocol is solved with ART1 neural network. It is implemented over the during cluster head selection phase. This is very much critical phase of leach protocol. After this implementation, leach-Art protocol the performance is 60% enhanced as energy is taken as parameter. But for end to end delay analysis it still needs a better protocol. For the specialized in delay and latency computer scientists have introduced the EESR protocol. This is discussed in detail in next section.

3. EESR Routing Protocol

Energy–Efficient Sensor Routing (EESR) [11] is routing protocol works efficient for densely deployed sensor networks. In this routing algorithm, there consists of a gateway, a base station, manager nodes, and a number of sensor nodes. The gateways transferred commands received from a manager to the base station and controls messages received from base station. The base station is a sensor node that has more computational ability and memory than general sensor nodes.

It receives commands from the gateway and sends queries to sensor nodes. It also collects data from sensor nodes and delivers control messages to the gateway.

The area of the application place is divided into four quadrants, namely (+ +), (+ -), (- -), and (- +), based on the 2-dimensional (x, y) coordinates. Each quadrant is then divided into sectors according to the distance from the base station. The number of sectors in each quadrant is determined by the minimum hops required to deliver a message from the base station to the farthest position in the quadrant. The base station is located at the coordinate center of the area. Manager nodes and sensor nodes have ability to collect data and deliver the data to other nodes within 1-hop distance. Each sector has one manager node in the center of the diagonal line of the quadrant. The base station gives unique sector ID to each sector. The sector ID is determined by the quadrant name and the distance from the base station.

Whenever an event occurred a sensor node investigates the sector IDs of all neighbor nodes within 1-hop. If there is a manager node within 1-hop distance, that node is selected as the next node to deliver the event. Otherwise, if nodes in the same sector exist within 1-hop distance, one of them is randomly selected as the next node. Otherwise, a neighbor node with the smallest sector number is selected as the next node because it is closest to the base station. If more than one node have the same smallest sector number, nodes in the same quadrant are preferred to prevent the event from going far to the other region.

After the event node selects one of the neighbors within 1-hop distance, it sends the event only to the selected sensor node. The selected node, then, performs the same selection procedure among neighbors within 1-hop distance, and sends the event only to the selected neighbor again. This procedure is repeated until the event arrives at the base station. Once a manager node is selected as the next node, the event can be delivered to the base station directly through the manger-to-manager transmission. The procedure of EESR is also shown in figure 1.
A discussion of the choice of parameter values and initial weights follows the training algorithm. The notation we use is as follows [15-16]:

- **n** - number of components in the input vector.
- **m** - maximum number of clusters that can be formed.
- **bij** - bottom-up weights (from F1(b) unit Xi to F2 unit Yj).
- **tij** - top-down weights (from F2 unit Yj to F1 unit Xi).
- **ρ** - vigilance parameter.
- **s** - binary input vector (an n-tuple).
- **x** - activation vector for F1 (b) layer (binary).
- **∥x∥** - norm of vector x, defined as the sum of the components xi.

**Description**

A binary input vector s is presented to the F1 (a) layer, and the signals are sent to the corresponding X units. These F1 (b) units then broadcast to the F2 layer over connection pathways with bottom-up weights. Each F2 unit computes its net input, and the units compete for the right to be active. The unit with the largest net input sets its activation to 1; all others have an activation of 0. We shall denote the inbox of the unit as j. This winning unit becomes the candidate to learn the input pattern. A signal is then sent down from F2 to F1 (b) (multiplied by the top down weights). The X units (in the interface portion of the F1 layer) remain “on” only if they receive nonzero signals from both the F1 (a) and F2 units as shown in fig. 2.

The norm of the vector x (the activation vector for the interface portion of F1) gives the number of components in which the top-down weight vector for the winning F2 unit tj and the input vector s are both 1. (This quantity is sometimes referred to as the match.) If the ratio of ∥x∥ and ∥s∥ is greater than or equal to the vigilance parameter, the weights (top down and bottom up) for the winning cluster unit are adjusted.

However, the ratio is less than the vigilance parameter; the candidate unit is rejected, and another candidate unit must be chosen. The current winning cluster becomes inhibited, so that it cannot be chosen again as a candidate on this learning trial, and the activations of the F1 units are reset to zero. The same input vector again sends its signals to the interface units, which again send this as the bottom-up signal to the F2 layer, and the competition is repeated (but without the participation of any inhibited units). The process continues until either a satisfactory match is found (a candidate is accepted) or all units are inhibited. The action to be taken if all units are inhibited must be specified by the user.

**Figure 1** the procedure of EESR algorithm [11]

**Algorithm**

A discussion of the choice of parameter values and initial weights follows the training algorithm. The notation we use is as follows [15-16]:

- **n** - number of components in the input vector.
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- **ρ** - vigilance parameter.
- **s** - binary input vector (an n-tuple).
- **x** - activation vector for F1 (b) layer (binary).
- **∥x∥** - norm of vector x, defined as the sum of the components xi.
Training Algorithm

The training algorithm an ART1 net is presented next. A discussion of the role of the parameters and an appropriate choice of initial weights follows.

Step 0. Initialize parameters:
\[ L > 1, \]
\[ 0 < \rho \leq 1. \]
Initialize weights:
\[ 0 < b_{ij}(0) < \frac{L}{L-1 + n}, \]
\[ t_{ji}(0) = 1. \]

Step 1. While stopping condition is false, do
Steps 2-13.

Step 2. For each training input, do steps 3-12.

Step 3. Set activation of all \( F_2 \) units to zero.
Set activations of \( F_1 \) (a) units to input vectors.

Step 4. Compute the norm of \( s \):
\[ \| s \| = \sum s_i \]

Step 5. Send input signal from \( F_1 \) (a) to the \( F_1 \) (b) layer:
\[ x_i = s_i. \]

Step 6. For each \( F_2 \) node that is not inhibited:
If \( y_j \neq -1 \), then
\[ y_j = \sum b_{ij} x_i. \]

Step 7. While reset is true, do step 8-11.

Step 8. Find \( J \) such that
\[ y_J \geq y_j \text{ for all nodes } j. \]
If \( y_j = -1 \), then all nodes are inhibited and this pattern cannot be clustered.

Step 9. Recompute activation \( x \) of \( F_1 \) (b):
\[ x_i = s_i t_{ji}. \]

Step 10. Compute the norm of vector \( x \):
\[ \| x \| = \sum x_i. \]

Step 11. Test for reset:
If \[ \frac{\| x \|}{\| s \|} < \rho, \text{ then } y_j = -1 \] (inhibited node \( J \))
and continue executing Step 7 again.
If \[ \frac{\| x \|}{\| s \|} \geq \rho, \]
Then proceed to Step 12.

Step 12. Update the weights for node \( j \) (fast learning):
\[ b_{ij} \text{ (new)} = \frac{L x_i}{L-1} + \| x \|, \]
\[ t_{ji} \text{ (new)} = x_i. \]

Step 13. Test for stopping condition.

Parameters Used

\( n \): number of components in the input vector.
\( m \): maximum number of clusters that can be formed.
\( b_{ij} \): bottom-up weights (from \( F_1 \) (b) unit \( X_i \) to \( F_2 \) unit \( Y_j \)). Used to store different clusters values. Permissible range is given by \[ 0 < b_{ij}(0) < \frac{L}{L-1 + n} \] sample value \( \frac{1}{1+n} \).
\( t_{ji} \): top-down weights (from \( F_2 \) unit \( Y_j \) to \( F_1 \) unit \( X_i \)).
\( \rho \): vigilance parameter. (For deciding the learning node).
\( s \): binary input vector (an \( n \)-tuple). Input array to store different input values.
Output array to decide the learning node.
\[ \| x \| \] - norm of vector \( x \), defined as the sum of the components \( x_i \).

Full algorithm is coded by using MATLAB.

Now the algorithm works as follows in our case:
Initialize parameters:
\[ L = 50 \]
\[ \rho = 0.7 \]
Initialize weights:
\[ b_{ij}(0) = 0.2 \]
\[ t_{ji}(0) = 1 \]

Fig. 2: Basic Architecture of ART1
4. EXPERIMENTAL RESULTS

The simulation is implemented in MATLAB. There are five routing protocols have been taken i.e Direct Diffusion, LEACH, LEACH-ART, EESR, EESR-ART. Our simulation results give two graphs Fig. 3 and Fig. 4. Firstly total energy consumption of routing protocols over number of sensor nodes. Secondly, average delay analysis of routing protocols over number of sensor nodes. EESR-ART has been given consistently better performance than other routing protocols. As the number of sensor nodes increases energy consumption and end to end delay values raises, on account of that EESR-ART give better result.

![Figure 3. Total energy consumption](image1.png)

![Figure 4. The average delay time](image2.png)
5. CONCLUSION

The energy efficient system is one of the major requirements in wireless sensor network of today’s date. To get this performance we need to overcome major constraints like limitation of power, packet delivery delay, latency etc. in this paper, we have chosen best routing algorithms to analysis of end to end delay. These routing algorithms also implemented with artificial neural network. The outcome of EESR-ART result is outstanding as compare to other algorithms. There is need to get rid of latency parameter. This is can also be implemented in future and have analysis over it.

REFERENCES


A Query Optimization Application in Database Management System Using Rough-Genetic Algorithm

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ABSTRACT

An improved rough-genetic system framework has been implemented for optimal query processing of a database management system. The system uses rough sets principles to summarize the database and remove duplicate values while genetic algorithm (GA) was used to improve classification and prediction accuracy using an evolutionary structure. The evolved GA structure is automatically integrated into the structure query language (SQL) database management system (DBMS) using a database schema based on the Optimal Query Structure (OQS) for Optimal GA processing. The genetic algorithm approach ensures that incorrect order of entry in the data input fields will not affect the performance of the prediction process by generating a population of randomly mutated attributes from the parent set, and for each population of selected individuals performing a fitness check. A random-mutation operation evolves a new set of individual solutions while automatically updating the OQS. The system has been applied to a plant species database and the results obtained were quite satisfactory with about 5% improvement over traditional SQL/Data mining query language (DMQL) approach.

Keywords: Rough sets, genetic algorithms, Optimal Query Structure, random-mutation

1. INTRODUCTION

The issue of query optimization in DBMS has generated a lot of interest with several attempts to apply data mining techniques and even evolving Data Mining Query Languages for this purpose. [1] have briefly introduced what they consider the major issues to be addressed in parallel query optimization. The issues that was tackled include, mainly the placement of data in the memory, concurrent access to data and some algorithms for parallel query processing. These algorithms were restricted to parallel joins, the authors describe, in a very synthetic way, data placement, static and dynamic query optimization methods, and accuracy of the cost model. Nevertheless, they do not show how to compare the two optimization approaches, and how to choose the appropriate optimization approach.

2. STATEMENT OF THE PROBLEM

The challenges of an efficient query optimization strategy for modern day DBMS’s is a common recurring problem in industry and academia. Several research efforts geared at improving query response times and reducing storage requirements are currently investigated on, in particular, in the area of data mining based queries for DBMS’s.

However, there is need to implement query optimizer test bed applications that include a comprehensive set of queries, reliable, efficient and time efficient.

3. AIM AND OBJECTIVES

The aim of this paper is to develop an improved query optimization application for Database Management System. The specific objectives include the following:

i) To develop an analytical attributes and data mining models, that will speed up queries and improved classification accuracy of the summarised dataset.

ii) To develop an Application that will implement data mining query language.

4. RELATED WORK

Several scheduling strategies of pipelined operators were also proposed. To improve the response time, they developed an execution model ensuring the best trade-off between parallel execution and communication overhead. [2] proposed a data mining query language dubbed “DMQL” for relational database management systems.
The design was inspired by an application they developed called DBMiner. DBMiner is a system graph user interface (GUI) app that allows and facilitates queries on a DMQL inspired database engine. Thus, their goal was to provide the necessary primitives for data mining engines to work on. [3] four algorithms (Maximum, MinDp, MaxDp, and Rate-Match) have been proposed to determine the join parallelism degree independently of the initial data placement. The originality of the algorithm tries to make correspond the production rate of the result tuples of an operator with the consumption rate of next operator tuples. Then, the authors describe six alternative methods of processor allocation in the clones of a unique join operator. They are based on heuristics such as the random or round-robin strategies, and on a model taking into account the effect of the resource contention.

In [4], a multi-join process in a multi-user context were of primary interest. They categorized system state in terms of multi-resource contention. They studied, more generally, the relational query optimization on shared nothing architecture. The Modular Parallel query Optimizers (MPO) determines dynamically the intra-operation parallelism degree of the join operators of a bushy tree. The authors suggest a dynamic heuristic to resource allocation in four steps applied in the following order: (i) Preservation of the data locality (or “data localization”), (ii) Size of the memory, (iii) I/O Reduction, (iv) Operation serialization of a bushy tree. In [5], a parallel algorithm to process a query compound of N joins for each search space shape (i.e. left-deep tree, right deep tree and bushy tree, Cf) was proposed. The authors considered two methods of hash join: the simple hash join and the hybrid hash join, Reports for each search space shape, the need in memory size, the potential scheduling, and the capacity to exploit the different forms of parallelism.

The study includes, the case where the memory resource is unlimited, and the more realistic case where the memory is limited. In the first case, the right deep tree is the most adapted to best exploit the parallelism. But, this structure is no longer the best when the memory is limited. Indeed, there were several strategies allowing to exploit the capabilities of the right deep trees when the memory is limited. The strategy, named “Static Right Deep Scheduling” consists in cutting the right deep tree in several separate sub-trees in a way that the sum of the sizes of all the hash tables of a sub-tree can fit in memory.

The temporary results of the execution of sub-trees T1, T2 …Tn will be stored in disks. The drawback of this strategy is that the numbers of sub-trees increases with the number of base and as such are not held stored in memory. Hence, this method reduces the pipeline chain and increases the response time. Two methods were proposed, one is based on segmented right-deep trees, and the other one is based on zigzag trees. The objective of these two methods is to avoid the investigation of the bushy tree search space and then simplifying the optimization process.

[6] identified that traditional database systems expect all data to conform to an explicitly specified rigid schema. However it was observed that vast amount of information available today is semi-structured that is irregular or incomplete. They observed that it was difficult and inefficient to manage this incomplete data using traditional relational, object-oriented system which were designed primarily for well-structured data. The researchers overcame this bottleneck by developing a database management system called “LORE”, whose sole purpose was for querying and storing semi-structured data. [7] performed an experimental study on three heuristics algorithms – Simulated Annealing (S.A), Tabu Search (T.S) and Genetic Algorithms (G.A) for the database utilities scheduling problem. They found out that the S.A performed better when compared to the T.S and G.A. Notwithstanding, T.S and G.A also fared reasonably well.

[8] proposed a data mining query language for knowledge discovery in a geographical information system; they postulated that spatial data mining is a process for discovering interesting, but not explicit patterns embedded in both spatial and non-spatial data. They presented a spatial data mining object query language (SDMOQL) design which is based on the standard object query language (OQL). The SDMOQL was embedded in a particular geographical information system known as INGENS (Inductive Geographic Information System) which is a prototype GIS that integrates data mining tools to help users in their task of topographic map interpretation. The SDOQL proposed in [8] support two data mining task which are:

i. Inducing classification rules.
ii. Discovering association rules.

For both tasks, the language permits the specification of task relevant data, the kind of knowledge to be mined, the background knowledge and the hierarchies, the interestingness measures, and the visualization for discovered patterns. [9] used a level wise apriori algorithm to optimize an association rule mining query, the level wise algorithms have been shown to work well with association rule mining from sparse data, however, there are inherent challenges as in many practical applications, the computation becomes intractable for a user given frequency threshold and the lack of focus leads to huge collections of frequency item set. In the proposals concerning parallel relational query optimization, few authors proposed a synthesis dedicated to parallel relational query optimization methods. [9] also investigated two promising issues, the efficient use of user defined constraint and computation of condensed representation of frequency item-sets. They showed how the benefits of these two approaches can be combined into a level wise algorithm. Their result showed that it can be used for the discovery of association rules in difficult cases i.e. dense and highly correlated data. [10] developed and implemented the DMQL inspired language which he dubbed DMQL-457 using a structured programming environment (Java) for the data mining of any DBMS. DMQL-457 is a streamlined version of the DMQL with the major focus of ease in use and implementation.
Using DMQL-457, on-line analytical processing (OLAP) for a test database schema or (data cube), was achieved with reasonable execution times. [11] developed an adaptive genetic algorithm with dynamic population size for finding the Optimal Join Ordering executing a query to a RDBMS. Due to high processing cost, the author stated that the evaluation of joins and their ordering as the primary focus of query optimization. However, the author focused was on the optimization of only a particular type of query called the Selection-Projection-Join (SPJ) query. [12] proposed an intelligent query answering system on three real life data sets (KDD99, Cover-type and Iris) using rough sets and G.A’s.

Adaptive Classification was achieved by reinforcing rough sets reducts with the G.A’s with good execution times on the aggregate functions and reasonable good classification prediction accuracies for the KDD99 and Iris Data sets (98.3% and 97.65% respectively). However, for the Cover-type data sets the classification accuracy was low at 64.2%. Also, average concept hierarchy prediction accuracy was given only for the KDD99 and Cover-type with predictions of 95.9% and 61.2% respectively. [13] proposed a genetic algorithm technique to perform a multi-join operational data in active data warehousing retrieval of data based on multiple queries. Using G.A, they were able to efficiently perform the multi-join operation using the cross-over, mutation and selection operators which in turn improved the data retrieval process with high data retrievals with increasing relational tables. [14], apprehended the field of data mining using neural network and genetic algorithm. They over viewed-data mining and said it’s a process designed to analyze and explore the data in search of consistent patterns or to analyze the systematic relationships between data or variables and then to validate the findings by applying the detected patterns to new subsets of data. They also over viewed neural network as a collection of many processing elements called neurons and all neurons interconnected to other neurons and each interconnection have a weight associated with it. They also over viewed genetic algorithm as an adaptive heuristic random global and direct search method based on imitaten of nature biological evolution mechanism. The authors concluded that neural network and genetic algorithm are two good data mining process tools widely used for classification and prediction in complex dataset.

[15] proposed an optimization for data flow specifies known as pack programs, that is able to reorder operators with MapReduce-Style-UDFs,(user-defined function) within an imperative language. This approach leverages static code analysis to extract information from UDFs, which is used to reason about the reorder-ability of UDF operators. This process allows a user to peek step-by-step into each phase of the optimization process, and finally the parallel execution of a chosen execution plan is selected using a set of analytical data flow programs from relational/ non-relational domains. In this paper, a rough-generic application (GOptima) has been developed for the mining of knowledge in a database.

5. METHODOLOGY

A rough-generic approach using object-oriented techniques was employed. This approach builds on the principles of rough-sets and genetic algorithms using a set of structured classes for the development of improved DBMS (GOPTIMA).

5.2 Rough-Genetic Principles

The rough-generic scheme for optimal query processing system demands that the information system (IS) be summarized prior to data mining. We define a rough-generic algorithmic system following a different approach at the genetic end (mutation before cross-over) Fig 1 shows the proposed Algorithmic Scheme for Optimal Query Processing.

![Fig1: Algorithmic Scheme for Optimal Query Processing](image)

5.3 Storage/Database Structure and Specification

In every information system, a domain of study needs to be specified [16]. In this study, the IRIS dataset, a plant species database, have been studied due to its popularity as a domain benchmark for studying the effectiveness of data mining algorithms and techniques in the literature. The domain scheme is shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Domain Scheme for Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

Key:  
DV – Decision Variable  
PV – Prediction Variable
Feature (Attribute) Selection and Labelling

The following features of the IRIS dataset are utilized:

i) the plant species – any of Iris-setosa, Iris-Versicolor, and Iris-Virginica

ii) the plant attributes – sepal-length, sepal-width, petal-length and petal-width

Based on selected features, the domain has the form as shown in Fig 2.

5.4 Data Querying Structure

Data querying structure takes two forms. One based on the standard SQL. For the standard case, a typical query on the IRIS dataset has the form:

\[
\text{String } s1 = "\text{SELECT * FROM IRIS WHERE Sepallength = '5.1' AND Sepalwidth = '3.2';}"
\]

IRIS = table in Relational Data Model
* = All attributes
Sepallength = Attribute 1
Sepalwidth = Attribute 2

Data mining Structure Optimized for SQL

Optimal (SQL) query structure for using the genetic algorithm (GA) will take the form:

\[
\text{String } s1 = "\text{SELECT ID FROM IRIS WHERE } \text{sa} \otimes \text{sb};"
\]

Here, sa and sb represent chosen attributes selected for optimal query processing and,

\[
\begin{align*}
\text{sa} &= A1 \\
\text{sb} &= A2 \\
\otimes &= \text{AND} \\
A1 &= \text{Sepallength} \\
A2 &= \text{Sepalwidth}
\end{align*}
\]

5.5 Output/Input Specifications

Input-output data are captured after connection to database has been established. The database result set object will serve as source container from which other primitive data types may derive functionality. A fitness criterion is defined in a fitness class. Table 2 and 3 shows the input and output specifications.

Table 2: Input specifications

<table>
<thead>
<tr>
<th>ID</th>
<th>Attribute</th>
<th>No of searches</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plant length No</td>
<td>10-50</td>
<td>Numeric, string</td>
</tr>
<tr>
<td>2</td>
<td>Plant length No</td>
<td>10-50</td>
<td>Numeric, string</td>
</tr>
<tr>
<td>3</td>
<td>Plant length No</td>
<td>10-50</td>
<td>Numeric, string</td>
</tr>
</tbody>
</table>

Table 3: Output specifications

<table>
<thead>
<tr>
<th>ID</th>
<th>Plant species</th>
<th>No of searches</th>
<th>Bit change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Iris-setosa</td>
<td>10-50</td>
<td>0-1</td>
</tr>
<tr>
<td>2</td>
<td>Iris-versicolor</td>
<td>10-50</td>
<td>0-1</td>
</tr>
<tr>
<td>3</td>
<td>Iris-virginica</td>
<td>10-50</td>
<td>0-1</td>
</tr>
</tbody>
</table>
Fig 2: Domain Scheme for Analysis with feature labels specified
5.6 Rough-Genetic Computational Class

The object-oriented paradigm encourages the use of structured classes. These core classes have been developed and this is exemplified in Fig 3.

![Fig 3: Computational Class Structure of Proposed System]

6. SYSTEMS TESTING AND RESULTS

The DBMS needed to be tested and deployed after writing and debugging the program. Testing is done to assess the efficiency of the program. The testing procedure is outlined as follows:

1. Run the Main Application
2. Enter numerical values of Sepal length and Sepal width using the data as a guide
3. Click the submit query button
4. Read and record the values

Results of tests have been tabulated in Table 4 using the equality aggregator. The results was compared with the standard SQL with the genetic algorithm (GA) optimized SQL for a DBMS. The Query attributes field represents the expected attribute values (alleles) for which the end-user requests a report. The entry process is generalized in the sense that end-user may enter any one measured or specified plant attributes to discover the species class. The standard (SQL) queries have been run using standard Java output console to simplify analysis report. The results show good performance of the GA optimized (SQL) which compared favourably well with the standard (SQL) with the select, aggregate queries for generations less than 50. With the Deceptive Pattern mining - captured by reversing the alleles, the GA optimized SQL out performed the standard SQL which return empty results. The reason for the GA success over standard SQL is that the GA will seek to create a new population of attribute pairs for each generation in the evolution process.
Table 4 Comparing Standard SQL with GA-optimized SQL

<table>
<thead>
<tr>
<th>Query Attributes</th>
<th>Standard SQL</th>
<th>GA Optimized SQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Attribute 1 (e.g. Sepal-length)</td>
<td>Plant Attribute 2 (e.g. Sepal-width)</td>
<td>Classified Specie</td>
</tr>
<tr>
<td>5.1</td>
<td>3.5</td>
<td>Iris-setosa</td>
</tr>
<tr>
<td>4.9</td>
<td>3.0</td>
<td>Iris-setosa</td>
</tr>
<tr>
<td>7</td>
<td>3.2</td>
<td>Iris-versicolor</td>
</tr>
<tr>
<td>3.5</td>
<td>5.1</td>
<td>Empty</td>
</tr>
<tr>
<td>4.9</td>
<td>3.0</td>
<td>Empty</td>
</tr>
</tbody>
</table>

A snapshot of the running application is shown in Fig4.

Running Patterns

Running Patterns describe the nature of the GA query using a classification aggregate query. This is depicted in Fig 4.

Fig 4: Running Pattern using the = Aggregate query for 10 Search
5. CONCLUSIONS

In conclusion, genetic algorithms and rough sets play crucial role in optimal query processing if properly planned. Using object-oriented approach and simple data structures can assure the quality of the data mining process and thus eliminate the need for expensive techniques such as using data mining query language (DMQL). Increasing the number of generations involved in the program solution not necessarily make the predictions much better in certain circumstances. Thus, trade-off has to be made between the required precision and query load or time.

6. RECOMMENDATIONS FOR FUTURE WORK

Genetic algorithm is a proven data mining algorithm of choice if efficient and accurate database systems are to be built. The developed system thus can bring in more efficient and accurate data mining features into a database management system. Using the system, database engineers can approach the query optimization in a more dynamic and object-oriented way which can make the end-user applications developed more robust. This application will therefore be useful in modern day intelligent database products in academia and industry. In future, this application can also be integrate into mobile computing environment in a platform independent way.

REFERENCES


Performance improvement through interference mitigation techniques in Transmitted Reference UWB system used in WPAN overlay systems

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ABSTRACT

In this paper, studies are performed and techniques are proposed for interference mitigation in Transmitted Reference ultra wideband (TR-UWB) system. The best method for suppressing and reducing the mutual interference is without modifying interfering systems. The coexistence of multisystem is given by: (a) Interference reduction from UWB systems to other narrowband (single and multiple) and wideband systems. (b) Interference reduction from other narrowband (single and multiple) and wideband systems to UWB systems. The TR-UWB signal using AcR based multi-resolution technique is used to avoid its interference to other wireless systems. By using a notch filter the reverse interference is alleviated at frontend of UWB receiver which is having much smaller bandwidth as Gaussian pulse-shaped multi-resolution environment. The BER performance of AcR receiver and modified TR-UWB receiver are investigated on AWGN and IEEE 802.15.3a UWB channel models. We show that for a modified TR-UWB receiver operating at low to medium SNR's, the system performance increases as the single NBI are perfectly suppressed, while at high SNR's the system still performs satisfactorily in presence of multiple narrowband and wideband interference using modified receiver structure in NLOS channel environment.

Keywords: TR-UWB, NBI, wideband interference, AcR, notch filter, IEEE 802.15.3a, Bit Error Rate.

1. INTRODUCTION AND MOTIVATION

Ultra Wideband Radio (UWB) is an emerging technology with big promise in imaging systems, vehicular radar systems, communication and measurement systems. UWB technology has for many years been used in radar and military communications but has not been allowed on the open market prior to 2002. In April 2002, the federal communication commission (FCC) [1] lifted the restriction on the use of UWB technology for non-military applications. Since then, more industries have started developing UWB systems. UWB systems send information with extremely short duration pulses, therefore allowing high speed data communication and diversity against multipath. Unlike traditional narrowband systems, UWB generates short pulses and uses these pulses for data modulation.

Therefore, UWB is alternatively referred to as impulsive, carrier less or baseband transmission. This is because the FCC only defines UWB as a signal that occupies more than 500 MHz in the 3.1-10.6 GHz spectral mask [2]. UWB communication systems use spectrum which is already allocated to other wireless systems, and so interference by and into UWB communication signals have been the subject of intense research interest; because reliable operation of these systems are highly sensitive to interference signals in the same band.

UWB coexistence and interference issues are very important. Up to now, most investigations of coexistence issues concern the interference of UWB devices on existing services such as UMTS, GPS WLAN and GSM [6], [7] and [9]. But recently, research progress shows that mitigation of interference by UWB signals are possible by using different pulse shapes, modulation techniques and whitening and shaping of the power spectral density(PSD) [3], [4], [5]. Feedback loop mechanism has also been proposed to enhance the signal-to-noise ratio of in Impulse Radio (IR) UWB receiver; however the mechanism was tested with sinusoidal interference model [9]. The IR-UWB concept relies on the transmission of a train of data pulses, each with very small duration in order of nanoseconds occupying a bandwidth of few gigahertz [8] and [13].

In this system Rake, SRAKE-MMSE receivers are the sub optimal demodulation schemes as the multipath diversities are automatically achieved [30]. However, from implementation point of view without information of number of rake fingers and MMSE equalizer taps accurate acquisition and channel estimation seems to be complex and difficult [17], [18], [20] and [21]. Further, for high data rate UWB system, orthogonality between each of the signals in various rake fingers is an invalid assumption, which leads to inter symbol interference (ISI) [21] and [23].
To overcome these aforementioned problems associated with IR-UWB system, a suboptimal low complexity transmitted reference (TR) autocorrelation receiver (AcR) is proposed by Hoctor and Talminson [25] and [26]. TR-UWB receivers are popular for their simplicity, capability to reduce the strongest UWB timing requirements and robust performance in multipath channels [14], [15] and [20]. The transmitted reference refers to the transmission of both data modulated pulse and an unmodulated pulse which is used as ‘reference’ for signal demodulation simultaneously. In a TR modulation format, a reference pulse is transmitted before each data modulated pulse. At AcR front end, the reference pulse is time aligned through a delay line with the data pulse [31].

Required level of energy for transmitted data detection is obtained through correlation of those two pulses over a certain integration time. Since both the pulse undergo the same channel distortion and reference signal is used as estimate of the multipath channel response [33]. Thus channel estimation constraint is greatly relaxed as the noisy estimate of channel can be directly obtained from received signal. The advantage of using TR-UWB over IR-UWB are to use all the energy of the data signal without requiring additional channel estimation and synchronization procedure is considerably simplified without using Rake reception [22]. In this paper, TR-UWB system performance is studied in the presence of strong narrowband, multiple NBI and wideband interference. To reduce the effects of interference by and into UWB signals, a new method is proposed in conjunction with a multi-carrier type transmission pulse technique.

The rest of the paper is organized as follows. In Section 2 we study the system model for TR-UWB and channel modelling. Section 3 is devoted for TR-UWB with interference. In section 4 we study performance analysis of modified TR-UWB receiver. Simulation results are discussed in Section 5. Section 6 concludes the paper.

2. TR-UWB SYSTEM MODEL

For UWB communication channels are highly dispersive in nature and so the channel estimation is a very challenging task. Designing a receiver that generates reference locally at the receiver, estimates the channel, and captures enough energy for data detection is a difficult task. Instead of locally generating it, the reference signal can be transmitted along with the information data. Such a system is known as transmitted reference (TR) system. TR signaling was used for military spread spectrum communication initially. TR has regained popularity in UWB communication systems TR-UWB is a simple receiver structure, which captures all of the energy available in a UWB multipath channel for demodulation at the receiver [14] and [15]. Further TR is a correlation receiver system, thus it does not require channel estimation and has weak dependence on distortion [21], [34], [32] and [33]. The major drawback of this system is the use of noisy template for demodulation. By using, an autocorrelation receiver that averages previously received reference pulses to suppress noise. TR signaling for an UWB system with AcR can exploit multipath diversity inherent in the environment [33]. By using the AcR, synchronization procedure is also considerably simplified. Due to suboptimal signal template taken from received signal, increased noise and interference power become a major drawback [18]. The system model for the transmitted reference system [34] is presented in Figure 1. A mathematical representation of UWB transmitted signal is

$$s_u(t) = \sqrt{E_u} \sum_{n=0}^{\infty} p(t-nT_u) + a_n p\left(t-nT_j-D_{\max N_j}\right)$$  (1)

Where \(p(t)\) is denoted as pulse having a duration of \(T_u\) of few hundred picoseconds and \(\int P^2(t)dt = 1\), i.e. its energy is normalized to unity. \(D_j\) is set to be larger than \(T_u + T_h\). The symbol energy is divided into \(N_j\) doubles, each one of them considering of two pulses delayed in time \(D_j\). \(D_j\) is referred to as delay hopping code. \(j = 0 \ldots N_j - 1\).

Figure 1. TR-UWB Transceiver Model

where, \(T_u\) is known as the duration of UWB multipath
channel \(h_{UWB}(t)\). The UWB channel is modeled as \(h_{UWB}(t)\)

\[
h_{UWB}(t) = \sum_{i=1}^{L} h_{i} \delta(t-t_{i})
\]

(2)

where the total number of multipath is \(L\), \(h_{i}\) represents the amplitude for \(i^{th}\) path and \(t_{i}\) is denoted as arrival time for \(i^{th}\) path. Assuming that pre-filter doesn’t distort input signal. At the channel output, the UWB signal is represented as:

\[
s(t) = s_{p}(t) \ast h_{UWB}(t)
\]

(3)

The received signal after a pre-filter with band width ‘W’ is given by

\[
r(t) = s(t) + n(t)
\]

(4)

Where, \(n(t)\) = Additive Gaussian noise with power spectral density \(N_{0}/2\) within the band width ‘W’. So \(s(t)\) can be rewritten as

\[
s(t) = \sqrt{E_{s}} \sum_{j=0}^{N_{d}-1} g(t-jT_{d}) + a_{j} g(t-jT_{d}) - D_{j}
\]

(5)

where \((0 \leq t \leq N_{d}T_{d})\) and

\[
g(t) = p(t) \ast h_{UWB}(t)
\]

(6)

The receiver consists of \(N_{d}\) branches, each one provided with a delay-line matched to one of the elements of the delay hopping code and with an integrator. The output of the receiver branch \(j\) is described by

\[
Z_{j} = \int_{jT_{d}}^{jT_{d}+T} r(t)r(t + D_{j}) dt
\]

(7)

Thus, the data modulated pulse is first time-analysis and then correlated with data unmodulated pulse which provides a noisy estimation of UWB channel response.

All the outputs \(z_{j}\) are then coherently combined to form the decision variable.

\[
Z = \sum_{j=0}^{N_{d}-1} b_{j} z_{j} = d \phi + n
\]

(8)

Where, the useful energy for data detection is given by

\[
\phi = N_{d}E_{s} \int_{0}^{T} g^{2}(t) dt
\]

(9)

\(g(t)\) represents a stochastic process, Noise term \(n\) can be modeled as a Gaussian random variable with zero mean term and variance.

\[
\sigma_{n}^{2} = N_{0}\left(\phi + TW_{0}/2\right)
\]

(10)

\(T = T_{d}N_{d}\) provides overall integration time for symbol detection. Conditioned to the channel \(h_{UWB}(t)\) or equivalent to the random variable \(\phi\), so the bit error probability is

\[
P(e / \phi) = Q(\phi / \sigma_{n})
\]

(11)

3. TR-UWB WITH NBI

The UWB signal must be kept under the spectral mask provided by regulations so that it will not damage the coexisting wireless systems and vice versa. However, the Gaussian monocycle pulses need to be filtered to meet the FCC spectral mask. Although the pulses designed in the aforementioned methods meet FCC spectral mask properly, and well suppress the single narrowband interference (NBI), but are unable to suppress the multiple narrowband interference (m-NBI) and wideband interference (WBI) situation [18], [19], [20], [22] and [23]. In this section the interference effects are theoretically investigated in a TR-UWB system using auto correlation receiver [22], [23] and [35]. It is convenient to model the interference at the UWB receiver front-end as a single tone sinusoidal signal [35].
The narrowband interference (NBI) signal is modeled as a traditional single carrier BPSK modulated waveform and given by \[i(t) = \sqrt{2P_i} \cos(\omega_0 t + \theta) \sum_{p=-\infty}^{\infty} g_p Z(t-kT_i - \tau_i)\] (12)

The decision variable equation explained in previous section
\[Z = \sum_{j=0}^{N-1} b_j \int_{t_j}^{t_{j+1}} [r(t+i(t)) - r(t+D_j)+i(t+D_j)] dt\] (13)

Equation (10) is the Fourier transform of \[g(t)\] computed at frequency \(f = f_c\). \(E_s\) is the transmitted energy per symbol. Thus it is concluded through analysis, presence of narrowband interference or wideband interference increases both noise power and also adds an extra interference terms which can severely deteriorate the performance.

4. PROPOSED TECHNIQUE FOR INTERFERENCE SUPPRESSION IN TR-UWB SYSTEM

Improving the transceiver by suppression of interference when the systems coexist with other spectrally overlapping narrowband wireless system. TR-UWB are susceptible to NBI because the interference will be multiplied at the AcR’s end. Hence the system needs improvement to counteract the interferers. Further Interference reduction from UWB systems to other narrowband (single and multiple) and wideband systems and vice versa are to be considered [10] and [24].

Narrow band interference (NBI) signal interference at 5.25 GHz is the slaughterer to UWB system whereas wideband interference (WBI) signals coexist with UWB system at 7.5GHz. Suppression of interference level using two different strategies is attempted in this research work such as:

- **UWB Pulse Design**: Interference is suppressed without using the frequency band where the interferer operates. Multi-resolution Eigenvalue decomposition technique is used for performing desired pulse shaping to the UWB signal. The transmitted waveform shape is designed properly, such that the transmission at some specific frequencies is omitted such that interference from UWB to other NB, multiple NB and wideband system is reduced [24] and [29].

- **Modified TR-UWB Receiver**: Suppression of interference to the UWB system is done by introducing a notch filter at the UWB autocorrelation (AcR) receiver. So that interference from other wireless systems to UWB system is mitigated [19] and [35].

The proposed technique does not reduce the capacity of the UWB system even the data rate changes from low to high data rate and hence ISI can be overcome [23]. Performance of these proposed techniques are investigated using MATLAB simulation.
4.1 UWB Pulse Design using Eigenvalue decomposition technique

Interference reduction from UWB systems to other narrowband and wideband systems can be done using pulse shaping technique. The UWB signal is divided into a number of pulses to increase the flexibility and to reduce the sensitivity to interference by splitting the frequency spectrum into sub-bands. The total UWB signal is the sum of all pulses as each pulse has a different center frequency having the same pulse width. Data can be transmitted through all the sub-bands or through only selected number of them. In the case of coexistence with other interference system such as narrowband interference (NBI), multiple narrowband interference (m-NBI) and wideband interference (WBI), a number of UWB sub-bands centered on the interferer can be removed. This was achieved using Eigenvalue decomposition model for UWB pulse design. The same UWB pulse can be used to perform a multi-resolution analysis of a transmitted UWB waveform into multiple sub-bands pulses centered on set of different sub-carriers.

UWB pulse design method was first presented in [28]. Design of UWB pulse uses the Eigenvalue decomposition model. The FCC desired spectral mask is given by

\[ H(f) = \begin{cases} 1 & f_L < f < f_H \\ 0 & \text{elsewhere} \end{cases} \]  

(22)

where \( f_L = 3.1 \text{GHz}, f_H = 10.6 \text{GHz} \).

The corresponding inverse Fourier transform is represented as

\[ h(t) = 2f_H \sin c(2f_H t) - 2f_L \sin c(2f_L t) \]  

(23)

The frequency response of a filter is decided based on FCC indoor mask [60]. Hence UWB pulses \( s(t) \) can be generated by filtering,

\[ \lambda s(t) = \int_{-\infty}^{\infty} s(\tau)h(t-\tau)d\tau \]  

(24)

where \( \lambda \) is an attenuation factor. A time-limited pulse \( p(t) \) is to be designed

\[ s(t) = 0 \quad \text{for} \quad |t| > T_m / 2 \]  

(25)

where \( T_m \) is the time duration of UWB pulse. Sampling is done at a rate of \( N \) samples per pulse period \( T_m \), equation (23) is expressed as follows:

\[ \lambda s[n] = \sum_{n=-N/2}^{N/2} s[m]h[n-m], \quad n=-N/2 \ldots N/2 \]  

(26)

where \( n \) and \( m \) are integer values. Equation (26) is expressed in vector form

\[ \lambda s = Hs \]  

(27)

where vector \( s \) represents the discretized UWB pulse, \( H \) is a real Hermitian Toeplitz matrix or known as constant diagonal matrix given by (28), \( s \) is an eigenvector of \( H \) and \( \lambda \) is the eigenvalue.

\[ H = \begin{pmatrix} h[0] & h[-1] & \ldots & h[-N] \\ h[-1] & h[0] & \ldots & h[-N+1] \\ \vdots & \vdots & \ddots & \vdots \\ h[N] & h[N-1] & \ldots & h[0] \end{pmatrix} \]  

(28)

The frequency spectrum and power spectral density (PSD) of the UWB pulse can be calculated by

\[ S(f) = \frac{T_m}{N} \sum_{n=-N/2}^{N/2} s[n]e^{-j2\pi f_n T_m/N} \]  

(29)

\[ PSD(f) = |S(f)|^2 \]  

(30)

We require forming a zero point of the PSD of UWB pulse at the centre frequency \( f_0 \) as the major power of the interferer is concentrated on \( f_0 \). Accordingly the desired pulse and the power spectral density (PSD) of the pulse are shown in Figure 3.

Figure 3 UWB pulse and PSD generated from Eigenvalue decomposition model

4.1.1 Single NBI Interference Mitigation

- The technique followed the method is discussed as below. The UWB band is divided into two bands: \( f_L, f_H \) and \( f_0, f_a \) maintaining \( f_0 > f_a \) [29].
- The Eigenvalue decomposition generates two sub-pulses \( s_f(t) \) and \( s_d(t) \) used in each sub-band. \( s_f(t) \) and \( s_d(t) \) meet the FCC spectral mask by adjusting \( f_0, f_a \) and \( S_f(f_0) = -S_d(f_a) \) is the pulse amplitude. \( S_f(f_0) \) and \( S_d(f_a) \) are the frequency spectrums of \( s_f(t) \) and \( s_d(t) \) respectively.
- The desired UWB pulse is generated by superimposing
the two sub-pulses. The PSD of UWB pulse has a zero point at $f_0$. Figure 4 shows the PSD of the UWB pulse suppressing single narrow-band interference [28]. Spectral density is reduced by about 50 dB around the interfering band using the above technique. Hence potential interference from UWB system to single NBI system is successfully mitigated.

4.1.2 Multiple NBI interference mitigation

Multiple NBI narrow-band interferers are superimposed over three places in the UWB band in the simulation analysis. The lobe of the pulse becomes larger with the increment of the sub-band number from the simulation point of view. The technique is described below.

- UWB band is partitioned into two bands: $(f_l, f_M)$ and $(f_M, f_H)$. Using the Eigenvalue decomposition method two pulse $s_1(t)$, $s_2(t)$ are generated. The narrowband interferences is assumed to be located in the lower band $(f_l, f_M)$. So at the receiver, $s(t)$ should be further processed to mitigate the narrow-band interferences.

- The desired pulse is obtained from $s(t) = s_1(t) + s_2(t)$. Figure 5 shows the waveform and depicts the PSD of the generated pulse.

At the receiver, we have used a doublet pulse consisting of two received pulses $s_d(t)$ with opposite amplitudes and separated from each other by $T_g$ time [16]. $T_g$ represents the delay time. The processed pulse $s_d(t)$ can be expressed as:

$$s_d(t) = \frac{1}{\sqrt{2}} \left( s_1(t) - s_1(t - T_g) \right)$$

(31)

The spectral amplitude of such a pulse can be computed as:

$$|S_d(f)|^2 = 2|S_1(f)|^2 \sin^2(\pi f T_g)$$

(32)

Spectrum of the designed pulse has nulls at frequencies at $f = kT_g$ for any integer $k$. $T_g$ can be adjusted for removing the interferences in the lower band. Spectral density is reduced by more than 30 dB and hence the potential interference from UWB system to multiple NBI system can be successfully reduced.

4.1.3 Wideband interference mitigation

UWB systems can coexist with several narrow-band devices and wide-band devices simultaneously. In such circumstances, the UWB band is divided into three sub-bands, having the interference bandwidth from $f_{IL}$ to $f_{IH}$, which is located in the middle of UWB band. The wide-band systems employ the multiple carriers and the main transmitted power is concentrated on the carriers. So our main aim is to generate nulls at each frequency of the carrier. The difference between this mode and two sub-bands mode is the delay time $T_g$ that could be longer according to the frequency intervals of the carriers. Therefore the wide-band interference can be mitigated successfully. This technique is discussed below.

- The UWB band is partitioned into three sub-bands: $(f_l, f_M)$, $(f_M, f_H)$, and $(f_{IL}, f_{IH})$. Then using the Eigenvalue decomposition method three sub-pulses $s_1(t)$, $s_2(t)$, and $s_3(t)$ are generated in each sub-band respectively. As $s_d(t)$ is in the interference bandwidth so at the receiver end, it can’t be used before further processing.

- A new pulse $s(t)$ with $s_1(t)$, $s_2(t)$, $s_3(t)$ is generated as

$$s(t) = s_1(t) + s_2(t) + s_3(t)$$

(33)

Its spectrum is given by

$$S(f) = S_1(f) + S_2(f) + S_3(f)$$

(34)
The received pulse in middle band $s(t)$ is processed in the same way based on the method proposed in the previous section. The processed pulse $s_d(t)$ can be expressed as:

$$s_d(t) = \left(\sqrt{1/2}\right) (s(t) - s(t - T_g)) \quad (35)$$

The spectral amplitude of this pulse can be written as

$$|S_d(f)|^2 = 2|S_2(f)|^2 \sin^2(\pi f T_g) \quad (36)$$

The PSD of the processed pulse in the middle band as shown in Figure.6, the spectrum has nulls at frequencies at $f = k T_g$ for any integer $k$. Suppose the wide-band system utilizes $N$ carriers, and the frequency interval between two carriers is $F_c$. Therefore, we can remove all the interference on every carrier by setting $T_g = 1/F_c$.

From previous section, $x_i$ in equation (17) can be effectively suppressed but the performance degradation occurs due to the remaining term $x_{\phi} + x_w$. The exact knowledge of the interferer frequency $f_i$ could provide minimization of equation (16). So that $x_{\phi}$ can be minimized implementing accurate delay lines such as delay must be smaller than $1/f_i$ for minimization of $x_{\phi}$. The extra term $x_w$ could be suppressed by positioning a notch filter around the carrier frequency of the interferer signal which provides a loss of significant portion of the desired signal along with interference $[30, 31]$. The best way to suppress the extra term by cancelling the $l(t)$ before operating the correlation between received and delay signal. To minimize the suppression of useful signal considering the bandwidth of the notch filter $W_N$ and thus the remaining bandwidth of the UWB signal is $W - W_N$.

Thus the potential interference from UWB system to wideband interference system can be successfully mitigated. Spectral density is reduced by about 30 dB at lower band and nearly 25 dB at higher band around the interfering band. Modified TR-UWB receiver

### 4.2 Modified TR-UWB Receiver

Modified TR-UWB receiver is suggested for interference reduction from other narrowband and wideband systems to UWB systems. Severe interference saturates an unprotected UWB receiver front-end $[11, 19, 27]$ and $[31]$. Overlaying of UWB system in existing WPAN environment causes interference. This interference degrades the performance of the TR-UWB system $[31]$. Interference suppression in the TR receiver is proposed by eliminating the interfering band by a notch filter. Notch filter effectively cancels out the interfering band. Notch filter has been implemented with filter order of 400 and operates around 5.25 GHz $[24]$.

Considering the channel $h_{\text{UWB}}(t)$, the probability of error of the TR-UWB with a notch filter of $W_N$ replaced by $W - W_N$ and $\phi$ by $\phi \frac{W - W_N}{W}$, which provides a uniform distribution of the signal energy over the entire bandwidth. So,

$$P(e) = Q \left( \frac{W - W_N}{W} \frac{\phi^2}{\sigma_n^2} \right) = Q \left( \frac{\text{SNR}_{W - W_N}}{\sigma_n^2} \right) \quad (37)$$

where, $\frac{W - W_N}{W}$ represents scaling term.

Comparing the equation (37) with the argument of $Q$ function in equation (38) with $x_i = 0$. We obtain a bandwidth of TR-UWB system with notch filter

$$W_N < W \frac{\sigma_i^2}{\sigma_i^2 + \sigma_n^2} \quad (38)$$
This provides a better performance than corresponding receiver without notch filter. Considering \( \int g^2(t) dt = 1 \) true for both single path channel and multipath channel, the useful signal energy becomes \( \phi = E_s / 2 \)

\[
I_\beta > N_0 W \frac{W-N}{2} \quad \text{(39)}
\]

The right side of the equation (39) provides the level of interference for which the received signal is filtered effectively.

Table 1 Parameter Settings for IEEE UWB Channel Models

<table>
<thead>
<tr>
<th>Scenario</th>
<th>( \Lambda ) (1/ns)</th>
<th>( \bar{\lambda} ) (1/ns)</th>
<th>( \Gamma ) (1/ns)</th>
<th>( \gamma ) (1/ns)</th>
<th>( \sigma_\xi ) (dB)</th>
<th>( \sigma_\zeta ) (dB)</th>
<th>( \sigma_\eta ) (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM1</td>
<td>0.0233</td>
<td>2.5</td>
<td>7.1</td>
<td>4.3</td>
<td>3.3941</td>
<td>3.3941</td>
<td>3</td>
</tr>
<tr>
<td>CM2</td>
<td>0.04</td>
<td>0.5</td>
<td>5.5</td>
<td>6.7</td>
<td>3.3941</td>
<td>3.3941</td>
<td>3</td>
</tr>
<tr>
<td>CM3</td>
<td>0.0067</td>
<td>2.1</td>
<td>14</td>
<td>7.9</td>
<td>3.3941</td>
<td>3.3941</td>
<td>3</td>
</tr>
<tr>
<td>CM4</td>
<td>0.0067</td>
<td>2.1</td>
<td>24</td>
<td>12</td>
<td>3.3941</td>
<td>3.3941</td>
<td>3</td>
</tr>
</tbody>
</table>

5. SIMULATION STUDY AND ANALYSIS

5.1 Signal waveform

Partition the UWB band generated by Eigenvalue decomposition technique, into two bands and three bands for NBI and wideband respectively [12] as discussed in previous section. Here, \( N=128 \), \( T_m=1 \) ns. So the interference on every carrier can be mitigated by introducing zero point on PSD plot.

5.2 IEEE 802.15.3a Channel model parameter

As we mentioned it before, we study the case of UWB channels CM1, CM2, CM3 and CM4 channel models [36]. We have used an oversampling factor of eight for the root raised cosine (RRC) pulse. According to this sampling rate, time channel spread is chosen equal to 100 for CM4 and 70 for CM3, this corresponds to respectively 12 =100 / 8 and 9 = 70 / 8 transmitted symbols. This choice enables to gather 99% of the channel energy. The coherence bandwidths of CM1, CM2, CM3, and CM4 simulation are 27 MHz, 26 MHz, 10.6 MHz, and 5.9 MHz respectively. CIR remains constant over the time duration of a packet. The CM1-CM4 indoor channel model is adopted in simulation. The simulated channel impulse responses for CM1, CM2, CM3 and CM4 are shown in Figure 8, Figure 10, Figure 12 and Figure 14. The power delay profiles for CM1, CM2, CM3 and CM4 are plotted in Figure 9, 11, 13 and 15 respectively. The simulation parameter settings for the entire four channel models are listed in Table 1.
5.3 Performance study of proposed interference reduction techniques for TR-UWB Communication System

The modified TR-UWB receiver model is studied using MATLAB. The block diagram of simulation model is presented in Figure 16. Transmitted pulse is generated by pulse shaping the Gaussian doublet pulse. In the performance analysis, first AWGN channel model is used and then UWB channel model is investigated. The central frequency and the bandwidth for both single NBI and multiple NBI are set to be 5.25 GHz and 200 MHz respectively. Whereas for WBI, the central frequency is 7.5 GHz and the bandwidth is 400 MHz. UWB operates at FCC part 15 limit of -41.3dBm/MHz and interference transmitted power is 100mW. When two transmitters experience same attenuation, the signal to interference ratio (SIR) is -20dB.

TR-UWB receiver module retrieves the transmitted data from the received signal. Wide band pass Filter (wide-BPF) at receiver frontend removes noise, which is out of band and effectively turns off the interfering band. The output from the auto-correlation is fed into a threshold device. This UWB system is operating at data rate of 12.5 Mbps. From Figure 17, it is observed that the simulated conventional AcR receiver model’s performance is closer to the theoretical optimum for AWGN channel model, its performance degrades.

At most 6dB SNR degradation occurs at $10^{-2}$ BER floor. Therefore, the conventional TR-UWB receiver fails to mitigate NBI. Figure 18, illustrates that the modified TR-UWB AcR receiver can mitigate NBI and its performance is closer to the theoretical TR-UWB. Further, the effect of strong interferers like multiple NBI and wideband is investigated and found that modified outperforms the conventional one and can mitigate those interference successfully.
Simulations study is done for evaluating the conventional TR-UWB system’s performance in UWB channel (IEEE 802.15.3a). Figure 19 illustrates BER performance comparison theoretical and simulated conventional TR-UWB with AcR receiver considering UWB channel models CM1, CM2, CM3 and CM4 based on different propagation environment. The performance of simulated conventional receiver is closer to the theoretical one. Effect of interference on UWB system using the AcR receiver model is investigated.

Figure 20 shows that the performance degrades due to the addition of single NBI. Thus new techniques are suggested to improve its performance. So the modified AcR receiver is proposed to mitigate interference and improve the BER performance of TR system.

The proposed technique of pulse shape design at transmitter to cancel out the interference band and further notch filtering at receiver’s end provides a suitable solution to this problem in both LOS and NLOS channel model. Further, the robustness of the modified AcR receiver is tested by incorporating strong interference like multiple narrowband and wideband.
Figure 21 illustrates the simulated results in presence of SNR value 14dB. Further, the modified TR-UWB receiver outperforms the conventional one in improving BER by mitigating interference for UWB channel models CM1 to CM4.

<table>
<thead>
<tr>
<th>UWB Channel models</th>
<th>CM1</th>
<th>CM2</th>
<th>CM3</th>
<th>CM4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver Model Type</td>
<td>BER</td>
<td>BER</td>
<td>BER</td>
<td>BER</td>
</tr>
<tr>
<td>Theoretical</td>
<td>$0.7 \times 10^{-4}$</td>
<td>$0.8 \times 10^{-3}$</td>
<td>$0.5 \times 10^{-2}$</td>
<td>$0.12 \times 10^{-1}$</td>
</tr>
<tr>
<td>Modified TR-UWB and single NBI</td>
<td>$0.5 \times 10^{-2}$</td>
<td>$0.12 \times 10^{-1}$</td>
<td>$0.46 \times 10^{-1}$</td>
<td>$0.78 \times 10^{-1}$</td>
</tr>
<tr>
<td>Modified TR-UWB and multiple NBI</td>
<td>$0.12 \times 10^{-1}$</td>
<td>$0.28 \times 10^{-1}$</td>
<td>$0.72 \times 10^{-1}$</td>
<td>$0.16 \times 10^{0}$</td>
</tr>
<tr>
<td>Modified TR-UWB and WBI</td>
<td>$0.23 \times 10^{-1}$</td>
<td>$0.5 \times 10^{-1}$</td>
<td>$0.1 \times 10^{0}$</td>
<td>$0.22 \times 10^{0}$</td>
</tr>
</tbody>
</table>
Higher data rate for wireless is mainly restricted by ISI caused by the multipath effect of the channel. The main drawback of a TR system is the noisy template used for detection. In the presence of ISI, the template suffers from the overlapping of the earlier transmitted pulses via multipath, thereby limiting the performance of the system. The data rate $R$ for TR-UWB system is defined by

$$ R = \frac{1}{N_s T_f} $$

where $T_f = 2(T_e + T_p)$, $T_e$ is the frame time, and $T_d$ is the delay between two pulses in a frame which for a non ISI case is greater than the multipath delay spread time $T_{mds}$ and $T_p$ and $T_f$ are known as pulse duration and frame time respectively. Therefore, ISI increases as the data rate increases.

Simulations study is carried out to evaluate the ISI effect in the modified TR-UWB AcR receiver.

Performance curves are obtained by varying the data rate from 10Mbps to 125Mbps. $N_s$ is the number of times the pulse is transmitted to capture adequate energy for detection. By taking $N_s = 1$, $T_p = 1$ ns and $T_d = 39$ ns, data rate is calculated as $R = 12.5$ Mbps. Similarly, data rates 10 Mbps and 125 Mbps can be maintained. Figure 24, Figure 25, Figure 26 and Figure 27 describes the performance of modified AcR receiver in presence of single NBI, multiple NBI and WBI increasing the data rate from 10Mbps to 125 Mbps in CM1-CM4 UWB channel models. The modified TR-UWB AcR receiver is able to mitigate single NBI and multiple NBI interference efficiently for data rates 10 Mbps, 12.5 Mbps and at a high data rate of 125Mbps.
However, suppression of wideband interference becomes difficult as indicated by almost flat BER floor, which is more prominent in NLOS CM3 and CM4 channel model case where ISI is prevalent.

6. CONCLUSION

Interference mitigation from UWB to other system by using Eigenvalue decomposition pulse design technique has some advantages such as the pulses meets FCC spectral mask, occupies a short duration and easy to implement. TR-UWB system performance is studied extensively in the presence of a strong NBI and WBI interference. Interference from TR-UWB is reduced by the energy in overlapping bands by using multicarrier based transmission pulses. Spectral density of the transmitted UWB signal around the interfering band is reduced than the peak. From the study of interference effects in TR-UWB system using AWGN channel model it is concluded that conventional AcR receiver cannot suppress NBI where as the modified AcR receiver is able to mitigate by notch filtering the signal at the front-end of TR-UWB. BER performance level is closer to the theoretical TR-UWB system. Robustness of modified one is further verified by introducing multiple NBI and wideband interferences to the UWB channel.

At low data rate of 10 Mbps system performance is better as the effect of ISI is negligible. At high data rate of 125 Mbps ISI affects the system and degrades the performance. Hence we can conclude that the modified receiver suppress the interference up to 125 Mbps data rate. As NBI suppression can be done at so high data rate, thus it can be concluded that this robust TR-UWB system provides very good technical solution to be used as UWB PHY layer for short-range high data-rate wireless applications as it can sufficiently coexist with other narrowband and wideband wireless systems. Further, the techniques adopted are very simple from design aspect.

Figure 27: Suppression of Interference using different data rate for CM4 channel model
REFERENCES


Authors’ Short Biographies

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A Comparative Study of Consistency Theorems in Distributed Databases

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ABSTRACT

Maintaining consistency in distributed databases requires a user or database administrator’s advanced expectation and preparation for failure nodes during the database operation. Though ensuring consistency in a database enhances and ensures database integrity, this integrity could only be easily achieved in centralized databases. Distributed databases require different mechanisms, theorems and trade-offs to guarantee that consistency can be ensured. This paper discusses and compared several developed theorems which either implements enforced consistency, ensures high-availability consistency or even demonstrates eventual consistency in distributed databases. It describes how several properties of distributed systems are chosen over another in a well-fashioned manner in database designs to maintain consistency in a distributed database.

Keywords: Consistency; Latency; Partition-tolerance; distributed database; CAP; PACELC

In centralized databases, one primary record is maintained because the data is stored in a single location and this makes the data very accurate and highly consistent unlike in distributed databases where the data is stored in multiple locations as such maintaining consistency in all locations will require more complexity. For a distributed database management system, to ensure data consistency across database fragments in the Distributed Databases Management System (DDBMS) and to encourage simultaneous data access, complex mechanisms are required and careful planning on how to partition a database and where to locate the database fragments can help ensure the performance and consistency of a distributed database.

2. CONSISTENCY THEOREMS

There are different theorems designed by developers in the quest for building distributed database systems which will provide maximum performance, maintain consistency and meet the scalability requirements of distributed architectures. This paper discusses details on these theorems to ascertain how they affect the choice of designing distributed database systems.

2.1 CAP Theorem

In a Symposium held on Distributed Computing, [10], [12], proposed a conjecture that “no distributed system can simultaneously provide consistency, availability and partition tolerance. This was later confirmed by [13] as a theorem. The properties gave rise to the acronym CAP (Consistency, Availability, and Partition Tolerance):
a. Consistency
For the nodes of a distributed system to show consistency, all the nodes must show a consistent view of data, meaning the same results is yielded as the system assures that operations have an atomic characteristic and changes are disseminated simultaneously to all nodes [11]. This makes all database clients to see the same data, even with concurrent updates.

b. Availability
The availability property ensures that the database clients can access at any time part of the data. The system must always at the end, process every request, even when failure occurs. This must be true for both read and write operations. This theorem has been confirmed by [11], [13] for unbounded, eventual responses.

c. Partition Tolerance
This property shows that the system continues to operate despite arbitrary message loss. A partition is an arbitrary split between nodes of a system, resulting in complete message loss in between [11].

2.1.2 CAP Architectures
CAP basically states that in building Distributed Database Systems, designers can choose two of three desirable properties: consistency (C), availability (A), and partition tolerance (P). Therefore only three architectures are possible: only CA systems (consistent and highly available, but not partition tolerant), CP systems (consistent and partition-tolerant, but not highly available), and AP systems (highly available and partition-tolerant, but not consistent) are possible [6].

Figure 1 describes the CAP Theorem:

i. Consistent and Available (CA) Systems
The systems grouped in this architecture ensures that the service of availability and consistency is provided but partitions are not tolerated. When partitions occur, the systems will become inconsistent. The combination is also known as high-availability consistency. Most of the traditional relational database management systems use this approach. To achieve high-availability consistency, replication mechanism is important as transaction protocols such as the two-phase commit (2PC) protocol are applied to ensure consistency. The separation into partitions may lead to so-called “split brain” scenarios, in which different partitions, create conflicting replicas as a result of isolation. The system can only recover from such scenarios by using some kind of consensus protocol. This in turn would disallow nodes to service requests unless a consensus is available. We would thus convert our CA approach into a CP approach at the sacrifice of availability. For larger distributed database systems, the CA approach is less suitable because of the shortcomings encountered [11].

ii. Consistent and Partition Tolerant (CP) Systems
The combination of consistency and partition tolerant properties provides a strong consistent service in distributed systems. In the presence of a partition, consistency is guaranteed, though if some nodes are temporarily unreachable, it will cause the nodes of a partition not to respond to requests, till an agreement is reached by all. This causes availability not to be always provided. The combination of these properties is also known as enforced consistency [11]. In situations where distributed systems needs to be designed and consistency maintained at all costs, the CP approach is the best, for instance in a banking application, where the balance of all accounts is a primary constraint. This model has been found to be implemented in relational database systems. Supporting consistent states even in case of network errors requires the usage of sophisticated algorithms for quorum and majority decisions. Such a protocol for solving consensus is the Paxos protocol [6].

iii. Available and Partition Tolerant (AP) Systems
The AP approach in distributed systems allows availability and tolerates partitions, though this may cause a node to be temporarily inconsistent. The combination of these properties results in eventual consistency [11]. Eventual consistency is a model for database consistency in which updates to the database will propagate through the system so that all data copies will be consistent eventually. A well designed distributed system might not appear robust and stable especially when this approach shows that consistency has been sacrificed for availability and partition tolerance, though many applications can favour availability at all costs and tolerate deferred consistency properties. In this case, it is important to keep in mind potential issues due to eventual consistent data on application level during development. Examples of systems that follow this approach are the DNS (Domain Name Systems) or web caches. Stale data (e.g. host mappings respectively cached responses) are acceptable for a
while, but eventually the latest version of the data disseminates and flushes older entries [11].

2.2 PACELC Model

The CAP theorem has gained serious criticisms with the rise of the NoSQL (often interpreted as Not only SQL) movement and the increasing interest in eventually consistent data stores. A central issue of the CAP theorem results from the simplifying error model that only targets network failures. It is especially the premature dropping of consistency as the answer to network errors that is raised to question by members of the database community such as Stonebraker [12].

Other fall-shorts of the CAP theorem as mentioned by [3] include the asymmetry of availability and consistency and the generalizing trade-off between consistency and availability. These disadvantages becomes obvious when regarding systems in the absence of partitions. A better way of portraying the space of potential consistency tradeoffs for DDBSs can be achieved by rewriting CAP as PACELC (Partition Availability Consistency Else Latency/Consistency): if there is a partition (P), how does the system trade off availability and consistency (A and C); else (E), when the system is running normally in the absence of partitions, how does the system trade off latency (L) and consistency (C)? As a consequence, systems can now be categorized more precisely [6].

As an example, eventually consistent systems (AP in terms of CAP) can be split up into PA/EL or PA/CL systems, yielding more details on their regular operational mode in the absence of partitions. Note that the latency/consistency tradeoff (ELC) only applies to systems that replicate data. Otherwise, the system suffers from availability issues upon any type of failure or overloaded node. Because such issues are just instances of extreme latency, the latency part of the ELC tradeoff can incorporate the choice of whether or not to replicate data.

2.2.1 PACELC Architectures

PACELC systems can be subdivided into different types depending on which of the properties the database systems focuses on.

i. Partition-occurs maintain Availability Else Latency (PA/EL) systems

In this type of systems, if a partition occurs, they give up consistency for availability, and under normal operation they give up consistency for lower latency. Giving up both Cs (Consistency) in the PACELC architecture makes the design simpler; once a system is configured to handle inconsistencies, it makes sense to give up consistency for both availability and lower latency. This can be observed in the default versions of these databases namely Amazon’s Dynamo, Facebook’s Cassandra, and Riak databases [9], [10]. These systems employ eventual consistency as is seen in AP systems of the CAP theorem.

ii. Partition-occurs maintain Consistency Else Consistency (PC/EC) systems

These types of systems will refuse to give up consistency, and will pay the availability and latency costs to achieve the consistency in its database. It can be found in databases with full ACID (Atomicity, Consistency, Isolation, Durability) properties. These database systems include VoltDB/H-Store, MegaStore, BigTable and Hbase.

iii. Partition-occurs maintain Consistency Else Latency (PC/EL) systems

This system cannot be said to be fully consistent, but it can be rather said that the system does not reduce consistency beyond the consistency level when a network partition occurs, instead it reduces availability. This can be seen in the PNUTS database built by Yahoo. The PACELC system can be seen as shown in Figure 2.

![Figure 2: PACELC Model](image)

3. RECOMMENDATIONS

Building and adopting a consistency model that will deliver stronger consistency guarantees will be very vital because there are applications that need to justify the responses they provide to users, such as medical systems that monitor patients and control devices, security systems. This calls for more research.
In as much as these models in some cases implement eventual consistency, full consistency becomes a necessary property in the development of sensitive systems because they cannot at some point base their results on stale or incorrect data.

4. CONCLUSION

It was clearly observed that consistency, availability, and partition tolerance cannot be guaranteed at the same time for a distributed system. In building distributed database systems, the trade-offs considered are so complex that neither CAP nor PACECLC can explain them all. It is important to state that bringing in the consistency/latency tradeoffs into the modern design of Distributed Database System Design becomes relevant to building a more robust distributed database systems, and unifying CAP and PACECLC into a single formulation can lead to a deeper understanding of modern Distributed Database System designs.

REFERENCES


Authors’ Briefs

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An Exploratory Study of the Risks and Motivating Factors of ICT Abuse among Students of Tertiary Institutions in Nigeria

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ABSTRACT

This research explores the risk and motivating factors of ICT abuse among students in tertiary institutions within the context of a developing country. This study is a preliminary investigation undertaken to explore the prevalence of a relatively new phenomenon among college students in the south-western part of Nigeria; Internet use that interferes with social or academic functioning. The study shows that small group of students, primarily student who do not notice that use of internet could lead to abuse, use the Internet to the degree that it has a negative impact on their academic or social lives.

Keywords: ICT, internet, risk, students, tertiary institutions

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

Information and communication technologies (particularly Computers and the Internet) are widely acknowledged as important resources for socio-economic advancement in both developed and developing countries. Information Communication Technology (ICT) is the processing, maintenance and integration of information, and the use of all forms of computer, communication, network and mobile technologies to mediate information. Communication technologies include all media employed in transmitting audio, video, data or multimedia such as cable, satellite, fibre optics, wireless (radio, infra-red, bluetooth, Wifi). Network technologies include personal area networks (PAN), campus area network (CAN), intranets, extranets, LANs, WANs, MANs and the internet [19].

Complete Internet access at the tertiary institutions provides students the opportunity to take care of their academic needs such as download of relevant materials for their course of study, payment of bills, checking for the latest news on the institution websites and possibly communicating with friends and family around the world. As a result, students’ misuse of the Internet for other use such gaming, pornography, entertainment and the like has been labelled as Internet abuse. It is a kind of internet use that interferes with social or academic functioning. Internet usage and access in the World has been proliferating year by year, with approximately 1.11 billion users in 2007, 1.67 billion in 2009, and 1.97 billion in 2010 [16], indicating an upward trend in the number of digitally literate people. The rapid growth has been interacted with people’s needs and motivation. Information, communication, and entertainment have been the prominent motives behind the use of powerful tool called Internet.

The World Wide Web (WWW) became available in Nigeria in 1996, while full Internet services became available in 1998, and number of NCC (Nigerian Communications Commission) licensed Internet service Providers rose to over 150 by 2001. With an estimated total population of over 140 million people, Nigeria is the most populated black nation in the world, with Internet hosts as low as 1,094. In late 2003, Nigeria had a total of 750,000 Internet users and 60 users per 10,000 inhabitants representing 0.5 percent of the population. Nigeria had a total of 853,000 PC’s and 0.71 pc’s per 100 inhabitants as at 2003. The history of the Internet has long been linked to university education. This is because the adoption of the Internet in Tertiary system has intensified access to information and communication by providing unreserved access to e-mail messages, web boards, online services, e-publication and so on.

The internet has leveraged itself as a mainstream Information and Communication Technology (ICT) tool in the academic environment. The internet has transformed how academic activities are being carried out by providing teachers and students a ubiquitous one step access to e-textbooks, publications, online distance learning, real time admission process automation and communication facilitation. However, there is always a positive and negative side of every phenomenon, the concept of Internet abuse has not been empirically researched in Nigeria. Therefore, the purpose of this exploratory study was to investigate if motivating factors of Internet use could lead students to become abuser and to identify the risks involved by this misuse. This will encourage college administrators and student affairs personnel, particularly those involved with mental health issues, to be aware of the types of problems that can arise from excessive use of the Internet.
2. RESEARCH QUESTIONS AND HYPOTHESES

This study aims to address the following research questions and the hypotheses.

RQ1: What is the overall profile of tertiary institutions students with respect to internet and computer use?

RQ2: Does usage of internet differ in terms of gender and age?

H2A: Male student are more likely to be susceptible to Internet abuse than Female student.

H2B: Young students are more prone to internet abuse than old students.

RQ3: What are the motivating factors for the misuse of internet?

H3A: Free and unlimited Internet access is a significant predictor of Internet abuse among Nigerian tertiary institution students.

RQ4: Having the motivating factors in place, what are the risks pose to the internet abusers?

H4A: Students who abuse the internet will present a poorer academic performance than standard Internet users.

H4B: student who are standard internet users develop good relationship than student that abuse it.

H4C: internet abuse student suffers health risk than non-abuse student.

3. BACKGROUND STUDY

Internet abuse is the most studied negative impact on information and communication technological. According to [22], internet abuse may better be conceptualized as an impulse-control disorder but the question still remains, is Internet abuse a distinct disorder? The evidence thus far indicates that a small percent of people develop problems from their use of the Internet. This does not, however, necessarily support that Internet abuse is a distinct disorder. The association between disturbed use of the Internet and other pathologies such as depression, loneliness, and social anxiety suggests that Internet abuse may be symptomatic of other disorders for some.

Rather than focus on a unified concept of Internet abuse, it may be more helpful to conceptualize and study disturbed patterns separately according to specific Internet activities [17]. Indeed, the misuse of internet services can involve different forms of related dependence behaviours, such as an abuse of social networks (such as facebook, twitter etc), cybersex, online gambling (e.g. casino), [1]. Internet abuse has been linked with some psychological variables, such as anxiety [2], shyness, social withdrawal [25] attention deficit/ hyperactivity disorder [4], dissociation [6], and insecure attachment styles [15].

The advantages of the Internet are undeniable despite the rapid flow of information and potential educational value of the Internet; there are several attributes of the Internet which may foster abuse among students in tertiary institutions in Nigeria. These attributes include easy and flexible access 24 hours a day; anonymity; provision of free, diversified, and unlimited number of social networks without geographical boundaries; greater control over one's self-presentation; and provision of numerous opportunities to fulfill the need for belongingness as well as to escape from emotional difficulties, problematic situations, and personal hardships. Technological abuse has its root in the assumption that new technologies contain inducing and reinforcing features which may contribute to the promotion of abusive tendencies. Indeed, research has demonstrated that some people are more likely to be involved in a problematic use of information and communication technologies, such as internet [27] or mobile phones [21].

The same gender gap between male and female has been noticed with Internet Abuse. [18] reported that male students were more likely than female students to be pathological users (12% vs. 3%), whereas female students were more likely than male students to have no symptoms (28% vs. 26%) or have limited symptoms (69% vs. 61%) of behavioural pathology. [20] reported that dependent Internet users included a significantly larger proportion of male to female (71% male and 29% female, respectively) than non-dependent users (50% male and female). Thus, these studies, and several more, demonstrate that at least male tertiary institution students are more prone to Internet Abuse.
The reasons for male predominance in Internet Abuse have been proposed to be overuse of pornography sites, dating sites online gambling and online gaming abuse. [22] give a satisfactory explanation supporting the view that pornographic sites lead to more frequent Internet Abuse: A study on gender differences in sexual arousal found that male tends to be more visual with respect to sexual fantasies while females are more process or verbally oriented. As the cost of bandwidths decreased drastically in recent years, the Internet has become more abundant with graphical information.

[18] measured pathological Internet use, including a new question on the extent to which academic obligations suffered due to the result of Internet usage; they found that 27.3% of students with pathological Internet use had missed classes because of online activities. [13] evaluated Internet dependency in a sample of 542 university students and found that 9% of the participants classified themselves as being psychologically dependent on the Internet, and also identified themselves as having trouble with schoolwork, missing class time, and having a sense of guilt and lack of control over their Internet use. Internet dependent students seem to be more likely to damage their academic careers due to excessive usage.

The results support greater use of the Internet by dependent users and increased probability for them to skip class [20]. [3] conducted an online survey on 49,609 students from 156 universities in Asia. They defined heavy Internet users as those who used the Internet over 33.9 hours per week and those under this threshold as non-heavy users. Differences in academic grades and learning satisfaction between heavy and non-heavy Internet users were statistically significant. Non-heavy users had better grades and greater learning satisfaction than heavy users. The data suggested that student who spends a significant amount of time online, experience academic and learning difficulties.

The two risks factors of Internet Abuse that cause poor academic attendance, are the maladaptive cognitions related to Internet addiction (shyness, depression, low self-esteem) [5], as well as the physical element of time loss. Internet addicted users spend excessive amounts of time in front of their systems. Moreover, these abnormal patterns of use cause lack of sleep because the student stays awake during late night hours in order to browse different web pages. This lack of sleep causes a lack of concentration and loss of interest in everyday lectures leading to reduced reading of course material and, consequently, poor marks during the exam period [14]. [5] suggests that free and unlimited access is a necessary contributory cause for the subject to develop pathological Internet use, which is similar to internet abuse. Research has shown that access to Internet differ among each student. Some students prefer to access the Internet from home, while others prefer to go outside of their home to places such as the school library or an Internet café. Additionally, it has been proven that the location for accessing the Internet has many times been associated with the development of Internet abuse [26]. Places where Internet access is unlimited or free, where there is no guardian or parental supervision increase there is high possibility for a subject to remain on the Internet. As mentioned above, tertiary institution students are most prone to this, because in their hostel or in the campus, free and unlimited access to the Internet is available with no parental supervision, enabling them to use it without restriction.

4. RESEARCH METHODOLOGY

This exploratory study was conducted in tertiary institutions in the south western part of Nigeria. Survey questionnaires were designed and administered directly to a total of 206 students who are in Colleges of Education, polytechnics and Universities. The questionnaires were administered specifically to students who were currently on campus. A total of 206 questionnaires were administered to the students. Out of the 206 students who received the questionnaires, only 200 students (97.7per cent) returned the completed and valid questionnaires. The questionnaires was designed specifically to explore the abuse of the internet, including the risk and the motivating factors. The questionnaires consisted of 3 sections of questions, section A deals with the demographic information of the respondents, section B consists of the motivating factors that leads to internet abuse and lastly section C involves the risk factors that students would experience from abusing the internet. Owing to the relatively small sample size and the exploratory nature of this study, we advise that the results presented in this paper should be treated cautiously as preliminary. We require a larger sample to arrive at more comprehensive conclusions.

5. DATA ANALYSIS AND RESULTS

The questionnaires were initially coded in order to quantify the items. Next, all the data were entered to Statistical Package for the Social Sciences (SPSS 17). Then, they were subjected to frequency and percentage analyses in order to check for possible errors made during the data entrance. This also helped to describe the variables. Finally, a series of one–way between–groups analysis of variance (ANOVA) to determine which hypothesis will be accepted or rejected.

5.1 The relationship between internet usage patterns and Internet abuse

Similar ANOVA tests were repeated to determine whether Internet abuse significantly differed across the levels of Internet usage patterns. Table 1 summarizes the results of ANOVA analyses.
Table 1: The Result of Anova Analysis

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Academic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>1.811</td>
<td>3</td>
<td>.604</td>
<td>.567</td>
<td>.637</td>
</tr>
<tr>
<td>Within Groups</td>
<td>205.409</td>
<td>193</td>
<td>1.064</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>207.219</td>
<td>196</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Health</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.566</td>
<td>3</td>
<td>.855</td>
<td>1.254</td>
<td>.292</td>
</tr>
<tr>
<td>Within Groups</td>
<td>129.635</td>
<td>190</td>
<td>.682</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>132.201</td>
<td>193</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AGE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>1.530</td>
<td>3</td>
<td>.510</td>
<td>2.316</td>
<td>.077</td>
</tr>
<tr>
<td>Within Groups</td>
<td>43.375</td>
<td>197</td>
<td>.220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>44.905</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GENDER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.394</td>
<td>3</td>
<td>.798</td>
<td>3.285</td>
<td>.022</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48.978</td>
<td>200</td>
<td>.243</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50.980</td>
<td>203</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monetary Cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>20.733</td>
<td>3</td>
<td>6.911</td>
<td>8.446</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>159.568</td>
<td>195</td>
<td>.818</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>180.302</td>
<td>198</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 shows one-way between-groups ANOVA results for the test of hypothesis to be rejected or accepted. From the result in the table: we will accept our hypothesis if the level of significance is above 0.05 and reject if it is below. It indicated that our first hypothesis is false (Male students are not likely to be susceptible to Internet abuse than Female student) the value of the level of significance from our statistical table is 0.022. The result shows that our first hypothesis to be false. From the table of the ANOVA, there is a value of 0.637 for level of significance which will allow us to accept the second hypothesis that ’Students who abuse the internet will present a poorer academic performance than students who don’t’. Accepting this hypothesis also validates the outcomes of other researches conducted to support this hypothesis. There was no significant difference to associate that ‘Free and unlimited Internet access as a significant predictor of Internet abuse among Nigerian tertiary institution students’. It demonstrates from the result of the analysis in the table above, that free and unlimited access will not increase the tendency of the students to become internet dependent.

The fourth hypothesis will be accepted because with a level of significance value of 0.077 which is greater than our level of significance of 0.05 indicates the acceptance of this hypothesis from the analysis of variance. The result reveals to us that ‘young students will have a higher tendency to become internet abuser than older students in the higher institution’. Based on the result obtained from the ANOVA table, there is a clear indication that ‘Students who abuses the Internet will suffer health risk than students who do not abuse the Internet’ then we will accept this hypothesis having a higher value of 0.292 which is far above our level of significance of 0.05.

5.2 Correlations between the Risk and Motivating factors
The table 2 is used to determine if there is any correlation between the motivating factors (Physical motivating factors and Emotional motivating factors) and the risk that could occur in academics, psychological, health, social and moral. The correlations between the Motivating factors and the Risks factors is displayed in a tabular form in table 3, only factors with level of significance higher than 0.05 will indicate there is a correlation between the factors: for easy understanding and to know which of this factors are correlated to each other.
Table 2: Correlation between Motivating Factors and Risk Factor

<table>
<thead>
<tr>
<th></th>
<th>Physical motivating factors</th>
<th>Emotional motivating factors</th>
<th>Academic</th>
<th>Psychological</th>
<th>Social</th>
<th>Health</th>
<th>Moral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Motivating</td>
<td>Pearson Correlation</td>
<td>-0.052</td>
<td>0.090</td>
<td>-0.084</td>
<td>-0.107</td>
<td>0.029</td>
<td>-0.149</td>
</tr>
<tr>
<td>factors</td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.494</td>
<td>0.226</td>
<td>0.269</td>
<td>0.155</td>
<td>0.698</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>184</td>
<td>178</td>
<td>181</td>
<td>174</td>
<td>177</td>
<td>179</td>
</tr>
<tr>
<td>Emotional Motivating</td>
<td>Pearson Correlation</td>
<td>-0.052</td>
<td>1</td>
<td>0.016</td>
<td>0.253</td>
<td>0.264</td>
<td>0.049</td>
</tr>
<tr>
<td>factors</td>
<td>Sig. (2-tailed)</td>
<td>0.494</td>
<td>0.822</td>
<td>0.000</td>
<td>0.000</td>
<td>0.507</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>178</td>
<td>195</td>
<td>194</td>
<td>187</td>
<td>187</td>
<td>188</td>
</tr>
<tr>
<td>Academic</td>
<td>Pearson Correlation</td>
<td>0.090</td>
<td>0.016</td>
<td>1</td>
<td>0.275</td>
<td>0.241</td>
<td>0.179</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.226</td>
<td>0.822</td>
<td>0.000</td>
<td>0.001</td>
<td>0.013</td>
<td>0.024</td>
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<tr>
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<td>190</td>
<td>191</td>
</tr>
<tr>
<td>Psychological</td>
<td>Pearson Correlation</td>
<td>-0.084</td>
<td>0.253**</td>
<td>0.275**</td>
<td>1</td>
<td>0.615</td>
<td>0.292</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.269</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
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<td>174</td>
<td>187</td>
<td>189</td>
<td>192</td>
<td>186</td>
<td>185</td>
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<tr>
<td>Social</td>
<td>Pearson Correlation</td>
<td>-0.107</td>
<td>0.264**</td>
<td>0.241**</td>
<td>0.615</td>
<td>1</td>
<td>0.354</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.155</td>
<td>0.000</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>177</td>
<td>187</td>
<td>190</td>
<td>186</td>
<td>193</td>
<td>186</td>
</tr>
<tr>
<td>Health</td>
<td>Pearson Correlation</td>
<td>0.029</td>
<td>0.049</td>
<td>0.179**</td>
<td>0.292</td>
<td>0.354</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.698</td>
<td>0.507</td>
<td>0.013</td>
<td>0.000</td>
<td>0.000</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>N</td>
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<td>188</td>
<td>191</td>
<td>185</td>
<td>186</td>
<td>194</td>
</tr>
<tr>
<td>Moral</td>
<td>Pearson Correlation</td>
<td>-0.149</td>
<td>0.142</td>
<td>0.162**</td>
<td>0.307</td>
<td>0.326</td>
<td>0.215</td>
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<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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<td>0.050</td>
<td>0.024</td>
<td>0.000</td>
<td>0.000</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>180</td>
<td>190</td>
<td>193</td>
<td>187</td>
<td>188</td>
<td>191</td>
</tr>
</tbody>
</table>
Table 3: Summary of Correlations between the Risk and the Motivating Factors

<table>
<thead>
<tr>
<th>No Correlation</th>
<th>Correlation Exist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical and Emotional motivating factors</td>
<td>Physical motivating factor and Academic risk</td>
</tr>
<tr>
<td>Physical motivating factor and Psychological risks</td>
<td>Emotional motivating factors and Academic risks</td>
</tr>
<tr>
<td>Physical motivating factor and Social risks</td>
<td>Emotional motivating factors and Psychological risks</td>
</tr>
<tr>
<td>Physical motivating factor and Health risks</td>
<td>Emotional motivating factors and Social risks</td>
</tr>
<tr>
<td>Physical motivating factor and Moral risks</td>
<td>Emotional motivating factors and Health risks</td>
</tr>
</tbody>
</table>

5.3 Descriptive Analysis of Internet Usage Pattern

Table 4 presents Internet usage patterns and their categories with respective percentages. In terms of the frequency of use, about (6.4%) used the Internet in the morning, about ten percent (9.3%) used it in the afternoon, more than a quarter used it in the evening (35.8%), with above a quarter also used it also in the night (36.3%), less than ten percent (6.9%) and about five percent (5.4%) used it overnight. More than a quarter of the users (37.4%) reported “home”, thirty-three percent (33.0%) reported “cybercafés,” and about one quarter of the proportion (26.1%) reported “school” as their dominant place of Internet use.

Moreover, a tiny proportion (3.5%) specified other places that included workplace, library, and others. When asked about the purpose for which they mostly use the Internet, 20.89%, 17.98%, 16.66%, 13.49%, 8.20%, 6.34% indicated Chatting, Social networking, Browse or surf the Internet, Looking for news, Email and Listen or download music respectively. The remaining, of about 16.38 percent, reported using the Internet for these purposes (Blog, Watch movies or TV online, Play computer games online, Internet shopping or selling and hacking).

Table 4: Descriptive Analysis

<table>
<thead>
<tr>
<th>Pattern / category</th>
<th>Frequency (f)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period of Internet use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>13</td>
<td>6.4</td>
</tr>
<tr>
<td>Afternoon</td>
<td>19</td>
<td>9.3</td>
</tr>
<tr>
<td>Evening</td>
<td>73</td>
<td>35.8</td>
</tr>
<tr>
<td>Night</td>
<td>74</td>
<td>36.3</td>
</tr>
<tr>
<td>Late night / early morning</td>
<td>14</td>
<td>6.9</td>
</tr>
<tr>
<td>Over – night</td>
<td>11</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>206</td>
<td>100.0</td>
</tr>
<tr>
<td>Dominant place of Internet use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyber café</td>
<td>67</td>
<td>33.0</td>
</tr>
<tr>
<td>School</td>
<td>53</td>
<td>26.1</td>
</tr>
<tr>
<td>Home</td>
<td>76</td>
<td>37.4</td>
</tr>
<tr>
<td>Work</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>Library</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>203</td>
<td>100.0</td>
</tr>
<tr>
<td>Dominant purpose of internet use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td>31</td>
<td>8.20</td>
</tr>
<tr>
<td>Chatting</td>
<td>79</td>
<td>20.89</td>
</tr>
<tr>
<td>Browse or surf the Internet</td>
<td>63</td>
<td>16.66</td>
</tr>
<tr>
<td>Blog</td>
<td>14</td>
<td>3.70</td>
</tr>
<tr>
<td>Use Social network sites</td>
<td>68</td>
<td>17.98</td>
</tr>
<tr>
<td>Watch movies or TV online</td>
<td>12</td>
<td>3.17</td>
</tr>
<tr>
<td>Play computer games online</td>
<td>18</td>
<td>4.76</td>
</tr>
<tr>
<td>Listen to or download music</td>
<td>24</td>
<td>6.34</td>
</tr>
<tr>
<td>Looking for news</td>
<td>51</td>
<td>13.49</td>
</tr>
<tr>
<td>Internet shopping or selling</td>
<td>8</td>
<td>2.11</td>
</tr>
<tr>
<td>Hacking</td>
<td>10</td>
<td>2.64</td>
</tr>
<tr>
<td>Total</td>
<td>378</td>
<td>100.0</td>
</tr>
</tbody>
</table>
5.4 Impact of Excessive Internet use on Academic, Social or General Lifestyle

We used five Likert-type scale to explore how Internet use might result in academic, social, or lifestyle problems in answer to the second research question. Previous research has shown that college students often underestimate the effect of their Internet use. We anticipated, therefore, that respondents might be reluctant or unable to give an accurate portrayal of how their Internet use affected various aspects of their lives. Thus, it may be more informative to compare relative differences; that is, the difference between those who use the Internet for longer periods of time compared with those who use the Internet infrequently.

If students have underreported Internet use, it seems probable that the differences between high and low user would be more likely to provide some information about the nature of this effect. For this analysis, we divided the Internet users into high-use and low-use groups. We defined high use as spending more than 300 minutes per day on the internet. Roughly 12% of the responding internet users indicated that they spent more than 300 minutes per day online. To assess the effects of Internet use in five areas (academic achievement, psychological, social, health, and moral), we used linear regression. Surprisingly, only one area is affected and that is psychological. There is no distinguished difference between high-use and low-use group. The respondent did indicate that they felt much negative effect in all areas because of their Internet use, the high-use group did report more negative consequences than the low use group did.

Table 5: Results of Effects of internet Use on academic achievement, psychological, social, health, and moral

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.278</td>
<td>.439</td>
<td>7.462</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Academic</td>
<td>.025</td>
<td>.067</td>
<td>.029</td>
</tr>
<tr>
<td></td>
<td>psychological</td>
<td>-.295</td>
<td>.127</td>
<td>-.220</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>.053</td>
<td>.116</td>
<td>.045</td>
</tr>
<tr>
<td></td>
<td>Health</td>
<td>-.021</td>
<td>.091</td>
<td>-.019</td>
</tr>
<tr>
<td></td>
<td>Moral</td>
<td>-.109</td>
<td>.094</td>
<td>-.092</td>
</tr>
</tbody>
</table>

a. Dependent Variable: amount of time you stay online

Coefficients
6. DISCUSSION

While those who use the internet excessively are difficult to identify (self-report of the problem appears to be rare), it is important to note that this problem occurs primarily among men and particularly in the hard science majors. However, as the use of Internet in both academic and non-academic venues continues to expand, it seems likely that the problem will continue to grow. It has been suggested that problems related to excessive Internet use stem from two primary sources: easy availability and a developmental vulnerability of the population. It seems obvious that methods for dealing with this problem should address the central causes; however, it is likely that developing effective developmental interventions may prove difficult.

Many students prefer to deal with problems as they occur instead of opting for preventive developmental interventions. One possible solution may be the use of programmatic interventions that focus on the developmental difficulties that influence excessive Internet usage. These programs may be most useful at institutions that have a high percentage of students in the hard science majors. Another suggested solution would be to monitor and or restrict Internet use. While this solution might seem counter-productive to computer systems administrators, increasing their awareness of the problem might provide some motivation for encouraging them to develop strategies that may help resolve this problem.

For example, instead of monitoring the direction or purpose of an individual’s Internet use, it may be more effective to develop a countdown timer that tracks the amount of time spent on-line. If each Internet account was structured so that it functioned as a debit system, those who use the Internet for excessive amounts of time would be using their allotted time more quickly and then perhaps flagged for further evaluation or inspection. While some system administrators might view this as an infringement of a student’s right to system access, this may be preferable to letting the dependent student go unnoticed.

It is clear that this problem has, until now, received relatively little research attention. As more research on the topic is done, it is hoped that more effective solutions and suggestions will be realized.

7. CONCLUSION

Very little data has been collected with regard to patterns of Internet use among college students. It is hoped that this preliminary study will encourage college administrators and student affairs professionals, particularly those involved with mental health issues, to become more aware of the types of problems that can arise from excessive use of the Internet. However, one limitation of this study must be considered. Given that this survey was administered around campuses, it may be that other students that are abusing the internet were not around campus at the time to take the survey. Therefore, it is possible that this survey is an underrepresentation of the extreme users - those students who are so consumed that they rarely leave their room or move around easily.

Since Internet use is often encouraged, or even promoted as a valued feature of academic institutions, it seems reasonable to assume that finding methods to deal with this problem will require multiple levels of intervention.
REFERENCES


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CC3000 Wifi Base Configuration Of Gateway For Internet Accessibility in Monitoring Variables Via Wireless Sensor Systems

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ABSTRACT

CC3000 WiFi base configuration of gateway for Internet access in monitoring variables via Wireless sensor systems tends to develop interconnection of various interface for physical parameters to be sent to internet, this work developed an interface based on the CC3000 WIFI Shield. The setup is made up of Sensor, ADC, Processor WIFI Shield and the gateway. Physical Parameter are collected and converted to digital electrical signal, processed and sent to the WIFI Shield which converts them to radio waves using Orthogonal Frequency Division Multiplexing (OFDM). To transmit to the internet the service set identifier SSID and Password of the gateway is provided, the SSID was included in the source code to enable connection to the gateway. This was accomplished by running various test like Scan test, Ping test, connection test, web Client test smart Configuration and self-connection test In summary this work developed a platform for data transfer. This application has the ability to retrieve sensed data directly from a wireless sensor system composed of sensors ADC WIFI and gateway.

Keywords: Wi-Fi, gateway, Sensor SSID WPA. Keywords: ICT, internet, risk, students, tertiary institutions

1. INTRODUCTION

Various parameters can be monitored, which include temperature, energy, tank levels, speed or just controlling switches, this wireless remote monitoring solution puts you informed and control in a matter of seconds. Heretofore, wireless monitoring was only possible outdoor using satellite and terrestrial networks. Indoor monitoring however, was stressful for these system owing to problems of multipath, signal impairment and so on, therefore the need for a system that can serve as a supporting network for accurate monitoring became necessary.. Wireless Sensor Systems are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location, this Location could be indoor or outdoor. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. Recent advances in wireless communications and micro electro-mechanical systems have motivated the development of extremely small, low-cost sensors that possess sensing, signal processing and wireless[2] communication capabilities. Hundreds and thousands of these inexpensive sensors work together to build a Wireless Sensor System, which can be used to collect useful information (i.e. temperature, humidity) from a variety of environment.

The collected data must be transmitted to remote base station (BS) for further processing. Wireless Sensor Systems (WSSs) have been used in many application domains such as habitat monitoring [1], infrastructure protection [1], and scientific exploration [2]. Smart environments represent the next evolutionary development step in building, utilities, industrial, home, shipboard, and transportation systems automation. Like any sentient organism, the smart environment relies first and foremost on sensory data from the real world. Sensory data comes from multiple sensors of different modalities in distributed locations.

Wireless Sensor Systems generally consist of a data acquisition network and a data distribution network, monitored and controlled by a management centre. The sensor node can measure data from any physical system and send it, usually via radio transmitter, to a command centre or sink node, either using a single hop or multiple hops operation. The data traverses through a number of data concentration devices (or gateways) and networks until it gets to its destination.[6] In order to improve viewership, this work goes beyond the present convention of having to arrange a set-up within a local area by providing an interface between a local area and the internet called the gateway. Such a setup might not be flexible and robust to meet up with the current demand.
This work, implements the stage which provide the interface that will connect to the web. This interface between the Local Area Network LAN and Wide Area Network WAN is called the Gateway. The gateway makes it possible for data to be sent to the internet which can be viewed via web-based application.

2. WEB-BASED APPLICATION

A Web-based application refers to any program that is accessed over a network connection using HTTP, rather than existing within a device’s memory. Web-based applications often run inside a Web browser. However, Web-based applications also may be client-based, where a small part of the program is downloaded to a user’s desktop, but processing is done over the Internet on an external server.[9] There is a lot of confusion created by the use of terms like Web-based, Internet-based and cloud-based when referring to applications. Web-based applications actually encompass all the applications that communicate with the user via HTTP. This includes light applications like Flash games, online calculators, calendars, and so on, as well as more intensive applications that use HTTP.

3. GATEWAY

An internet gateway essentially means a system that is acting as a router for other devices on the network to receive internet access.

- A gateway may contain devices such as protocol translators, impedance matching devices, rate converters, fault isolators, or signal translators as necessary to provide system interoperability. It also requires the establishment of mutually acceptable administrative procedures between both networks.
- A protocol translation/mapping gateway interconnects networks with different network protocol technologies by performing the required protocol conversions.
- Loosely, a computer or computer program configured to perform the tasks of a gateway. For a specific case, see default gateway.

Gateways, also called protocol converters, can operate at any network layer. The activities of a gateway are more complex than that of the router or switch as it communicates using more than one protocol.

4. MODEM

The Origin of Modems

The word “modem” is a contraction of the words modulator-demodulator. A modem is typically used to send digital data over a phone line. The sending modem modulates the data into a signal that is compatible with the phone line, and the receiving modem demodulates the signal back into digital data. Wireless modems convert digital data into radio signals and back.

Figure 1 Setup of a MODEM[8]

Modems came into existence in the 1960s as a way to allow terminals to connect to computers over the phone lines. When a modem first makes a connection, you will hear screeching sounds coming from the modem. These are digital signals coming from the computer to which you are connecting being modulated into audible sounds. The modem sends a higher-pitched tone to represent the digit 1 and a lower-pitched tone to represent the digit 0 as shown in figure 1 and 2.

Figure 2 Working Principle of MODEM[10]

Communication between LAN and WAN is shown in figure 3 and figure 4, which is made possible by the gateway. A number of variables can be measured via sensor for onward conditioning via the Analog to Digital Converter (ADC) then to the Processor, unlike other setup where GPRS is used as gateway which rather appear as being too slow. This work adopts the use of Wifi Shield that has higher data delivery rate..
5. WIFI SHIELD

The Arduino WiFi shield allows an Arduino board to connect to the internet using the WiFi library and read and write an SD card using the SD library. The WiFi Library is included with the most recent version of the Arduino IDE. The firmware for the WiFi shield has changed in Arduino IDE. The firmware for the WiFi shield has changed in Arduino IDE.

It is strongly recommended to install this update per these instructions. The WiFi library is similar to the Ethernet library and many of the function calls are the same. To use the shield, mount it on top of an Arduino board (e.g., the Uno). To upload sketches to the board, connect it to your computer with a USB cable as usual. Once the sketch has been uploaded, one can disconnect the board from the computer and power it with an external power supply. Digital pin 7 is used as a handshake pin between the WiFi shield with the block diagram in figure 5 and the Arduino, and should not be used.

6. SMARTCONFIG

SmartConfig is the special functionality in the CC3000 that allows setting the SSID and password settings without having to type or re-program the module. Any iOS/Android device can be used to set the configuration—solving the annoying deployment problem of how to set the connection details for a new device.

7. SMARTCONFIGCREATE AND SMARTCONFIGRECONNECT

These two SmartConfig sketches should be used together to demonstrate how the SmartConfig app was used on the smartphone to pass connection details to the CC3000.

8. SMARTCONFIGCREATE

This sketch will initialise the CC3000, erasing any previous connection details stored on the device. It will then enter SmartConfig mode with a 60 second timeout where it waits for configuration data to arrive from the Smart Phone.

If a connection was successfully established, the connection details will be stored in the non-volatile memory of the CC3000, and the module will be configured to automatically reconnect to this network on startup (meaning no need to run the SmartConfig app unless the AP details change or one erase the stored connection details on the module).
There won’t be need to edit the sketch to add the SSID and password - the SmartConfig app does that.

9. SMART CONFIG RECONNECT

This sketch shows the process involved of using CC3000 in 'reconnect' mode, and avoid erasing all stored connection profiles, which is unfortunately necessary with other sketches where manual config data is provided.

- Initialize the CC3000 with a special SmartConfig flag so it doesn't erase the profile data
- Access Point connection (based on saved AP details)
- DHCP address assignment
- Disconnect

Using the SmartConfigCreate Sketch

Step One: Install the SmartConfig App
Before one can use SmartConfig to provide an AP connection details, there is need to install the SmartConfig app:

Step Two: Configure the SmartConfig App on your Phone
Once installed the SmartConfig app, connect to the AP that the CC3000 will be using (HOMENETWORK) as shown in figure 6 and then load the app. Figure 6 shows the device configuration with the AP's SSID, Gateway IP Address and Device Name fields already populated:

The code on the Arduino will send messages back to your computer over the USB connection and these are visible in the Arduino Serial Monitor. Open the Serial Monitor by clicking on the icon at the top right of the Arduino window. This resets the Arduino and allows you to see the messages.

Serial Monitor not opening?
Make sure you’ve got the same Serial Port you used to Upload the code. You can selected it in Tools→Serial Port. After a few seconds you should see— reset --- BERGCloud: Connecting to WiFi network... BERGCloud: Using SmartConfig BERGCloud: CC3000 firmware version 1.28 BERGCloud: CC3000 MAC address XX:XX:XX:XX:XX:XX In place of the Xs you should see the CC3000's MAC Address. Your CC3000 firmware version may also be different. Leave the Serial Monitor open so you can check the progress of the Smart Config.

10. OPEN THE TI SMART CONFIG APP ON IOS DEVICE

The iOS device will need to be connected to the network you would like your device to join. It will set the SSID to the network name automatically. In this case it's "Test 2.4GHz".
Enter your Wi-Fi Password [ 3 ]
This will be shown as plain text.

Press start to attempt configuration
The button will change colour to red in figure 8

Check if configuration is complete
On completion the button with change back to blue.

--- reset ---
BERGCloudCC3000 version: 203
BERGCloud: Connecting to WiFi network...
BERGCloud: Using SmartConfig.
BERGCloud: CC3000 firmware version 1.28
BERGCloud: CC3000 MAC address XX:XX:XX:XX:XX
BERGCloud: Waiting for DHCP...
BERGCloud: IP address: XX.XX.XX.XXX
BERGCloud: Netmask: XXX.XXX.XXX.0
BERGCloud: Gateway: XX.XX.XX.X
BERGCloud: DHCP server: XX.XX.XX.X
BERGCloud: DNS server: XX.XX.XX.X
BERGCloud: Looking up host: bridge.bergcloud.com
BERGCloud: Host IP address: 46.137.83.12
Waiting...
Connecting took 21 seconds.
That's all for this example.

Now a connection to WiFi is established
Not secure enough?
Because of the way Smart Config transmits the data between the phone and the CC3000 one may want to encrypt the config data using a pre-shared key set in the app and in your Arduino code.

Define a pre-shared key in your Arduino code
To set up Smart Config with a pre-shared key it can either open and upload the File→Examples→BergCloudCC3000→Smart_Config_With_Key example or modify the Smart_Config code you should already have open.
If you want to modify your Arduino code, find the line
If you want to modify your Arduino code, find the line
#define WLAN_SMARTCONFIG_KEY          NULL
and replace it with
#define LAN_SMARTCONFIG_KEY  "1234567abcdefgh"
The key can be set to any 16 characters. But it must be exactly 16 characters.
Upload the code and open the Serial Monitor as you did in steps 4 and 5.

Set the key in the Smart Config app
After opening the Smart Config app set the Password and enter the pre-shared key abcdedfghijklmnop in the Key field and press Done. Make sure you enter all 16 characters.

Enable the key
Touch the small circle to the right of the Key to use it.
Figure 10  Set the key in the Smart Config app

Figure 11 Enable the key

The circle will become a tick and if your key is 16 characters long you will be able to press the blue Start button to begin the Smart Config process as in figure 11.

Configure the CC3000
Press the Start button, it will turn red and become blue when it's complete as shown in figure 12.

Figure 12 Configure the CC3000

You can check the state of your device in the Serial Monitor, just like in step 9.
**The connection will be established again**
That's all this example code will do.

11. TEST RESULTS
The CC3000 was interfaced with an ArduinoMega 2560 and the following test were carried out
- Board Test
- Scan Test
- Ping test
- Connection test
- Web client test
- Smart configuration and Fast connect test

11.1 Board Test
The board test was carried out purposely to show that the CC3000 wifi shield is working. That is to test its workability. The test result is shown in figure 13.

Figure 13 Board test of the CC3000 wifi shield
One major function of the wifi module is its ability to identify and detect networks within its surrounding. These networks could be open or closed irrespective of their security implementation or protocols.

11.2 Scan Test
These tests were carried out in order for the wifi module to scan or search and display available networks within a confined environment.

The CC3000 WIFI shield scans its environment for available networks irrespective of the security levels and display on the serial monitor the properties of that network which includes the name or SSID of the network, the MAC address of the network, the RSSI port number and the security mode either WPA2, WPA or unsecured network.

11.3 Connection Test
Aside scanning a network, one major ability of the WIFI module is to connect to that network. This can only be achieved if the WIFI shield has all the necessary credentials to connect to the network access point as in figure 15.

![Figure 15 Connection test](image)

![Figure 14 Scan test](image)

![Figure 16 Arduino code for CC3000 connection test](image)
The credentials required for these connection includes the network’s SSID and the Password access only if the network is a secured network. The information include the MAC Address of the chip, assigned IP address, IP addresses of the DHCP Server, DNS Server, Default Gateway and the SSID of the network.

PING TEST
Ping is a network troubleshooting tools used to verify communication between two different hosts in the same network (intranet) or outside the network (Internet). It send an echo message to check if the host if reachable or not. This test is very important as it assure us that our wifi chips can communicate with a server from different network as in figure 17.

After a connection is achieved, the cc3000 through the access point can ping an IP address or web server and as well as transmit packets and receive packets too. This is only possible when a connection is established between the wifi shield and the access point.

11.4 Web Client Test
Having established a connection the Wi-Fi shield is capable of pinging a web address in figure 18 and retrieving information about the web address as shown in figure 19. The web address in this case is example.com after establishing a connection.

Figure 17 Ping test

PING TEST

Figure: 18 Web client test source code

Figure 19 web client test result
12 CONCLUSION

Establishes the interface between the physical world and the web, the work succeeded in developing an interconnection of various stages, and a compatibility was accomplished by running various test like Scan test, Ping test, connection test, web Client test smart Configuration and self-connection test. The success of this test shows that the configuration of all the various stages brought about interconnection between all the stages, thereby making data transfer possible

REFERENCES


Framework for the Development of An Optimized Solution for Quality of Service Delivery Using Fuzzy Logic and Genetic Algorithm

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ABSTRACT

Selection of Web Services is one of the most important steps in the application of different types of Web Services such as Web Service composition systems and the Universal Description, Discovery, and Integration (UDDI) registries. The more available these Web Services are on the Internet, the wider the number of these services whose functions match the various service requests. Therefore, selection of services to suit the users’ requirements has become an important, challenging and time consuming problem. Selecting Web Services with optimized solution largely depends on the Quality of Service (QoS) since it plays a significant role in selecting such services. The selection process based on QoS allows the user to specify their requirements not only based on functional attributes but also on non-functional attributes. The framework for an optimal system that will provide an optimal improvement using fuzzy and genetic algorithm during the selection process is proposed. Our architecture carries out the process of selecting an optimized solution stored or contained in the QoS database (KB). It is expected that its implementation will improve the selection process and optimize Quality of Service delivery in Web Services scenarios.

Keywords: Optimized Solution, Quality of Service QoS, Fuzzy Logic, Genetic Algorithm and Databases

1. INTRODUCTION

Over the years, internet computing like most other areas of computer science has witnessed momentous developments. Most of these developments have been triggered by the increase in the complexity of software. Software complexity has given rise to new paradigms and among these new technologies are the Service Oriented Architecture (SOA) and Service Oriented Computing (SOC). According to Rotem-Gal-Oz [9] Service Oriented Architecture is an architectural style for building systems based on interacting coarse-grained autonomous components called services. Each service exposes processes and behavior through contracts, which are composed of messages at discoverable addresses. It therefore implies that the major pillar of the Service Oriented Architecture (SOA) is a Service. Web Services are interfaces that describe a collection of operations that are network-accessible through standardized web protocols. The word service is used interchangeably with web service since services are being deployed on the web. A service according to [4] provides a specific function, typically a business function, such as booking a flight, analyzing an individual’s credit history or processing a purchase order. A service can provide a single discrete function, such as converting one type of currency into another, or it can perform a set of related business functions, such as handling the various operations in an airline reservations system.

Web services are fast becoming a defacto for the implementation and deployment of applications that model both user and organizational needs. Service Oriented Computing on the other hand is seen as an emerging discipline promoting science, research, and technology, which are related to web services [3] [6]. The emergence of the Service Oriented Computing paradigm with its implicit inclusion of web services has caused a precipitous revolution in the platform of software engineering, web based selection and composition of web services, cloud computing, grid computing among others. Service computing has brought about a shift in the focus of application providers from the traditional approach of either building in-house applications or buying applications from vendors to the web approach. The major motivation and also rapid adoption of the Service Oriented Computing paradigm has been identified by Rosenberg [8] as the fact that businesses offer their application functionality as services over the internet in order to enable other companies or users to integrate and compose these business services into their applications. It is actually of economic significance when a person or organization can have access to a web service, pay for it and use it to achieve business goals.
Apart from the economic significance of using and deploying web services, several other reasons that have motivated the migration towards Service Oriented Computing and the consequent use of Service Oriented Architecture include the following: the need to integrate legacy systems into new applications, reusability of web services, scalability, flexibility and operational convenience.

2. WEB SERVICES

Web services are emerging technology that enables different applications running on different machines to exchange data. Using web service technology, an application can be implemented by web service composition by composing existing individual web services in accordance with the business process of the application. This means the application is provided to customers in the form of a value added composite web service. The long term goal of web service technology is to enable distributed applications that can be actively assembled via web service composition in accordance to changing business needs. When discussing web service technology, Quality of Service is a significant concern, as it is a critical factor which directly determines the success or failure of a web based application. An important and challenging issue of web service selection is how to deliver Quality of Service requirements. This includes user focused elements such as response time, execution cost, availability, reliability and reputation as well as how to find an optimized solution for the Quality of Service delivery. This in turn best fulfills users’ expectations and achieves their satisfaction.

2.1 Service Oriented Architecture

Service Oriented Architecture can be better understood when web services are understood. Ouzzani [5] describes a web service as a piece of software that can be defined, described and discovered by eXtended Markup Language (XML) artifacts. A core concise definition of a web service is given by W3C to be a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine process able format (specifically WSDL, which stands for Web Service Description Language). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using Hyper Text Transfer Protocol (HTTP) with an eXtensible Markup Language (XML) serialization in conjunction with other Web-related standards. Figure 2.4 illustrates the various technologies involved with web services. Web Services are interfaces that describe a collection of operations that are network-accessible through standardized web protocols. When a required operation is not found, several services can be combined to get a composite service that performs the desired task. [7].

Fig. 1: A web service illustrating needed technologies [1],

Information flow between the various actors in a web service is illustrated in figure 2.5. The flow is simple; a service provider advertises his services on the repository which can either be the UDDI or is referenced in the UDDI. A client finds the needed web service based on published functionalities on the UDDI through a service provider. Sometimes, a particular service does not meet the client’s needs, that is, when the client needs to compose several services. The client accesses and uses the service through the service provider.
2.2 A Review of the Existing Systems

The number of parameters is one of the main concerns for fuzzy systems, especially when it is desired to increase the number of inputs and rules, since for the standard fuzzy system the number of parameters increases exponentially when the numbers of inputs or rules are increased, and computational complexity increases accordingly.

A detailed and in depth analysis of existing systems are reviewed in order to determine the gap to be filled, we reviewed the following:

(i) The fuzzy approach build or model decisions based on the rules stored or contained in the knowledge base (KB) for service selection process. Therefore, decision is based on information or data. In most real-world settings, decision-relevant information is incomplete, uncertain and imprecise.

(ii) The number of rules increases exponentially as the number of system variables, upon which the fuzzy rules are based, is increased.

2.3 Limitations in the Existing Systems

Fuzzy systems are rule based systems (knowledge based systems). The rule base of a fuzzy system is composed of fuzzy IF-THEN rules that are similar to the rules used by humans in their reasoning.

The under listed are the drawback and limitation in the existing systems:

(i) it is hard to obtain optimal fuzzy set due due to the number of generated rules as the number of system variables are increased,

(ii) the fuzzy set doesn't have learning capability, it depends on a pre-defined set of rules which depends on the numbers of inputs that are to be processed, and

(iii) the problem of defining the rule base:

(iv) redundant rules: whose actions are covered by other rules

(v) wrong rules: badly defined, thereby upsetting the system performance, and

(vi) conflicting rules: worsens the system performance when co-existing with other rules in the RB (rule base).

These limitations make the system performance less efficient and effective due to fact that the service selection results always contain:

a. Irrelevant and unjustified QoS values
b. Non-existing web services and
c. Wrong and inconsistent QoS values

Hence, the system performance is poor and unacceptable. These limitations is the central driving force behind the design of a more efficient and effective system where two techniques are combined in a manner that overcomes the limitations.

2.4 Research Gap

A typical scenario to be used in illustrating the problem of Quality of Service based Selection of Web Services is drawn from the academic community attend a conference planner. This is the case of a user who plans to attend an international conference.

The user needs to carry out several tasks which would naturally include:

i. Getting advert information for the conference,

ii. Registering for the conference either through the bank or by a cashless transfer procedure,

iii. Booking a flight for the conference and

iv. Making hotel reservations and

v. The need for car rental services.

From the illustration just given, it is obvious that one service cannot fulfill the needs of this conference attendee. The need for web service composition arises when a single web service cannot meet the desires of a web service user. This is applicable both for an individual user and for business to business and enterprise level application integration; composition of web services plays an important role.
Also suppose a large number of user web services with different criteria, such as, reputation, reliability, availability, cost and response time are available for every service component, the task of Quality of Service based service composition is to select the optimal user services for each of them.

An important and challenging issue of web service selection is how to meet Quality of Service requirements. This includes user focused attributes such as reputation, reliability, availability, cost and response time as well as how to provide optimal solution for Quality of Service results for the composites. This in turn best fulfills users’ expectations and achieves their satisfaction. The objective of the web service selection is to maximize the Quality of Service values. Selected web service should have high reputation, reliability and availability whereas the cost and response time should be less. Therefore, the problem addressed in this work is to find an optimized solution for service selection bearing in mind the satisfaction of the user’s Quality of Service.

3. RESEARCH DIRECTION

The aim of this study is to develop an efficient and effective system that will help users select services with respect to their preference and QoS-based optimization using fuzzy and genetic algorithm. A service design environment that is an integral part of the entire optimization and selection process will then be enabled.

3.1 The Quality of Service Model

There are many measures available for different QoS criteria; however, we consider the following five generic quality criteria for services (QoS parameters): reliability, availability, reputation, execution duration, and execution price. The QoS model that we propose is composed of five criteria as parameters for the quality model: reliability, availability, reputation, execution duration, and execution price. Each one is presented below and a difference is made between the QoS of single service and the composition.

**Reliability**
The quality of reliability is a measure of the service invocation trustworthiness. It is defined as the ratio between the numbers of service invocations that comply with the negotiated QoS over the total number of service invocations.

**Availability**
The quality of availability of a web service is the probability that the service operation is accessible. This is defined by the proportion of the service’s uptime and downtime. The quality of availability is the probability that the service can be accessed and used. It means that this quality is obtained by the number of times the service answers a request divided by the number of total requests.

**Reputation**
The reputation quality is the measure of its trustworthiness. It depends on the user’s experience using the service. Different end users can have different opinions about the same service. Reputation can be defined as the average ranking given to the service by end users [10]

**Execution Duration**
The execution duration measures the execution time between the moment the request is sent and the moment the results are received. It is defined as the fee to be paid to the service provider by the service requester for executing a particular service. The cost is always associated with the value of the service functionality, i.e. the more complex the function it provides, the higher the service price cost.

**Execution Price**
The Execution Price is the amount that a service requester needs to pay for executing a service [10] [11] [12].

**Fuzzy System**
A basic generalized layout of a fuzzy system unit can be seen in figure 2.16 which comprises four principal components: fuzzification, knowledge base, inference engine, and defuzzification.

3.2 Fuzzification

It means converting a crisp value of process variable into a fuzzy set. In order to make it compatible with the fuzzy set representation of the process state variable. Fuzzification interface also involves the following functions:

1. Measures the value of input variables,
2. Performs a scale mapping that transfers the range of values of input variables into corresponding universes of discourse,
3. Performs the function of fuzzification that converts input data into suitable linguistic values which may be viewed as labels of fuzzy sets.
3.3 Genetic Algorithms

The motivation for using genetic algorithms for the design of the algorithm employed in this work is due to the intractability of the mathematical model used in the problem addressed in this work. Before giving a review of methods that have been used by several authors for web service compositions and optimizations, a brief description of some important concepts surrounding genetic algorithms is given.

The choice of genetic algorithm for solving the problem described in this work was motivated by the fact that finding all the compositions for all service combinations of web services is a NP hard problem. Genetic algorithms are a heuristic method based on survival of the fittest. Genetic algorithms were invented by John Holland in the 1960s and were developed by Holland and his students and colleagues at the University of Michigan in the 1960s and the 1970s. Holland’s genetic algorithm is a method for moving from one population of chromosomes to a new population by using a kind of “natural selection” together with genetic inspired operators which include crossover, selection, and mutation.

According to him some of the advantages of genetic algorithms include the following:

i. Genetic algorithms optimize with continuous or discrete variables.

ii. They do not require derivative information.

iii. They can carry out simultaneously searches from a wide sampling of the cost surface.

iv. They have the capacity to deal with a large number of variables.

v. They are well suited for parallel computers.

vi. They optimize variables with extremely complex cost surfaces and can jump out of a local minimum.

vii. They have the capability of providing a list of optimum solutions, not just a single solution.

viii. They encode the variables so that the optimization is done with the encoded variables.

ix. Genetic algorithms work with numerically generated data, experimental data, or analytical functions.
These advantages are intriguing and produce stunning results when traditional optimization approaches fail. However, genetic algorithms are not a fix-it-all method. For optimization problems with few variables, straightforward cost function and small search spaces, traditional optimization approaches still outperform genetic algorithms [2].

Fig. 4: Flowchart for Genetic Algorithm
4. SYSTEM ARCHITECTURES

4.1 Existing Systems Architecture

![Diagram of Existing Architecture](image)

**Fig. 5: Existing Architecture of the web service selection by Priya et al. (2014)**

4.2 Analysis of Existing System

i. The user input vague request to Fuzzy Service Discovery module to find the list of services that are available in the registry.

ii. The registry will return the collection of service description to fuzzy service selection.

iii. The returned service may be available or not available to the user (which depends on the service provider).

iv. If the services are not available, because of the user preference matching the service and on seeing the service down, the user gets dissatisfied.

v. The user move to next preference matching the services.

vi. This process is time consuming and results in more cost and poor response time.
4.3 The Proposed System Architecture/Framework
Several researchers have applied fuzzy approach for Quality of Service based web service selection and composition. But they did not use any optimization technique to find an optimized solution to the problem. In this work, the key point is to employ genetic algorithm (GA) in modulating, improving and optimizing the fuzzy system to find an optimized solution. Our Proposed System Exhibits two (2) important characteristics or uniqueness :-

i. Fuzzy System:-
   Model user preference and the desired QoS parameters of the service with fuzzy approach (IF-THEN rules).

ii. GA System:-

Optimized the control structure or decisions-making and search for an optimized solution (best rules) to the given problem. Find an optimized solution-best service to the user’s preference during the selection process.
3.5.1 Proposed System Design

The proposed architecture for the web service selection must be remodeled to meet the user’s request. The composition of QoS properties is done with the help of fuzzy rule and fitness function based service selection. Figure 7 shows the proposed system architecture of the optimized web service selection:

i. End user gives vague request (query relevant services) to the Fuzzy service selection broker

ii. Fuzzy service selector analyze the given request by passing it to fuzzy inference engine

iii. Fuzzy Inference engine calls the knowledge base and evaluate the QoS criteria’s for the listed service

iv. Genetic Algorithms then optimizes the fuzzy system parameters.

v. Finally, there is optimization of composition unit works based on Genetic Algorithms. Fuzzy rules, which are created based on user request together with user constraints, constitute one fitness function.

vi. GA parameters are defined for the system. QoS criteria’s related to different compositions are evaluated and an optimized solution is selected in accordance with user request and convenience.

4.4 Optimal Improvement

The design of the parameters of a fuzzy system can be analyzed as an optimization problem. To overcome the limitations, genetic algorithm (GA) offer a possibility to solve these problem. Therefore, to overcome the drawbacks and limitations, genetic algorithm (GA) is proposed for designing and optimizing the parameters of the fuzzy system to obtain an optimized solution.

The most important key area to be optimized is the Knowledge Base (KB). The Knowledge Base of a fuzzy system consists of the Rule Base and Data Base.

Rule Base (RB) - a rule base containing a number of fuzzy IF–THEN rules,

Data Base (DB) - a database which defines the membership functions of the fuzzy sets used in the fuzzy rules.
5. CONTRIBUTIONS TO KNOWLEDGE

To draw an accurate, reasonable and reliable conclusion in a fuzzy system, the knowledge base plays an important role and is the heart of the system, “heart – stores all data, information, rules and constraints used by fuzzy inference engine for solving difficult problems or tasks”. Once a fuzzy system is built, we are faced with a large number of parameters which need to be optimized and tuned in order to improve the system performance in terms of the results (conclusions) obtained. The key quality of this study is to achieve and obtain the optimal structure of a fuzzy system. A genetic algorithm (GA) is applied for optimization in a way that it determines fuzzy sets, their shape and their optimal number. Optimizing the entire knowledge base of the fuzzy system has a finer dimensionality and efficiency, and is therefore more likely to contain optimal solution. With these considerations, there is an obvious improvement in the system performance in terms of the results (conclusions) obtained. Therefore in this study, we seek to develop an architectural design for integrating and synthesizing of fuzzy system using a genetic algorithm. This will be able to achieve a trade-off between execution time and the optimized knowledge base thereby improving the system performance in terms of efficiency and good response time which provide the delivery of optimized solution for Quality of Service.

6. FUTURE WORK

In this paper, we presented the several quality of service parameters, existing QoS Models, their challenges/limitations as well as our proposed Architecture for optimal web service selection. The architecture constitutes user, who requests for service available in the registry, pool of service providers in the registry and a system. The system constitutes a broker and a registry. The broker employs a fuzzy and genetic algorithm system based service selection. This fuzzy and genetic algorithm system takes QoS parameter input from the details stored in the registry and finds the weight for each service by composing the QoS parameters. Future work will delve into the implementation procedure for web service selection and results from the implementation and evaluation will be provided. Automated interfaces for web service selection system, based on users’ queries will also be shown.

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Performance Evaluation of Image Edge Detection Techniques in the Domain of Human Computer Interaction

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ABSTRACT

Edge detection is a kind of method of image segmentation based on range non-continuity. Image edge detection is one of the basal contents in the image processing and analysis, and also is a kind of issues which are unable to be resolved completely so far. Detecting edges is very useful in a number of contexts. It plays an important role in digital image processing and practical aspects of our life. This leads to the investigation of various edge detection techniques solved by the use of Time Variation Execution Method. With the comparative analysis, at the execution time, prewitt edge detector performs faster than the others, while canny edge detector produces better edges than the other edge detectors.

Keyword: Edge detection, Image, Prewitt edge detector, Canny edge detector, Time variation execution.

1. INTRODUCTION

Edge detection is a kind of method of image segmentation based on range non-continuity. Image edge detection is one of the basal contents in the image processing and analysis, and issues which are unable to be resolved completely. The separation of the image into object and background is a critical step in image interpretation. When we imitate the human visual system by using computer algorithms, quite a lot of problems can be encountered. When image is acquired, the factors such as the projection, mix, aberrance and noise are produced. These factors bring on image feature is blur, distortion and very difficult to extract image feature. This made it difficult to detect edge. [1][4] Detecting edges is the first step in the image segmentation and very useful in a number of contexts. Edge detection, feature extraction and object recognition heavily rely on the quality of the segmentation. Without a good segmentation algorithm, an object may never be recognizable. However, contours can be correctly reconstructed either by performing edge grouping or boundaries of segmented regions[2][3][6].

2. METHODOLOGY

Formulated Time Variation Execution method (TVEm) used to determine the faster performance of execution time and best image producer between edge detection techniques. TVEm works around differential operators to detect changes in the gradients of the grey levels. The component of differential operators comprises of Noise reduction by smoothing Noise contained in image through the input image I (i, j) with Gaussian filter as given by \( F(i, j) = G*I(i, j) \). [5][7] Finding gradients used to detect the edges where the change in grayscale intensity is maximum. Required areas are determined with the help of gradient of images in i and j directions are given as

\[
D_i = \begin{bmatrix}
-1 & 0 & +1 \\
-2 & 0 & +2 \\
-1 & 0 & +1 \\
\end{bmatrix}
\quad \text{And} \quad D_j = \begin{bmatrix}
+1 & +2 & +1 \\
0 & 0 & 0 \\
-1 & -2 & -1 \\
\end{bmatrix}
\]

With smoothed image and giving gradients in i and j directions,

\[
G_i = D_i * F(i, j) \quad \text{And} \quad G_j = D_j * F(i, j)
\]

Therefore edge strength of gradient of a pixel is given by:

\[
G = \sqrt{G_i^2 + G_j^2}
\]

The direction of gradient is given by:

\[
\theta = \arctan\left(\frac{G_j}{G_i}\right)
\]

Non maximum suppressions is carried out to preserve all local maxima in the gradient image, and deleting everything else this results in thin edges. For a pixel M (i, j) work round the gradient direction in the nearest 45°, then compare the gradient magnitude of the pixels in positive and negative gradient directions. If gradient direction is east then compare with gradient of the pixels in east and west directions say E (i, j) and W (i, j) respectively [9][8].
But, if the edge strength of pixel \( M(i, j) \) is larger than that of \( E(i, j) \) and \( W(i, j) \), then preserve the value of gradient and mark \( M(i, j) \) as edge pixel, if not then suppress or remove. Hysteresis Thresholding is the output of non-maxima suppression that still contains the local maxima created by noise. [11][13] A pixel \( M(i, j) \) having gradient strength \( G \), following conditions exists to detect pixel as edge: If \( G < \) than \( t \)-low discard the edge, If \( G > \) than \( t \)-high keep the edge. If none of pixel \( (x, y) \)’s neighbours have high gradient strength but at least one falls between \( t \)-low and \( t \)-high search the 5 × 5 region to see if any of these pixels have a strength greater than \( t \)-high. If so, keep the edge or Else, discard the edge.[10][14]

3. EDGE DETECTION CODES

function varargout = Edge_Detection_Techniques(varargin)
% EDGE_DETECTION_TECHNIQUES M-file for Edge_Detection_Techniques.fig
% EDGE_DETECTION_TECHNIQUES, by itself, creates a new EDGE_DETECTION_TECHNIQUES or raises the existing
% singleton*.
% %
% H = EDGE_DETECTION_TECHNIQUES returns the handle to a new EDGE_DETECTION_TECHNIQUES or the handle
to
% the existing singleton*.
% %
% EDGE_DETECTION_TECHNIQUES('CALLBACK',hObject,eventData,handles,...) calls the local
% function named CALLBACK in EDGE_DETECTION_TECHNIQUES.M with the given input arguments.
% %
% EDGE_DETECTION_TECHNIQUES('Property','Value',...) creates a new EDGE_DETECTION_TECHNIQUES or raises
% the
% existing singleton*. Starting from the left, property value pairs are
% applied to the GUI before Edge_Detection_Techniques_OpeningFcn gets called. An
% unrecognized property name or invalid value makes property application
% stop. All inputs are passed to Edge_Detection_Techniques_OpeningFcn via varargin.
% %
% *See GUI Options on GUIDE's Tools menu. Choose "GUI allows only one
% instance to run (singleton)".
% %
% See also: GUIDE, GUIDATA, GUIHANDLES
% %
% Edit the above text to modify the response to help Edge_Detection_Techniques
% %
% Last Modified by GUIDE v2.5 25-May-2012 10:52:11
% %
% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name', mfilename, ...
    'gui_Singleton', gui_Singleton, ...
    'gui_OpeningFcn', @Edge_Detection_Techniques_OpeningFcn, ...
    'gui_OutputFcn', @Edge_Detection_Techniques_OutputFcn, ...
    'gui_LayoutFcn', {}, ...
    'gui_Callback', {});
if nargin && ischar(varargin{1})
gui_State(gui_Callback) = str2func(varargin{1});
end

if nargout
    [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT
% --- Executes just before Edge_Detection_Techniques is made visible.
function Edge_Detection_Techniques_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.

% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to Edge_Detection_Techniques (see VARARGIN)

% Choose default command line output for Edge_Detection_Techniques
handles.output = hObject;

% Update handles structure
guidata(hObject, handles);

% UIWAIT makes Edge_Detection_Techniques wait for user response (see UIRESUME)
% uiwait(handles.figure1);

% --- Outputs from this function are returned to the command line.
function varargout = Edge_Detection_Techniques_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;

% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

global Tstimg
w=cd;
cd(strcat(w,'FingerprintDB'))
[Filename PathName]=uigetfile('*.jpg;*.bmp;*.tif','Select an Image');
if Filename~=0
Tstimg=[PathName,Filename];
set(handles.text2,'string','Tstimg')
axes(handles.axes1)
imshow(Tstimg)
else
msgbox('Select a Fingerprint')
set(handles.text2,'string',"")
end

% cd(strcat(w,'\FingerprintDB'))
[Filename PathName]=uigetfile('*.jpg;*.bmp;*.tif','Select an Image');
% cd(w)
if Filename~=0
Tstimg=[PathName,Filename];
set(handles.text2,'string',Tstimg)
axes(handles.axes1)
imshow(Tstimg)
else
msgbox('Select a Fingerprint')
set(handles.text2,'string',"")
end

% --- Executes on button press in pushbutton2.
function pushbutton2_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
img1 = getimage(handles.axes1);
img2 = rgb2gray(img1);
axes(handles.axes1);
imshow(img2)

% --- Executes on button press in pushbutton3.

function pushbutton3_Callback(hObject, eventdata, handles)
    % hObject    handle to pushbutton3 (see GCBO)
    % eventdata  reserved - to be defined in a future version of MATLAB
    % handles    structure with handles and user data (see GUIDATA)
    global Tstimg edgeopt
    rgbimg = imread(Tstimg);
    figure, imshow(rgbimg), title('original image')
    img2 = rgbimg;
    tic
    h = fspecial('laplacian');
    filteredimg = imfilter(img2, h);
    h2 = fspecial('gaussian');
    smothenedimg = imfilter(rgbimg, h2);
    level = graythresh(smothenedimg);
    BW1 = im2bw(rgbimg, level);
    switch edgeopt
        case 'Prewitt'
            %if edgeopt=='Prewitt'
            edgeimg = edge(BW1, 'prewitt');
            type = 'Prewitt Method';
            timehandles = handles.textp;
            case 'Sobel'
            %elseif edgeopt=='Sobel'
            edgeimg = edge(BW1, 'sobel');
            type = 'Sobel Method';
            timehandles = handles.texts;
            case 'Canny'
            %elseif edgeopt=='Canny'
            edgeimg = edge(BW1, 'canny');
            type = 'Canny Method';
            timehandles = handles.textc;
        end
    Eelapsed = toc;
    axes(handles.axes3)
    imshow(edgeimg)

    set(timehandles, 'string', Eelapsed)
    BW3comp = ones(size(BW1)) - BW3;
    BW4comp = ones(size(BW1)) - edgeimg;
    figure(1), imshow(smothenedimg), title('smothened image')
    figure(2), imshow(filteredimg), title('Filterd image')
    figure(3), imshow(BW1), title('Binary masking of the image')
    figure(4), imshow(edgeimg), title(type)
4. RESULTS

Edge detection methods investigated so far are further assessed by quality measures that give reliable statistical evidence to distinguish among the edges obtained. The absence of the ground true edge reveals the search for an alternative approach to assess and compare the quality of the edges resulted from the detectors exploited so far.

The execution time for an image was documented for six months and the result were shown in the tables 1 and 2. The total averaged report for the execution time generated between April and September, 2014. The performance of the various edge detection techniques as shown in Fig. 1.

Table 1: EVALUATED TABLE from April to September, 2014

<table>
<thead>
<tr>
<th>MONTHS</th>
<th>PREWITT</th>
<th>SOBEL</th>
<th>CANNY</th>
</tr>
</thead>
<tbody>
<tr>
<td>APRIL</td>
<td>27.63</td>
<td>29.54</td>
<td>80.43</td>
</tr>
<tr>
<td>MAY</td>
<td>28.21</td>
<td>30.02</td>
<td>81.80</td>
</tr>
<tr>
<td>JUNE</td>
<td>28.31</td>
<td>30.02</td>
<td>81.80</td>
</tr>
<tr>
<td>JULY</td>
<td>27.16</td>
<td>29.54</td>
<td>83.12</td>
</tr>
<tr>
<td>AUGUST</td>
<td>28.76</td>
<td>30.22</td>
<td>85.25</td>
</tr>
<tr>
<td>SEPTEMBER</td>
<td>28.65</td>
<td>30.02</td>
<td>82.82</td>
</tr>
</tbody>
</table>
The total execution time shown in Table 1 is used to derive the performance level of the best edge detection technique. The average total execution time shown in Table 2 with the corresponding graph plotted in Fig. 1.

<table>
<thead>
<tr>
<th>EDGE TECHNIQUES</th>
<th>PREWITT</th>
<th>SOBEL</th>
<th>CANNY</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE TOTAL TIME</td>
<td>31.89</td>
<td>33.87</td>
<td>99.98</td>
</tr>
</tbody>
</table>

When compared the performance level and shortest execution time of edge detection techniques, Prewitt and Sobel showed the broken edges at some junctions. Though Prewitt worked faster than Sobel and Canny did, their results were of average quality compared to the Canny detectors. The Canny operator can detect the complete, continuous and detailed edges, but it also smoothenhs some edges in the smoothening process. Based on the speed, the canny is slowest operator in the particular application. The Sobel and Prewitt operators are similar based on the speed. The Sobel operators can save most of the high frequency information of the image, but the Prewitt operators only save a little high-frequency information.

**5. CONCLUSION**

This study has provided the best levels of performance and shortest execution time with image of human computer interaction. The study demonstrated that Prewitt edge detector performs faster than the canny and sobel techniques but Canny edge detector gives better result than others with some positive points. It is less sensitive to noise, adaptive in nature, resolved the problem of converting to a grayscale image first, provides good localization and detects sharper edges as compared to others.

**REFERENCES**


