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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. 4, December, 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
Managing Editor
Afr J Comp & ICTs
ABSTRACT

A Theorem Prover is a Computer Program that automates logical reasoning of finding proofs for some mathematical theorems. Examples of such tools are A Computational Logic for Applicative Common Lisp (ACL2) and Prototype Verification System (PVS). The motivation for this paper was the observation that ACL2 tool can prove theorems in first order logic only while PVS tool proves theorems in higher order logic only. The above two tools which are application programs are neither flexible, nor scalable and therefore cannot prove some theorems within their domains. It was also observed that certain theorems exist for which ACL2 and PVS tools could only generate partial proofs. The aim of this paper was therefore to design a single tool that has the ability to generate proofs of some theorems of the two tools. The method used involved carrying out evaluation on the response of each of the tools to theorem problems. In the process, set notations were used. In particular, the tools were defined and represented as sets with their attributes representing members of the set. Integration was then carried out based on direct mapping of the two sets to obtain members of the set of the new tool. Furthermore, an algorithm was developed, and a Delphi Pascal programming language was used to implement the integration of the two tools. The findings showed that the developed tool is able to prove some theorems in set theory, e.g., equivalent set and Cartesian product set and also support proof of some real numbers analysis e.g. Cartesian product and relation equivalent among others. The new tool designed called BT tool is also flexible and scalable.

Keywords: Industrial Tool, Integration, Support, Computational Logic, Application Common Lisp (ACL2) & Prototype Verification System (PVS)

INTEGRATION

Integration describe a link between two tools that enables the strengths of properties of each tools to be deployed smoothly within a single formal development. Integration of formal methods can happen on many levels, including tools, languages, models, notations, methods, and techniques. Tool integration can happen on many levels. Possible choices and related issues are language extension (i.e. embedding): cumbersome, slow and inconvenient. , hard translation: (error prone) .Point-to-point translation (i.e. features of one tool are added to another): does not produce elegant results, but could be acceptable.

Generic frameworks: seems like the best approach to find some commonality between the tools and “glue” them together using this commonality. The information shared as the “glue” must exist in both tools. There are many possible commonalities between the tools, including: tools sharing common language (e.g. VHDL); tools sharing common data; tools having underlying inference systems that can be specified in rewriting logic. Integration of tools ought to share common interface. One approach is to have one tool produce output to be fed into another tool; another would be to be able to call one tool without exciting the other (i.e. have shared data).
The first approach is easier to implement but works more slowly in practice. Formal methods tools can be integrated into the existing “non-formal” toolkits, or can be integrated into separate formal toolkits such as Telelogic Tau toolkit. “Non-formal” toolkits are widely accepted in industry. Theorem provers on the other hand are computer programs that automate the reasoning of finding proofs within a mathematical theory [Woodraw et al, 1985]. Examples of theorem provers are Prototype Verification System (PVS) and A computational Logic for Application Common Lisp (ACL2).

To understand what automated reasoning is, we must first understand what reasoning is. Reasoning is the process of drawing conclusions from facts. These conclusions must follow inevitably from the facts from which they are drawn. In other words, reasoning is not concerned with some conclusions that has a good chance of being true when the facts are true. Indeed, reasoning refers to logical reasoning, not of common-sense reasoning or probabilistic reasoning. The only conclusions that are acceptable are those that follow logically from the supplied facts. Automated reasoning is concerned with the study of using the computer to assist in the part of problem solving that requires reasoning [Wos, 1985]. We can easily see that automated theorem provers are the product of the automated reasoning field. The idea of automated reasoning is not new. Many of the greatest mathematicians and computer scientists of the century had thought of automated reasoning. All the historical information about the development of logic can be found in Martin Davis’ survey article [Davies, 1983].

Leibniz recognized the necessity of three basic elements for automated reasoning: 1) A formal language, 2) Formal rules of inferences, and 3) Knowledge. In the nineteenth century, George Boole developed the propositional calculus which provided a language and a set of inference rules in which much ordinary common-sense reasoning can be expressed. The advantage of this language was that there was a procedure that would determine whether any sentence in the language was true or false in a finite amount of time. Unfortunately, the language of propositional logic is not expressive enough. In 1879, Gottlob Frege expanded the propositional logic to full first-order logic which allows much more complex statements to be expressed and verified. It was David Hilbert in the early 1920’s who initiated a research program in which one of its goals was to discover a systematic procedure that would decide the truth or falsity of any statement in Frege’s first-order logic. Unfortunately, in the 1930’s, Church and Turing, based in Godel’s work, independently discovered that there is no procedure that will decide whether any given statement in first-order logic is true or false [Alonzo, 1995 and Harry et al, 1981]. The decidability of the satisfiability of the first-order logic can be obtained by applying a reduction method to translate the first-order formula to any of the special classes of first-order formulas known for which there exists a procedure to determine the truth value [Alonzo, 1995]. One of these translation or reduce methods is the resolution method proposed by Robinson [Robinson, 1965].

A proof is a structure or sequence of well-formed formulas that can be built using a procedure in a finite amount of time, if each of the well-formed formulas in the sequence is either an axiom or is immediately derived from preceding well-formed formulas in the sequence by means of one of the rules of inference2 [Alonzo, 1995]. If the procedure to build a proof is sound then the existence of a proof implies that the sentence is true. If it is complete then for every true sentence there must be a proof. There are several sound and complete procedures to determine the proof of a given first-order formula, such as sequent calculus and tableaux calculus etc [Melvin, 1983].

1.1 Industrial Uses of Theorem Provers

Commercial use of theorem proving is mostly concentrated in integrated circuit design and verification. e.g since the Pentium FDIV bug, the complicated floating point units of modern microprocessors have been designed with extra scrutiny for removing bugs, and in the latest processors from AMD, Intel, and others, automated theorem proving has been used to verify that division and other operations are correct.

1.2 Theorem Provers of ACL2 and PVS tools

ACL2; (A Computational Logic for Applicative Common Lisp): is the name of a functional programming language based on Common Lisp, a first-order mathematical logic and a mechanical theorem provers. The theorem prover is used to prove theorems in the logic i.e theorems about functions defined in the programming language. ACL2, is sometimes called an “industrial strength version of the Boyer-Moore system,” a product of Kaufmann and Moore, with many early design contributions by Boyer. The ACL2 theorem prover is interactive in the sense that the user is responsible for the strategy used in proofs. But it is automatic in the sense that once started on a problem, it proceeds without human assistance. In the hands of an experienced user, the theorem prover can produce proofs of complicated theorems.

The ACL2 theorem prover is a computer program that takes formulas as input and tries to find mathematical proofs. It uses rewriting, decision procedures, mathematical induction and many other proof techniques to prove theorems in a first-order mathematical theory of recursively defined functions and inductively constructed objects [Alonzo, 1995]. It has been used for a variety of important formal methods projects of industrial and commercial interest, including: Verification that the register-transfer level description of the AMD Athlon processor’s elementary floating point arithmetic circuitry implements the IEEE floating point standard [Russinoff, 1998 and Russinoff et al, 2000]. Similar work has also been done for components of the AMD k5 processor [Moore et al, 1998], the IBM Power 4 [Sawada, 2002] and the AMD Opteron processor. Verification that a micro architectural model of a Motorola digital signal processor (DSP) implements a given microcode engine [Brock et al, 1999] and verification that specific microcode extracted from the ROM implements certain DSP algorithms [Brock et al, 1999], verification that microcode for the Rockwell Collins AAMP7 implements a given security policy.
This has to do with process separation [David et al., 2003], Verification that the JVM bytecode produced by the Sun compiler javac on certain simple Java classes implements the claimed functionality [Moore, 2003] and the verification of properties of importance to the Sun bytecode verifier as described in JSR-139 for J2ME JVMs [Liu et al., 2003]. Verification of the soundness and completeness of a Lisp implementation of a BDD package that has achieved runtime speeds of about 60% those of the CUDD package (however, unlike CUDD, the verified package does not support dynamic variable reordering and is thus more limited in scope) [Sumner, 2000]. Verification of the soundness of a lisp program that checks the proofs produced by the Ivy theorem prover from Argonne National Labs; Ivy proofs may thus be generated by unverified code but confirmed to be proofs by a verified Lisp function [McCune, 2000].

Prototype Verification System (PVS) on the other hand consists of a specification language, a number of predefined theories, a type checker, an interactive theorem prover that supports the use of several decision procedures and a symbolic model checker, various utilities, including a code generator and a random tester, documentation, formalized libraries, and examples that illustrates different methods of using the system in several application areas. It consists of specification language; a number of predefined theories, a theorem prover, of various utilities, documentation and have various examples illustrating deferent methods of using the system in several application areas. (Owre et al., 1996). Typical applications of PVS include the formalization of mathematical concepts and proofs in areas such as analysis, graph theory, and number theory, the embedding of formalisms such as I/O automata, modal and temporal logics, the verification of hardware, sequential and distributed algorithms, and as a back-end verification tool for computer algebra as well as code verification systems.

1.3 Related Works
The claim that the lack of tools is one of the major reasons for the difficulties of incorporating formal methods in industry is a misconception and a myth (Bowen and Hinchey, 1995). The actual reason is the lack of adequate, powerful, user friendly strength tools that will aid the application of formal methods to industry and allow them to be fully integrated with existing methods (Butler, 2001). The importance of providing means for connecting with external tools has been widely recognized in the theorem proving community. Some early ideas for connecting different theorem provers are discussed in a proposal for the so-called “interface logics” [Guttman, 1991], with the goal to connect automated reasoning tools by defining a single logic L such that the logics of the individual tools can be viewed as sub-logics of L. More recently, with the success of model checkers and Boolean satisfiability solvers, there has been significant work connecting such tools with interactive theorem provers. The PVS theorem prover provides connections with several decision procedures such as model checkers and SAT solvers [Rajan et al., 1995 and Shanker, 2001].

The Isabelle theorem prover [Nipkow et al., 2002] uses unverified external tools as oracles for checking formulas as theorems during a proof search; this mechanism has been used to integrate model checkers and arithmetic decision procedures with Isabelle [Muller et al., 1995 and Basin et al., 2000]. Oracles are also used in the HOL family of higher order logic theorem provers [Gordon et al., 1993], for instance, the PROSPER project [Dannis et al., 2000], uses the HOL98 theorem prover-as a uniform and logically-based coordination mechanism, between several verification tools. The most recent incarnation of this family of theorem provers, HOL4, uses an external oracle interface to decide large Boolean formulas through connections to state-of-the-art of Binary Decision Diary (BDD) tool and SAT-solving libraries tool [Gordon, 2002], and also uses oracle interface to connect HOL4 with ACL2. (Meng and Paulson , 2004), interface Isabelle with a resolution theorem prover.

In 1991, Fink et al, described a proof manager called PM [George et al., 1991], that enabled HOL input to be transformed into “first-order assertions suited to the Boyer-Moore prover.” In 1999 Mark Staples implemented a tool called ACL2PII for linking ACL2 and HOL98 [Mark, 1991]. ACL2PII was used by Susanto and Melham [Kong, 2003]. Both PM and ACL2PII provided ways of translating between higher-order logic and first-order logic, when translating from untyped Boyer-Moore logic to typed higher-order logic it can be hard to figure out which types to assign. Staples points out that the ACL2 S-expression NIL might need to be translated to F (Boolean type), or [ ] (list type) or NONE (option type), depending on context. The ACL2PII user has to set up “translation specifications” that are pattern-matching rewrite rules to perform the ACL2-to-HOL translation. These are encoded in ML and are thus not supported by any formal validation. In 2006, Mike Gordon, Warren A. and Matt Kaufmann also integrated HOL and ACL2.  

1.4 Motivation for Integrating ACL2 and PVS Tools
Research showed that ACL2 tool can only prove theorems in first order logic while PVS tool prove theorems in higher order logic only. The above two tools which are also application programs designed to prove some selected theorems are not flexible, not scalable and therefore cannot prove some theorems within their domains. It was also observed that certain theorems exist for which ACL2 and PVS tools could only generate partial solutions, hence a motivation for their integration.
2. MATERIAL AND METHOD

The study worked on existing tools and carried out performance evaluation of the existing theorem provers, case study of ACL2 and PVS tools. The evaluation was carried out based on the response of each of the tools to theorem problems for them to prove. And as a result, a list of attributes of each of the tools was obtained, based on the responses and performance of the provers on selected theorems (problems). Using set notations, the tools are defined and represented as set with their attributes representing members of the set. Integration was carried out based on the direct mapping of the two sets (ACL2 and PVS) to obtain the members of the set of the new tool.

![Diagram of the integration process]

Fig 3.1 Framework for the integration of ACL2 and PVS tools
3.2 Flowchart showing the integration of ACL2 and PVS tools
3.2.1 Functional system design representation

Let $x$ represent a logic theorem (problem). Note that a logic theorem represents the computational problem solvable or provable by theorem provers (ACL2, PVS) under consideration.

Let $x_p(1), x_p(2), x_p(3), x_p(4), x_p(5)$ represent the intrinsic (characteristics) properties of $X$.

Such that, $X = \{ x_p(1), x_p(2), x_p(3), x_p(4), x_p(5)\}$

$X$ is made up of sub-problems

**Challenge**

Derive a single tool (theorem prover) efficient enough to prove $x_p(1), x_p(2), x_p(3), x_p(4), x_p(5)$ at a single evaluation after evaluation of the problem (theorems) using ACL2 and PVS tools

**Observation 1**

With ACL2 theorem prover

$X$ is partially solvable

Assumption

$x_p(1), x_p(2)$ are solvable using ACL2

$x_p(5), x_p(3), x_p(4)$ remain unsolvable after evaluation using ACL2.

**Observation 2**

With PVS theorem prover

$X$ is still partially solvable

Assumption

$x_p(1), x_p(2)$ are unsolvable using PVS

$x_p(3), x_p(4), x_p(5)$ are solvable by PVS

Note that $x_p(5)$ is solvable by both i.e $x_p(5)$ is not a concern of this study.

**TASK:** Integration of functional properties of ACL2 and PVS tools efficient enough to prove all the sub-problem at once.

3.2.2 Mathematical representation of PVS tool using set notation

The attributes of PVS tool are:

- Prove some theorem in set theory (ST) e.g. equivalent set and Cartesian product set.
- Supports prove of some real numbers analysis (RN) e.g. Cartesian product and relation equivalent.
- Supports prove of some quantifier reasoning (QR) e.g. expression translation from logical reasoning to English expressions.
- Some Mathematical concepts formalization proving(MCF) e.g. character case support and Fibonacci support
- Some inductive proof checking (IPC) e.g. principle of mathematical induction, well-typed functions and complex rational analysis.

Let the attributes of PVS tools be represented in terms of set notation

Thus: $PVS = \{ST, RN, QR, MCF, IPC\}$

3.2.2 Algorithmic Design of the proposed integrated tools

1. Start the design
2. Get PVS properties
3. Get ACL2 properties
4. Initialize the properties
5. Map the functional properties of the tools directly
6. Implement tool integration modules
7. Integrate PVS and ACL2 tool
8. Implement the Interface
9. Generate the interface
10. If design tool evaluation is satisfiable goto 11 else goto 2
11. Stop

3.2.3 Mathematical representation of ACL2 using set notation

The attributes of ACL2 tool are:

- Some inductive proof checking (IPC) e.g. principle of mathematical induction, well typed functions and complex rational analysis.
- Some complex rationales support(RCR)
- Some well typed functions support (WTF)

Let the attributes of ACL2 tool be represented in terms of set notations
Thus: ACL2= \{IPC, RCR, WTF\}

3.2.4 Mathematical representation of Integrated Theorem Prover (ITP)
Let ITP tool represent the integration of ACL2 and PVS tools.
In terms of set relation, ACL2 and PVS tool are subset of ITP tool
ACL2 \in ITP
PVS \in ITP
ITP= \{ACL2, PVS\}
ITP= ACL2 \cup PVS
Thus:
ITP = \{ST, RN, QR, MCF, IPC, RCR, WTF\}
It can be said that, the union of the member of the ACL2 and PVS subset are members of the ITP set.

3.2.5 System (pseudocode) design
Class pvs_acl2 (pvs, acl2, bt, pvs_att, acl2_att, bt_att)
begin
    pvs_att:=pvs;
    acl2_att:=acl2;
    bt_att:= nil;
    bt_att:=pvs_att + bt_att;
    bt_att:=acl2_att + bt_att;
    bt:= bt_att;
end;

4. RESULTS AND DISCUSSION
4.1 Implementation of the Design
The figure 4.2 below explicitly analyses the attributes of ACL2 and PVS and then incorporated the attributes to a new tool defined as BT Tool. The attributes of the ACL2 tool is a shown below. The ACL2 tool takes formulae as input and find mathematical proofs. It uses rewriting decision procedures, mathematical induction and many other proof techniques to prove theorems in a first-order mathematical theory of recursively defined functions and inductively constructed objects in the integrated design BT tool (Alonzo, 1995). The PVS tool in the design support several decision procedures and various utilities, documentation and formalized libraries, that illustrates different methods of using the designed integrated BT tool for several application areas. It also support proofs theorems in set theory and prove of some complex rationals. It helps to translates quantifiers logical input of the designed BT tool to a more conceptual format. The inference rules can be supplied as inputs and the definitions will be generated as output by the integrated BT tool. It also takes hints or lemma as input, stimulates it and displays the closest related definition and the proof as output. It takes a concept definition as input, formalized it and displays the syntax equivalent as output in the BT tool. It also takes a set of theorems as input, stimulates the input and displays the closest related definition and the proof in the designed BT tool as output.
Figure 4.2: Start-Up Page for the BT Tool design

The attributes of ACL2 as shown in figure 4.3 include complex rationals support, well-typed functions, and support for Inductive Proof Checker. These attributes as incorporated in ACL2 make it function independently as a tool before being incorporated in the integrated BT tool. The function includes taking formulae as input and finding the mathematical proofs. It also takes decision procedures, mathematical induction and many other proof techniques to prove theorems. For example, it takes real value numerator, real value denominator, operator, imaginary value numerator, and imaginary value denominator in the complex support prove as input to generate the detailed equation as output solution. Also, Figure 4.4 shows an example of the implementation of operational behavior of the complex rational support attribute of ACL2. It takes RealVal Numerator, RealVar Denominator, Operator, Imaginary Value Numerator and Imaginary Value Denominator as input at two consecutive iterations and then generates the detailed equation and the overall solution to the problem as output.
4.5 Testing of the Attributes of PVS tool in the Design

The figure 4.5 shows the attributes of PVS. The basic attributes include support for theorems in set theory, supports for real number analysis, support for quantifiers reasoning, supports for proof of analysis and support for formalization of mathematical concepts. These attributes are inherited in PVS tool before it is integrated in the designed BT tool. The above attributes help to translate logical input to a more conceptual understanding. And also supplies inferences as input and generates the resultant definition as output. For example, it takes a concept definition as input formalized the input and display the syntax equivalence as output. It also takes a set theorem as input, stimulates the input and displays the closest related definition as output.

![Figure 4.5: Attributes of PVS tool in the Design](image-url)
Figure 4.6: Testing of the Attributes of the New Design BT Tool
4.7 Performance Evaluation

Performance evaluation can be defined as assigning quantitative values to the indices of the performance of the system under study. Evaluating and analyzing integrated system is difficult due to the complex interaction between application characteristics and architectural features. To study the performance of the integrated BT tool designed and the existing PVS tool and ACL2 tool. The following parameters are used:

a. **Output statistics**-this parameter examines the capabilities of the technique towards providing the desirable integrated tool.

b. **Accuracy**-this factor evaluates the validity (ability of a tool to achieve its objective) and reliability (ability of a tool to meet its requirement specification) of the integrated tool.

c. **Cost/effort**-this parameter investigates the cost and effort invested in each performance evaluation strategy in context with computer and human resources.

d. **Resource consumption**-this parameter examines the amount of resources consumed/required by the performance of the new integrated tool.

e. **Time consumption**- this parameter examines the amount of time consumed/required by the performance of the designed tool.

f. **Trustability/Believability**- these parameters reveals how much one can trust on the results of performance of the integrated tools.

g. **Scalability complexity**-this parameter examines the ability of the integrated tool acceptance of other tools attributes or complexity involved in scaling during performance of the integrated designed tool.

h. **Flexibility**-this parameter examines the flexibility of performance towards adapting the modifications or inherited attributes made to the integrated tool and checking their effect.

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>ACL2</th>
<th>PVS</th>
<th>BT TOOL (INTEGRATED TOOL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Statistics</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Cost/effort</td>
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<td>Medium</td>
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<tr>
<td>Resource consumption</td>
<td>medium</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Time consumption</td>
<td>medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Trustability</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
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<td>Scalability</td>
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<td>None</td>
<td>High</td>
</tr>
<tr>
<td>Flexibility</td>
<td>None</td>
<td>None</td>
<td>High</td>
</tr>
</tbody>
</table>

4.8.1 Analysis of Tools Performance

From the table 1 above, it is seen that the integrated BT tool designed is very flexible and scalable compare to ACL2 and PVS tool which is neither scalable nor flexible. The PVS tool is also more Trustable than ACL2 tool in its performance. The cost and effort of getting the integrated BT tool designed is more than that of the PVS tool and ACL2 tool. Though the cost and effort of getting ACL2 tool is lower than that of the PVS tool. The time taking for the performance of the integrated BT tool design is however less compare to PVS tool. PVS tool also spend more time in its performance compare to ACL2 tool. The integrated BT tool design consume less resources for its performance compare to PVS tool (high) and ACL2 tool (medium). The PVS and ACL2 tools have lower performance output than the integrated BT tool. The above analysis of the three tools show that the integrated BT tool has overall best performance evaluation than the existing PVS and ACL2 tools.

5. CONCLUSION

A design and implementation of an Industrial Integrated Tool Support was carried out in this study. The new tool designed hereby called BT tool inherited the attributes of ACL2 and PVS tools. The new tool developed is able to prove theorem in set theory and prove of some complex rational. The tool developed was also flexible (integrate well with existing tools) and scalable (accept attributes of existing tools and any other tools attributes that want to integrate with it in the future). The new tool is of economic advantage to industries because it saves time and money. The study has been able to increase the number of formal methods tools in industry.
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The Development of an Environment for Satellite Image Processing, Analysis and Visualization (ESIPAV) - A Raster-Based Geographic Information System Software.

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**ABSTRACT**

There is need to understand geographic phenomena from a synoptic perspective, and how these mutually interact with our world. Sensors on-board satellites have been deployed into Earth’s orbit to capture data about the Earth’s surface. The size and complexity of these data necessitate the use of computer software to work with these data to derive relevant information. Licenses of available GIS software are expensive, thus fostering the use of their pirated versions and the subsequent lack of confidence in presenting or publishing works done with such versions. The aim of this work is to develop indigenous raster-based software for the analysis, processing, and visualization of satellite image data. Data organization within the GeoTiff file format would be studied, and algorithms would be developed, implemented and tested with the Java programming language to enable the extraction of satellite image data, from the GeoTiff file, and its subsequent processing and visualization. Data used for testing and debugging ESIPAV includes a scanned color map of Yenegoa LGA of Bayelsa state, Nigeria; Landsat multi-spectral images of Path 191 Row 53 (8-Bit, 2001) and Path 188 Row 54 (16-Bit, 2013). Using the Java programming language and a number of objects present in the `java.io` and `java.awt.image` packages, satellite image data was extracted, characterized, systematically structured, processed, and visualized in various color modes and magnifications. There was successful image data extraction, organization, and visualization for gray scale single-band single-file image display, RGB multi-band single-file image display, and RGB multi-band multi-file image display (band combination).

**Keywords** - GIS; Satellite Image; Software

**African Journal of Computing & ICT Reference Format:**


**1. INTRODUCTION**

There is need to understand Earth surface phenomena and processes, both anthropogenic and natural, from a synoptic perspective. This enables humans to see how these observed phenomena affect our physical world and vice-versa. Earth observation satellites, and others, have been launched into various Earth’s orbits to actualize this dream. The Nigerian Space Agency is not left out in this, and it has been able to successfully launch three (3) Earth-observation satellites into space, viz: NigeriaSat-1 (2003) [1], NigeriaSat-2 [2] and NigeriaSat-X (2011) [3]. The data captured by the sensors on-board these satellites, and the geo-information synthesized from them, is taking large and complex dimensions in terms of size, processing and applications.

It is compulsory, therefore, to employ the use of computers and software to work with these data, and for the Agency to develop software tools to enable it directly work with the data generated by the satellites it launched into space.

Efforts in this direction in the Agency have not taken place. Hence, the design and implementation of this work. Additionally, existing GIS software are expensive to purchase by Research Officers which results in the widespread use of cracked and pirated versions. Moreover, research works carried out by these officers are compiled with caution when presenting their works in external fora or sending them for publication.
Another challenge is that it is only the analysis and functions packaged with these software that can be accessed and made use of. If there is need for custom/special analysis that is not present in these software packages, needed work may be stuck.

This work is a product of indigenous efforts to enable the direct analysis, processing, and visualization of satellite image data, thus enabling the identification of various earth surface features, relevant for various applications such as environmental, agricultural and geological applications.

2. RESEARCH OBJECTIVES

The research objective is to develop a raster-based software for the analysis, processing, and visualization of satellite image data. (ESIPAV = Environment for Satellite Image Processing, Analysis, and Visualization).

Precise steps needed to achieve the stated purpose are as follows:

i. To map out the details of the data layout of the GeoTIFF file format, which is the default publishing format in which many satellite image data are stored and obtained;

ii. To develop software algorithms, in the Java Programming Language paradigm, that enables the extraction, analysis/processing, and visualization of the details highlighted in (i);

iii. To implement/code, and test the algorithms developed in (ii) using the Java programming language.

3. METHODOLOGY

The GeoTIFF Image format, which is the default publishing and downloadable format for Landsat and NigeriaSat satellite imageries, was extensively studied and mapped. Its header structures and the information they reference were represented and implemented in appropriate Java Programming Language data concepts and structures. As shown in [4], the GeoTIFF image format is basically the TIFF format with the spatial referencing component embedded in a number of its header tags. The TIFF format is thus made up of headers and the image data. The first of the headers is the Image File Header (IFH), which references the offset to the rest of the headers known as Image File Directories (IFD). The IFDs encode various information about the nature of the image data in the file. Such information as the number of bands present, image data storage pattern, number of bits used to store data, color, offsets to the actual image data, spatial reference, etc [5]. Various classes/software templates present within the Java programming language were considered in the formulation and implementation of algorithms [6].

3.1 Algorithm for Reading Image Data from GeoTIFF files

1. Read and verify TIFF signature;
2. Read offset to the IFH and read the IFH;
3. Get the number and offset to the sequence of IFDs;
4. Read IFDs and obtain relevant information about vital image data characteristics and the offsets to the chunk or strips of actual image data;
5. Read the actual image data;
6. Cache image data to facilitate subsequent retrievals.

File, FileInputStream, ObjectInputStream and RandomAccessFile objects from the java.io package were used in the extraction of header structures and the actual image data from GeoTIFF Image files.

3.2 Algorithm for Analysis and Processing of Image Data

1. Characterize and compute image data statistics;
2. Create Lookup Table for image data improvement;
3. Create appropriate type of data bank, depending on image data characteristics;
4. Create appropriate sample model for image data;
5. Create appropriate color model for image data.

Usually, because raw image data is not well spaced when its histogram is observed, there is need to stretch the image data to enable a measure of contrast in its display. To accomplish this, a custom-made object was designed and created to characterize raw satellite image data and to construct a well-designed lookup table object to be used to stretch the image before it is sent to the display. LookupOp, ByteLookupTable, and ShortLookupTable objects (all from the java.awt.image package) were used to accomplish this stretching, depending on unique image data characteristics.

DataBuffer, DataBufferByte, DataBufferFloat, DataBufferShort, and DataBufferUShort objects from the java.awt.image package were used to organize the extracted raw image data into data banks, depending on image data characteristics such as number of bits used for the storage of a single pixel and whether the data is signed or unsigned. SampleModel, ComponentSampleModel, and PixelInterleavedSampleModel objects from the java.awt.image package were used to model the structure of the image data depending on whether the data is for a single band (Grayscale display), or a mixture for three (3) bands (RGB color display). ColorModel, and ComponentColorModel objects from the java.awt.image package were used to represent the appropriate color mode for displaying the image data.
3.3 Algorithm for Visualization of Image Data

1. Combine the data buffer, sample model, and color model to create image;
2. Stretch the created image with the already created lookup table;
3. Send the stretched image to the display;

The union of the `DataBuffer` and `SampleModel` objects results in the creation of the `WriteableRaster` object. In turn, the union of the `WriteableRaster` and `ColorModel` objects results in the creation of the `BufferedImage` object (all from the `java.awt.image` package). The `BufferedImage` object is then stretched with the already created `LookupTable` object. Then, the final/stretched `BufferedImage` object is the object sent for display on the screen and thus enabling detailed identification and observation of various earth surface features at different magnification ratios.

![Figure 1: Block Diagram Showing How the BufferedImage Object is created.](image-url)
4. SYSTEM FLOW CHART

The following are the steps that ESIPAV executes to successfully render satellite image file(s):

![System Flow Chart](image)

**Figure 2**: ESIPAV’s System Flow Chart.
5. IMPLEMENTATION

All ESIPAV’s Java code development/implementation, testing and debugging was done using version 8.0.2 of NetBeans Integrated Development Environment.

Satellite images were obtained as samples for software debugging and testing. These samples include a scanned color map of Yenagoa Local Government Area of Bayelsa state, and Landsat multispectral images (Bands 1 to 8) of Path 191 Row 53 (Year 2001, 8 bit) and Path 188 Row 54 (Year 2013, 16 bit).

![Figure 3: NetBeans IDE - The Environment where ESIPAV is developed in the Java Programming Language.](image1)

![Figure 4: ESIPAV Interface for selecting path(s) to satellite image(s) to be visualized.](image2)
The top segment of Figure 2’s interface is designed to allow the selection of band files to be visualized as a color band composite. Diagnostic band composites, either true or false color, are useful for the identification of earth surface features on satellite imagery. The bottom segment is useful for visualizing single band files in gray scale, as well as multi-band single-files in RGB color.

5.1 Test Results

Images from test results are presented below

Figure 5: ESIPAV Gray Scale Image Display for Band 7 of Landsat 8-Bit Stretched Image of Path 191 Row 53, displaying a segment of the Image.

Darker regions denote where there is wetness/water, (where Band 7 infrared radiation is absorbed), while the lighter regions are where Band 7 infrared radiation is reflected/emitted such as for green vegetation and bare surfaces. Combination of other diagnostic bands would help in further detailed identification of earth surface features.

Figure 6: ESIPAV Color Image Display for RGB Band 754 of Landsat 8-Bit Stretched Image of Path 191 Row 53, displaying same segment as Figure 5.
Now in color, various earth surface features are more distinguishable from one another. Blue is showing water, Green is showing vegetation, purple is wetlands, and brown is bare surfaces.

**Figure 7:** ESIPAV Gray Scale Image Display for Band 4 of Landsat 16-Bit Stretched Image of Path 188 Row 54.

The interpretation for this image is same as in Figure 5.

**Figure 8:** ESIPAV Color Image Display for RGB Band 432 of Landsat 16-Bit Stretched Image of Path 188 Row 54, covering the same area as Figure 7.
Figure 9: ESIPAV Color Image Display for RGB Band 754 of Landsat 16-Bit Stretched Image of Path 188 Row 54, displaying a segment of the area shown in Figure 7.

It is observed that at this magnification, earth surface features are clearly discernable and identified. Water bodies (blue), swamps/wetlands (purple), cultivated areas (patterned blue and purple among and including the green regions), etc. are clearly identifiable.

6. CONTRIBUTION TO KNOWLEDGE

This work has clearly shown indigenous capacity to develop highly technical systems that meets important scientific applications that are unique to our needs in the area of working with remotely-sensed satellite image data and GIS (Geographic Information System). This minimizes or eliminates dependence on foreign-developed software that is handed-down, whether it applies to our unique needs or not.

7. CONCLUSION AND FUTURE WORK

ESIPAV has been successful in the analysis of the TIFF section of the GeoTIFF image format; the extraction of raw image data; a measure of analysis and processing of image data (for image data stretching); and the visualization of image data in gray scale single-band single-file mode, RGB color multi-band single-file mode, and RGB color multi-band multi-file mode.

However, the work does not end there. The development so far is the laying of the foundation for future implementations that are currently being mapped out to enable further satellite image data processing such as image data correction/filling, image cutting/sub setting, and satellite image data auto-classification/automated earth-surface features identification.

REFERENCES

A Review of the Bitcoin Digital Payment System with Emphasis on its Security

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ABSTRACT

Bitcoin is a fast growing cryptographic currency payment system. Although all transactions carried out using this service are publicly available, Bitcoin offers privacy and anonymity to users behind these transactions. This system has faced a lot of criticisms owing to uncertainties regarding the true value of a Bitcoin, and also with regards to the security and privacy provisions of the Bitcoin system. This paper reviews the functionalities of Bitcoin, and discusses the effectiveness of the measures put in place to ensure the security of the overall network. It also highlights the issue of user privacy and anonymity in Bitcoin, and possible ways to address them.

Keywords - Bitcoin; transaction; security; privacy; anonymity

1. INTRODUCTION

Bitcoin is a pseudonym for the world’s first decentralized online crypto-currency payment system. It is decentralized, meaning its operation does not depend on any trusted entity, thus all transactions are carried out over the internet in a peer to peer manner. It was first introduced in 2008 by Satoshi Nakamoto [1] in a report that contained details of the Bitcoin design. The Bitcoin technology is open source and relies heavily on cryptographic primitives such as the use of hash functions and digital signatures to validate ownership.

Since the introduction of Bitcoin, it has gained a lot of attention from the media and the general public. The idea of having an online currency which could be traded alongside hard currencies seemed remarkable and implausible, thus Bitcoin faced many criticisms and opposition from the general public and several government bodies [2]. The lack of acceptance arose mostly from the uncertainties regarding the true value of a Bitcoin, and also the security and privacy of the Bitcoin system. Though still a novel invention, some researchers have analysed the Bitcoin system and have published their findings regarding the feasibility and security of the Bitcoin. Furthermore, there have been other proposed online currencies which are not exactly novel, but are simply modifications of the original invention [3, 4]. However, according to recent reports [5], Bitcoin remains the most popular and most valuable crypto-currency available despite the introduction of newer crypto-currencies.

The security of the Bitcoin system revolves around trust by computation, that is, network users are required to exhibit proof of work (POW) by completing a computationally hard problem[6]. The collective computing power accumulated by participants over a period of time ensures that no participant or group of participants is allowed to cheat, as they lack the computation strength necessary to dominate the trust system. The more the POW accumulates, the harder it is to dispute.

In this paper, a review of the Bitcoin system will be carried out and the security and user privacy issues relating to Bitcoin will also be discussed. This paper is organized as follows: Section 1 presents background information on the Bitcoin system. Section two explains the major operations that make up the Bitcoin system. Section three discusses the security aspects of this system with respect to privacy and anonymity. Section four provides a brief analysis and discussion and section five concludes the report.

Background on Bitcoin

According to a document on the history of digital payment systems, the concept of a cryptographic currency was first proposed by Wei Dei in 1990’s and he called it B-money [4]. A similar concept called Bitgold was also proposed by Nick Szabo. These early digital currencies relied on centralized entities that made anonymous payments impossible [7]. Bitcoin is said to have based its idea on these initial proposals and was proposed in October 2008 by Satoshi Nakamoto, a name which has been speculated to be a pseudonym representing more than one person [8]. In January 2009, the Bitcoin network was officially launched with the release of the genesis block which was the first block in the Bitcoin chain.
According to [9], the first unofficial Bitcoin transaction was made in 2009 between Satoshi and a developer called Hal Finney. Soon after, a significant transaction was made when 10,000 BTCs was used to purchase two pizzas. Later that year, an exchange rate was established for the Bitcoin and this marked a significant breakthrough for the crypto-currency. The Bitcoin is very volatile with unstable exchange rates over time; it has seen a high point of 1110 USD per Bitcoin and rates as low as 5 USD in 2011. As of the time of writing this report, the value of a Bitcoin is 533 USD, falling from a 947 USD within one week. This high volatility is a reason why many have condemned the crypto-currency despite its growing popularity and successes. Governments of different countries have also raised concerns about how the untraceability feature of the Bitcoin may lead to tax evasions, money laundering and other illegal transactions. Bitcoin transactions were soon after banned in China [2].

Bitcoin services operate a peer to peer network scheme, hence no central authority or bank is required to make regulations or control the currency, and this attracts both legitimate and illegitimate users who do not want government involvement in their transactions. Bitcoin also assures privacy for its users by allocating pseudonyms called Bitcoin addresses to the users whenever they wish to participate in a transaction [10]. Despite the supposed reliance on pseudonyms for privacy provision, each transaction consists of a chain of digital signatures. This creates serious concerns because since transaction details are publicly available, they can be tracked and linked to a specific user. Androulaki et al [10] in their work evaluated user privacy in Bitcoin when used to conduct daily transactions in a university, according to their results, the measures put in place are not sufficient to provide privacy for most of its users. These privacy and security issues will be discussed in more detail in section three.

2. THE BITCOIN SYSTEM

This section concisely describes how the Bitcoin system works. As mentioned in the previous section, Bitcoin is a peer to peer online payment system that relies on proof of work and public key encryption. Bitcoins (BTCs) are transferred between users by generating transactions [1]. The users take part in these transactions by adopting pseudonyms, commonly referred to as Bitcoin addresses. These Bitcoin addresses are the means by which bitcoins are received, quite similar to how email addresses are used to receive and send emails. Each user also has a digital wallet that stores and manages hundreds of Bitcoin addresses belonging to the user. These addresses are individually mapped to separate public/private key pairs using a transformation function [10]. The transfer of ownership of Bitcoins amongst addresses is only possible with the correct keys.

In the Bitcoin system, transactions are broadcast by each user to other peers in the network. The following sections briefly explain the concepts and activities that make up the Bitcoin system.

A. Transactions

As mentioned above, BTCs are transferred between peers by generating a transaction. A transaction is created by digitally signing the hash of the last transaction the Bitcoin was used for and the public key of the intended user, and integrating the signature in the coin [10]. Simply put, a transaction typically has input and output values; the input represents the output of the previous transaction and the output of the current transaction becomes the input for the next transaction. Over time, a chain of signatures is formed, and this can be used to verify the authenticity of a BTC. These digital signatures are a means to avoid double spending attacks by users. The process through which transactions are verified is called mining [1].

B. Mining Bitcoins

According to Hobson [11], Bitcoin mining can also be referred to as the process of adding transactions to the block chain so that there can be a general consensus from the users on the same set of transactions, and also so that double spending of Bitcoins is avoided. This process revolves around the proof of work (POW) computations. To start the mining process, the user must run a mining software which carries out the following steps repeatedly:

- All unconfirmed transactions are collected into a block. This also includes the hash of the last block added to the block chain, and in addition a nonce, which could be any random number.

- Following step 1, a hash of the newly created block is done, and the hash value is examined. A predefined number known as the ‘difficulty’ is set and the important factor here is the number of leading zeros. If the number of leading zeros is smaller than the predefined number, then a repeat of step 1 is carried out with an increment to the nonce, while ensuring that a different hash value is reached each time [11]. If the leading zeros are more than the predefined number, then the next step can be taken

- After successfully completing the previous steps, the user is said to have mined a block successfully and the block is added to the block chain. The user can then broadcast the hash (including the transactions) along with the nonce, to other network users. Newly created bitcoins are then awarded to the user in a special coin base transaction [11] and this marks the initial production of bitcoins.

Other network users receive the block and examine its contents to ensure that there are no invalid transactions and that they produce the correct results when hashed. If all values correspond, then this new block will serve as input to a new mining process by another user. And the whole steps are performed again, thus increasing the chain. This is the process of validating transactions. The mining process is not performed by all network participants; instead a few ‘special’ users carry out the important task of block creation and transaction validation on behalf of the network.
The POW ‘difficulty’ feature in the mining process is used to control the rate at which blocks are mined, and this has a direct effect on the number of Bitcoins in circulation. The POW difficulty tries to maintain a block mining rate of one block every 10 minutes. According to [11], a reward of 25 BTC is given to a user after completing a block, and after four years the reward is halved. This encourages miners to work continuously and provide support for the Bitcoin network. The Bitcoin mining process has been taken as a lucrative business up by some users and requires a lot of computational power, which can be very expensive. If invalid blocks are created, network peers will reject them, and the miners will be invalidated.

C. Bitcoin Wallets
A Bitcoin wallet contains all the Bitcoin addresses belonging to a user. These addresses all have individual public keys and the corresponding private keys are stored on the users wallet file locally [11]. It is advisable for users to have as many addresses as possible and it is their sole responsibility to keep the wallet file safe. The loss of a wallet file means the loss of associated Bitcoins since they can only be spent with knowledge of the private keys. These Bitcoins remain on the Bitcoin network but are not spendable without the required private keys.

D. Spending Bitcoins
To spend Bitcoins, a user must join the Bitcoin P2P network via a Bitcoin client. A user possesses coins based on previous transactions that named its address as a recipient or as a reward for completing a block [8]. Suppose a user Alice wishes to transfer 2 Bitcoins to another user Bob, first Alice starts a new transaction that endorses coins received from previous transactions which have not been spent by Alice yet. For example, she endorses 5 bitcoins received from Charlie using a digital signature, and takes this as the input to her new transaction. As the output, she indicates that she wants to remit 2 Bitcoins to Bob, leaving her with 3 Bitcoins. The network users collectively agree on the validity of the transaction by adding it to the public history of previously validated transactions which is at the end of the longest block chain [12].

3. SECURITY IN THE BITCOIN SYSTEM
The security of this system is partly based on assumption that it is impossible for dishonest players to gain computation power high enough to compromise the system. That is, as long as there are more valid blocks, it is extremely difficult to outnumber the honest computations. Blocks are added to the longest chain in the network as it is considered as the correct one [11]. Therefore if an attacker wants to modify a block, it will need to compute the POW of the block and all the blocks along the chain. This is an extremely challenging and expensive task. And because more honest users keep validating blocks, the attacker can barely meet up. This is one of the security advantages of the decentralized Bitcoin system. However, there is also the issue of privacy, anonymity, and possible attacks against network users.

A. Privacy
The Bitcoin system is such that all Bitcoin transactions are publicly available; this is to ensure that the transactions can be validated to curb double spending [13]. The public announcement of these transactions seem like an apparent flaw in the system with regards to privacy, however, privacy can still be achieved by keeping the public keys anonymous. It is visible to the public when someone transfers an amount to another person but no one knows who the sender or recipient is. The use of new key pairs for each transaction is an added measure to provide unlinkability [1]. However, this cannot be avoided with multiple input transactions which could inadvertently disclose that the inputs were from the same owner. Furthermore, it is possible for users to link other users to a wallet address. A user Charlie may broadcast his wallet address on a social networking site requesting for anonymous donations. By observing the block chain, users can deduce the addresses Charlie has been transferring bitcoins to.

B. Theft and Loss of Bitcoins
As with any network and computing system, especially one that promises anonymity and user privacy, the Bitcoin network is an attraction for hackers and Malware creators. The network is susceptible to attacks which can result in the theft of private keys. As reported in [13], a Denial of service attack was launched at a Denmark-based Bitcoin payment service provider and the attackers emptied the wallets of many Bitcoin users. Malware writers according to the same report have been developing malware to steal wallets stored on infected machines. The perpetrators of the DDOS were traced back to Russia, but were never found. This goes to question the reliability of the entire system.

Barber et al [8] proposed the use of threshold cryptography so that private keys can be split into shares and distributed in multiple locations. Thus, instead of having the private keys stored on one device, e.g. laptop, a user can also have it stored on a mobile and a service provider. Therefore the user can only spend Bitcoins when a threshold these storage locations is activated.

4. ANALYSIS AND DISCUSSION
The security provision in terms of anonymity and user privacy in the Bitcoin system can be seen as a strength and also a weakness. The system offers anonymity enough for money laundering and other illegal activities to be paid for without being traceable to any individual. Some of these illegal transactions are made using anonymous web clients such as the Tor network, which makes it even harder for criminals to be caught. The network is purely decentralized, thus there’s no central authority to act as an arbitrator in case issues arise.
On a positive note, some honest users just desire a fast and secure payment service without encountering unnecessary charges and restrictions placed by any entity. Anonymous whistle blowing sites also see it as a means to raise funds, while keeping the identities of the contributors private. The novelty of the Bitcoin system makes it difficult to be understood properly. It takes a lot of time to research and grasp the concepts behind generating bitcoins and maintaining wallets. Users who simply read about Bitcoins on the internet and opt to join the network without fully understanding the implications or are not be aware of the security measures needed to guard the Bitcoin wallet, are likely to lose their bitcoins. To protect Bitcoin wallets from theft, threshold cryptography as proposed in [8] may be one way to go about it by splitting the private key into shares and storing in different locations. Though a good idea, it makes spending Bitcoins a hassle, as the user will need to activate the threshold number of devices each time a transaction is to be made. However, it may be a small price to pay as against loosing huge investments.

The publicly available history of transactions could pose a possible risk to Bitcoin. Researchers [12, 14] have downloaded the entire history of Bitcoins to analyse and possibly identify patterns which may threaten the anonymity feature of the Bitcoin system. In their study, they came to the conclusion that it is possible, using appropriate tools and some external identifying information, to associate public keys with each other. Also, they claim that wallet and exchange service providers are capable of tracking user activity to a certain level.

1. 5. CONCLUSION

Bitcoin as a first generation crypto-currency is still yet to reach its maturity. Its volatile nature makes it even less attractive to many who are not confident enough to take risks; however, a fairly large population has joined the Bitcoin network. The flexibility and anonymity provisions, however appealing, come at a security cost. The availability of transactions publicly has a cost of being analysed by external parties to extract information, Bitcoin wallets can easily get lost or stolen, the Bitcoin exchanges could crash, and so on. Though technical affiliates of the Bitcoin network may argue that strong anonymity is not the primary goal of Bitcoin, It is imperative that users are aware of the security implications of Bitcoin before joining the network.

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On the Migration of Senior Secondary Final Examinations from Paper-based to Electronic Examinations

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ABSTRACT

This study investigated the readiness of the society viz students, teachers and examination bodies to migrate the WAEC/NECO/JAMB examinations from paper-based to wholly Computer Based Tests (CBT). It also examined the success level of JAMB CBT in Lagos, Nigeria. Overall it re-examines the effects of using ICT in education for both students and teachers. The descriptive survey design and inferential statistics were used for the research study. The population consisted of examination bodies’ staff, teachers and students of secondary schools in Lagos State. Data collected for the study were analysed using percentage scores and Chi-square test. The study revealed at a level of significance of 0.05 that ICT facilities are marginally available in Lagos State, there are a high number of computer literates among the stakeholders, CBT has made some in-road and is preferred to paper-based tests. It reveals CBT as a relative success which must be consolidated. Similarly, the study make suggestions to enhance the migration from paper based examinations to standardized CBT.

Keywords- Electronic Examinations, Schools, E-exam, CBT, Senior Secondary

1. INTRODUCTION

Examinations are still regarded as the most preferred measure of knowledge and performance in the educational sector. Globally, examination results serve as an indicator or factor on which decisions about students, instructors, administrators, boards at the district, local or national level The Federal policy states that “Nigeria shall use public examination bodies for conducting national examinations in order to ensure uniform standards at this level.” It further specifies among other things the adoption of Open and Distance Education being the mode of teaching in which learners are removed in time and space from the teacher; “using a variety of media and technologies.” [1] Whereas school examinations are used for internal purposes such as promotion, public examinations are more involved and competitive being conducted on behalf of the state to all those who meet defined entry criteria [2]. They include examinations used to shortlist candidates for government service; state schools or other higher institutions, scholarship beneficiaries and training programs. In Nigeria, these include Primary School Leaving Exams, Secondary School Certificate Exams, Unified Tertiary Matriculation Exams, Presidential Scholarship Exams, etc. which are respectively administered by bodies such as the West African Examinations Council (WAEC), the National Examinations Council (NECO), the Joint Admissions and Matriculation Board (JAMB), the National Universities Commission (NUC), the Public Service Commission, etc. under the supervision of the Federal Ministry of Education.

Public examinations started in Nigeria when the colonial government introduced it to select qualified people into the civil service. It involved written tests and at times was supplemented with oral interviews and practical demonstration of proficiency. Though our focus is on secondary school leavers’ final examinations and associated examinations to enter into higher institutions, we note that the issue is similar for graduates seeking further studies in foreign schools, professional qualifications from various professional bodies or employment through various recruitment tests administered by external agencies. In order to overcome the challenges associated with written tests or paper based examinations, an electronic examination (e-exam) is explored. This is termed Computer Based Testing (CBT) and refers to the electronic copy of an existing conventional paper and pencil test administered on computer or allied devices. The two tests are identical in terms of scope and content but the mode of delivery differs [3]. E-examinations platform is a system that involves the conduct of examinations through the web or intranet or other information technology accessories [4]. The recent trend of electronic testing in the country is worthy of study to ascertain the preparedness of stakeholders on its adoption.
This is to verify whether the core challenges are being addressed adequately in a timely and cost effective manner, namely:

i. The huge financial cost of administering public examinations and logistics problems

ii. The prevalence of examinations malpractices

iii. Late release of candidates results

Comparatively it may also be possible to assess overall performance of students and to identify new problems that need to be mitigated.

2. RELATED WORKS

Recent studies [5 - 9] identify advantages of E-examinations to include the following:

i. Simplification of the examinations delivery process

ii. Time savings in creation, deployment, assessment and archiving of examinations

iii. Use of fewer personnel for supervision/invigilation and grading which translates to cost savings

iv. Auto-marking of scripts which facilitates prompt release of results especially for multi-choice type questions. Legibility issues are eradicated.

v. Re-useability of software systems and updating database pools for further examinations with randomization of questions sequencing.

vi. Improvements in analysis of exam data and quality of information they can yield

vii. Minimization of exam malpractices via impersonation, collusion, leaked question papers, etc.

viii. Quick correction of observed lapses in the entire process

It is desired that a comprehensive system support different types of questions viz multiple choice, ordering or ranking, open ended and essay writing, drag and drop, hot spot and all linguistics skills, with options to include images, audio and video files, aside having a management tool for analyzing, scheduling and reporting. From the students’ perspective, there are even more benefits of electronic examinations such as new forms of self-contained knowledge diagnostics represented by digital practice examinations (for the purpose of exercising) and periodic course-accompanying electronic tests. Self-contained knowledge diagnostics can also be fostered through supplying exemplary solutions to students' incorrect exam answers. Moreover, the (partial) automatic correction of tests leads to an increase in objectivity of examination marks. Additionally, the notification on results immediately after the end of the exam is highly welcome among students as an effective means of feedback. All these are implemented in a project the author is involved in named Andrews Challenge [10] which is a secured e-exam web portal to publicly compete for scholarships and job placements amidst one’s peers. It is also being utilized for “mock school-cert” O’Level examinations by several schools.

It is a customizable and configurable web-based system encoded with PHP and MySQL database for testing various educational levels and public segments according to divers curricula and settings We posit that a robust students’ record management system should not only handle personal bio-data, fees payment status, courseware and grades but should also facilitate E-examinations.

The need to process large volumes of exam candidates with inherent risks as manifested at the March 2014 Nigerian Immigration Service recruitment tragedy [11] has brought the need for E-examinations to the fore. The Nigerian legislature has resolved that such public examinations must henceforth be conducted on electronic platforms. Presently, the National Open University (NOUN) and JAMB have commenced e-examinations and most universities also conduct their Post-UTME examinations electronically at designated test centres. JAMB introduced CBT in May 2013 alongside its conventional paper examinations which was expected to be phased out by 2015. It is still an option for its nearly two million candidates who have to grapple with computer literacy and its biometric authentication [12].

JAMB used over 300 centres for the just concluded CBT across the nation and staggered the exam over a reasonable period which shows that though Nigeria might not have enough centres but we are moving forward in this sector. We still need more CBT examination centres in each state of the country so as to avoid students travelling down to another state for them to be able to write their CBT. However, the preparedness of schools, students, administrators and examination bodies ought to be well ascertained as well as their adaptation to this innovation. Calls for the adoption of e-examinations abound though little is known to have been done with respect to the evaluation of its implementation in our environment. Most universities, as depicted in Figure 1 have IT centres for deploying their POST UTME as CBT and equally schedule over a period due to paucity of computers relative to the large pool of applicants.

Figure 1: A CBT Session
Recently, West Africa Examination Council introduced Computer Studies as a subject in secondary schools as from 2015 students will start writing computer studies WAEC examination irrespective of the school whether public or private secondary school. Lagos State government started a programme “Train the trainers” that is train the teachers in computer literacy it was supported by the British Council, the programme has helped a lot both the teachers and the students. Nigerian Universities also have CBT has entrance examination, University of Lagos, University of Ilorin just to mention a few also have some of their general 100 and 200 level course examinations administered via by CBT. This tells us that if a student doesn’t have a good foundation from secondary school he/she would not be able to adapt well for tertiary education.

Interestingly, much has been done in proposing E-exam models [13]. It was noted that teachers are already being trained for ICT skills in Lagos state where teachers do write promotional examinations through computer tests. Having established previously the availability of ICT facilities for education and their utilization for e-learning in Lagos [14], this study focuses on the readiness of students, teachers, school management and exam bodies for CBT at the Senior Secondary completion level.

3. METHODOLOGY

The technique employed in this research is the conduct and analysis of a statistical survey. This was via designed questionnaires for secondary school pupils, teachers and national examination bodies’ staff. The population though Nigeria is taken as fairly represented by Lagos which is the commercial hub and former federal capital. Random sampling of data is done across all the educational zones of the state in each local government area. The main survey took place (in 2014/2015 academic session) after an initial two-week pilot study that allowed us to moderate the questionnaires appropriately. Students returned 1868 questionnaires in all, teachers returned 548 and exam bodies staff returned 44. The core issues the survey sought to address are perceptions on computer literacy, facilities availability, preferred testing modes and resolution of perceived challenges.

4. DISCUSSION OF RESULTS

An introductory part of our questionnaire collects demographic data as per status, sex etc. and other generic information on perception of ICT and CBT. The comments highlight the perceived challenges facing CBT deployment such as inadequate CBT examination centers, irregular power supply, potential hacking of the systems for compromises, inadequate fund by the government and school proprietors for infrastructure, etc. In each questionnaire, section A options for answers are just 2 (YES or NO) while Section B options for answers are 3 (HIGH, AVERAGE and LOW). The Chi-square method [15] was used to analyse several hypotheses based on the answers from the questionnaires distributed to senior secondary school students, teachers and staff of examination bodies. Few calculations are shown for illustration of how results are obtained within each group.

| Table 1: Respondents Opinion in Section A |
|---|---|---|---|
| **SN** | **Question** | **Yes** | **No** | **Total** |
| 1 | Are you computer literate? | 1461 | 402 | 1863 |
| 2 | Have you ever been involved in a CBT? | 583 | 1225 | 1808 |
| 3 | For WAEC/NECO/JAMB, do you prefer CBT to paper based tests? | 1481 | 950 | 2431 |
From Table 1, it is deduced that 78%, 98% and 100% of the respondents are computer literate in the respective student, teachers and external examiners categories. Besides, 32%, 9% and 64% have been involved or partaking in CBT in these categories while 53%, 86% and 82% prefer CBT to paper based tests. This results indicate that while the exam bodies feel prepared and eager for CBT, the students are not as much while the teachers though moderately enthusiastic have not had enough opportunity to deploy such in schools due to infrastructural constraints.

We could ascertain whether the opinions offered are totally random or dependent on the categories by evaluating Ch-Square tests as illustrated with sample calculations for Question 1.

### Table 2: Respondents Opinion in Section B

<table>
<thead>
<tr>
<th>SN</th>
<th>Question</th>
<th>High</th>
<th>Ave</th>
<th>Low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Rate your skill at using the computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students</td>
<td>824</td>
<td>755</td>
<td>230</td>
<td>1809</td>
</tr>
<tr>
<td></td>
<td>Teachers</td>
<td>327</td>
<td>171</td>
<td>6</td>
<td>504</td>
</tr>
<tr>
<td></td>
<td>Exam Bodies</td>
<td>39</td>
<td>5</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1190</td>
<td>931</td>
<td>236</td>
<td>2357</td>
</tr>
<tr>
<td>5</td>
<td>Rate the success of CBT for entrance examinations into Nigerian Universities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students</td>
<td>1226</td>
<td>432</td>
<td>163</td>
<td>1821</td>
</tr>
<tr>
<td></td>
<td>Teachers</td>
<td>432</td>
<td>90</td>
<td>5</td>
<td>527</td>
</tr>
<tr>
<td></td>
<td>Exam Bodies</td>
<td>38</td>
<td>6</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1696</td>
<td>528</td>
<td>168</td>
<td>2392</td>
</tr>
</tbody>
</table>

Approximately 10%, 1% and 0% of the Students, Teachers and exam bodies attest that they have low proficiency in computer usage and similar percentages perceive CBT for UTME and POST UTME success rate as low. This might be explained by the fact that people are usually sceptical of change and doubt/fear what they don’t know. For Question 1, is the response as per literacy of respondents random or intrinsically dependent on categories?

We formulate the Null Hypothesis that it is independent and the Alternate Hypothesis that they are related. Let $o$ be the observed value, $e$ the expected value then we have Table 3 as follows.

### Table 3: Contingency table for Chi-Square Evaluation - Question 1

<table>
<thead>
<tr>
<th></th>
<th>o</th>
<th>e</th>
<th>$(o-e)^2/e$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1461</td>
<td>1547.69</td>
<td>4.86</td>
</tr>
<tr>
<td>2</td>
<td>532</td>
<td>452.76</td>
<td>13.87</td>
</tr>
<tr>
<td>3</td>
<td>44</td>
<td>36.55</td>
<td>1.52</td>
</tr>
<tr>
<td>4</td>
<td>402</td>
<td>315.31</td>
<td>23.83</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>92.24</td>
<td>68.07</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>7.45</td>
<td>7.45</td>
</tr>
</tbody>
</table>

The degree of freedom (DF) for each contingency table is $(r-1)(c-1)$

Where $r = 3$ and $c = 2$, thus DF is 2x1 or 2

Chi-square calculated from our table is 119.59. At Level of significance 0.05, Chi-square tabulated $(0.05, 2)$ is 5.99
The calculated value (4119.59) is greater than the tabulated value (5.99 so we reject the Null Hypothesis).

The inference is that computer literacy in these various categories have some underlying factors responsible for it. Such factors are due to policy implementation and the digitalization of this era, which are inherent enablers for adopting CBT. Similarly, it is found that other responses are not based on pure chance but intrinsic to the various categories.

It facilitates prompt release of results but the systems must be secured and verified before such releases, hacking or errors due to ‘technological hitches’ will lower user confidence. Government and industry should support CBT due to its potential to open up the educational space (via distant learning programs) and cost effective measures. JAMB needs to improve its operations while WAEC and NECO may plan towards CBT for it is expected of them. It is a question of “When not If...” in the not too distant future, all examinations will be electronics-based.

ACKNOWLEDGMENT
The author acknowledges the field work coordinated by his student; Shakirat Balogun

REFERENCES

Our contributions to knowledge include the following:
1. Demonstrating the need for and advantages of CBT  
2. Evaluating the stakeholders’ perception of and readiness for wide-spread adoption of CBT for SSS final examinations. In particular, we showed that preference rate to abandon paper-based examinations is correlated to e-literacy levels among students, teachers and exams-body staff.  
3. Providing an e-platform such as Andrews Challenge for schools to deploy mock or real CBT

5. CONCLUSIONS
CBT has become a reality in our society despite the associated challenges of its implementation for final senior secondary school examinations. Foreign institutional examinations and international certifications are increasingly being offered via this mode and the citizens are adapting. The transition to computer-based testing will place Nigeria at the forefront of innovative, 21st-century assessment design and delivery. For students, the benefits include using technology to better demonstrate what they know and are able to do. For teachers and administrators, the benefits include more immediate feedback on student achievement, to help address student mastery of knowledge and skills and to guide instructional planning in subject areas.


Automatic Diagnosis of Depressive Disorders using Ensemble Techniques

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ABSTRACT
Depression is widespread and often undiagnosed or misdiagnosed, globally, because of acute shortage of mental health professionals and its high comorbidity with other disorders. Though various classification algorithms have been used on depression datasets, and high classification accuracies reported in the past decade, studies have shown that more than 90% of people who suffer from depressive symptoms in the developing countries of Africa do not have diagnostic facilities and treatment. To overcome the difficulties, this paper reports the preliminary findings of a study to investigate the use of ensemble techniques for the automatic diagnosis of depression using a dataset of 580 patients (severe depression = 271, mild depression = 23, moderate depression = 272 and no-depression = 14), collected from the University of Benin Teaching Hospital-UBTH and Primary care centre in Nigeria. The performance analyses and results obtained with the machine learning algorithms, trained independently and jointly with different combinations, are discussed using various performance metrics. The area under the receiver operating characteristics curve-AUC for ensemble classifiers shows a remarkable improvement over the individual classifiers.

Keywords: Machine learning, ensemble techniques, depression disorders, Mental health.

1 INTRODUCTION
In the past decade, various classification algorithms have been used on depression datasets and high classification accuracies have been achieved (Das & Sengur, 2010; Sacchet, Prasad, Foland-Ross, Thompson, & Gotlib, 2015; West, Mangiameli, Rampal, & West, 2005). In machine learning community, Ensemble methods are learning models that improve predictive performance by combining the opinions of multiple learning models (Daumé III, 2012). Its main advantage is the unlielihood of all the models used to make the same mistake. Ensemble methods have been used extensively for medical diagnosis (Das & Sengur, 2010; West et al., 2005). Preotiuc-Pietro (Preotiuc-Pietro, Sap, Schwartz, & Ungar, 2015) used a combination of different classifiers to determine Twitter users who self-reported having either Post-traumatic stress disorder (PTSD) or depression and achieved a high accuracy.

1.1 MACHINE LEARNING ALGORITHMS FOR DEPRESSION
Machine Learning (ML) is simply the training of a model from data that generalizes a decision against a performance measure. ML algorithms have been successfully applied in many fields including medical diagnosis, spam detection, credit card fraud detection, digit recognition, speech understanding, face detection, product recommendation, customer segmentation and shape detection (Witten, Frank, & Hall, 2011). Common ML problems are classification, regression, clustering and rule extraction. Some commonly used ML algorithms for solving real-world problems, such as depression diagnosis, include Bayesian networks, Artificial neural networks, Support vector machines, K-means, Decision tree and Random forest (Witten et al., 2011) are discussed briefly.

Bayesian networks: Bayesian networks is a probabilistic reasoning tool for managing imprecision of data and uncertainty of knowledge in real-world problems. Bayesian networks is constructed, either by hand (manually) or by software (from data). As a real-world problem-solving tool, Bayesian networks have been used to address problems in different areas of medicine. Curiac (Curiac, Vasile, Banias, Volosencu, & Albu, 2009) presented a Bayesian network-based analysis of four major psychiatric diseases: schizophrenia (simple and paranoid), mixed dementia (Alzheimer disease included), depressive disorder and manic depressive psychosis.

Artificial neural network: Artificial neural network (ANN), a mathematical representation of the human neural systems is efficient in modelling and making sense of real-world clinical data in which the relationship among the variables is unknown or complex (Amato et al., 2013). ANN is quite helpful in real-
world problems that do not have algorithmic solution or when there is need to pick out interesting structures from existing data. In psychiatric diagnosis, Mukherjee et al (Mukherjee, Ashish, Hui, & Chattopadhyay, 2014) used Back propagation feed forward neural network (BPFFNN) and Radial basis function neural network (RBFNN) models to detect depression. Training the models with 45 real-life medical data instances showed that the two approaches obtained the same diagnostic efficiency as clinicians.

Fuzzy logic: Fuzzy logic (FL) is a set of mathematical principles for knowledge representation that allows intermediate values to be defined between conventional binary logic like true/false, yes/no, high/low (Hasan, Sher-e-alam, & Chowdhury, 2010). Being a multivalued logic, FL imitates human reasoning sense and deals with situations when we have just one item which partly belongs to one class and partly to another. Abdullah et al (Abdullah, Zakaria, & Mohamad, 2011) proposed a design a FuzzyExpert System (FES) for the diagnosis of hypertension risk for patients aged between 20’s, 30’s and 40’s years, divided on gender line. The proposed system, used Mamdani inference method and when tested with data collected from 10 persons with different work background was found to provide a faster, cheaper and more reliable diagnostic results compared to the traditional methods.

Support Vector Machines: A support vector machine (SVM) is a way of performing classification by finding a separating boundary (hyperplane) that separates the data into two categories (Daumé III, 2012). SVM offers a possibility to find solution to real-world problems, such as depression diagnosis, that cannot be linearly separated in the input space by making a non-linear transformation of the original input space into a high dimensional feature space, where an optimal separating hyperplane can be found. Sacchet (Sacchet et al., 2015) conducted an analysis to differentiate the depressed individuals from healthy controls using SVM in conjunction with structural global graph metrics. Data was obtained from multiple brain network properties of 32 (14 diagnosed with MDD) participants, all women aged 18-55 years, at the Stanford Center for Neurobiological Imaging. The SVM model, when tested, was able to diagnose depression with 71.88% accuracy, 71.43% sensitivity and 72.22% specificity.

K-nearest neighbor: The K-nearest neighbor (KNN) presents a simple but effective means of making classification decisions. KNN performs prediction by finding a training example V that is most similar to the test example V̂. Ghasemi and Khalili (Ghasemi & Khalili, 2014) conducted a research to compare the predictive strengths of multilayer perceptron (MLP) and K-nearest neighbour (KNN) for the diagnosis of bipolar disorder. With 70% of the available data used for training the models, the diagnostic results showed the superiority of the MLP model with 16% error rate to that of the KNN with 21% error rate.

2.0 PROBLEM STATEMENT

Depression is one of the most common psychiatric disorders globally. Depression is difficult to detect by clinicians because it shares symptoms with other physical and/or mental disorders (Chattopadhyay, 2014). The World Health Organisation (WHO, 2012) has shown that more than 90% of people who suffer from depressive symptoms in the developing countries of Africa do not have access to diagnostic facilities and treatment.

In most developing countries like Nigeria, with scarce mental health services (Ganasen et al., 2008), traditional diagnostic practice in depression services typically involves clinician-to-patient interview where judgments are made from the patient's appearance and behaviour, subjective self-reported symptoms, depression history, and current life circumstances (Baasher, Carstairs, Giel, & Hassler, 1975). The views of relatives or other third parties may be taken into account. A physical examination to check for ill health, the effects of medications or other drugs may be conducted. This intuitive model, though still in use today, is slow and leaves diagnostic decision-making entirely to the subjective clinical skills and opinion of the clinicians (Chattopadhyay, 2014).

3 METHODOLOGY AND DATA COLLECTION

This study seeks to investigate the strenght of ensemble techniques to automatically detect depression in Nigeria and other developing countries. The steps taken to achieve the objectives are as follows:

a) Collect depression data from the mental unit of the university of Benin Teaching Hospital (UBTH) and Primary health centre in Nigeria.
b) Extract the features (symptoms of depression).
c) Build ensemble models using Weka (Waikato Environment for Knowledge Analysis), a popular, free machine learning tool (Bouckaert et al., 2013).
d) Test the performance of the built model on a set of real-world depression cases.

The data used for training the machine learning algorithms consisted of 580 data instances and 23 attributes collected from the UBTH and primary health centre in Nigeria. There were 254 male and 326 female patients from 12 to 92 years old (with a mean age of 41.8 and standard deviation of 16.3). The features shown in Table 1 were identified as relevant for the screening and diagnosis of depression.
Table 1. Features of depression extracted from the dataset

<table>
<thead>
<tr>
<th>S/N</th>
<th>Features</th>
<th>code</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>age</td>
<td>ag</td>
<td>integer</td>
</tr>
<tr>
<td>2</td>
<td>sex</td>
<td>se</td>
<td>Integer</td>
</tr>
<tr>
<td>3</td>
<td>marital status</td>
<td>ms</td>
<td>Integer</td>
</tr>
<tr>
<td>4</td>
<td>sad mood</td>
<td>sm</td>
<td>integer</td>
</tr>
<tr>
<td>5</td>
<td>suicidal</td>
<td>su</td>
<td>Integer</td>
</tr>
<tr>
<td>6</td>
<td>loss of pleasure</td>
<td>lp</td>
<td>Integer</td>
</tr>
<tr>
<td>7</td>
<td>insomnia</td>
<td>in</td>
<td>Integer</td>
</tr>
<tr>
<td>8</td>
<td>hypersomnia</td>
<td>hy</td>
<td>Integer</td>
</tr>
<tr>
<td>9</td>
<td>loss of appetite</td>
<td>la</td>
<td>Integer</td>
</tr>
<tr>
<td>10</td>
<td>psychomotor agitation</td>
<td>pa</td>
<td>Integer</td>
</tr>
<tr>
<td>11</td>
<td>psychomotor retardation</td>
<td>pa</td>
<td>Integer</td>
</tr>
<tr>
<td>12</td>
<td>loss of energy</td>
<td>le</td>
<td>Integer</td>
</tr>
<tr>
<td>13</td>
<td>feeling of worthlessness</td>
<td>fw</td>
<td>Integer</td>
</tr>
<tr>
<td>14</td>
<td>lack of thinking</td>
<td>lt</td>
<td>Integer</td>
</tr>
<tr>
<td>15</td>
<td>indecisiveness</td>
<td>id</td>
<td>Integer</td>
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<tr>
<td>16</td>
<td>recurrent thoughts of death</td>
<td>rt</td>
<td>Integer</td>
</tr>
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<td>17</td>
<td>impaired function</td>
<td>if</td>
<td>Integer</td>
</tr>
<tr>
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<td>weight gain</td>
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<td>Integer</td>
</tr>
<tr>
<td>19</td>
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</tr>
<tr>
<td>20</td>
<td>stressful life events</td>
<td>sl</td>
<td>Integer</td>
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<td>financial pressure</td>
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</tr>
<tr>
<td>23</td>
<td>employment status</td>
<td>es</td>
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</tr>
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<td>24</td>
<td>depression diagnosis</td>
<td></td>
<td>nominal</td>
</tr>
<tr>
<td>25</td>
<td>comorbidity</td>
<td></td>
<td>nominal</td>
</tr>
<tr>
<td>26</td>
<td>treatment</td>
<td></td>
<td>nominal</td>
</tr>
</tbody>
</table>

3.1 Proposed Ensemble Techniques

Stratified cross validation technique (Witten et al., 2011) was used to split the dataset of 580 patients (severe depression = 271, mild depression = 23, moderate depression = 272 and no-depression = 14), into three equal folds, in which two-thirds (387) of the dataset was used for training the model while the remaining one-third (193) was used for testing. This procedure was repeated three times to ensure an even representation in training and test sets. Weka provided the platform for the data analysis, preparation, model testing and result evaluation shown in Fig. 1.
4. RESULTS AND DISCUSSION-

Analysis of the Performance of Proposed Techniques

The results of the machine learning techniques, trained independently, and jointly, are presented in Tables 2, 3, 4, 5 and 6. The ensemble methods, in different combinations, show minor, but consistent improvement over the scores of each individual classifier. Matthews correlation coefficient (MCC) calculated all four values (TP, FN, FP and TN) of the confusion matrix. Receiver operating characteristics (ROC) provided the area under the curve (AUC) of the plot of the true positive rate (y-axis) against the false positive rate (x-axis). An excellent classifier will have ROC area values between 0.9 and 1.0 while a poor classifier will have ROC area values between 0.6 and 0.7 (Saito & Rehmsmeier, 2015). Similar to ROC, precision provided a very powerful way of evaluating the performance of the ensemble classifiers given the imbalanced dataset used for the study. A precision of 0.876 is interpreted as 87.6% correct predictions among the positive predictions.

One perspective for future improvements is to increase the size of the dataset and modify the model to separate patients having other diseases in addition to depression. Another direction for possible improvement to the model is to reduce the dimensionality of the attributes (features) using Principal component analysis (PCA).
Table 2. Results of independent classifiers.

<table>
<thead>
<tr>
<th></th>
<th>TPR</th>
<th>FPR</th>
<th>Prec</th>
<th>F-Score</th>
<th>MCC</th>
<th>ROC Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN</td>
<td>0.902</td>
<td>0.084</td>
<td>0.876</td>
<td>0.885</td>
<td>0.825</td>
<td>0.975</td>
</tr>
<tr>
<td>MLP</td>
<td>0.938</td>
<td>0.047</td>
<td>0.921</td>
<td>0.925</td>
<td>0.895</td>
<td>0.971</td>
</tr>
<tr>
<td>SVM</td>
<td>0.910</td>
<td>0.079</td>
<td>0.855</td>
<td>0.881</td>
<td>0.831</td>
<td>0.916</td>
</tr>
<tr>
<td>FL</td>
<td>0.926</td>
<td>0.064</td>
<td>0.928</td>
<td>0.907</td>
<td>0.872</td>
<td>0.951</td>
</tr>
<tr>
<td>KNN</td>
<td>0.947</td>
<td>0.028</td>
<td>0.946</td>
<td>0.946</td>
<td>0.919</td>
<td>0.959</td>
</tr>
</tbody>
</table>

Table 3. Two-classifier combination results

<table>
<thead>
<tr>
<th></th>
<th>TPR</th>
<th>FPR</th>
<th>Prec</th>
<th>F-Score</th>
<th>MCC</th>
<th>ROC Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN+ MLP</td>
<td>0.931</td>
<td>0.056</td>
<td>0.898</td>
<td>0.912</td>
<td>0.877</td>
<td>0.982</td>
</tr>
<tr>
<td>BN+ SVM</td>
<td>0.910</td>
<td>0.079</td>
<td>0.855</td>
<td>0.881</td>
<td>0.831</td>
<td>0.975</td>
</tr>
<tr>
<td>BN+ FL</td>
<td>0.931</td>
<td>0.059</td>
<td>0.935</td>
<td>0.913</td>
<td>0.881</td>
<td>0.980</td>
</tr>
<tr>
<td>BN+ KNN</td>
<td>0.947</td>
<td>0.028</td>
<td>0.946</td>
<td>0.946</td>
<td>0.919</td>
<td>0.989</td>
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<tr>
<td>MLP+ SVM</td>
<td>0.910</td>
<td>0.079</td>
<td>0.855</td>
<td>0.881</td>
<td>0.831</td>
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<td>MLP+ FL</td>
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<tr>
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<td>0.949</td>
<td>0.949</td>
<td>0.924</td>
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</table>
### Table 4. Three-classifier combination results

<table>
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<tr>
<th>Combination</th>
<th>TPR</th>
<th>FPR</th>
<th>Prec</th>
<th>F-Score</th>
<th>MCC</th>
<th>ROC Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN+ MLP+ SVM</td>
<td>0.929</td>
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<td>BN+ MLP+ FL</td>
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<td>0.058</td>
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<tr>
<td>BN+ MLP+ KNN</td>
<td>0.943</td>
<td>0.046</td>
<td>0.936</td>
<td>0.933</td>
<td>0.905</td>
<td>0.991</td>
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<td>BN+ SVM+ FL</td>
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<td>0.903</td>
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</tr>
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<td>MLP+ SVM+ FL</td>
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<td>MLP+ FL+ KNN</td>
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<td>0.991</td>
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<tr>
<td>SVM+ FL+ KNN</td>
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<td>0.061</td>
<td>0.932</td>
<td>0.910</td>
<td>0.878</td>
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### Table 5. Five-classifier combination results

<table>
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<tr>
<th>Combination</th>
<th>TPR</th>
<th>FPR</th>
<th>Prec</th>
<th>F-Score</th>
<th>MCC</th>
<th>ROC Area</th>
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<tbody>
<tr>
<td>BN+ MLP+ SVM+ FL</td>
<td>0.929</td>
<td>0.062</td>
<td>0.895</td>
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<tr>
<td>BN+ MLP+ SVM+ KNN</td>
<td>0.931</td>
<td>0.059</td>
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<td>0.913</td>
<td>0.881</td>
<td>0.990</td>
</tr>
<tr>
<td>MLP+ SVM+ FL+ KNN</td>
<td>0.933</td>
<td>0.058</td>
<td>0.936</td>
<td>0.914</td>
<td>0.884</td>
<td>0.990</td>
</tr>
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</table>

### Table 6. Four-classifier combination results

<table>
<thead>
<tr>
<th>Combination</th>
<th>TPR</th>
<th>FPR</th>
<th>Prec</th>
<th>F-Score</th>
<th>MCC</th>
<th>ROC Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN+ MLP+ SVM+ FL+ KNN</td>
<td>0.933</td>
<td>0.059</td>
<td>0.899</td>
<td>0.912</td>
<td>0.878</td>
<td>0.991</td>
</tr>
</tbody>
</table>
5. CONCLUSIONS AND FUTURE WORK

The diagnosis of depression still remains a major challenge because of its high comorbid factor and acute shortage of mental health professionals. Ensemble techniques, consisting of Bayesian networks, Back-Propagation MLP, SVM, Fuzzy logic and Nearest neighbour, was used to improve the needed diagnosis and prediction accuracy of depression. Though recommendations cannot be made at this stage of the research, the results from the algorithms presented offer a foundation for preliminary conclusions. It suggest that, even though the algorithms achieved high accuracy when used independently, utilizing them jointly creates a better system to support clinical decisions in predicting the level of risks of depressive disorders.

6. RESEARCH IMPLICATIONS AND FUTURE WORKS

There have been rampant cases of missed diagnosis of depression in Nigeria, leading to ineffective treatment and increased burden of the disorders on the sufferers. The proposed model will support clinical decisions in the diagnosis of depression. The future scope of this work would be to modify the model to separate patients having other diseases in addition to depression.

REFERENCES


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Some Issues of Accountability Framework in Data Intensive Cloud Computing Environment

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ABSTRACT

Data Intensive Cloud Computing Environment is becoming a social phenomenon due to being widely accepted among researchers, industries and day to day affairs and for harboring ramified quality of service concerns. However, it may lead to numerous acceptance of responsibility in terms of accountability issues. Even though cloud service providers may vouch for the fact that data is accountable, there are really no means by which the users can make sure in context to quality. Accountability may be regarded as one of the QoS issues by preserving data transparency and traceability. This paper addresses some issues that may serve in designing an efficient and effective accountability framework for Data Intensive cloud computing environment. Further this includes some analysis through based on the proposed considerations which has been performed on other models in order to ensure viability and compatibility among all.

Keywords: Data Intensive Cloud Computing Environment, Accountability Framework, QoS issues, transparency

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

Cloud computing makes use of resources and services which are communicated over the Internet. Over the last few years cloud computing has emerged to be one of the most powerful technologies and since then has been maximizing the effectiveness of shared resources. As it is cost efficient and incorporates almost unlimited storage the number of users has been growing enormously. However it may also harm an organization if not utilized properly. Cloud computing too faces issues related to data breaches and security as it is prone to attack [1]. Ensuring the fact that a user’s data is secured or not is becoming increasingly complicated for the Cloud Service Providers.

Accountability may be used to safeguard data against illegal tampering and also to protect valuable data. Moreover, accountability is the willingness to revel and accept responsibility for performance which may be agreed upon expectations [2]. A system that includes accountability may be such that faults can be reliably detected, and each fault can be undeniably linked to at least one faulty node [3]. According to Pearson [4], Accountability for an organization consists of accepting responsibility for the stewardship of personal and/or confidential data with which it is entrusted in a cloud environment, for processing, sharing, storing and otherwise using the data according to contractual and legal requirements from the time it is collected until when the data is destroyed (including onward transfer to and from third parties).

The principle of accountability significantly incorporates transparency, validation and remediation. Some conceptual attributes which underpin the idea of Accountability are Responsibility, Transparency, Availability, Remediation, Verifiability, Suitability, Attributability and Interoperability.

2. LITERATURE SURVEY

In 2001, Ko [5], proposed TrustCloud, a framework for ensuring trust and accountability in a cloud making use of five abstraction layers. A clear distinction of abstraction layers reduces ambiguity. The framework has five layers which work differently and have different set of sub-components. The System layer accomplishes central logging and is inclusive of Operating Systems, File Systems and the Cloud’s Internal Network. The Data Layer makes data centric logging possible through Provenance Logger and Consistency Logger. Provenance Logging must be secure and privacy aware, consistent, transparent, scalable, persistent and efficient. Consistency logger supports rollback, recovery, replay, backup and restoration of data using transaction logs which ensure Atomicity, Consistency, Isolation and Durability (ACID) properties. The Workflow Layer takes into account audit trails and audit related data which are part of software services in the cloud. The proposed mechanism serves as a powerful tool for enforcing trust and accountability.
However, the study is merely speculative and does not deal with feasibility. The study could have been satisfactory if practical things were taken into consideration. Sundareswaran [6] in 2011, proposed an automatic logging mechanism to support the cloud framework. The framework is platform independent as well as highly decentralized framework ensures data protection using certain degree of usage control. The basic framework comprises of a logger and log harmonizer. Public and private keys are created on the basis of Identity Based Encryption. Use of SSL based certificates and SAML based authentication is instrumental in providing accountability. The system uses an end to end auditing mechanism via the push and pull mode. The performance study focusses on monitor Log Creation time, Authentication Time, time taken to Perform Logging, log merging Time and Size of Data-JAR file. The work can effectively provide data accountability by monitoring the usage of data. It also makes sure that any access to the data is being tracked. It enforces strong back end protection. The weakness in the proposed model is that given so many performance studies, it will be expected to result in excessive resource consumption. The approach is loosely based on Amazon EC2 and could have been general instead of specific.

Sundareswaran [7] in 2012, proposed an object centered approach by integrating logging mechanisms and user’s data and policies in order to establish a framework. The basic framework is same as their already proposed scheme. The end to end auditing mechanism makes use of push and pull mode to offer accountability. Performance study parameters remain same except the fact that an additional overhead added by Java Virtual Machine Integrity Checking can be evaluated using hash codes. The strength of the study is automatic logging of data, back end protection and effective monitoring of data usage. The data owner can audit even those copies of data which were created without his awareness. The limitation of the system is that it does not emphasize on assigning Software Tamper Resistance to Java applications. A more generic object oriented approach may have been satisfactory to implement autonomous protection of data.

In 2013, Rajesh [8] proposed a Cloud Information Accountability (CIA) framework making use of access control, usage control and authentication to meet the Service Level Agreements. The framework uses two major components, the logger and the log Harmonizer to provide logging access and for monitoring and rectifying respectively. A logger encrypts log records making use of public key given by the data owner which were then sent to the log harmonizer. A log harmonizer generates a master key for decryption and sent the key to the client. The generated key creates a logger which is a Java Archive (JAR) file and has access control mechanisms. The Identity Based Encryption technique has been utilized to create a pair of public and private keys. The JAR file is forwarded to the Cloud Service Providers and certified by open SSL based certificates.

When a user logs in, log record is filed, is encrypted and stored. Log file corruption is handled by log harmonizer leading to end to end accountability. However, the proposed framework has certain loopholes which question its feasibility in a large scale cloud environment. Logging equipment generally record data within given intervals of time, therefore data will not be recorded if something inappropriate happens between the intervals.

In 2013, Preetha [9], proposed a framework which highlights automated logging and distributed auditing whenever an entity accesses a system. The logger and the log harmonizer maintain accountability by making use of encryption and decryption techniques. However, log records strengthen the morality of accountability. A log record can be represented as

$$\text{ri} = \langle \text{ID,Act,T,Loc}, h((\text{ID,Act,T,Loc})| \text{ri} - 1\. . . |\text{ri1}), \text{sig} \rangle$$

Where ri denotes that an entity ID has performed an action Act on the user’s data, given time T and location Loc

$$h((\text{ID,Act,T,Loc})| \text{ri} - 1\. . . |\text{ri1}), \text{sig} \rangle$$

denotes the checksum of the previous record concatenation with the main content. A collision hash free function is used to obtain the checksum. The time of access is deduced using the Network Time Protocol and the location can be figured out by the IPAddressAct. The paper emphasizes on log verification by repairing the Java Runtime Environment (JRE) to preserve its integrity before the logger is executed. Hashing techniques justify the integrity of the logger component. The work triggers authentication and also preserves the integrity of the JRE. However, the framework has neither been validated nor deployed in the professional cloud computing environment. Hash tables are often difficult to implement and even though they take constant time on average, their cost can be significantly high.

In 2013, Zheng [10] stated that traditional approaches banked upon encryption, authentication and access control mechanisms, but securing cloud technology requires effort. The Cloud Accountability framework recommended in this paper has three components, the programmable JAR, logger and a log Harmonizer. For auditing, two modes i.e. push and pull have also been mentioned [11]. Programmable JAR relates to the extended capabilities of JAVA Archives to automatically log the usage. The logger is a nested JAVA file that stores user’s data, whereas the log harmonizer implemented as a JAR file is responsible for auditing. The Cloud accountability model for A4Cloud has been proposed which works upon the Accountability Layer, Accountability Principle and Accountability Mechanism. The solutions provided to ensure accountability have many limitations and technological challenges like log storage issues, log storage and merging, and interception of data. Another drawback of the proposed framework is that it is specific to Amazon.
In 2013, Ashwini [12], expressed that accountability is needed for monitoring data usage and it is the verification for authentication and authorization. With the Cloud Information Accountability [13] frameworks as the base, and considering the Amazon Cloud storage, the major components of the framework have been nominated as a logger, a JAR module and a JAR executor. A logger ensures that whenever logging mechanism occurs, any access to data in the JAR file is recorded and migrated to log record which is further encrypted. A jar module encompasses a JAR generator and a JAR executor wherein the generated JAR file is loaded to the JAR executor. It is the JAR executor which sends the user’s log details to the logger component. The Attribute Based Encryption (ABE) is used for key generation and the CP-ABE technique ensures that each data item undergoes encryption when uploaded to the cloud. Clearly, the framework can protect data using programmable JAR and is effective for auditing mechanism. However, it is not generalized and cannot be adopted in all environments. Moreover in Attribute Based Encryption the data owner needs to use every authorized user’s public key to decrypt data and often the application of this scheme is restricted to real environment as it uses the access of monotonic attributes to control user’s access in the system [14].

In 2014, Chavali [15] proposed a framework, wherein the data owner determines the authorization principles and policies and the user is responsible for handling rule and logs for each access. The logger and log harmonizer coordinate to encrypt log records and generate key for decryption mechanism. Pattern generated by the key owner leads to creation of Java Archive files which include access management rules. Secure Socket Layer (SSL) based certificates certify Cloud Service Provider to the JAR. Security Assertion Markup Language (SAML) is used for identity confirmation. The proposed framework prevents various attacks like detecting illegal copies of users’ information. The Fog Computing Methodology [16] had been deployed for securing data which include User Behavior Profiling and Decoys. In the User Behavior Profiling method, observing how, when and how much amount of data is being utilized by a client, one can infer whether abnormal access to data is taking place or not. The metered information is often used in fraud detection. Decoy information like honey files and honeypots can be utilized to detect unauthorized access to data which relies on the idea of confusing an attacker who may be extracting useful information. Thus, decoys contribute in validating whether access is authorized or not when abnormal access is identified, and confusing an attacker with bogus information. The work ensures that data usage is transparent and also support a variety of security mechanisms. However Fog Computing introduces certain demerits on the selection of technology platforms, web applications and other services [17]. Besides honeypots are known to introduce risks to the environment.

3. ISSUES OF ACCOUNTABILITY FRAMEWORK IN DATA INTENSIVE CLOUD COMPUTING ENVIRONMENT

In this section, we focus on some important considerations that may assist in designing an efficient and effective framework in order to ensure accountability.

Several frameworks have been put forward in the past to assure accountability in cloud computing environment. Though all the frameworks strive to ensure accountability, the problem domain of each is very different. We assimilate all the problem domains in an effort to identify issues that may enable us to design a framework to ensure accountability. A distinct minimum threshold value for each attribute defines the tolerance level of the model with respect to the given attribute. Any value below this level is considered non bearable by the system and does not encourage accountability.

Data Security
Protection of data from unintended users, otherwise Data Security can be attained by deploying security architectures like virtual private clouds or dedicated private clouds. The proposed framework should vouch for 95 percent data securitys.

Data Leakage
When data is relocated in an unauthorized manner from a data center to an exterior domain data leakage is said to have been taking place. Our proposed framework should not encourage this and limit the data leakage to (0-5%). Vaulters ensures zero data for leakage by adopting an end to end security.

Trust Management
Trust management represents social trust and is an indispensable aspect of cloud computing. It is a crucial component for ensuring accountability. In nearly of all cases, the accuracy of a trust management model is never below 90%, however it may decrease to a minimum 85% [18].

User Privacy
Privacy issues are a result of magnanimous amount of information over the network. While some users are unaware of privacy risks, others do not care. For a system to possess the feature of accountability user privacy should be at least 95%.

Anomaly Detection
Anomaly detection refers to identification of events and occurrences which do not conform to a given pattern. An accountable system model should be able to perform anomaly detection as high as 96.24% at a false positive rate of 0.03% [19]. Density based techniques, ensemble techniques and cluster analysis are a few anomaly detection techniques.
Data Transparency
Data transparency is the ability to access and work with data irrespective of its location and to gain assurance regarding data accuracy. It is a key characteristic of accountability. In this proposed framework we seek to attain at least 99% data transparency.

Data Tracking
Data tracking deals with a tracking system to report data changes. In our framework, we would like the data tracking efficiency to be at least 75%. CloudFence is a framework which aims at providing transparent and fine grained data tracking capabilities of both the service providers and users [20].

Tamper proof logging files
To ensure accountability log files should be immune to any kind of tampering. This would screen the files from insertion, deletion and modification from malignant attackers.

It is possible to gain 100% tamper free log files with systems like BotSwindler effectively embedded into the framework [21]. Tripwire Log Centre is equally effective for presenting secure and reliable logs. It can also perform event alerting as well as automation.

Data provenance
Data provenance allows us to not only trace and record the origin of data but also to examine the movement of data across databases. It involves ownership of a document and the log of tasks maintained for users. Though data provenance contributes a lot to maintain accountability, it faces several challenges [22]. Thus we restrict data provenance to 75%.

Thus an integrated Monitoring system could act as the backbone for Cloud Information Accountability framework. The data can be logged by virtue of the monitoring system and assimilated to form meaningful reports. Figure 1 represents the permissible value of attributes for the proposed Framework.

Figure 1. Proposed Accountability Framework Attributes with their requisite percentage
4. CRITICAL EVALUATION

The nominated frameworks may be critically evaluated in a tabular manner focusing on the problem discussed, the framework components, the mechanisms proposed and reference models if any. Based on the evaluation, we introduce attributes that may overcome the drawbacks of previous frameworks. The table may be composed as follows.

Table 1: Comparison of different frameworks

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Cloud information Accountability Framework by Sundareswaran (1) in 2011 [6]</td>
<td>Data Handling by CSPs to other entities, privacy protection, reliable and tamper proof Log files</td>
<td>Logger(nested JAR file), Java JAR file, Log Harmonizer</td>
<td>Oblivious Hashing, Automated Logging Mechanism, End to End Auditing Mechanism, Identity Based Encryption</td>
<td>Eucalyptus, Amazon EC2</td>
</tr>
<tr>
<td>Cloud information Accountability Framework by Sundareswaran [7]</td>
<td>Data integrity, Data Provenance, Distributed Accountability</td>
<td>Logger(nested Java JAR file), Log Harmonizer</td>
<td>Oblivious Hashing, Automated Logging Mechanism, End to End Auditing Mechanism, Identity Based Encryption</td>
<td>Eucalyptus, Amazon EC2</td>
</tr>
<tr>
<td>Cloud Information Accountability (CIA) Framework by Preetha in 2013 [9]</td>
<td>Data Security, Trust Management, Integrit of Data Storage, Log Verification</td>
<td>Logger (pure/access), Log Harmonizer</td>
<td>Identity Based Encryption, Oblivious Hashing, End to End Auditing Mechanism</td>
<td>APPLE core</td>
</tr>
<tr>
<td>Framework for Accountability and Auditing by Ashwini in 2013 [12]</td>
<td>Security issues, Data usage, Data Protection, Anomaly Detection</td>
<td>Logger, JAR Module(JAR generator, JAR executor), ABE key generator</td>
<td>Attribute Based Encryption, Automated Logging Mechanism</td>
<td>Amazon web service s3 (cloud storage)</td>
</tr>
<tr>
<td>Cloud Accountability Framework (proposed)</td>
<td>Data Leakage, Data Security, Trust Management, Privacy, Anomaly Detection, Transparency, Data Tracking, Tamper proof Log Files, Data Provenance</td>
<td>An Overall integrated Monitoring System to ensure Accountability, Automated Logging, Anomaly Detection Techniques</td>
<td>CloudFence</td>
<td></td>
</tr>
</tbody>
</table>
5. ACCOUNTABILITY TESTING

Ensuring Accountability is one of the most important requirements for any cloud. Amazon Elastic Compute Cloud is a web service which aims at providing resizable computing capacity to the cloud. A4 Cloud enforces trust management by making use of legal and regulatory mechanisms and also encourages technological advancements and can further be used to strengthen monitoring [23]. Amazon Web Services as well as A4 clouds are distinguished by a set of features to promote Accountability. Similarly Microsoft Azure which is an open cloud computing platform enforces data accessing mechanism by deploying and managing applications and services. It also establishes computing security by focusing on privacy preservation. We may include a number of common features for all the frameworks to exhibit accountability testing. Further a comparison study may the set of attributes for both the frameworks and determine degree of accountability each framework aims for. The following are some features we can depend on for accountability testing:

Reliability
Reliability is defined as the probability of a service being operated without failure in a stipulated time and gives the condition. The mean time between failures often denotes reliability and performance of a system is given by the difference of total elapsed time and sum of downtime calculated over the number of failures. This is similar to the difference between available time and downtime calculated over number of breaks.

Availability
Availability refers to the time a system qualifies for providing its intended function. It is essentially the time a customer can avail the service. Hence availability is the difference of total service time and total time for which the service was not available calculated over the total elapsed time.

Interoperability
Interoperability is the potential of a system to perform services from different vendors. It also refers to the capability a service to communicate with other services irrespective of operating systems and architecture. Thus interoperability is given by the number of platforms offered by the provider calculated over number of platforms required by user for interoperability.

Transparency
Transparency may be described as the degree to which the usability of a user gets affected following any changes in a service. We can therefore deduce that it is the time for which capability of a user application is hampered provided a change in the service. We calculate transparency in terms of frequency. Hence transparency is the summation of time for service effect for customer calculated over the number of occurrences whole divided by the number of customers availing the service.

Suitability
Suitability is the degree to which a Cloud provider meets the requirements of a customer. Suitability is computed by Number of non-essential features provided by service over number of non-essential features provided by customer. It is 1, if all features are satisfied, else 0.

6. ACCOUNTABILITY TESTING COMPARISON

The Proposed framework has listed a few attributes. Now we compare frameworks on the basis of magnitude of percentage of each feature to determine overall accountability achieved. Considering total number of days to be 365, and the downtime being 3.65 days following 4 failures in a year for A4Cloud we can deduce the percentages as follows. Further for Amazon EC2, the downtime is 8.65 minutes, revealing the number of failures to be 15. For Microsoft Azure, given a span of 365 days, the number of outages is 409 and the downtime region is 1.45 hours [24].

<table>
<thead>
<tr>
<th>Cloud Services Attributes</th>
<th>A4Cloud</th>
<th>Amazon EC2</th>
<th>Microsoft Azure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>90.33%</td>
<td>97.16%</td>
<td>99.99%</td>
</tr>
</tbody>
</table>

The study has been conducted to deduce that accountability testing can be done using the above parameters. We reinforce our work by comparing the availability of Amazon EC2 and Microsoft Azure [25] which is approximately the same. Out of the many services the consumers demand there are many that A4 cannot provide making interoperability one of the biggest challenges. However, Amazon EC2 and Microsoft Azure offer almost the same number of platforms required by the users. As all the three models stress upon Accountability and Trust Management, transparency level is virtually the same for all. Further all the three models satisfy suitability features bringing suitability factor to 1 which is nothing but 100%.
7. CONCLUSION
In this study we have interpreted different cloud frameworks which underpin accountability. As cloud services are used by both large and small scale organizations, being a global phenomenon it suffers from quality of service concerns. Along with the cloud service providers, the users must simultaneously work together in order to ensure accountability as well as protection of data. The greatest perturbation of cloud users is loss of data and privacy. Our study provides a comparison on proposed different cloud accountability frameworks to address such accountability related issues. Additionally issues of accountability framework in data intensive cloud environment have been identified. Accountability mechanism has been performed wherein features common to the different cloud frameworks have been compared mathematically to infer the degree of accountability provided by each of the frameworks. This also validates that the proposed framework can adapt to any platform and is compatible with various services as well.

FUTURE WORK
As cloud computing is not fully mature and there are yet many unexplored territories, cloud is prone to certain issues which require attention. This introduces the idea of accountability. Though we have observed that most of the frameworks tackle issues like data integrity and end to end accountability many QoS issues still prevail and need to be worked upon. Different tools and architectures have been proposed but the issues have yet not been mitigated. While performing research we came across the fact that there is no framework that provides 100% accountability to the issues raised. In our future work, we may integrate the existing system with functionalities to reduce the loopholes. As security breaches know no bounds, the necessity of a comparatively superior accountability framework will always be there. Furthermore, easily configurable monitoring systems could be proposed so that monitoring of data can take place across all services of a cloud.

REFERENCES


Author’s Profile

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Comparative Analysis of Selected Supervised Classification Algorithms

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ABSTRACT

Information is not packaged in a standard easy-to-retrieve format. It is an underlying and usually subtle and misleading concept buried in massive amounts of raw data. From the beginning of time it has been man’s common goal to make his life easier. The prevailing notion in society is that wealth brings comfort and luxury, so it is not surprising that there has been so much work done on ways to sort large volume of data. Over the year, there are various data mining techniques and used to sort large volume of data. This paper considers Classification which is a supervised learning technique. Therefore the need to come up with the most efficient way to deal with voluminous data with very little time frame has been one of the biggest challenges to the AI community. Hence, this paper presents a comparative analysis of three classification algorithms namely; Decision Tree (J-48), Random Forest and Naïve Bayes. A 10-fold cross validation technique is used for the performance evaluation of the classifiers on KDD’99, VOTE and CREDIT datasets using WEKA (Waikato Environment for Knowledge Analysis) tool. The experiment shows that the type of dataset determines which classifier is suitable.

Keywords: Classification, Decision Tree (DT J-48), Random Forest (RF), Naïve Bayes (NB).

1. INTRODUCTION

Knowledge discovery in databases (KDD) is the process of sorting through large amounts of data and picking out relevant information. It is the automated extraction of hidden predictive information from large databases [4], hence it is useful for collecting and interpreting data from huge database [5]. Data mining in relation to Enterprise Resource Planning is the statistical and logical analysis of large sets of transaction data, looking for patterns that can aid decision making. Now, statisticians view data mining as the construction of a statistical model, that is, an underlying distribution from which the visible data is drawn [9]. There are some who regard data mining as synonymous with machine learning. There is no question that some data mining appropriately uses algorithms from machine learning. Machine types used by machine-learning practitioners, such as Bayes nets, Support Vector Machines, decision trees, hidden Markov models, and many others.

Classification is the process of finding the hidden pattern in data. Classification is one of data mining functionalities. It finds a model or function that separates classes or data concepts in order to predict the classes of an unknown object. The data analysis task is classification, where a model or classifier is constructed to predict class (categorical) labels, such as “safe” or “risky” for the loan application data. These categories can be represented by discrete values, where the ordering among values has no meaning. Because the class labels of training data is already known, it is also called supervised learning.
2. CLASSIFICATION ALGORITHMS

A. DECISION TREE

Decision tree is a predictive modeling technique most often used for classification in data mining [10]. The Classification algorithm is inductively learned to construct a model from the pre-classified data set. An advantage of using decision tree algorithms is that its construction does not require any domain knowledge. Hence a data mining expert with little knowledge of networking can help build accurate decision tree models and decision trees can handle high dimensional data. Each data item is defined by values of the attributes and classification may be viewed as mapping from a set of attributes to a particular class. Each non-terminal node in the decision tree represents a test or decision on the considered data item. Choice of a certain branch depends upon the outcome of the test. To classify a particular data item, we start at the root node and follow the assertions down until we reach a terminal node (or leaf). A decision is made when a terminal node is approached [11]. In decision tree, Each internal node tests an attribute, Each branch corresponds to attribute value, Each leaf node assigns a classification and When DT is used instances are describable by attribute. Target function is discrete valued, Disjunctive hypothesis may be required very useful when there is possibly noisy training data.

A. Random Forest

Random Forest is an ensemble of trees specifically decision trees, which has been ensemble using different methods such as bagging, boosting ,random split selection. Random forests, a meta-learner comprised of many individual trees, was designed to operate quickly over large datasets and more importantly to be diverse by using random samples to build each tree in the forest. Randomly sample with replacement (bootstrap) the training set and select 2/3 of data to be used for tree construction, choose a random number of attributes from the in Bag data and select the one with the most information gain to comprise each node and continue to work down the tree until no more nodes can be created due to information loss (). Diversity is obtained by randomly choosing attributes at each node of the tree and then using the attribute that provides the highest level of learning. Performance of the random forests algorithm is linked to the level of correlation between any two trees in the forest. The more the correlation increases, the lower the overall performance of the entire forest of trees.

The way to vary the level of correlation between trees is by adjusting the number of random attributes to be selected when creating a split in each tree. Increasing this variable (m) will both increase the correlation of each tree and the strength of each tree. At some point the tree correlation and tree strength will complement each other providing the highest performance. In addition, increasing the number of trees will provide a more intelligent learner just as having a large diverse group will make intelligent decisions. A random forest is a classifier consisting of a collection of tree structured classifiers \( \{ h(x, Q_k) \} \) where the \( \{ Q_k \} \) are independent identically distributed random vectors and each tree casts a unit vote for the most popular class at input \( x \) [2].

B. Naïve Bayes

The Bayesian classification represents a supervised learning method as well as a statistical method for classification Assuming an underlying probabilistic model, it allows to capture an certainty about the model in a principled way by determining probabilities of the outcomes [1]. In simple terms, a naive Bayes classifier assumes that the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature. Naïve Bayesian classifiers simplify the computations and exhibit high accuracy and speed when applied to large databases. A disadvantage of using Bayesian networks is that their results are similar to those derived from threshold-based systems, while considerably higher computational effort is required [11]. Another disadvantage is that in naïve bayes approach it is assumed that the data attributes are conditionally independent [12] which is not always so (it should be noted however that despite this, Bayesian classifiers give satisfactory results because focus is on identifying the classes for the instances, not the exact probabilities). Naïve Bayes (NB): Handles continuous attributes three ways: model them as a single normal, model them with kernel estimation, or discretize them using supervised discretization. For each trial we use 4000 cases to train the different models, 1000 cases to calibrate the models and select the best parameters, and then report performance on the large final test set. We would like to run more trials, but this is a very expensive set of experiments. Fortunately, even with only five trials we are able to discern interesting differences between methods [13].

The naive Bayesian classifier works thus: Each data sample is represented by an \( n \) dimensional feature vector, \( X = (x_1, x_2..., x_n) \) Suppose that there are \( m \) classes \( H_1, H_2..., H_m \). Given an unknown data sample, \( X \), the classifier will predict that \( X \) belongs to the class having the higher posterior probability, conditioned on \( X \). That is, the naive Bayesian classifier assigns an unknown sample \( X \) to the class \( H_i \) if and only if: \( P (H_i / X) > P (H_j / X) \) for \( 1 \leq j \leq m \). This posterior probabilities are computed using Bayes theorem. In other words an unknown sample \( X \) is assigned to the class \( H_i \) for which the \( P (H_i / X) \) is the maximum.
3. EXPERIMENTAL RESULTS

This section presents the result of experimental studies using both crisp-valued and real-valued data sets. We evaluate algorithms on KDD’99 and on datasets, which are available in the WEKA tool. In our experiment, DT(J-48), Random Forest and Naïve Bayes were compared using Weka. A short experimental evaluation for benchmark datasets is presented. The information of the data sets contains names of dataset, number of instances and number of attributes which are given in Table 1.

Table 1: Experimental datasets

<table>
<thead>
<tr>
<th>Index</th>
<th>Dataset</th>
<th>Instances</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KDD’99</td>
<td>487,271</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>VOTE</td>
<td>435</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>CREDIT</td>
<td>1,000</td>
<td>21</td>
</tr>
</tbody>
</table>

A. Weka Classification

The Waikato Environment for Knowledge Analysis (Weka) is a comprehensive suite of Java class libraries that implement many state-of-the-art machine learning and data mining algorithms. Weka is freely available on the World-Wide Web and accompanies a new text on data mining [7] which documents and fully explains all the algorithms it contains. Applications written using the Weka class libraries can be run on any computer with a Web browsing capability; this allows users to apply machine learning techniques to their own data regardless of computer platform.

Tools are provided for pre-processing data, feeding it into a variety of learning schemes, and analyzing the resulting classifiers and their performance [8].

An important resource for navigating through Weka is its on-line documentation, which is automatically generated from the source. The primary learning methods in Weka are —classifiers, and they induce a rule set or decision tree that models the data. Weka also includes algorithms for learning association rules and clustering data.

The core package contains classes that are accessed from almost every other class in Weka. The most important classes in it are Attribute, Instance, and Instances. An object of class Attribute represents an attribute—it contains the attribute’s name, its type, and, in case of a nominal attribute, its possible values. An object of class Instance contains the attribute values of a particular instance; and an object of class Instances contains an ordered set of instances—in other words, a dataset.

In this paper we have taken the classifiers such as Decision Table, Random Forest and Naïve Bayes. The datasets that are used are KDD’99, VOTE and CREDIT (both of WEKA tool) are classified using the above referred classifiers. Table 2, 3, 4 shows the correctly and incorrectly classified instances and classification time of mentioned classification algorithms respectively.

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>Correctly Classified Instances</th>
<th>Incorrectly Classified Instances</th>
<th>Classification Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECISION-TREE</td>
<td>99.9598</td>
<td>0.0402</td>
<td>130.98</td>
</tr>
<tr>
<td>RANDOM FOREST</td>
<td>99.9733</td>
<td>0.0267</td>
<td>142.71</td>
</tr>
<tr>
<td>NAIVE BAYES</td>
<td>99.6661</td>
<td>1627</td>
<td>32.79</td>
</tr>
</tbody>
</table>
Figure 1, depicts the performance of the discussed classification algorithms on KDD’99 dataset. Random Forest exhibit highest classification accuracy and is the best supervised classification algorithm for KDD’99 data set.

![Figure 1: Classification Accuracy and Time for KDD’99 dataset](image)

**TABLE 3: Classification Accuracy And Time For Vote Dataset**

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>Correctly Classified Instances</th>
<th>Incorrectly Classified Instances</th>
<th>Classification Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECISION-TREE</td>
<td>96.3218</td>
<td>3.6782</td>
<td>0.06</td>
</tr>
<tr>
<td>RANDOM FOREST</td>
<td>95.4023</td>
<td>4.5977</td>
<td>0.28</td>
</tr>
<tr>
<td>NAIVE BAYES</td>
<td>90.119</td>
<td>9.881</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 2, depicts the performance of the discussed classification algorithms on VOTE dataset. Decision Tree exhibit highest classification accuracy and is the best supervised classification algorithm for VOTE data set.

![Figure 2: Classification Accuracy and Time for VOTE data set](image)
Table 4: Classification Accuracy And Time For Credit Data Set

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>Correctly Classified Instances</th>
<th>Incorrectly Classified Instances</th>
<th>Classification Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECISION-TREE</td>
<td>70.5</td>
<td>29.5</td>
<td>0.22</td>
</tr>
<tr>
<td>RANDOM FOREST</td>
<td>73.6</td>
<td>26.4</td>
<td>0.31</td>
</tr>
<tr>
<td>NAIVE BAYES</td>
<td>75.4</td>
<td>24.6</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Figure 3, depicts the performance of the discussed classification algorithms on CREDIT dataset. Naïve Bayes exhibit highest classification accuracy and is the best supervised classification algorithm for CREDIT data set.

4. CONCLUSION

Inarguably, various algorithms have been used for many researches; it is of high importance to note that each of the algorithms has its own advantages and disadvantages. Figure 1, Figure 2 and Figure 3 above show the performance of some selected algorithms in classifying connection records (KDD Cup ’99 data set, VOTE and CREDIT (WEKA) datasets). Despite the fact that algorithms gave different detection rate and one is better than the others albeit on different dataset, none is actually said to be best. It is pertinent to note that different classifiers have different knowledge regarding the problem and they approach the problems differently. The type of dataset determines which is best.

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The factors improving firm Performance in Competitive Intelligence on Small and Medium Enterprise in Gauteng, South Africa

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ABSTRACT

The study aimed to investigate the extent to which the usefulness of Competitive Intelligence (CI) gives rise to improve competitive performances in Small and Medium Enterprise (SMEs) in South Africa. The study enhances the roles of technological and environmental factors in improving competitive advantage for SMEs, which focus on five geographical zones in Gauteng province only. Firstly, two models were applied in this study, the adoption of the Modified Technology Acceptance Model (TAM) in combination with the modified SMEs Competitiveness Model to investigate the extent to which competitive intelligence improved firm performance. Secondly, a quantitative research approach was applied, where purposive sampling was utilised as a data collecting tool from individuals at lower, middle and top management levels. This research argued that perceived ease of Use (PEOU) and perceived usefulness are the most important factors that determine the application of CI tools for competitive advantage in SMEs. The results indicate that, IT Training, SWOT and political, economic, social and technology (PEST) are also significant explanatory factors of competitive intelligence (CI) that enhance firm performance in the context of small and medium sized enterprises. All statistical analyses were performed by using structural equation modelling with the statistical package for the social sciences (SPSS) version 14.0. The study recommended that, before SMEs will survive beyond the remarkable year, technological tools, PEOU, and PU are important factors that explain the utility of SWOT and PEST which are found to be the best constructs for a new framework for the utilisation of CI tools in SMEs.

Keywords: Competitive Intelligence, SMEs, Perceived Ease of Use and Perceived Usefulness

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

Competitive intelligence (CI) is increasingly becoming vital in organisations in all sectors, be it private, non-profit organisation or public. The rapidly increasing global competition has made Competitive Intelligence an important tool for organizations’ success. It is important that Small and Medium Enterprises (SMEs) keep abreast with what is happening in both the internal and external business environment. This is paramount for their sustainability and success, sustainability and success of SMEs is essential for the economic growth of any country especially in the developing country. Some researchers have described, that competitive intelligence is the process of developing actionable foresight regarding competitive dynamics and non-market factors that can be used to enhance competitive advantage [1]. It is simply a systematic process of determining information needs, collecting the right information for analysis and applying the results of the Competitive Intelligence process in strategic planning [2].

For the purpose of this study, Brody’s definition has been embraced because it is wider and simple. [3] defines CI as “the process by which enterprises gather actionable information about competitors and the competitive environment and, ideally, apply it to their planning processes and decision-making in order to improve their enterprise’s performance.” CI helps organizations to understand and respond to their competitors in their internal and external environment. This implies that CI tools play important roles for the survival of organisations. It is crucial for SMEs to take cognisance of changes in their environment such as; political, legislatives, changes in customers’ expectations and competitors’ behaviours. Hence, benchmarking for internal and external best practice is needed for SMEs in the making of strategic decisions. Businesses need accurate, complete, and valid information for decision-making. From the strategic marketing point of view, CI is looked at as a tool that could be used for information collection [2]. Similarly, CI may also contribute to the technological knowledge and intelligence within organization. Such knowledge could be used in the analysis of information systems’ innovations within organisations.
[4] noted that, CI is essential for the initiation of innovation process, observation of markets and in devising strategies. This could assist the organizations to excel in its business environment and to retain its customers. They asserted that, CI functionalities could also be extended in the production and manufacturing environment in designing and developing new products. Competition is not a force to be taken lightly in the business world. In fact, companies face competition every day [5]. Competitive dynamics refers to the evolution of a country’s industries and the moves and countermoves of competitors, suppliers, customers, alliance partners and potential competitors [1]. Competitive dynamics includes the ability to provide products and services as or more effectively and efficiently than the relevant competitors; for example, success in international trade, high productivity, competitive cost of production and high quality of goods and share in regional or global markets [1]. The need for information about this force has been named “competitive information,” “corporate intelligence,” “corporate information” and “business intelligence.

2. PERCEPTION OF COMPETITIVE INTELLIGENCE AND BUSINESS INTELLIGENCE IN SMALL AND MEDIUM ENTERPRISES

Competitive Intelligence also referred to as corporate or business intelligence [6]. CI is confused with business intelligence (BI) [7]. The difference between BI and CI is that, BI is internal intelligence about and within one’s own company, whereas CI is external intelligence about the firm’s competitors [7]. BI plays a critical role in providing actionable intelligence to enable good business decision-making. International research shows clear evidence of the benefits of implementing sound BI practices [8]. According to [9] points out that BI system combine operational data with analytical tools to present complex and competitive information to planners and decision makers. The objective is to improve the timeliness and quality of inputs to the decision process. BI is used to understand the capabilities available in the firm; the state of the art, trends, and future directions in the markets, the technologies, and the regulatory environment in which the firm competes; and the actions of competitors and the implications of these actions [9].

According to [6] he pointed out that CI is the product of processed business information, meaning that it has been analysed and interpreted. Intelligence is anchored in past and present data to anticipate the future, in order to drive and guide decisions in enterprises. The intelligence field has developed several sub-domains, such as Competitive Technical Intelligence According to [1] the planning and focus phase concentrates on the (CTI), which applies the intelligence process to the technical identification of needs in order to collect all relevant information, environment; sourcing intelligence, which is concerned with which is the second phase. In the third phase all collected human resources; and Competitor Intelligence, which focuses information must be verified to determine rationality and factuality purely on understanding competitors. CI and BI is an all-of the analysis. This information is then communicated in an embracing approach to understanding a firm’s competitive landscape [10].

According to [11], Competitive Intelligence scanning is an act of creating market opportunities from out wittingly discerning and zooming in on the right information favourable as well as unfavourable to the organization in the competitive race (the view from the author of the current research). For effective Competitive Intelligence scanning, members in teams or in the organization should have competencies to access and decode market information and build the whole portrait of opportunities from minimal decoded information earlier than its competitors.

3. Factors improving Competitive Intelligence Cycle

The CI cycle had its origin in the Key Intelligence Topic (KIT) process [1]. This process was developed to allow the CI director to identify and prioritise both senior management and organisational Key Intelligence needs. In the KIT process it is determined what the CI unit should research and to whom this intelligence should be delivered. An effective CI process, according to the Society of Competitive Intelligence Professionals (SCIP), is run in a continuous cycle, called the CI cycle [7]. The SCIP describes the CI cycle as the process by which raw information is acquired, gathered, transmitted, evaluated, analysed and made available as finished intelligence for policymakers to use in decision making and action. According to [7] there are five phases which constitute this cycle, which are shown on figure 3.1 below.1. Planning and direction, 2.Collection, 3.Analysis, 4.Dissemination; and 5. Feedback

Figure3.2: Competitive Intelligence Cycle. Source: [7]
Training is an additional construct to the CI process, it is clear that training contributes to the success of each phase. It is important that a regular audit is conducted to determine the level of CI skills in organisations. Training is then initiated according to the organisation’s identified needs as shown below by [12].

Figure 3.3: CI cycle. Source: Muller [12]

A study conducted by [2] explored CI as a complex business construct and as a precedent for marketing strategy formulation as shown in Figure 3.3 below. This research develops and tests intelligence as a precedent to marketing strategy formulation, revealing multiple phases and contributing aspects within the process. It also discovers that the practice of Competitive Intelligence, while strong in the area of information collection is weak from a process and analytical perspective. The figure below demonstrates the Competitive Intelligence Process and Structure

Figure 3.3: Model of Competitive Intelligence Process. Source: [2]

The model of the intelligence process provides insight as to significant factors related to the various phases. The intelligence process and structure as well as the organizational awareness and culture are seen as having direct impact on all of the various phases in the intelligence course. From the intelligence process and structure, two factors have arisen:
(1) The existence of a formal infrastructure; and (2) The level of employee involvement. [13] presented a formulation of the System of Competitive Intelligence that is up-to-date and responsive to an area of research which enables the constant upgrading and improvement of business management practices, so that a competitive edge may be maintained and a market differentiation established. From the results gathered, the construction of the model will be started and its strong and weak points commented upon. It was observed that the Model of System of Competitive Intelligence can guarantee the survival of a company, through analysing information quickly and in an integrated way, thus permitting well-founded decisions to be made in real time. The design of Competitive Intelligence, as a process that monitors all elements of the external environment of an organization is still recent. Competitive Intelligence is the product of an input process that begins with the Collection of Data, which is Planning, Collection, Analysis and Dissemination of information as shown in Figure 3.4 below.

![Figure 3.4: Intelligence cycle. Source: [13]](image)

In order to measure and take into consideration the response of the decision-makers, their needs for intelligence must be continually taken into account. And even, perhaps, to the extent that the whole process must be repeated. CI as the term suggests, is the gathering of “intelligence” about the environment and competitors in order to create and maintain a competitive commercial advantage [14]. In South Africa and Belgium, exporters are not yet well equipped and not very active to conduct effective CI, especially in the areas of planning, process and structure, data collection, data analysis, and especially skills development [15].

4. POLITICAL, ECONOMIC, SOCIAL AND TECHNOLOGICAL (PEST) IMPACTED COMPETITIVE INTELLIGENCE

For every business to exist it is highly dependent on the external environment in which an organisation exists. PEST is a useful tool for understanding the environment that an organisation operates in. Factors can be used for evaluating market growth or decline, and direction for a business. CI tool entails that the organisations have to be aligned with what is happening within their political, environment, society and technological areas within their industry in order to stay competitive [16]. Researchers define the PEST analysis as follows: (1) Political factors include government regulations such as employment laws, environmental regulations and tax policy. (2) Economic factors are those that affect the cost of capital and purchasing power of an organisation. They include economic growth, interest rates, inflation and currency exchange rates. (3) Social factors are those that impact on the consumers’ needs and the potential market size for an organisation’s goods and service. They include population growth, age demographics and attitudes towards health. Technological factors are those that influence barriers to entry, make or buy decisions and investment in innovation, such as automation, incentives and the rate of technological change.

5. THE IMPORTANCE OF COMPETITIVE INTELLIGENCE ON FIRM PERFORMANCE

Globally, organisations are paying attention to CI, because it supports organisational needs in terms of gathering, interpreting and disseminating external information [1]. CI is a vital component of a company’s strategic planning and management process. It pulls together data and information from a large and strategic view, allowing a company to predict or focus on what is going to happen in its competitive environment [7]. According to [17], CI leads to achieving innovation and ensures the survival of the organization. CI is used particularly in supporting competitive action – for pricing, in determining market strategies, in preparing for merger or take-over talks and so on. In the study conducted by [10], they pointed out that the intent of CI is to better understand customers, regulators, competitors and so forth to create new opportunities and forecast changes in the quest for sustainable competitive advantage. The primary output from CI is the ability to make forward-looking decisions. CI can be classified in two ways. The first one, strategic CI, can inform senior management of the possible Threats and Opportunities, while the second, tactical CI, can be used to organise the company’s staff around developing the changes needed based on the insights gained by CI. The most common benefit of CI,
however is its ability to build information profiles that helps a company identify its competitor’s Strengths, Weaknesses, Strategies, Objectives, Market positioning and likely Reaction patterns. In addition, [5] lists the benefits of obtaining CI for businesses and suggests that the benefits far outweigh the costs. The four major benefits are as follows:

1. Differentiation,
2. Cohesive marketing communication plans,
3. Pre-selling an idea to the target audience, and
4. Building credibility with your customer.

This information profiles include data needed to effectively identify, classify and track competitors and their behaviour. Using them, a company begins to look for points of comparison regarding its strengths and weaknesses versus its competitors [7]. The value of the intelligence, produced through a CI program, can possibly be measured across one or more of the following attributes

- Accuracy – all sources and data must be evaluated for the possibility of technical error or misperception;
- Objectivity; Systems is designed to accomplished more goals and objectives
- Usability – must be in a form that facilitates ready comprehension and immediate application;
- Relevance – its applicability to a decision maker’s requirements, with potential consequences and significance of the information made explicit to the decision maker’s circumstances;
- Readiness – CI systems must be responsive to the existing and contingent intelligence requirements of decision makers for all levels of the organization; and
- Timeliness – intelligence must be delivered while the content is still actionable under the decision maker’s circumstances.

CI represents a continuous process of gathering data, information and knowledge about actors (competitors, customers, suppliers, government etc) which interact with organization in the business environment in order to support decision making process for enhancing competitiveness of organization.

Recently, [18] indicated that the use of CI impact positively on the growth; however the quality and performance receives less influence, as a competitive advantage of the organization.

It concentrates on identification of change and market, rivalry, technology, novelty, pattern of customer behaviours, and the future prediction trends, which are needed for competition. In fact, CI is a process of figuring out what is happening and deciding what steps and actions should be taken before one’s competitors. Some benefits of using Competitive Intelligence include differentiation, cohesive marketing communication plans, pre-selling as an idea to the target audience and having the ability to build credibility with customers.

**6. BACKGROUND OF RESEARCH PROBLEM**

The purpose of this study is to determine the extent to which the factors of Competitive Intelligence improving firm performance in SMEs. The aims to achieve this, by examining the roles of a selection of Technological factors and specific Environmental factors in enhancing Competitive advantage for Small and Medium size companies, within the Telecommunications Industry in the Gauteng Province. Although competitive intelligence plays a key role in companies’ strategic management with a view to sustaining competitive advantage but research shows that after intensive study on SMEs, companies are still not survivals in South Africa, in to order meet up with their highly expectations.

**7. RESEARCH OBJECTIVE**

The main objective of this study is to investigate factors improving firm performance on Competitive Intelligence in SME’s in Gauteng, South Africa.

**8. THEORETICAL FRAMEWORK**

Figure 8.1 below is a representation of the theoretical framework which is discussed factors improving competitive intelligence. This theory is fundamentally divided into three sections namely; Technological Factors, CI Tools, and Entrepreneurial competencies.
**Technological Factors**
Technological factors are referred to as factors that are relating to technique or proficiency in practical skills when using IT system [21]. In the context of SMEs competency systems, technical factors may be looked at as those factors that influence the use of IT to utilize CI tools like SWOT analysis, PEST, Knowledge Management and Benchmarking.

**Information Technology Efficacy**
CI has benefited from advances in Information Technology Infrastructure and the elevation of Knowledge Management into a dominant corporate function [12]. A key thrust of CI is analysis, which turns raw data (a collection of facts, figures, and statistics relating to business operations) into actionable intelligence (data organized and interpreted to reveal underlying patterns, trends, and interrelationships) [22]. The growth of CI has important implications for both the management and operation of IT units, as IT resources are called upon to support CI activities elsewhere within organizations. CI management is a well-established function in organisations in developed countries, because managers realise that if they do not monitor the actions and activities of their competitors, their strategic plans will fail [1]. Nevertheless, organisations in African countries continue to be surprised by undesirable changes in the environment and it appears that the advances in managing intelligence are as yet largely unknown in these countries.

**Perceived Ease of Use (PEOU)**
Technology Acceptance Model [23] is regarded as the most noticeable model describing the acceptance computer technology. Research had identified TAM as a cost effective tool for predicting user acceptance of systems. A study of [24] describe Perceived Usefulness and Perceived Ease of Use as factors that predict user acceptance of a technology. They further argued that substantial theoretical and empirical support has accumulated in favour of TAM compared with alternative models such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour.

**Perceived Usefulness (PU)** is defined as the users’ subjective probability that using a certain application system will increase his or her job performance [19].

**IT Training**
IT training in the use of CI is regarded as an important factor for adoption and use of Competitive Intelligence. An information system user’s satisfaction can be measured by some attributes of the system. The reality of the CI function in the South African organisational structure still holds a demoted position [1]. Individuals who developed this function now view it as a “back-room” activity. The overwhelming result is that there are skills inequalities between what skills respondents view as crucial and those that rated highest in their self-evaluation. Skills identified as most important include, among others, networking, research skills and analytical abilities.
According to [12] listed the generally accepted skills put together by practising CI professionals: Traits – creativity, persistence, written and oral communication skills, analytical ability, understanding of scientific methodology, independent learning skills and business understanding. Teachable skills – strategic thinking, business terminology, market research presentation skills, knowledge of primary information sources and research methods, enhancement of journalistic interviewing, analytical abilities. Professional experience – knowledge of corporate power structures and decision-making processes, industry knowledge, enhancement of primary research skills.

**Competitive Intelligence Tools and knowledge Management**

According to [25], Knowledge Management (KM) is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organisation’s objectives. A study conducted by [14] suggested that the concept of Knowledge Management is maturing to the point where different strands are being identified. In the study conducted by [26] added that KM is the capturing, filing and categorization of the information and Competitive Intelligence the focusing, analysing and auctioning of data. Without knowledge Management one could not do Competitive Intelligence as it requires access to information. Knowledge of Information Technology is also a prerequisite for natural implementation of the concept of Competitive Intelligence [27]. They concluded that a suitable equation of the technological dimension in a firm presupposes the existence of a critical internal mass, particularly in terms of qualifications and competences. Knowing how to add value to information in order to obtain a competitive advantage is the real key factor for implementing a CI process.

**The SWOT**

SWOT refers to a structured planning method used to evaluate the strengths, Weakness, Opportunities, and Threats involved in a business venture. The value of this modified SWOT analysis in the evaluation of current tools and techniques lies in the identification of where they are best applied, and the understanding of their limitations [7]. The need to systematically acquire and analyse intelligence from internal and external business environment is seen as a crucial element in making effective business decisions. The SWOT analysis framework is quite commonly used to evaluate a company – where Strengths and Weaknesses are “internal” evaluations of the company’s competencies, whereas Opportunities and Threats are “external” evaluations about the industry or market within which the company does business [7]. Thus, to apply the traditional SWOT framework to analyse tools and techniques, the traditional questions for each quadrant have been adjusted accordingly.

**Political, Economic, Social and Technological Factors (PEST)**

Environments pose important constraints and contingencies for organisations, and their competitiveness depends on their ability to monitor and adapt their strategies based on information acquired through Competitive Intelligence activities [28]. The most used tools include PEST analysis, scenario analysis [29]. Environmental uncertainty increases information processing need as managers must identify opportunities and threats, and implement necessary strategies and structural adaptations [30]. CI contributes by providing analysis and understanding of the company’s external environment [1]. In order to create and maintain a market advantage, firms must monitor a vast array of factors about competitor activities, which include all aspects of the business [29].

**Benchmarking**

The concept of benchmarking is not new, as companies have used it for many years. It is used to measure performance using specific indicators cost per unit of measure which usually uses quality time and cost. Benchmarking can be referred to as a measurement of the quality of an organisation’s policies, products, programs, strategies, etc. and their comparison with standard measurements. CI recognises that information on companies is only valid if information on the environment is also collected [14]. This may relate to the general economic situation, to trends in the particular industry or geographic area, to changes in legislation or to developments in technology. This is where CI gains over benchmarking: benchmarking simply uses information on competitor performance; it fails to identify environmental factors that may have significantly affected that performance [14].

Research conducted by [31], stated that, two functions are involved when benchmarking. It covers areas where extent factors that deal with setting goals by using objectives to extend valve and secondly bear learning from offers. The study [31] also argued that benchmarking does not replace strategic planning but it supports it. Therefore benchmarking can be used to research any company that produces similar products and services. The process of benchmarking involves different ways to practice it and many organisations have their own way of benchmarking that suits their need. However, [31] identifies the benchmarking processes as follows:

- Deciding on the scope of word by identifying what to benchmark
- Planning the benchmarking process
- Understanding your own SWOT analysis
- Research your competitors to understand how they perform
- Learning from date to quantity performance gaps and identity which parties that might be particularly useful to performance
Furthermore researchers have identified that benchmarking can be divided into two categories, competitive benchmarking and process benchmarking. Competitive benchmarking measures performance of the organisation against competitors, it relies on a set of predetermined performance entries. Process benchmarking measures the performance of the process and overall functioning of the organisation that leads in these processes. The oval purpose of benchmarking is to provide realistic goals to improve the various processes within organisations. The results should be to improve competitiveness position of the organisation.

**Entrepreneurial Competencies improving firm Performance**

Entrepreneurial competencies can be defined as individual characteristics that include both attitudes and behaviours which enable entrepreneur to achieve and maintain business success. The competitive scope of SME’s lies firmly within the entrepreneur’s opportunity, relationship, conceptual, organizing, and strategic and commitment competencies. The entrepreneur’s experience, education, and training can be seen as the antecedents of entrepreneurial competencies. More importantly, for an SME’s, the process of achieving competitiveness is strongly influenced by the key players of competencies [32]. The significance of inspecting the environment has been associated to the performance and growth of the firm. It helps in dealing with information and strategic decision-making, which ultimately leads the organisation to grab more market share [18]. Non-satisfactory competitive practices lead to insufficient market value [18]. The competitive scope of an SME’s lies firmly within the entrepreneur’s opportunity, relationship, conceptual, organizing, and strategic and commitment competencies.

9. RESEARCH METHODOLOGY

In this section the research design is described with emphasis on the research strategy, and data collection method as well as the research approach. The study followed a quantitative approach where a case study was employed. The case study was an appropriate strategy in the reported study and focused on five SME’s in the Telecommunications industry, based in Gauteng Province. For the purpose of the study, these SME’s were given simulated names. To gather the primary empirical data, quantitative survey questionnaires were used for the study. All statistical analyses were performed by using structural equation modelling with the Statistical Package for the Social Sciences (SPSS) version 14.0. Underpinning this research, two models were applied; an adaptation of the modified technology acceptance model (TAM) in combination with the Perceived ease of use Model (PEOU) to investigate the factor improving firm performance on competitive intelligence to SMEs in the context of South Africa.

10. SUMMARY OF THE FINDINGS, AND CONCLUSION

The purpose of this study is to present the analysis of the collected data as well as the findings in keeping with the aims and objectives of this research. The first part of the section presents a tabulation of the demographic characteristics of the sample of the subjects surveyed. The second part presents the Descriptive Analysis and Data Analysis in relation to the responses of the subjects. This is followed by an analysis of the patterns of data for each research hypothesis by using a range of inferential techniques. All statistical analyses were performed by using structural equation modelling with the Statistical Package for the Social Sciences (SPSS) version 14.0.

The Table below represents Descriptive Statistics analysis: Table 1

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
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<td>(Constant)</td>
<td>1.189</td>
<td>1.316</td>
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<td>903</td>
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<td>PEOU</td>
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</table>

Explanation: The highlighted variables above are all significant at 0.05; level except for the Knowledge Management.

Correlations

Before one undertakes Regression Analysis, it is always necessary to undertake a Correlation Analysis between the independent and the dependent variables in order to check for multicollinearity (high correlation between the variables). High multicollinearity may result in findings being confounded. The formula used is as provided below:
\[ r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}}} \]

Table 2: showing Correlations

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</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Regression Analysis**

The purpose of the research is to demonstrate that Perceived Ease Of Use and Perceived Usefulness are the most important factors that explain the utility of Competitive Intelligence (CI). The best test to model the above relationship is the regression analysis where CI is specified as the criterion or dependent (Y) variable and PEU and PU are modelled as independent or predictor variables (X).
The formula utilised is presented as below:

\[ y_i = \beta_0 + \beta_1 x_i + \epsilon_i, \quad i = 1, \ldots, n. \]

Where \( y_i \) is the dependent variable, \( \beta \) are the coefficients and \( x_i \) is the independent variables.

Based on the Regression Analysis, the results are as follows:

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>486.963</td>
<td>5</td>
<td>97.393</td>
<td>30.316</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>507.592</td>
<td>158</td>
<td>3.213</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>994.555</td>
<td>163</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results show that the regression model is significant, implying that \( x \) predicts \( y \). The highlighted variables below are all significant at 0.05 level except for the knowledge management variable.

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI Utilisation</td>
<td>11.6646</td>
<td>2.47013</td>
</tr>
<tr>
<td>PEOU</td>
<td>18.8049</td>
<td>2.87975</td>
</tr>
<tr>
<td>IT training</td>
<td>22.9634</td>
<td>3.27641</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>23.3720</td>
<td>2.82876</td>
</tr>
<tr>
<td>SWOT</td>
<td>34.5549</td>
<td>5.83858</td>
</tr>
<tr>
<td>PEST</td>
<td>25.5610</td>
<td>4.62747</td>
</tr>
</tbody>
</table>

As a measure of association, Regression Analysis is utilised to ascertain the degree of Association between variables. That is, it is about knowing if a high level of one variable tends to be associated with (or goes with) a high or low level of another variable.

<table>
<thead>
<tr>
<th>Variables Entered/Removed&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Variables Entered</th>
<th>Variables Removed</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PEST, Knowledge Management, PEOU, IT training, SWOT&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.</td>
<td>Enter</td>
</tr>
</tbody>
</table>

(a) Dependent variable: C I utilisation (b) all requested variable entered

Findings: From the results above, the PEST and SWOT are the CI tools that are needed for improving firm performance to enhance competitive advantage. Knowledge Management and Benchmarking are removed because they do not have correlation with other variables of firm performance to enhance competitive advantage. Based on the findings, the results proved that (PEOU), PU and IT Training are the technological factors that enhance the usage of CI tools for competitive advantage in the SMEs. The prime sampling method utilised in this research was convenient sampling or cohort analysis. This method was selected on the basis that it would ensure greater homogeneity of the respondents surveyed. It was important to ascertain how successful this exercise has been. To this end, Descriptive Statistics was used to present the frequency distributions of subjects’ responses. A summary is presented in the chart below:
Figure 6 Utility of Competitive Intelligence

The above summarizes the responses, when participants were asked about their firm performance use of competitive intelligence to improve their work.

Table 7 shows the competitive intelligence tools

The above summarizes the perception of participants on how they adopt and adapt to the systems of competitive intelligence to enhance firm performance.
The above summarizes the firm performance by using of technology aspect tools to enhance competitive intelligence, to improve and protection of organization information.

Internal Comparison Reliability

Internal Comparison Reliability referred to as Internal Consistency is said to exist when the scores on several questions, all of which were designed to measure a characteristic or construct such as utilization of Competitive Intelligence (CI) are all highly correlated. A Cronbach Alpha test was undertaken to achieve this in the first instance, and the following results bear this out. Normally, a Cronbach alpha score greater or equal to 0.70 is regarded as an acceptable level for indicating internal consistency. This allows a researcher to calculate a composite score on a construct such as utilization of Competitive Intelligence (CI). The formula normally used for a cronbach’s alpha measure is presented as follows:-

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^{K} \sigma_{X_i}^2}{\sigma_X^2}\right)$$

where $\sigma_X^2$ is the variance of the observed total test scores, and $\sigma_{X_i}^2$ is the variance of component i for the current sample of persons.

11. TECHNOLOGICAL FACTORS

<table>
<thead>
<tr>
<th>Result of Cronbach’s Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>cronbach’s Alpha</td>
<td>N of Items</td>
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<tr>
<td>.850</td>
<td>6</td>
</tr>
</tbody>
</table>

In addition to the Descriptive Statistics (such as frequency distributions etc) several inferential statics were conducted in a bid to determine the significance of the relation between Competitive Intelligence (CI) and other variables (eg Technological and PEST factors), that together result in enhanced competitive advantage in Small and Medium Enterprises. These statistics were essentially measures of Association between the predictor and criterion variables. The most important of these was Regression Analysis. From the findings, it was established that technological factors, PEOU and PU are the most important factors that explain the utility of Competitive Intelligence (CI). It is hypothesised that environmental factors could have a negative impact on a firm’s performance. However, based on the findings the results have only proven that (PEOU), PU and IT Training are the technological factors that enhance the usage of SWOT and PEST to enhance competitive advantage in SME’s. These explain the new framework for utilisation of CI tools in SME’s.
12. SUMMARY

In the summary, the analysis suggests that (PEOU) and (PU) are the most important factors that explain the benefit of firm performance of SWOT and PEST for competitive advantage in SMEs. The results also indicated that IT Training, SWOT and PEST are also significant explanatory factors of Competitive Intelligence (CI) in the context of SMEs. However, KM and Benchmarking were found to be non-correlative. These findings are important particularly in relation to the purpose and propositions of this research.

13. CONCLUSION

Enterprises in South Africa need more information-handling skills, to perform a sustainable business survival, if they would like to participate in a successful rapidly changing world economic growth. Business Survival must acquire the skills, in term of business innovations, technology and flexibility associated with intelligence. Informal monitoring of competitive developments is no longer sufficient to ensure timely warning of competitors’ moves or the opening of new opportunities. Increasingly, trade performance will depend on the quality of a country’s coordinated intelligence capabilities. Effective CI can give South African enterprises many strategic advantages. Commercial success will be more and more dependent on having the best intelligence systems and resources that means proper intelligence management. Changes in patterns of access to and utilization of intelligence, knowledge and information are taking place daily in industrialized countries and there are many ways of responding to the intelligence challenge. It is therefore paramount that South African manufacturing enterprises should take cognizance of developments in other countries so as to keep up with current developments.

14. RECOMMENDATION

From this study, recommendations that can be drawn are that for SMEs to survive beyond the five year mark, technological tools such as PEOU, and PU are most important factors that explain the firm performance of SWOT and PEST which are found to be the best constructs for a new framework for the utilisation of CI tools in SMEs.

Suggestion for Future Works

Based on the suggestion for future work by the researchers, they observed that, there is still a dearth on the study on process of adoption, challenges facing on the adoption, and acceptability of the adoption, therefore it is open for further studies. This will help us to evaluate the impact of these systems in various services. However the suggestion for the future work will also shed light on software application usage in different organisation on the ease of job performance, skill generation and the professional improvement and productivity as a whole.

Acknowledgement

The authors would like to acknowledge Tshwane University of Technology for providing funding and required resources to complete this work. It would have been impossible to complete this effort without their continuous support.
REFERENCES


Authors’ Biographies

**Lynette Magasa** has over 15 years’ working experience in the engineering and information technology sector under Boniswa Corporate Solutions as a CEO. She was awarded Top Performing Business Woman of the Year at the 11th Annual Business Awards 2013. In 2014 she was also awarded as Top Black Female Leader of the Year and Fast Growth Black-owned SMME Awards at the 13th Annual Oliver Empowerment Awards and 2015 she was awarded Top empowered achiever of the year (2015). Her passion for the sector and her belief in the strategic objective behind the foundation of her company. Juggling being an entrepreneur, mother, and being a student does not faze Magasa she is also armed with Diploma Logistics from Tshwane University, B.Tech in Information Technology, Masters Programme administration (MAP) Wits university, M tech degree at Tshwane University of Technology (TUT) and currently busy with her MBA with Regenesys Business School.

**Professor Zeleke Worku** is an employee of Tshwane University of Technology (TUT) Business School in Pretoria, South Africa. He holds a Ph.D. in statistics (University of the Orange Free State in Bloemfontein, South Africa) and a second Ph.D. in sociology (Aalborg University, Denmark). Professor Worku’s key research interests are in small businesses, project management, service delivery, econometrics, monitoring and evaluation, statistical data mining, biostatistics, epidemiology and public health. Before he joined TUT Business School, Professor Worku has worked at the University of Natal in Durban (1998 to 1999), Vista University in Pretoria (2000), University of Pretoria (2001 to 2007), and University of South Africa (2008 to 2009). Professor Worku lives and works in Pretoria with his wife and two children.

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Economic Reliability Acceptance Sampling Plan Design with Zero Acceptance Number

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ABSTRACT

This paper presents a double acceptance sampling plan where the first sampling assumes zero as the acceptance number. In zero acceptance number sampling plans, the sample items of an incoming lot are inspected one at a time. The projected method in this paper follows these rules: if the number of nonconforming items in the first sample is equal to zero, the lot is accepted but if the number of nonconforming items exceeds zero, i.e is equal to one, then second sample is taken and the rule of zero acceptance number would be applied for the second sample. In this paper, a mathematical model is developed to design single stage and double stage sampling plans. This model can be used to determine the optimal tolerance limits and sample size. In addition, an analysis is carried out to illustrate the effect of some important parameters on the objective function (total loss function). The results show that the two stage sampling plan has better performance than single stage sampling plan in terms of total loss function and sample size.

Keywords: Quality control, Acceptance sampling, Optimal design, Producer’s loss, Consumer’s loss, Loss Function

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

An acceptance sampling plan is the overall system for accepting or rejecting a lot based on sample information. The acceptance plan identifies both the sample size and other criteria which are used to accept or reject the lot. Sampling plans can be classified as single, double, multiple, chain, sequential plans e.t.c. Acceptance sampling plan is very significance in the area of quality control/management and it can be applied when its requirements is satisfied. For instance, in single acceptance sampling plans, decision about in-coming lot is taken based on the results of inspection. If the number of defective items are larger than the acceptance number (c) then the lot is rejected, or else the lot is accepted.

Double acceptance sampling plan is an extension of single sampling plans, based on the fact that the producer might be psychologically dissatisfied if his products are rejected on the basis of just a single inspection. The double sampling plans are more efficient than the single sampling plans in terms of sample size. Double sampling plans are generally used when final decision cannot be reached by the inspectors based on the result of inspecting the first lot. The process of double sampling plans can be found in [3 and 4]. Whenever the incoming quality level is particularly good or particularly poor, double sampling plan will reach an acceptance or rejection decision faster; therefore the average sample size will reduce.
Acceptance sampling plan uses statistical methods to determine whether to accept or reject an incoming lot. Two approaches are proposed for designing the acceptance sampling models. In the Firstly, the sampling plan is designed based on two-point method. In this method, the designer specifies two points on the operating characteristic (OC) Curve. These two points define the acceptable and unacceptable quality levels for acceptance sampling [5, 12 and 17]. Secondly, the optimal acceptance sampling method is determined by minimizing the total loss function, which consists of the producer's loss and the consumer's loss [7, 10, 11, 14 and 15].

Literatures revealed that many approaches have been proposed for designing sampling plans. One approach is to design economically optimal sampling system. The other approach is to design a statistically optimal sampling system. Furthermore, some studies have considered the combination of these two approaches. The model used in this study can be categorized as an economic model for sampling plan. This approach has been employed by many authors recently. [11] presented an economical acceptance sampling plan. Their plan has three options, namely:

1. They used continuous loss function.
2. Inspection error is considered in their sampling plan.
3. Their model can be used for designing close to optimal sampling plan.

[8] proposed an economical acceptance sampling plan based on Bayesian analysis. [6] proposed an economic design of control chart. They used Taguchi continuous quadratic loss function. Their objective was to minimize the total quality cost and to determine the optimal parameters of control chart. [13] used Taguchi quadratic loss function for economical operation of control chart. They considered sampling cost and the loss function in order to obtain total operation cost. [1] presented variable sampling plan for normal distribution based on Taguchi loss function. [10] recently proposed an optimization model for obtaining the optimal control tolerances and the corresponding critical acceptance and rejection thresholds based on the geometric distribution which minimizes the loss function for both producers and consumers.

It is assumed that the rejected lots are 100% inspected, that means all items would be inspected. This concept is used in developing the objective functions where the cost of inspected items in the case of rejecting the lot involves both the producer loss and consumer loss. The single sampling plan is a decision rule to accept or reject a lot based on the results of one random sample from the lot. The procedure is to take a random sample of size \( n \) and inspect each item. If the number of defects does not exceed a specified acceptance number \( c \), the consumer accepts the entire lot. This is the most common plan commonly used, although this plan is not the most efficient in terms of the average number of inspected items.

In double sampling plan, after inspecting the first sample, there are three possibilities:
1. Accept the lot
2. Reject the lot
3. Take a second sample

In a double sampling plan, experimenter specifies two sample sizes \( n_1 \) and \( n_2 \) and two acceptance numbers \( c_1 \) and \( c_2 \). If the quality of the lot is very good or very bad, the consumer can make a decision to accept or reject the lot on the basis of the first sample, which is smaller than in the single sampling plan. To use the plan, the consumer takes a random sample of size \( n_1 \). If the number of defective items is less than or equal to \( c_1 \), the consumer accepts the lot. If the number of defective items is greater than \( c_1 \), the consumer rejects the lot. If the number of defective items is between \( c_1 \) and \( c_2 \), the consumer takes a second sample of size \( n_2 \). If the combined number of defective items in the two samples is less than or equal to \( c_2 \), the consumer accepts the lot. Otherwise, it is rejected.

In Electronic especially Hard Disk Drive (HDD) industry, the use of zero acceptance single sampling plans is widely adopted, particularly for a six sigma process where the quality of product is practically controlled under very low fraction defective level, i.e., in part per million basis. These days, manufacturers are directing toward the implementation of lean production system, which is strongly compelling for the smaller lot sizing to eliminate unnecessary wastes or losses and to minimize the production cycle time. However, the zero acceptance single sampling plans have been implemented as a protection to re-assure the quality of supplied product. The zero acceptance number plans were originally designed and used to provide over all equal or greater consumer protection with less inspection than the corresponding MIL-STD-105D sampling plans. In addition to the economic advantages, these plans are simple to use and administer. Because of these advantages and because greater emphasize is now being placed on zero defects and product liability prevention, these plans have found their place in many commercial industries, although they were originally developed for military products.

There is no specific sampling plan or procedure that can be considered the best suited for all applications. It is not practical to cite all of the applications in which these \( c=0 \) plans are used. Regardless of the products, wherever the potential for lot-by-lot sampling exists, the \( c=0 \) plans may be applicable. This model is therefore to improve the performance of sampling designs with zero acceptance number which has many applications in the industrial environments. The zero acceptance number single sampling plans have some advantageous over classical sampling plans. For example, it leads the customer to psychologically justify the quality level of their suppliers.
When it is used under two stages, it possess the minimum average total inspection if only a prescribed single point on the operating characteristics (OC) curve requirement must be achieved. For small lot sizes, this will also help the manufacturer to minimize the average total inspection as well as the production lead time. To design the zero acceptance single-sampling plans, the sampling distribution of the observed defective must be taken into account, with respect to lot size for greater accuracy.

In this paper, an economic double (two-stage) sampling plan is designed. This model develops an economic model for the sampling plan. The results of the plan are compared with the other models of acceptance sampling plan which were studied by other authors.

1.1 Process Flowchart for Single and Double Stages Acceptance Sampling Plan

The following are the operating procedure for single and double sampling plans:

![Flowchart Process for Single Acceptance Sampling Inspection](image-url)
Fig. 2: Flowchart Process for Double Acceptance Sampling Inspection
Notations and Definitions
The following notations and definitions will be used in the rest of the paper

<table>
<thead>
<tr>
<th>Notation</th>
<th>Definition</th>
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<tr>
<td>$\Delta$</td>
<td>Half the specification width</td>
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<td>$\tau$</td>
<td>Target of the quality characteristics</td>
</tr>
<tr>
<td>$C_p(x)$</td>
<td>Producer’s loss</td>
</tr>
<tr>
<td>$C_u(x)$</td>
<td>Consumer’s loss</td>
</tr>
<tr>
<td>$A$</td>
<td>Coefficient of consumer loss function</td>
</tr>
<tr>
<td>$B$</td>
<td>The cost spending by producer to repair or replace a rejected item</td>
</tr>
<tr>
<td>$N$</td>
<td>Lot size</td>
</tr>
<tr>
<td>$l$</td>
<td>Inspection cost per item</td>
</tr>
<tr>
<td>$n_1$</td>
<td>Sample size for first sampling stage</td>
</tr>
<tr>
<td>$n_2$</td>
<td>Sample size for second sampling stage</td>
</tr>
<tr>
<td>$c$</td>
<td>Specified acceptance threshold of nonconforming items in the second sampling stage</td>
</tr>
<tr>
<td>$g$</td>
<td>Specified acceptance threshold of nonconforming items in the second sampling stage</td>
</tr>
</tbody>
</table>

2. MATERIALS AND METHODS

This paper centers on economic design of sampling system, thus the inspection cost, producer loss and consumer loss are explicitly considered in the model. The main concept considered here deals with the product design that we have determined the optimal value of tolerance for product quality inspection. This model does not consider statistical measures like type I and type II errors because these risks are mostly considered in contracts between producer and consumer based on quality standards. This model can be applied at the final inspection station in production lines where minimizing the cost is important.

It is assumed that the consumer's cost associated with a product is incurred when the quality characteristics fall within the specification limits, and the producer's loss to replace an item is incurred when the quality characteristics exceed the specification limits. A quadratic function is assumed to represent the consumer's cost when quality characteristics fall within the specification limits. The graphical solution to this problem is depicted in figure 1. The producer’s loss to repair or replace an item, regardless of the values of the quality characteristics, is $B$. The consumer must spend $A$ to repair or replace the item if the quality characteristics exceed $\tau \pm \Delta$ where $\Delta$ is half the specification width and $\tau$ is the target of the quality characteristics [11]. Therefore the probability of accepting an item $P_a$ is determined as follows:

$$P_a = \int_{-\Delta/2}^{\Delta/2} f(x) \, dx \quad (1)$$

$\tau \pm \Delta$ is specification limits that denote when the values of quality characteristics fall within these limits, then the item is conforming but if we want to consider the consumer loss in the optimization then the tolerance limits change to $\tau \pm g$ because larger deviations from target value leads to increasing the consumer’s loss. $\tau \pm g$ are the tolerance limits and similar to specification limits. They are applied for inspection process and when the values of quality characteristics fall within the tolerance limits, the item is conforming. This figure shows continuous quadratic function between the specifications, while the function passing through zero at the target. The intersection of loss functions for consumer and producer’s the inspection
tolerance that minimizes the total loss. Suppose \( C_p(x) \) be the producer’s loss and \( C_c(x) \) be the consumer’s loss as shown in equation (2) and (3) respectively.

\[
\begin{align*}
C_p(x) &= B \quad (2) \\
C_c(x) &= \frac{4}{\Delta^2} (x - \Delta)^2 \quad (3)
\end{align*}
\]

The loss associated with one inspected item is determined as follows:

\[
K = I + \int_{-\infty}^{\infty} B f(x)dx + \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx + \int_{-\infty}^{\infty} B f(x)dx 
\]

where \( I \) is inspection cost per item, \( \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx \) is cost of the accepted item without inspection. [11] also proposed the following model for designing a single sampling plan model. They assumed a sample size of \( n \) items is taken from the process and if the number of defective item in this sample was more than zero then the lot is rejected otherwise it is accepted.

Therefore, the loss model is determined as follows:

\[
E(L) = n_1 K + p(N - n_1) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx + (1 - p)(N - n_1)K 
\]

(5)

Where \( n_1 K \) is the expected loss of item in sample one and \( p(N - n_1) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx \) is the expected loss of accepted items without inspection and \( (1-p)(N-n_1)K \) is the expected loss of inspected items. The concept of zero acceptance number is utilized in sampling process thus \( p \) is determined as follows:

\[
p = \sum_{i=0}^{n_{21}} (n_{21})^i p_{21}^i (1-p_{21})^{n_{21}-i} = (1 - p_{21})^n 
\]

(6)

It is supposed that a lot with size \( N \) is received. The concept of zero acceptance number is utilized in the second sampling stages. Suppose that first sample with size of \( n_1 \) items is inspected. For the received lot with \( N \) items, if the number of defective items in the first stage of inspection was equal to zero then the lot is accepted but if one defective item was found in the first sample of inspection, then second sample size of \( n_2 \) items will be taken. If there were more than one nonconforming item in the first stage of sampling, then the lot would be rejected. Again, if the number of the defective items in second sample was equal to zero, then the lot would be accepted otherwise the lot would be rejected. Therefore, the total loss function used in this study is determined as follows:

\[
E(L) = n_1 K + n_2 p_2 K + p_2(N - n_2) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx + p_2 p_3 (N - n_1 - n_2) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx + (1 - p_1 - p_2)K + p_2 p_3 (N - n_1 - n_2)K
\]

(7)

where \( n_1 K \) is the expected loss of inspected items in first sample and \( n_2 p_2 K \) is the expected loss of inspected items in the second sample. \( p_2(N - n_1) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx \) is the expected loss of accepted items without inspection, \( p_2 p_3 (N - n_1 - n_2) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx \) the expected loss of accepted items without inspection, \( (N - n_2) \int_{-\infty}^{\infty} A(x - \mu)^2 f(x)dx \) multiplied with the probability of taking the second sample \( p_2 \) and probability of accepting the lot in the second sample, \( p_3(1 - p_2)K \) is the expected value of accepting all remained items in the lot.
(N-n_1)K multiplied with probability of rejecting the lot in first sampling stage (1-p_2)p_3p_4(N-n_1-n_2)K is the expected loss of inspecting all remained items in the lot. (N-n_1-n_2)K multiplied with probability of taking the second sample, p_3 multiplied with the probability of rejecting the lot in second sampling stage, p_4. Also p_1 denotes the acceptance probability in the first sampling stage and p_2 denotes the probability of taking the second sample as shown in equation (8).

\[
p_1 = \sum_{i=0}^{n_1} \binom{n_1}{i} p_1^i (1 - p_2)^{n_1 - i} = (1 - p_2)^{n_1}.
\]

\[
p_2 = \sum_{i=1}^{n_2} \binom{n_2}{i} p_2^i (1 - p_2)^{n_2 - i} = \binom{n_2}{1} p_2 (1 - p_2)^{n_2 - 1}.
\]

(8)

Also p_3 denotes the acceptance probability in the second sampling stage and p_4 denotes the probability of rejecting the lot and inspecting all items in the lot (incurred the loss K for each item),

\[
p_3 = \sum_{i=0}^{n_2} \binom{n_2}{i} p_3^i (1 - p_2)^{n_2 - i} = (1 - p_2)^{n_2}.
\]

\[
p_4 = 1 - p_3
\]

(9)

Comparing the total loss of two sampling methods, the following result is obtained:

\[
E(L_1) - E(L_2) = \binom{n_2}{1} p_3 (1 - p_2)^{n_2 - 1} (1 - p_2)^{n_2} (N - n_1 - n_2) (K - A)
\]

(10)

Therefore, the following decision making method is obtained.

If K<A, then single sampling plan is preferred, otherwise, double sampling plan would be better. It is of note that all items are inspected after rejecting the lot and the objective function is designed based on rectified sampling. The model is used to simulate existing values using statistical software (R) so as to compare the obtained result with existing ones.

Producer and consumer risks are not being considered in the optimization model. Adding these risks as constraints in the model is possible where it is important to design an optimized economic statistical sampling method. The loss function of double sampling plan is minimized separately. Also, the loss function of single-sampling plan is minimized separately. The difference between these two objective functions are computed in order to find out which one is less and optimal.

![Graphical quadratic function](image)

**Fig. 3:** Graphical quadratic function. Source: [9].
3. RESULTS AND ANALYSIS

In this section, a statistical example is presented to illustrate the performance of this model. This example shows how the model can be applied to obtain the optimal values of parameters $n_1$, $n_2$, $\delta$ in order to minimize producer’s and consumer’s loss. In this example, the lot size is equal to 50000, and $\Delta=1$, $\delta=0$, $I=10$, $B=50$. The minimum total losses for two stages sampling plan and single stage sampling plan are obtained by solving optimization model with mentioned input parameters. The different combination of alternative values for $n_1$, $n_2$, $\delta$ is used together and their corresponding loss objective functions are determined. Since the search space is limited thus, numerical simulation method was used to solve the model. First, 104 set of alternative values for $n_1$, $n_2$, $\delta$ are generated in logical intervals. Then, this model and classical models have been solved with these input values. To illustrate the performance and statistical advantages of this sampling method, the average sample number (ASN) for each set of parameters was calculated, [16]

Since statistical measures (i.e risks) are not included in the optimization model, thus analyzing power of sampling system is not needed the risks at AQL and LQL points was obtained to see the behavior of the sampling plan. The results have been summarized and displayed in table 1 and 2. From these table, it is observed that the risk of producer (1-Pa(AQL)) and the risk of consumer (Pa(LQL)) in the two stage method is less than classical one stage method in most of the cases.

It can be seen that the optimal sampling design in two stages method is $n_1=4$, $n_2=13$, $\delta=4.2$ and its minimum loss is equal to 1857344. It can be seen that the optimal sampling design in single stage method is $n=6$, $\delta=4.2$ and its minimum loss is equal to 1859660. The value of objective function in two stages sampling model is less than single stage sampling model. This result was expected because $K=37.34>A=36$ in this system. Also, ASN in two stages sampling method is 6 and it is equal to sample size of single stage method. Also, producer and consumer risks in two stages sampling model is 0.010 and 0.02, respectively where the values of these risk in single stage method are 0.04 and 0.05, respectively that denote the better performance of the proposed method considering risk values.
Table 1: The value of cost function for alternative values of \( n_1, n_2 \) in two stages (double acceptance sampling) plan

<table>
<thead>
<tr>
<th>( n_1 )</th>
<th>( n_2 )</th>
<th>ASN</th>
<th>( 1 - p_L(AQL) )</th>
<th>( 1 - p_L(LQL) )</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>11</td>
<td>14</td>
<td>1.0000</td>
<td>0.0300</td>
<td>0.0500</td>
</tr>
<tr>
<td>9</td>
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<tr>
<td>4</td>
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<td>0.0400</td>
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4. SENSITIVITY STUDY

The effects of some important input parameters like:
1. Coefficient of consumer loss function (A),
2. Producer’s cost to repair or replace a rejected item (B) and
3. Lot sizes (N) on the objective function were examined.

Figure 4 shows the variation of the objective function with respect to the lot size. It is observed that objective function increases by increasing the lot size. This means that it is better to provide a small value of lot size for lot acceptance model in order to decrease the expected loss for each item in quality inspection plan. Also, a sensitivity study is performed in order to rejected item (B) on the objective function. According to figure 5 and 6, it is observed that the objective function increases by increasing the value of B and A respectively with fewer slope rather than figure 4. Conclusively, figure 4 shows that total loss function increases considerably by increasing the lot size, which is in line with [16].

![Fig. 4: Lot size (N) versus Objective function](image-url)
Fig. 5: Producer’s cost to repair or replace a rejected item (B) versus Objective function

Fig. 6: Coefficient of consumer loss function (A) versus Objective function
5. DISCUSSION AND CONCLUSION

A comparison study is performed between single stage sampling model and double-sampling model based on loss objective function for plans with zero acceptance number. This method provides the protection for both producer and consumer by minimizing the summation of loss for each one. The double sampling plan was compared with classical single sampling plan and a sensitivity analysis was carried out to compare the model performance under different scenarios of parameters selection. The advantages of this model rather than the existing traditional ones is to help decision maker to select the optimal sampling parameters in the case that zero acceptance number policy is employed in order to decrease the total loss for both producer and consumer.

Acknowledgement
The authors would like to thank the referees for their useful suggestions on the previous studies.
REFERENCES


Improving Security and Efficiency with ABE Standard Scheme and NFC Technology in the Healthcare Sector

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ABSTRACT

Every man wanted a better life in various sectors in the world today. In the healthcare sector, people want to get better medicines by a doctor. Even they also want to keep their records to help in the future. So we apply the NFC (Near Field Communication) in our health care system. This system allows the physician to provide a better medicine for the patient and prevent medication errors during patient treatment. NFC Technology is a small-range high-frequency new emerging wireless communication technology. RFID technology (Radio Frequency Identification Technology) has been used in NFC tag. This NFC tag stores some amount of information in it with a unique identification number, therefore, it is useful in many different real-time applications like transport system, the smart postures system etc. In Healthcare Application System (HAS) nurse performs various system works by simply tapping NFC mobile phone to the NFC tag and gives a prescription for the patient, with the help of the doctor. One main issue in data sharing systems is the application access policies and support for policy updates. In health care services such as security, efficiency and accuracy are also very important aspects. Using NFC in Healthcare Application System and the key attribute of NFC Tag ID for Cipher text-Policy Attribute-Based Encryption (CP-ABE) handles both aspects very well and removes existing disadvantage of key escrow problems. NFC technology allows intelligent devices; NFC Tag, NFC Enable Smart Phone, MIFARE card in hospitals is a big step for the automation of the healthcare system.

Keywords: NFC Tag, RFID, HAS, CP-ABE, MIFARE card

1. INTRODUCTION

Monitoring the patients in hospitals, Doctor Needs to operate on every patient differently because every patient may have a different illness and different symptoms are chances of getting confusion between patient's disease and treatment. Along with this issue patient, health records [1] which depict patient treatment history and reports are retained on paper which is difficult to maintain and unreliable for a longer period. Building healthcare system [2], [3], [4], [5], [6] using NFC Technology it may protect patients record and helps the doctor to side out such fatal mistakes while doing treatment. But security is a major concern in data storage. CP-ABE provides a cryptographic solution for data security on the cloud network. Use of NFC technology makes the insurance claim nation faster with complete transparency and credibility by connecting it with unique ID of NFC tag and with the use of CP-ABE encryption standard for security purpose. Many developed countries and increasingly mature society of the need to develop smart call in many health care facilities, to deliver best Medical facilities. This study suggests a practical idea based on NFC technology for an application that can offer different medicines services to patients. NFC is a high frequency secure wireless communication technology [7]. NFC works in a short range of about 4 inches between two devices. NFC-enabled handsets are ongoing and finalized with a simple wave or close track of two devices to each other. From a practical point of understanding, NFC operates at 13.56 MHz NFC operates several data broadcast rates; 106 kbps, 212 kbps, and 424 kbps. NFC enables communication between the tags and electronic equipment, which means that reader and writers [8]. NFC is already used for applications related to financial payments [9] and ticketing. We are proposing a new use of NFC mobile devices to access medical external tags to identify patient health cards. Health cards could be on an external label or retained on patient identification. This can provide more personal folder sharing control with a doctor approved by a simple tap of mobile devices. NFC allowing users to do safely contactless transactions, the spontaneous digital content, access and connect electronic devices simply by touching or in close taking devices proximity [8]. NFC technology allows three modes: read / write mode, peer-to-peer mode, and card emulation mode [10]. Radio Frequency Identification Technology (RFID) has been used in NFC tag.
This RFID technology and various wireless technologies are able to support users in different service sectors [11]. NFC device can perform as an NFC tag emulator or a tag reader. In reader / writer mode NFC device looks information in the NFC tag or write the information to the tag. These labels can be stuck on chip displays e. g., allowing the user to retrieve additional information by understanding the label with the NFC device. It detects a label near immediate impact using the escape mechanism. An application on an NFC device can read data from and write data to the tag detected using read-write mode operations [8]. This tag also has to run different applications with the support of NFC device.

The supported data rate in this mode is 106 Kbit / s. The second mode is peer to peer mode. In this mode, data are exchanged between the two devices. This mode is based on ISO 18092 standards and rope two communication modes: passive and active. In passive mode, it begins by creating the communication RF signal and the target respond to the command of the sender. In the active mode, to start communication, it must generate their RF signals. The NFCIP-1 initiator starts communication session and target responses to the control of the initiator. The third operating mode is the emulation mode of the card. In emulation mode, the camera will stop producing a RF wave and convert into passive mode. NFC has two types of communication. One is the active communication mode and the passive communication. In the active mode of communication throughout the data transmission procedure and the parties themselves generate a carrier. In active mode communication information are sent using the modulation amplitude shift keying (ASK).

This means that the base signal RF (13.56 MHz) is moderate with numbers in accordance with a coding arrangement. If the baud rate is 106 bauds, the encoding device is the encoding said, modified Miller. If the transmission rate is greater than 106 k bauds Manchester coding device is applied. In the coding apparatus set a single bit of data is performed in a fixed time period. This period of time is divided into two halves, called half bits. In Miller coding, a zero is encoded by a break in the first half bit and no break in the second half bit. In the passive communication mode, mobile phone initiating provides support and independent field device responds by modulating the current field.

In this mode, the camera can draw its independent operating energy of the electromagnetic field provided Initiator and the creation of a target device transponder. Attribute-based encryption (ABE) is a promising approach that achieves a cryptographic access control to fine-grained data [12], [13], [14]. It provides a way to set access policies [15], [16] based on different attributes of the requester, the environment, or the data object. In CP-ABE Standard encryptor defines its own attribute set over a group of attributes that must be possessed with decryptor in order to decrypt the ciphertext [17], [18], [19] and enforce it on the contents [20], [21]. Thus, each user with a different set of attributes is authorized to decrypt the individual data items by the security policy. It eliminates the need to depend on the data storage server to prevent unauthorized data access. Also, it removes existing disadvantage of key escrow problems [22].

2. RELATED WORK

Nowadays, most research in the health care system is to improve medical facilities to provide the better healthy environment for the patient. In many hospitals, they are very difficult to manage patient records and to provide a better medicine. Because huge data to be stored on the server and nurses are manually entered using a web browser or client software. In the previous health surveillance system, the doctor needs to attend patients when they take medication at home. Different medical devices that measure for e.g., blood pressure, weight or heart rate is integrated into the system. They send the measurements to a radio receiver connected to a PC. Users identify themselves using an NFC tag they must put near an NFC-enabled-reader PC-drive to store the measurements in the background organization [23].

NFC medium formed the NFC Data Exchange Format (NDEF) and NFC tag operations. NFC tags are contactless cards based on RFID architecture [24]. NFC competence is appropriate to maintain the user-defined hi-tech experience. With NFC mobile devices, nurses can perform various tasks related to patient follow-up from beginning to end easy communication. NFC mobile phone may interact with RFID tags (known NFC tags) distributed by [25] environment. In the health care sector, operation and procedure of RFID technology has been researched, while its NFC subclass has been tested and found. In addition, smart appliances have become an important part of our lives and ease of use has been definitively evaluated in general and also for elderly people and reduced. Therefore, the possibilities for the commercial potential of NFC technology are great, although the NFC applications have yet to prove their contribution and relevance to the medical field. Little research has focused on improving the value of patients’ treatment. For example, storage of the separate drug dosing information and the avoidance of unnecessary trips to a pharmacy out of stock in the Voter circumstances [26].

In a clinical context, NFC is used by many researchers. It has implemented a solution based on NFC technology to avoid defects of drugs in hospitals. As an additional way to the success of medical data, define different responses based NFC that allow doctors or nurses to collect data by touching medical devices with a mobile phone. Smart poster applications are one of the biggest important applications of this mode. In this application, users are able to read data from NFC posters and spend their NFC mobile strategies. Review of Literature Survey [27], depicts NFC has been used in different sectors like smart posters, payment services, electronic wallet, loyalty management etc. Following are some application areas where NFC has been used.
2.1. Public Transport System

Nowadays many countries are using NFC in public transport systems. Tapping your phone with kiosk gives you up-to-date information about schedule and delays. Contactless cards which used for ticketing options. Many transport agencies from worldwide countries have been using NFC-enabled mobile phones.

2.2. Mobile Payment Using NFC Technology

The system provides adequate security level for payments [28], ubiquitous implementation using new available technical components.

2.3. Entrance Control System

Entrance controls system validates the entry into transport control system, monitoring in the railway station, corporate offices etc. It reduces efforts required for manually checking. NFC enables the right way to control and validate or invalidate tickets or passes in the entrance control system. Tickets can be checked or validate it by touching a control device (like an RFID, NFC Tag etc.) with your mobile phone.

2.4. NFC In Tourism

NFC technology is a key point for various stakeholders in tourism industry sector. NFC device provides more information on the spot about different places and makes all things easier for tourists. NFC tags placed on monuments for checking can give more information about its monument. NFC technology will be a key point for various stakeholders in the tourism industry.

2.5. Smart Postures

NFC smart posters are the objects in or on which readable NFC tags have been placed. Various smart posters are developed using secure NFC tags. It can be done by using web server for securely retain the details of the poster.

2.6. Loyalty Management In Retail Sector

With the use of NFC can reduce the efforts required for keeping cards and vouchers in the wallet. By just Touching NFC mobile phone to the card, we can make payment.

3. ARCHITECTURE OF PROPOSED HEALTHCARE APPLICATION SYSTEM WITH NFC TECHNOLOGY, CP-ABE ENCRYPTION STANDARD AND CLOUD NETWORK

If the patient comes first time in the hospital for treatment, his information will be filled at the receptionist counter such as name, address, phone number and relatives phone number, initial amount to be filled in the card, ward number; bed number etc. such way the patient will be admitted. After registration, the patient will be given the NFC-enabled wristband tag and MIFARE card. If in case the admitted patient has been registered earlier, then he will be given the wristband with unique ID contains in it and MIFARE card directly and will be allotted with an appropriate bed number. NFC tag ID will become the patient's unique identification number for further reference and CP-ABE Standard to provide security for all data over the cloud. During patient registration his/her claim nation sends to the respective insurance agency via SMS and Email for speed up the claim nation procedure, increasing transparency and credibility in the healthcare.

While claiming insurance when the patient admitted to the hospital, his detail information includes his Policy No, Name, Disease, Hospital Name etc. will be sent to the respective insurance agency. All patients' information will also be stored in the wristband and the MIFARE card in both cases. When doctor will go for the checkup he will just tap his NFC-enabled mobile phone to the patient wristband and he will get all the details regarding patient's disorder or disease, consultation with the doctor, prescriptions given previously, the test conducted etc. After checkup new prescription given by doctor will be stored on the server for further reference.
Doctor himself can see the patient’s previous treatments reports on his NFC enable smartphones and write which test to be conducted. Detail Architecture Representation of the system as shown in Figure. 1. To take medicine from the store he can use his MIFARE card for payment. Medical manager taps his/her NFC enable mobile phone to retrieve information of which medicine has to give to the patient. He also receives SMS about which medicines have to give a patient. The MIFARE card will be swapped and the respective charges will be deducted from amount and changes will be stored on a server at regular interval. Medical manager and the pathologist can only retrieve information about prescription and tests to be conducted respectively. When the patient will be discharged all his dues like rent of the bed etc. for appropriate number of days he or she spent in the hospital, and doctors consulting fees will be calculated. After clearing all the dues, he will be discharged from the hospital. This all patient’s record will be accessible in any hospital for their reference. It results into reduces the headache of patients to keep their previous treatments record with him and the doctor can refer it with a single touch. This globalization makes the healthcare very effective with less time and efforts.

3.2. Prescription For Patient Through Nfc Device And Tapping Interaction

The doctor uses an application that demonstrates all the demand of the patient on the screen that is sent from the central server. The doctor selects a patient's request. The application shows the patient's medical history. If a patient is new, then the doctor prescribed on the basis of their symptoms. But if the patient is old, then the doctor can check old medicine that was given by him and can also see his previous symptoms. Then doctor prescribed some medicines based on symptoms and sends the prescription to the nurse with the help of cloud server.

3.3. Healthcare Application System

This NFC health care system is based on the mode of read / write. In reader-writer mode device can access NFC tag. The system architecture consists of following main elements: Doctors’ NFC Enable Smartphone, NFC tag or NFC Device, cloud server. The server centralizes the conversation between the nurse and the doctor. It also includes patients, nurses, and physician database. The server also allows the system administration to manage all this data.

3.4. Work Model Of Healthcare Application System

Nurse/Receptionist will launch the application of NFC Based Hospital Management System by providing the IP address of the server to connect to the server. Once connected to the server, NFC Tags’ unique identification number of the affected patients is permanent and stored in the server. The doctor must log successfully to view the patient’s request. In Fig, the doctor is able to see the patient's application form and patient information. If the patient is already registered, then the doctor can also see patients’ previous symptom and medication prescribed for this symptom. Doctor prescribed the patient and sends the prescription to the mobile phone of the nurse and medical manager. Lastly, Nurse will check the payment and if it is paid, she will clear the account.
3.5. New Approaches For Healthcare Application System

- Secure Element
- Security over Cloud Network (ABE-CP-ABE/MA-ABE)

3.5.1. Secure Element
The Secure Element (SE) resists the attacks that can be found in any smart card. The Secure Element may build with different protocols, hardware, software, and interfaces. In proposed Healthcare Application system secure element [29], [30] is based on the following assumptions:
- The SE is part of the NFC Tag
- The Cloud is part of the HAS
- The HAS manages the SE/NFC Tag
- Hospitals are linked to the HAS
- Communication is carried over a single Channel: HAS, NFC Reader, and NFC Tag.

3.5.2. Security Over Cloud With Abe-Cp-Abe/Ma-Abe
Attribute-based encryption (ABE) is a promising approach that achieves a cryptographic access control to fine-grained data [12], [13], [14]. It provides a way to set access policies based on different attributes of the requester, the environment, or the data object. CP-ABE Standard enables an encryptor to define the attribute set over a group of attributes [31], [32] that a decryptor need to possess to decrypt the ciphertext [33], [34] and apply it on the contents [20], [21]. Thus, each user with a different set of attributes is authorized to decrypt the individual data items by the security policy. This effectively eliminates the need to rely on the data storage server to prevent unauthorized data access. Also, it removes existing disadvantage of key escrow problems [22].

4. DATA SHARING ARCHITECTURE
Following Fig. 3 shows the architecture of the data sharing system and their entities.

4.1. Key Generation Center (KGC)
It is a key authority which is use to give public and secret parameters for CP-ABE Standard. It also has control for revoking, issuing, and updating the attribute set for different users [35]. It gives different authorized access rights to users based on their attributes.
4.3. Data Storing Center
Data Storing Center provides a data sharing service. It is responsible for monitoring external user access to data storage and provision of corresponding content services. The data storage center is another key authority that generates custom user key with the KGC. It also issues and revokes attribute group keys for users attribute, which is used to apply a thin validated user access control.

4.4. Data Owner
It owns data information. Data Owner wanted ease of sharing or cost-saving, therefore, it uploads data into the external storing center for ease of accessibility. It defines access policy and encrypts data before it is delivered to storing center. To access information of user's encrypted content, decryptor needs to possess a set of attributes, only then, he will be able to receive and decrypt the text data.

4.5. Healthcare Management
HAS management has depended on the following entities for the good management of Patient data:
• Cloud Service Provider (CSP): a CSP has important resources to manage distributed cloud storage servers and to direct its database servers. These services can be used by the HAS to manage patient data stored in the cloud servers.
• HAS: HAS handles interaction between doctor and patient, and use to store and retrieve data over cloud servers.
• Users/Doctor: The users are able to access the data stored in the cloud, according to access rights decided by the system, such as rights to write, read etc. The web interface [36] is used by the

users to modify, retrieve, and restore data from the cloud network, based on their access rights.

4.6. NFC Integration
The proposed system is based on cloud architecture with NFC Tags/Readers. NFC Tag in HAS is mainly used for authentication of a patient over the cloud, whereas the other section, that is a cloud is used to store Patient Sensitive information using CP-ABE Standard. Each Patient is identified by a unique ID of NFC Tag, AccID. The AccID is intimated to a Patient when he registers himself with the HAS. Healthcare Application System stores these details in a cloud server. The NFC Enabled mobile device/Readers are used to authenticating patients to his account over the cloud network. The communication and all data exchange over the cloud network will be encrypted using CP-ABE Standard.

5. CONCLUSION
Advances in technology increases, the focus is on creating better health care systems. With a use of new emerging NFC technology, all hospitals can better track patients' treatment information. It makes the Healthcare sector with proper management and easier for good treatment of patients with reducing medication errors. The proposed system provides automation, security and scalability in the Healthcare System. Also, the enforcement of access different policies and the support of different policy updates are very important challenging issues in the data sharing systems. In this study, CP-ABE attribute based data sharing scheme handles it efficiently by setting different access policies for effective security.

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Authors’ Brief

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Towards The Development of a Mobile Intelligent Poultry Feed Dispensing System Using Particle Swarm Optimized PID Control Technique

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ABSTRACT

The manual pattern of feeding of poultry birds incurs an exorbitant cost on poultry farming. This pattern of feeding which is predominant in the tropics gives a low return on investment, low yield and low profit. These shortcomings are as a result of contamination of the poultry feed, wastage of the feed, fatigue and stress involved with monitoring of the birds and administration of the feed. Hence, there is a need for a system which is capable of addressing these limitations. This study proposes the design of a mobile intelligent poultry feed dispensing system using Particle Swarm Optimized PID control technique. The system will be capable of moving from one point to another within a deep litter poultry house, as well as dispense both solid and liquid feed to poultry birds at specific time intervals. The system shall be intelligent with a Proportional-Integral-Derivative (PID) controller tuned with the Particle Swarm Optimization algorithm in order to increase the performance of the system. The successful development of the anticipated intelligent poultry feeding system is expected to reduce human intervention, increase year and profit as well as provides high return on investment in poultry farming.

Keywords: PID Controller, Particle Swarm Optimization, Microcontroller, Precision Livestock Farming, Dispensing

African Journal of Computing & ICT Reference Format:

1. BACKGROUND TO THE STUDY

The application of the principle of process engineering to intensive and extensive livestock management is referred to as Precision Livestock Farming (PLF) [1]. In PLF, the potential of Information and Communication Technology (ICT) is utilized to assist farmers to automatically monitor animals onsite and remotely. This in turn improves production efficiency, increases animal and human welfare using appropriate hardware and necessary software techniques [2].

The application of PLF to poultry feeding has provided tremendous benefits from literature for improved production efficiency of chicken, geese, guinea fowls and most importantly, improved techniques of rearing of birds [3]. The poultry industry contributes immensely to the development of the Nigerian economy as it serves as a major source of egg and meat which have a high nutritional value in the supply of protein. There are mainly four management systems employed in the rearing of poultry birds which are the Free Range system, Battery Cage system, Deep Litter system and Perchery houses [4]. In the free range system, birds are kept in an open space and fed manually. Some of the shortcomings of this method are missing of some birds and lot of human involvement [5]. In the Battery Cage system, the birds are kept in individual cage compartments in a large controlled environment [6]. The major challenge of this method is that it is very expensive to implement and there is a high risk of disease outbreak and cannibalism [7]. In the case of the Deep Litter system, the birds are kept in a building with leaves, saw dust, dry grasses or straw on the floor. The birds are allowed to move freely within the building. This method reduces the level of worm infection and provides protection for the birds against predators [5].

Poultry farmers in Nigeria encounter many problems such as contamination of the feed, wastage, high level of human involvement and stress of constant monitoring of the poultry birds. Some of these problems are tackled by increasing the work force on the farm or individually monitoring the birds but these are stressful and expensive to implement. Due to the limitations outlined, there is a need to develop an intelligent mobile system that will dispense both solid and liquid feed to the birds as well as control the amount of feed that is dispensed to poultry birds in poultry farms. A number of related works exists in literature. Authors in [8] designed and constructed a computer controlled poultry feed dispenser and temperature regulator. The system was made up of a dispenser which was capable of communicating with a computer via a parallel port. The system was also capable of dispensing feed at specific time intervals. But some of the limitations of the system were that it was not sensitive to obstructions, there was a high cost of maintenance and the system was affected by long distances due to the parallel port connection.
Furthermore, in [3] a mobile intelligent poultry feed dispensing system was developed which was able to move, detect and avoid obstructions and dispense solid feed to poultry birds. But some of the limitations of the system were that it could not dispense liquid feed and the solid feed dispensed was sometimes too large for the chicks to feed on. Similarly in [9], a mobile intelligent poultry feed and water dispensing system was designed using fuzzy logic control technique. The system is capable of sensing the feed and water level and dispenses feed and water when the levels were low. But some of the limitations of this system were that it was not mobile and fuzzy logic is not suitable for highly complex systems as it requires a lot of data and expertise to develop fuzzy rules and membership functions [10].

In addition, [11] developed an intelligent poultry liquid feed dispensing system using fuzzy to address the limitations of [3]. Although the system was able to detect the level of the feed and dispense the feed if the level was low, it had limitations such as the inability of dispensing solid feed, immobility and the absence of a mechanism to prevent contamination. The author in [5] addressed some of the limitations of [11] by developing a mobile intelligent poultry liquid feed dispensing system using Genetic Algorithm (GA) tuned PID control technique. This system was mobile and dispensed the liquid feed in a recycling manner to avoid contamination. But the major limitation of this system was that it was not capable of dispensing solid feed. In addition the GA characteristics suffer from premature conversion and are not efficient in solving large optimization problems [12]. In this paper, we propose to design a mobile intelligent poultry feed dispensing system using Particle Swarm Optimized PID control technique as anticipated in [13]. The system shall be capable of moving from one point to another within a deep litter poultry house and dispenses both solid and liquid feed to poultry birds at specific time intervals. The system is made intelligent with a Proportional-Integral-Derivative (PID) controller tuned with the Particle Swarm Optimization algorithm in order to increase the performance of the system. The PSO algorithm will be implemented based on its characteristics which include the swarm size, acceleration coefficients and inertia weight.

The remaining part of the paper is organized into four sections. Section 2 presents a brief overview of Particle Swarm Optimization (PSO) and rationale for optimizing anticipated system with PSO; The PID control and rationale for PID in our system are briefly discussed in Section 3; Section 4 presents mechanical, hardware and software design consideration of the anticipated intelligent mechatronic poultry feeding system. Section 5 concludes our proposition and our plan towards final development of the anticipated intelligent system.

2. PARTICLE SWARM OPTIMIZATION

Particle Swarm Optimization (PSO) is a global optimization method developed by Kennedy and Eberhart in 1995. It is developed from swarm intelligence and on the behaviour of bird flocks and fish schools. The PSO algorithm emulates the behaviour of animal groups that have no leaders and hence will find food by random [14] [15]. The particles search for food and communicate with one another. While they are searching for food, there is always one particle that has better resource information about where the food source can be located. Hence, through the communication, the particles will eventually converge towards the food source [16]. The process of the PSO algorithm to find optimal solutions to problems follows the behaviour of these particles [15]. PSO has been applied in a number of areas such as gantry crane systems, dynamic first order systems and magnetic levitation systems [17].

PSO has many advantages over other global optimization methods such as fast convergence, simplicity and the ability to drive nonlinear plants and high order systems [18]. The PSO algorithm is given as follows [19]:

1. Randomly initialize particle positions and velocities
2. While not terminate
   a. For each particle i:
      i. Evaluate fitness $y_i$ at current position $x_i$
      ii. If $y_i$ is better than $p_{best}$, then update $p_{best}$, and $p_i$
      iii. If $y_i$ is better than $g_{best}$, then update $g_{best}$, and $g_i$
   b. For each particle i
      Update velocity $v_i$ and position $x_i$ using:
      \[ v_i = v_i + U(0,\phi_1)(p_i - x_i) + U(0,\phi_2)(g_i - x_i) \]  
      \[ x_i = x_i + v_i \]

   For each particle i:
   - $x_i$ is a vector denoting its position
   - $y_i$ is the vector denoting its velocity
   - $y_i$ denotes the fitness score of $x_i$
   - $p_i$ is the best position that it has found so far
   - $p_{best}$ denotes the fitness of $p_i$
   - $g_i$ is the best position that has been found so far in its neighbourhood
   - $g_{best}$ denotes the fitness of $g_i$
   - $U(0,\phi_i)$ is a random vector uniformly distributed in $[0,\phi_i]$ generated at each generation for each particle.
   - $\phi_1$ and $\phi_2$ are the acceleration coefficients
determining the scale of the forces in the direction of $p_i$ and $g_i$

2.1 Rationale for PSO for Controller Optimization

Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) techniques are popular optimization techniques in Controller tuning but PSO has numerous advantages over GA. PSO is simple and has fewer parameters to adjust compared to GA. The calculation complexities of mutation, selection and cross over in GA are absent in PSO and hence, PSO calculations can be completed easily and faster [14]. PSO also has an effective memory capability and can adapt to changes in an environment [20]. Other advantages of PSO are that it can be applied to both scientific and engineering research and it occupies bigger optimization ability [15].
In literature, a number of related works in have been reported in the area of PID Controller tuning with PSO. In [16], PSO was used to tune the PID controller for a coupled tank system. The study showed that the PSO tuned PID controller exhibited better performance than the PID controller that was tuned using classical techniques. Authors in [21] carried out a study on the comparison of PI controller tuning using GA and PSO for a multivariable experimental four tank system. The system compared the performance of decentralized GA and PSO tuned PI controllers. The results showed that the PSO tuned PI controller showed better performance and robustness in both servo and regulatory responses. Also in [22], a study on PID controllers tuning optimization with PSO algorithm for nonlinear gantry crane system was carried out. The results of the study showed that the PSO tuned PID controllers were effective in moving the trolley and the length of the rope as fast as possible and with low payload oscillation.

These competitive performance advantages of PSO compare to GA accounted for further tuning of the Poultry feed dispensing system’s PID Control with Particle Swarm Optimization (PSO) technique as anticipated in [13].

3. PID CONTROLLERS

The Proportional-Integral-Derivative (PID) controller is a closed loop controller and is one of the most widely used controllers in industrial applications. Approximately 95 percent of control systems in the manufacturing industry are designed with this particular controller due to its ease of implementation in digital systems, robustness and cost effective maintenance [23]. Furthermore, PID controllers are the optimum choice and perform better than other controllers in many applications [24]. PID Control has a simple structure and is a linear control methodology which acts directly on the error signal [12]. It has been considered as a classical output feedback control mechanism for Single-Input-Single-Output systems [25]. The controller calculates the error signal and adjusts the inputs continuously in an attempt to minimize the error [24]. The efficacy of the PID controller lies in the tuning technique used in determining its parameters [26].

The PID controller shown in Figure 1 comprises of three elements which are the Proportional term (Kp), the Integral term (Ki) and the Derivative term (Kd). Equation (3) shows the transfer function for a PID controller [27].

The function of each term is defined as follows:

i. **Proportional Gain** (Kp): Provides overall control action proportional to the error signal

ii. **Integral Gain** (Ki): Reduces steady state error through low frequency compensation by an integrator

iii. **Derivative Gain** (Kd): Improves transient response through high frequency compensation by a differentiator

\[ G_{PID}(s) = K_p + \frac{K_i}{s} + K_d s \] (3)

![Figure 1: A PID Control System [27.](image)]
3.1 Rationale for Intelligent PID Controller in the system design

PID Control by convention is a linear control methodology which acts directly on the error signal [12]. It has been considered as a classical output feedback control mechanism for Single-Input-Single-Output systems [25]. The PID controller calculates the error signal and attempts to minimize the error by adjusting the inputs continuously [24]. In order to achieve the desired performance, the three parameters (\(K_P\), \(K_I\) and \(K_D\)) of the PID controller need to be tuned. Tuning of the PID parameters involves adjusting the proportional, integral and derivatives gains in order to make the output of the control system track a target value efficiently [25]. The tuning methods of the PID controller are mainly classified into Traditional tuning techniques and intelligent tuning techniques [12]. Tuning PID parameters is very crucial in finding the optimal parameters that will give satisfactory results [17].

Traditional methods of tuning PID controllers are easy but satisfactory results are not usually obtained. Due to the difficulty in finding optimal PID parameter values, researchers have been using other intelligent methods to find the most appropriate value for those parameters [22]. Furthermore, tuning methods in which the proportional, integral and derivative gains are fixed have the disadvantage of lacking capability and flexibility [28]. Moreover, the intelligent tuning technique allows for online tuning of the parameters and flexibility of the parameters. This accounted for intelligent tuning of the anticipated feed dispensing system intelligent optimization technique with Particle Swarm Optimization.

4. SYSTEM DESIGN

This section describes the methodology and materials used in the design of the proposed mobile intelligent poultry feed dispensing system.

4.1 Proposed System Overview

The mobile intelligent poultry feed dispensing system consists of various parts which include the wheels, troughs, feeder, drinker, DC motor, DC liquid pump, Arduino Mega 2560 microcontroller, a feed conveyor and the liquid feed hose. The Arduino Mega 2560 is the controller of the system. It ensures that the design requirements of the system are met at all times. The system is designed in such a way that the solid feed trough will be filled with the solid feed and the liquid feed trough will be filled with the liquid feed. A power button will be pressed and the system will move forward. The system will then dispense the solid feed to the feeder for ten seconds and dispense the liquid feed to the drinker for five seconds. The time of dispensing of the feed is selected based on the rate at which the DC motor and DC pump dispense the feed to the feeder and drinker respectively. The system will then wait for the poultry birds to feed from the feeder and drinker before moving forward again to a new location. The system has a feed level sensor for the solid feed. This is designed so as to reduce the rate of wastage of the feed. In addition, the system has a mechanism of recycling the liquid feed after the feeding time has elapsed. This is done so as to reduce the rate of contamination and wastage of the feed. Figure 2 shows an overview of the proposed system while Figure 3 shows a block diagram of the proposed system.
4.2 System Hardware Design Considerations
The dispensing system is design to be controlled by an Arduino 2560 microcontroller board (PID Controller) for cost and flexibility reasons. The system shall consist of a mechanical unit which comprises of DC motors for the movement of the system from one point to another at specific time intervals and also for the dispensing of the solid feed. The system also shall comprise of DC pumps for dispensing of the liquid feed. The system shall be powered by a 12V DC battery which shall be regulated to 5V using the LM7805 voltage regulator in order to power the microcontroller. The system shall also comprise of feed sensing unit which shall be implemented with a Sensor (Light Dependent Resistor) in order to determine the level of the solid feed before it is dispensed to avoid wastage of solid feeds.

4.2.1 System Mathematical Modelling
The system in Figure 2 can be modelled as Figure 4. Figure 4 consists of PID controller connected in series with two parallel subsystems (the solid and liquid feed). The subsystems represent the solid feed dispensing unit and the liquid feed dispensing unit. In order to obtain a transfer function of the whole system, the transfer functions of both the solid feed dispensing unit and the liquid feed dispensing unit need to be obtained separately. Figure 5 shows the block representation of the liquid feed of the system.

Where,
- \( G_d(s) \) is the Liquid fed dispensing unit and
- \( G_s(s) \) is the Solid Feed Dispensing Unit.
Liquid Subsystem Modelling

The liquid feed trough model was obtained based on the flow rate of the liquid feed entering the trough and the flow rate of the liquid feed exiting the trough. The flow rate of the feed entering the trough is denoted as $F_{\text{in}}$ while the flow rate of the feed exiting the trough is denoted as $F_{\text{out}}$. The height of the trough is denoted as $h$. The liquid subsystem is assumed to be cylindrical, hence the use of the cylindrical shape.

![Figure 5: Model diagram of the liquid feed trough](image)

Where:

- $F_{\text{in}}$ = Rate of flow into the container (inflow)
- $F_{\text{out}}$ = Rate of flow out of the container (outflow)
- $h$ = height of container

The volumetric flow rate of a liquid is given as:

$$\text{Flow Rate} = \frac{dv}{dt}$$  \hspace{1cm} (4)

The volume of the container is:

$$V_{\text{vol}} = \pi r^2 h = Ah$$  \hspace{1cm} (5)

Hence, $\frac{dv}{dt} = A \frac{dh}{dt}$

Also, $A \frac{dh}{dt} = F_{\text{in}} - F_{\text{out}}$  \hspace{1cm} (6)

The flow rate of the liquid feed entering the trough is directly proportional to the applied voltage. On the other hand, the flow rate of the liquid feed exiting the trough is directly proportional to the height of the trough.

In-flow is proportional to the applied voltage,

$$F_{\text{in}} \propto V$$

$$F_{\text{in}} = K_v V$$  \hspace{1cm} (7)

Out-flow is proportional to the height of the container,

$$F_{\text{out}} \propto h$$

$$F_{\text{out}} = K_h h$$  \hspace{1cm} (8)

Since, $A \frac{dh}{dt} = F_{\text{in}} - F_{\text{out}}$

$$A \frac{dh}{dt} = K_v V - K_h h$$
Therefore,
\[
\begin{align*}
\frac{\partial h}{\partial t} &= \frac{K_1V}{A} - \frac{K_2h}{A} \\
\frac{\partial h}{\partial t} &= \left(\frac{K_x}{A}\right)\frac{V}{A} - \left(\frac{K_x}{A}\right)h
\end{align*}
\]

Using Laplace Transforms:
\[
\begin{align*}
\mathcal{L}[h] &= \frac{K_x}{s^2A^2}V - \frac{K_x}{sA}H \\
\mathcal{L}[h] &= \frac{K_x}{s^2A^2}V - \frac{K_x}{sA}H \\
\mathcal{L}[H] &= \frac{K_x}{sA} \left(\frac{V}{A}\right) \\
\mathcal{L}[H] &= \frac{K_x}{s^2A} \left(\frac{V}{A}\right)
\end{align*}
\]

The following parameters are obtained based on the area of the proposed liquid feed trough and the proposed DC liquid pumps to be used for the liquid feed dispensing unit:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area of Container)</td>
<td>1256cm²</td>
</tr>
<tr>
<td>(K_f) (Flow Constant)</td>
<td>10676</td>
</tr>
<tr>
<td>(K_s) (Flow Constant)</td>
<td>89.7</td>
</tr>
</tbody>
</table>

Substituting into equation (10), we have;
\[
G_s(s) = \frac{sA}{s^2A^2}
\]

b. Solid Feed subsystem

The solid feed trough model was obtained based on the electrical input which is the applied voltage and the mechanical output which is the angular velocity of the DC motor as shown in Figure 6. The velocity of the motor determines the rate of dispensing of the solid feed. Unlike the liquid feed model, the dispensing rate does not depend on the height of the solid feed trough.
Where:
\[ i_a(t) = \text{Armature current} \]
\[ R = \text{Armature resistance} \]
\[ L = \text{Armature inductance} \]
\[ v_b = \text{Back EMF} \]
\[ T_m = \text{Motor Torque} \]
\[ v_a = \text{Applied voltage} \]
\[ J = \text{Rotor inertia} \]
\[ \omega = \text{Angular Velocity} \]
\[ B = \text{Viscous friction co-efficient} \]
\[ K_t = \text{Torque Constant} \]
\[ K_b = \text{Back EMF constant} \]
\[ \theta = \text{Angular displacement} \]
\[ T_d = \text{Disturbance Torque} \]

For the Electrical Circuit, the sum of voltage drops is given as:
\[ L \frac{di_a(t)}{dt} + v_a(t) = v_a(t) \]

Transforming into Laplace, we have:
\[ LsI_a(s) + V_a(s) = V_a(s) \] (12)

The torque – armature current relationship is given as:
\[ T_m(s) = k_t i_a(s) \] (13)

As for the Mechanical Circuit,
\[ T_m(s) = J \frac{d\omega(t)}{dt} + B\omega(t) \]

Transforming into Laplace, we have:
\[ T_m(s) = J\Omega(s) + B\omega(s) \] (14)

The back EMF – angular velocity relationship is given as:
\[ v_b = k_b \omega(t) \]

Transforming into Laplace, we have:
\[ V_b = k_b \Omega(s) \] (15)

Substituting the value of \( I_a \) in equation (11) for \( I_a \) in equation (10), we have:
\[ \frac{\frac{T_m(s)}{k_t} R + LsT_m(s)}{k_t} + V_a(s) = V_a(s) \]
\[ \frac{T_m(s)}{k_t} R + LsT_m(s) + V_a(s) = V_a(s) \]
\[ \frac{T_m(s)}{k_t} R + LsT_m(s) = V_a(s) \] (16)

Substituting the value of \( V_b \) in equation (13) for \( V_b \) in equation (14)
\[ \frac{T_m(s)}{k_t} + \frac{\frac{T_m(s)}{k_t} R + LsT_m(s)}{k_t} = V_a(s) \] (17)
Substituting the value of $T_m(s)$ in equation (12) for $T_m(s)$ in equation (15)

$$\frac{2(\text{k}_e s^2+\text{R}_s s)(s+\text{Z})}{\text{k}_e} + \frac{\text{h}_b s^2}{\text{k}_e} \Omega(s) = V_m(s)$$

$$\Omega(s) = \frac{(R + L s) \Omega(s)}{k_2} + k_2 \Omega(s) = V_m(s)$$

$$\Omega(s) = \frac{1}{R + L s + \text{k}_2}$$

$$V_m(s) = \frac{\text{output}}{\text{input}} = \frac{\Omega(s)}{V_m(s)}$$

Therefore,

$$G_m(s) = \frac{k_2}{(R + L s)(s + \text{Z}) + k_2}$$

(18)

**Table 2: Values obtained based on the proposed DC motor to be used for the solid feed dispensing unit.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>k_e</td>
<td>3.475 NM/Amp</td>
</tr>
<tr>
<td>k_b</td>
<td>3.475 V/rad/sec</td>
</tr>
<tr>
<td>B</td>
<td>0.03475 MN/rad sec</td>
</tr>
<tr>
<td>J</td>
<td>0.068 Kg/m²</td>
</tr>
<tr>
<td>R_m</td>
<td>7.56 Ω</td>
</tr>
<tr>
<td>L</td>
<td>0.055H</td>
</tr>
</tbody>
</table>

Substituting the following values into the transfer function:

We have:

$$G_m(s) = \frac{3.475}{0.068 s^2 + 0.055 s + 1.256}$$

(19)

**4.3 System Software Design Considerations**

The Particle Swarm Optimization algorithm shall be implemented in MATLAB R2013a. The optimized algorithm shall be used to tune the PID controller. The tuned PID controller is envisioned to enhance the performance of the dispensing system in terms of the rise time, settling time and overshoot. The Hardware of the controller is implemented using the Arduino Mega 2560 which is programmed via the Arduino Integrated Development Environment. Figure 7 shows the flowchart of the operation of the anticipated mobile intelligent poultry feed dispensing system.
Figure 7: Mobile Intelligent Poultry Feed Dispensing System Flowchart
5. CONCLUSION AND FUTURE WORKS

The development and application use of the anticipated intelligent mechatronic system in the poultry industry will immensely reduce the labour poultry farmers undergo in feeding their poultry birds. The proposed system will apply ICT resources in order to improve human and animal welfare. The system will also provide a cost effective method of administering feed to poultry birds, reducing contamination, reducing wastage and also provide a method that is easy to adopt by poultry farmers. This in turn will result in an increase in profit and yield. At this stage the proposed design is open to suggestions. In Future, the design system in section four shall be developed using the appropriate microcontroller and electronic components to improve efficiency, boost productivity and reduce human intervention in deep litter poultry systems. In addition, hybrid intelligent techniques shall be investigated in the process of improving the performance of the system. Finally, a power management system can be incorporated in order to control the energy consumption of the system.
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BIographies

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Modeling of Thermal Resistance for Nano-Scaled DG MOSFET and CSDG MOSFET

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ABSTRACT

Micro and Nano technology devices exhibit excellent performance and scalability but in contrast they have heating effect. To analyze and minimize this thermal effect in terms of thermal resistance a model has been presented in this work for the application of mechatronics switch. It will be suitable for the sensors and systems. A simple and accurate method has been discussed for extraction of the effective thermal resistance of a double-gate MOSFET and cylindrical surrounding double-gate MOSFET. The drain, source and channel resistance has been extracted and gate resistance has been taken as negligible due to negligible gate current.

Keywords – Microelectronics, Nanotechnology, Sensor, Switch, Thermal resistance modeling, MOSFET junction temperature, VLSI.

1. INTRODUCTION

Mechatronics includes various technical areas such as modelling, manufacturing, system integration actuator, sensors, micro-devices, opto-electronic system, robotics, automotive system, etc. [1]. In a mechatronics motion control some parameters such as robustness, actuation, position control, force control etc. have an effective model [2]. Regtien [3] provides an overview of the various sensors and systems which are required and/or applied in mechatronics. Also, the emphasis is on the understanding the physical principles and possible configurations of sensors has been discussed. The mechatronics system design methodology to integrate the different field / discipline knowledge, through the design and development process of mechatronics product has been discussed in [4, 5].

There are various applications of optical switches that require precision positioning of micro-actuators. The analog nature of micro electro mechanical switches (MEMS) and indeterminate device characteristics (due to manufacturing tolerance), make these switches impracticable and expensive calibrations process [6]. In the present research, I have tried to obtain the internal thermal resistance for the switch (using double gate MOSFET and cylindrical surrounding double gate MOSFET). So that the behavior of the switch pertaining to the thermal effect can be analyze, change or set in advance according to the application in the mechatronics system.

Semiconductor devices have definite operating temperature limits. High operating temperatures are undesirable since performance is degraded, reliability is impaired, and device destruction may be a possibility [7]. Typically, for every 10°C rise above 100°C, the operating life of the device reduces to halved. It is thus imperative that semiconductor devices run as cool as possible. The evaluation of temperature increase in circuit simulation is an important issue for several Silicon technologies. Self-heating can be particularly severe in case of advanced micro and nano-technology. For Silicon on Insulator (SOI) substrate, due to the poor thermal conductivity of the substrate, MOSFET devices are strongly affected by self-heating issues [8]. In the power transistors a relevant temperature increase can be observed due to the large operating voltages [9, 10]. The total thermal conductance of a traditional MOSFET is defined by constructing the equivalent thermal circuit which basically contains only resistors [11]. Generally, the basic techniques for power semiconductor thermal resistance measurements are optical, chemical, physical and electrical. Each of these techniques has its advantages and disadvantages [12].

Magnone et. al. [13] has proposed a methodology to define an equivalent resistive thermal network that allows modeling the lateral heat propagation through the Silicon substrate of power devices. The basic idea is to split the substrate in basic elements of length $\Delta L$ and to associate to each element, lumped thermal resistances. Caviglia and Iliadis [14] has derived a model for small signal dynamic self-heating for the general case of a two-port device and then specialized to the case of an SO1 MOSFET.
Kang et al. [15] has presented the method for extraction of gate electrode resistance as well as the channel resistance. This model extracted the analytical parameter with help of Y-parameter analysis and presented the extraction results of the high frequency gate resistance ($R_G$), with various geometries at different bias conditions. Kang et al. also developed an analytical physics based gate resistance model. Yan et al. [16] has presented a model that the overall gate resistance can be lowered through silicidation or the use of multiple gates. For example, the thickness of gate silicide must scale with channel length, thereby yielding a higher sheet resistivity for shorter devices. Also, increasing the number of gates tends to increase the source or drain junction capacitance and degrade circuit density.

Razavi et al. [17] has described the impact of distributed gate resistance on four aspects of the performance of the devices: cut-off frequency, maximum frequency of oscillation, input referred thermal noise, and time response. In the digital applications the devices usually switch fast enough such that the self-heating can be ignored in circuit simulation. For analog applications accurate simulations require that instantaneous temperature be included in the modeling. But in both the cases, ignoring thermal effects can lead to various errors in parameter extraction [18].

In this work, double-gate (DG) MOSFET [19, 20] and cylindrical surrounding double-gate (CSDG) MOSFET [21, 22] has been taken to model the thermal resistance effect. These MOSFETs are in the range of nanotechnology and have small scaled parameters. The resulting analytical model accounts for the thermal conductance of each region of the transistor: gate, gate dielectric, source, drain, body, Si-substrate, interconnects, etc. But in the presented model substrate is negligible, so have not been considered. I obtained that the effect of heating in these MOSFETs is less compared to the traditional MOSFETs. These MOSFETs can also be use for the RF switches and amplifiers.

The organization of this paper is as follows. The modeling of thermal resistance which has been used for the analysis of DG MOSFET and CSDG MOSFET has been discussed in the Section II. The thermal modeling of DG MOSFET has been analyzed in the Section III. The thermal modeling of CSDG MOSFET has been analyzed in the Section IV.

The effects of thermal resistance on various parameters have been discussed in the Section V. Finally, Section VI concludes the work and recommends the future works.

2. MODELING OF THERMAL RESISTANCE

When power is applied to a semiconductor device, the chip / junction temperature will rise to a value based on the power dissipated in the chip and the ability of the device package and its heat sink to remove this heat [7]. A steady state condition is reached when the heat generated is equal to the heat removed. Heat flows from a higher temperature to a lower temperature region, and the quantity that resists this flow of heat energy is called thermal resistance [13, 18]. A thermal circuit can model the transfer of heat from a semiconductor chip to its surroundings with direct analogy to an electrical circuit. In this work, this theory is used in the boundary of the MOSFETs, means the drain, source, gate, and channel region has been considered to observe the thermal resistance. The external components such as heat sink, ambient or air have not been considered. In an electrical circuit, if current $I$ flow from a point at voltage $V_H$ to a point at voltage $V_L$ as shown in the fig. 1(a), then using Ohm’s law the electrical resistance $R$ between the two points is:

$$R = (V_H - V_L) / I$$

Therefore,

$$V_H = V_L + IR$$  \hspace{1cm} (1)$$

Now for the thermal circuit, equivalent to the electrical circuit, there is an analogous relation as [7]:

- Power dissipated ($P_D$)  \rightarrow  Current source ($I$),
- Temperature ($T$)  \rightarrow  Voltage ($V$), and
- Thermal resistance ($\theta$)  \rightarrow  Electrical resistance ($R$).

Hence using thermal Ohm’s law, if heat flows from a point at temperature $T_H$ to a point at temperature $T_L$ and dissipates power $P_D$ as shown in the fig. 1(b), then the thermal resistance $\theta$ between the two points is:

$$\theta = (T_H - T_L) / P_D$$

Therefore,

$$T_H = T_L + P_D \theta$$  \hspace{1cm} (2)$$
In the Double-Gate MOSFET (as shown in Fig. 2a) [19], there are two gates means one gate on each side of the Silicon oxide layers. This MOSFET creates two MOSFET back to back and the resistance structure is shown in fig. 2(b). The $R_s$, $R_{ch}$ and $R_d$ are the source resistance, channel resistance and drain resistance respectively. The $R_G$ is the gate resistance and it has no effect in the thermal resistance model due to the negligible gate current in the MOSFET. The subscript 1 and 2 represent that the particular resistance is due to Gate-1 and Gate-2 respectively.

These resistances are converted to its thermal resistance as shown in the fig. 2(c) using the fig. 1 and then equated using Equation (2) and Equation (3). The gate resistance has no effect in the working of MOSFET in terms of switching. The gate creates the path from source to drain. From the fig. 2(c), using thermal Ohm’s law, the final thermal resistance has been calculated as follows:

$$\theta_1 = \theta_s + \theta_{ch} + \theta_d$$
$$\theta_2 = \theta_s + \theta_{ch} + \theta_d$$

3. ANALYSIS OF THERMAL RESISTANCE OF DG MOSFET

For a typical arrangement of an integrated circuit (DG MOSFET and CSDG MOSFET) comparing the thermal resistance (for example $\theta_1$, $\theta_2$, and $\theta_3$) with the electrical resistance (for example $R_s$, $R_{ch}$, and $R_d$) in series combination as shown in fig. 1(c). The sum of these three thermal resistances is the total thermal resistance will be like the $R_{total} = R_s + R_{ch} + R_d$, so the thermal resistance equivalent with thermal Ohm’s law will be:

$$\theta_{total} = \theta_1 + \theta_2 + \theta_3 \quad (3)$$

The total thermal conductance $G_{th}$ reflects the average temperature rise $\Delta T$ in the transistor for $\Delta T = P_d / G_{th}$, where $P_d$ is the power dissipation [11].
Fig. 2. Double-Gate MOSFET (a) Basic structure, (b) Resistive model, and (c) Thermal resistive model.

These $\theta_1$ and $\theta_2$ are in parallel, following the parallel combination of the resistances due to the Gate-1 and Gate-2. So the total equivalent thermal resistance of the DG MOSFET will be:

$$\theta_{DG} = \theta_1 \Pi \theta_2$$

$$= \frac{(\theta_{s1} + \theta_{s2} + \theta_{d1})(\theta_{s2} + \theta_{s3} + \theta_{d2})}{(\theta_{s1} + \theta_{s2} + \theta_{d1}) + (\theta_{s2} + \theta_{s3} + \theta_{d2})}$$

(4)

In this Equation (4), the thermal resistance will decrease compared to the normal MOSFET as it is parallel combination of resistance. Hence this DG MOSFET is suitable for the application of RF switches.

4. ANALYSIS OF THERMAL RESISTANCE OF CSDG MOSFET

In the CSDG MOSFET (as shown in Fig. 3a) [22], there are two circular gates (due to hollow cylindrical structure) i.e. one gate on the external peripheral and second one is inside the internal peripheral of the Silicon oxide layers. This MOSFET creates two MOSFET like a cylindrical structure and its resistance structure is shown in fig. 3(b). The $R_s$, $R_{ch}$ and $R_d$ are the source resistance, channel resistance and drain resistance respectively. The subscript 1 and 2 represent that the particular resistance is due to Gate-1 and Gate-2 respectively. The difference in the values of these resistances with compare to DG MOSFET parameter is that, these are circular resistance for the CSDG MOSFET as in Equation (5). These resistances are converted to its thermal resistance as shown in fig. 3(c) using the fig. 1 and then equated using Equation (2) and Equation (3).

$$R = \frac{\rho L}{A} \quad (5)$$

where $\rho$ is the resistivity of the material, $L$ is the channel length and $A$ is the circular perimeter of the CSDG MOSFET as in this fig. 3(a), it will be $2\pi a$ (internal perimeter for internal resistance) and $2\pi b$ (external perimeter for external resistance). Similar to DG MOSFET, the gate resistance has no effect in the working of CSDG MOSFET in terms of switching. The gate creates the path from source to drain. From the fig. 3(c), using Thermal’s ohm law, the final thermal resistance has been calculated as follows:
The thermal resistance affects the switching speed of the RF switch. A higher switching speed can be achieved due to the increased mobility and decreased thermal or electrical resistance. As in the thermal equivalent circuits of DG MOSFET and CSDG MOSFET, the thermal resistances are in parallel combinations, which reduce thermal resistance and hence the heating effect on the application of the devices. So, the RF switches designed by using DG MOSFET and / or CSDG MOSFET are having higher switching speed compared to the traditional MOSFET. The thermal resistance has improved performance, increased reliability, and higher density of MOSFET integrated circuits. Reliability can be increased if thermally activated processes slowdown. This can be done better with the help of CSDG MOSFET as compared to the DG MOSFET. The noise behavior can be improved as these structures have reduced thermal noise due to reduction in the equivalent thermal resistance as shown in the fig. 2(c) and fig. 3(c), with the help of Equation (4) and Equation (6). Due to the improved heating effect, one can achieve the higher packing density.

CONCLUSIONS AND FUTURE RECOMMENDATIONS

In this work, I have modeled the thermal resistance for the DG MOSFET and CSDG MOSFET using thermal Ohm’s law. Using this technology, the thermal effect on the RF switch can be analyzed in detail in future work. The proposed model can be further analyzed by physics based gate resistance model which can accurately predict the bias dependency, dependence on the number of fingers, channel lengths, and widths, junction temperatures, thermal stabilities, and thermal runaway effects of self-heating [23]. This DG MOSFET and CSDG MOSFET thermal resistance management process can further be used for RF amplifier development with junction to case temperature [24].

6. FUTURE WORK

In future work, this work can be extended to some of the application from Automation and robotics, Automotive engineering Computer aided & integrated manufacturing systems, reliability, control systems techniques, Games technologies, Systems Industrial engineering, Machine vision, Sensing and control systems etc. [25].

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A Model for Animation of Yorùbá Folktales Narratives

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ABSTRACT

African folktales particularly, Yorùbá folktales are on the verge of extinction due to modernization. Though attempts have been made in the area of digital storytelling and multimedia technology to enhance its teaching, learning and competitiveness. The paper argues that animation as a multimedia element has drawn the attention of both young and old, and has shown to be a veritable tool for both formal and informal education used in making sense of place, culture and heritage serving as a medium for fostering the spirit of reading among children and younger adults, promoting socio-cultural norms, and values, preserving and conserving our cultural heritage and revitalization of our indigenous languages. The aim of this study is to propose a model of animation for Yorùbá folktales in order to motivate the reading and socio-cultural awareness among children and young adults. In order to capture the animation and Yorùbá folktales features and components for the model, this paper focuses on related conceptual model, review of previous models and analysing the digital application of animation in Yorùbá folktales. As a result, the study hopes to help preserve and popularize folktales among children and young adults which will also provide guideline strategy to animators in developing Yorùbá folktales.

Keywords: Animation, Yorùbá folktales, Multimedia, Model, Education.

1. INTRODUCTION

The rapid advancement in Information and Communication Technology (ICT) in the last decades have significantly changed the content and practice of education. This advancement of ICT application in education makes it complimentary medium of education and learning process. In fact, in the last two decades, there has an increasing demand for instructional needs both in quality and quantity. Today, ICT plays an important role in educational institution as well as entertainment and since its technologies has come into every facets of our lives including learning; many educational studies and curriculum have been consummated to that structure. So, the introduction of ICT into education as well as entertainment has provided more efficient and customized software teaching aide thus reaching a great number of people [27].

The use of this IT application has enabled instructional materials to be utilized in a variety of exciting elements to deliver knowledge and instructions in order to ensure that student focus on learning strategies. Also, the bedrock of the information revolution is the development of digital technology particularly, multimedia, which has brought about a significant change in the way we conceive, describe and foresee our world.

Multimedia Technology is an aspect of ICT which involves the use of text, pictures, audio sounds, videos and computer generated animation or any combination to convey facts, beliefs, ideas and stories that when communicated will provide value to the audience on a computerized platform [25]. The multimedia elements when appropriately used are able to strengthen students’ understanding and memory of the learning content. In essence the emergence of multimedia technology is one of the most exciting innovations in this age of IT [10].
Multimedia technology finds its application in various areas including, but not limited to, advertisements, art, education, entertainment, engineering, medicine, mathematics, business, scientific research and spatial temporal applications. It is used in instruction in a variety of creative and stimulating ways such that it can be used to teach specific subject matter, societal values, or to change behaviour by endangering specific socio-cultural attitude, such as to address health matters among others.

Animation is a Latin word called ‘Anima’ which means ‘soul’. Simply put, to animate is to give life to inanimate objects, drawings, and images. In fact, animation is the rapid display of sequence of images to create an illusion of movement [23, 4, 11]. The development of modern animation began in the 1930’s in America during which the animation popularized by Disney using 3D. During the 1964, the scene of animation shifted to computer where Bell laboratories started to develop computing techniques for producing animated films. However, cartoon animation in Nigeria is dated back to the colonial era among which the pioneering cartoonist is Akinola Lesekan. There exists two types of animation namely; two-dimensional (2D) and three-dimensional (3D) animations. Though there is no rigorous classification of computer animation [18], they are however classified into three (3) such as 2D animation drawn in colloid or other traditional painting, computer animation and stop motion which is based on production process, and its impact[22]. There are various techniques for creating animations: flipbooks, stop-motion, cut out, rotoscoping and so on.

In ancient times and ancient societies, storytelling is one of the oral traditions practiced in the community through which knowledge (beliefs, such as customs, norms and values) and information are delivered by words of mouth (orally) from the older generation to younger generations [15,8]. There are several types of stories which include folktale, animal stories, legends, myths, proverbs, and tales [31]. Folktales are stories about people’s lives and imaginations as they struggle with their fears and anxieties about the world around them. [2] defined folktale as sayings, verbal compositions, and social rituals that have been handed down by word of mouth from generation to generations. Folktales is one of the commonest and most popular form of oral literature in African societies. In term of form, it is a traditional story which is told for entertainment and believed to be handed down in written or oral form. In this context, the folktales as a literary genre embraces a range of narratives that varies from explanatory stories, humanistic stories to fairy tales [5, 6, 9].

Presently, they are found in large concentration along the West African coast as well as other major cities of the world (14, 3).

Yorùbá language is spoken mainly by the natives of southwestern part of Nigeria with an estimated population of over 37.2 million [16].

1.1 Problem Statement

There have been several attempts by folklorist and other stakeholders in Nigeria to document, produce and present their various folktales. Today, African folktales particularly, Yorùbá folktales are on the verge of extinction and the danger that looms over Yorùbá language and its heritage is increasing daily especially as more natives move to urban areas where most interactions are done in English language (urbanization). Furthermore, there is at the moment, a dearth of criticism of Nigerian folktale especially, Yorùbá folktales which is fundamentally as a result of non-recognition of the folktale as a form worthy of serious academic attention in our educational system, hence the insufficient production of its animated stories and play among native animation developers. Also, the Yorùbá folktales are slowly being forgotten by the youths and children in this 21st century due to modernization and they seem to have no knowledge of the existence of such stories since they are exposed to foreign stories such as Cinderella rather than tales of Ijápá and Baba onikan. It is also true that many adults or parents rarely or never tell such tales to their children any longer.

Currently, Nigeria produce few or no animation stories, while most of the animation stories viewed are imported from United States, Japan, Korea and so on which in essence are technological enhanced than the local ones in Nigeria. However in terms of content (value, moral, lesson etc) and plot, they are poorly suited for children in Nigeria because they do not conform with our local socio-cultural values which is peculiar to Africa [32, 33].

Therefore, there is need for research to develop a framework or model with good story plot that takes into consideration the socio-cultural values for educating as well as entertaining our children. This will help in preserving and popularizing Yorùbá folktales in our society so as to ensure the continuity of folklore for future generations. This study hopes to revive and redeem the dearth thus making folktale art more vibrant and recognizable. In order to conserve Yorùbá folktales, a model for animating Yorùbá folktales will be presented and discussed in this paper as a guide for animators.

Having described the background of the study, the problems addressed, and the aim, the rest of this paper is organised as follows. Section 2, examines previous related works, folktales and animation principles while the conceptual framework is discussed in Section 3. Section 4 describes the proposed framework for digital animation of Yorùbá folktales in general based on several characteristic features, and Section 5 is the conclusion.

Yorùbá people have a rich and complex folklore system, which consists of riddles (alọ-apamọ), jokes (èfè), wise sayings (ọrọ-èjìnlè), Proverbs (òwé), Folktales (dàlò), and so on. These folktales add value to life and teach morals which help in making decision and motivate the awareness of the society to change behavior [17]. The Yorùbá homeland is located in West Africa. It stretches from a savanna (grassland) region in the north to a region of tropical rain forests in the south.
2. RELATED WORKS

The study of narratives has had a long history in Artificial intelligence. Narratives are a representative of aspect of human experience. They are used to communicate, convince, encourage and entertain [7]. [5] and [7] categorized narratives into formal, somewhat, traditional (myth, legend and folktale) and informal folktale is a generic term for various form of narrative prose literatures found in oral traditions of the world. Folktales are heard and remembered and they are subject to various forms of alterations in the course of retelling thus folktale differs. [35] in his work stated that these tales are receptive of the specific cultural background. Folklore is common to all people, its understanding, appreciation and sharing in another culture's folklore transcends race, colour, social class, and creed more effectively than any other single aspect of human existence.

The Yorùbá recognizes two (2) classes of tales: folktales (ààlọ̀) and Myth-legend (ìtàn). Folktales seem to have resulted from the combination and evolution of simpler elements that contains several cycles and recycles of basic narrative structure. It will not be possible to make much progress in the analysis of narrative until the simplest and most fundamental structures are analyzed in direct connection with the aim of identifying the basic functional units of narratives and also determining their overall structure.

Folktale plays significant roles in the life of the society it belongs. Folktales have been shared in every society to entertain, educate, and preserve culture. As emphasized in the United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention for the Safeguarding of Intangible Cultural Heritage (2003), folktales play an invaluable role, along with other cultural traditions, in bringing people closer together and ensuring exchange and understanding among them [30]. This affords message with great content to target audience, that is, children wherein the result shows that different factors have effects on the children such as liking and disliking cartoon character, costumes, accessories. Rough folktales, children are given a glimpse into a world where fantasy and reality meet. Again, most folktales and songs condemn bad behaviour as goodness triumph over evil and is always rewarded; heroes and heroines live happily ever after, while villains are suitably punished.

2.1 Previous Works on Folktales Animation

From literatures, there are several research in digitization of folktales with the view to presenting a computational model for the development of digital artifact and software. [29] subjected the African folktales, particularly Yorùbá folktale narratives to computational analysis which prompted the need to expand the application. The study considered Yorùbá folktale which is said to be an essential tool for educating the children and youth on the morals and culture of the society. [24] evaluated the effectiveness of storytelling based on local content of Malay folktale. In the study, seven types of folktales were selected. In order to accomplish this, the old content were replaced with new medium of presentation by using multimedia technology of 3D, interactivity, internet and web education.

In 2007, [23] presented a conceptual model for edutainment Animation Software in order to motivate socio-cultural awareness among children. In the study, the proposed model used 2D animation which also includes some learning activities related to the story. However, the folktale part needs to be modified so that it can give the characteristics and features of the folktale as shown in Figure 1.

![Figure 1: Conceptual model for Edutainment animation](image)

[2D animation]

[Learning activities related to the story]

[Scenario Simulations]

[games] [Puzzles]

[Multimedia elements: graphics, audio, music]

[2D animation]

[Edutainment animated folktale software]

[Folktales]

[Socio-cultural values]
Similarly, [9] presented her Courseware development to project positive value and Images of TRAdigital Malay Oral narrative (CITRA) model which is also in line to revive and encourage the reading habit among student. Here, the proposed model illustrated in Figure 2 consists of several components such as pedagogical approaches, learning theories and holistic development but not much details were given on the characteristics and elements of folktale.

![Figure 2: CITRA model for Edutainment animation](image)

According to [1] the mobile Yorùbá language tutor ‘Asa’ is an interactive application for kids to get acquainted with the basics of Yorùbá language. The application uses games, animation, voice, and colorful graphics to teach the Yorùbá culture and contains topics including etiquettes and ethics in the language. Again, [34] presented a Malaysian folktale animation which improved on the drawback identified in the earlier developed model.

![Figure 3: Proposed Model for animation Malay Folktale.](image)
However, the models presented are software based consisting of several modules which did not provide much details on animation principles and folktale features, although it was focused on Malaysian folktale. As a result of this, there has been a limited research on developing animation model for folktale. Therefore, this research aim to examine the principal components of animated folk stories focusing on Yorùbá folktale in increasing children’s recognition and understanding of Yorùbá folktale.

2.4. Principle of Animation

The principles of animation were developed to make animation, especially character animation, more realistic and entertaining. These principles can be applied to the types of computer animation. Nowadays, there are several animation software that can be used in creating animated videos. Others include Adobe Photoshop, Anime studio, 3D Max, Poser, and many others. There are downloadable software programs and on-line applications, 2D program with automated templates, 3D modeling environments and sophisticated rendering platforms.

The process of producing animation in conventional method emphasizes some principles during the production. This is to ensure that the animation is produced not only able to attract the attention of the audience, but also look realistic. Therefore, in the production of digital animation, whether it is 2D or 3D animation, some basic principles have to be followed in order to ensure that the result obtained are more interesting and realistic [13,11, 26]. Some of the principles include squash and stretch, exaggeration, slow-in and slow-out, staging, secondary action, character personality etc.

3. CONCEPTUAL FRAMEWORK

Meanwhile, there has been an increasing interest in the analysis of various narratives (folklore) genres. In view of this impact, several studies have been carried out on folktale and its analysis. Generally, there are two main theories of narrative: Functionalist and Structuralist through which the relationship within which narratives are examined [21]. The first explicit theory of narrative, that is, the functionalist theory focuses on the roles played by narratives while the latter is concerned about how it is produced. Propp’s while studying hundreds of Russian folk stories and fairy tales stated that all narrative have common structure. But [12] observed that Propp’s work was a reaction to his dissatisfaction with the early 20th century theory.

As a functional enthusiast, he identified 31 functions parts and concluded that it is made from comparison of theories of the tales that the result will be morphology which is a description of tales according to its constituent components parts and relationship of the component to each other and to the whole story. Propp’s proposed the scheme for its representation of range of Russian folktale.

However, the structuralist theory deals with features common to narratives, analyzing the nature, form and function of narration. [20] in his work while simplifying the idea of narrative theory suggested that all narratives including folktale have five stage model starting from initial state of equilibrium through an action disturbing or distorting that states to the attempt of resolving the disruption state, the solution state and finally to the terminal state in which the equilibrium is re-established the earlier theory proposed by Propp was relatively good but short of explicitness needed for a computational model of folktale. This is because they are loosely defined and lack formal definition for characters.

In the context of this work, it was discovered that the theory or model could not give the character components of the folktale some representation. For example, forgiveness and other characteristic attributes are found insufficiently represented or modeled by Propp’s theory hence, not suitable for representing folktales and fables outside the Russian folktale [28]. However, the structural model of Todorov’s theory is found amenable to the Yorùbá folktale and will be used adequately to analyse the folktale in preparation for the animation works.

4. RESULTS AND DISCUSSION

In order to present the proposed conceptual model for animated Yorùbá folktale, several models that were proposed by various developers have been developed. In addition, a comparative study has been done among the models and a suitable framework proposed. The conceptual model gives a view of the design phase of the project development. The complete and conceptual model is highly important as appoint of reference providing guideline strategy for animators in developing Yorùbá folktale. The knowledge of the characteristic and feature components is significant in developing folktale animation for our cultural heritage. The model comprised of its structure in terms of the basic components and how they are interconnected. The model has eight elements as illustrated in Figure 4.

Here, we discuss the basic components of the model, the technology as well as the medium employed in realizing each components of the model, the technology as well as the medium employed in realizing each component.
Child Development: This refers to the physiological, biological and emotional changes that occur in human between birth and end of adolescent as individual grows from dependency to maturity. The child development approach takes into consideration the literary experience of children which assists in cognitive learning, psychomotor and affective development of the children.

Animation principle: There are several animation principles of which twelve principles of animation are revised and selected ones will be applied in this project. The principles of animation that will be employed in the creation of the animation package are exaggeration, anticipation and squash and stretch. These principles are selected because the combination of them gives more effects and virtually a lot of thing can be achieved. For example, the characteristic in anticipation can be applied in the facial animation and character animation comprising of the mouth, eyes, nose and so on. Also, in the development process, the exaggeration principle elements such as sound, action body movement, facial expression and speech play an important role in order to make the animation more convincing. Similarly, the prominence given in the plot is to highlight the scene, expression and poses which can be adequately done by manipulating the colour, lightening and angle [19].

Learning Approach: The approach to learning is quite fundamental to knowledge acquisition, which affect how children learn and perceive things. In the development process, the folktale will be delivered through indirect approach such as with the use of thematic and literature based approach (comprehension) which will make the children to be involved, engaged both in spirit and mind. This kind of learning will eventually bridge the gap between formal and informal setting because they are everyday happening and occurrence.

Language Style: This proposed model is developed on the language style in that the children can learn how to read and rely their experience effectively. The use of pictures and other visual representation of the folktale character and plots in addition with the text will make it relatively easy for children to learn and others to engage with the cartoon in a language that is not their native tongue.

Folktale: Essentially in Yorùbá folktale, there are nine components. They include the opening formulae, plot, character (actor), proverb, theme, morals, language style, songs and closing formulae. The study of Yorùbá folktale has emotional influence which conveys particular meaning to the children.

Medium: The instructional medium used in the proposed framework for the animation of the Yorùbá folktale is the multimedia technology which is linked together in a way that affords the children the ability to visualize the narrated story in 2D animation.

Learning style: There are about 7 learning style of which three are primary: visual, auditory and tactile. The use of blended learning style for teaching and educating the children is relatively new concept incorporated into the model. This is because our traditional educational system uses linguistic and logical teaching methods which do not have the memory recall capacity for the children.
5. CONCLUSION

A model for the development of Yorùbá animated folktale has been presented. The model consists of 8 elements. As a conclusion, this is developed as a guideline for the development of Yorùbá folktale animation designed to meet the needs of young children and adolescent. With this framework, it will encourage animators to develop Yorùbá folktale animation. Thus, this effort will help in educating young children to adopt good moral, values as well as promoting socio-cultural awareness and preserving our cultural heritage. Besides, helping to revive and sustain the existence and popularity of Yorùbá folktale among future generation.

ACKNOWLEDGEMENTS

The authors would like to thank everyone that is involved directly or indirectly with this project especially to the coordinator of Computing and Intelligent System Research Group CISRG (http://www.ifecisrg.org).

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Increasing Agricultural Productivity in Nigeria Using Wireless Sensor Network (WSN)

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ABSTRACT

Nigeria is a country endowed with fertile soil which as a result is expected to bring forth bumper harvest of agricultural products. However, the major challenge is the farmer not having full control over the activities on farmland and its environment which in most cases, if not well managed, brings about low agricultural productivity. This paper therefore proposes precision farming solution using Wireless Sensor Network to increase agricultural productivity in Nigeria. With this, the system will be able to sense environmental parameters and thereafter transmit its findings to the base station in order for the farmer to make decisions such as to actuate irrigation scheduling, fertilization scheduling and so on. On the farmland, sensors are meant to be uniformly distributed and used for nodes localization. The proposed system is expected to proffer solution to challenges starring agricultural productivity in Nigeria at the face.

Keywords— Agriculture, Precision Farming, Wireless Sensor Network,

1. INTRODUCTION

Nigeria has a population of over 170 million making it the most populous country in Africa. Its domestic economy is dominated by agriculture, which accounts for about 40% of the Gross Domestic Product (GDP) and two-thirds of the labour force. Agriculture supplies food, raw materials and generates household income for the majority of the people.

Trade imports are dominated by capital foods, raw materials and food [1]. Nigeria is currently preoccupied with the challenge of diversifying the structure of its economy most especially with the dwindling oil price. With attendant danger that fall in oil price poses to Nigerian economy, agriculture remains a viable option to diversifying the structure of its economy. The importance of agricultural productivity cannot, in anyway, be overemphasized in tackling this issue staring the country in the face as it remains the single largest contributor to the well-being of the rural poor and sustaining 70% of the total labour force [2].

In order to improve the low agricultural productivity in Nigeria, there is a need for more innovative solutions using modern technologies. Precision Farming solution using WSN technology is being proposed as a way out.

Sensor nodes deployed in an environment, as shown in figure 1, environmental parameters such as temperature, pressure, humidity, or location of objects. Signals from these sensor nodes are transmitted to a local sink which may be connected to a gateway in order to send the data to an external network such as internet so that a remote user can access information about the environment. The received data from sensor nodes may be analyzed and appropriate decision or action taken depending on the application itself [20]. In precision farming, information received about the farm helps the farmer in using the right input needed to improve the crop yield such as fertilizer, water, etc, on the farm. Right use of these inputs, at the right time, in the right place and in the right amount will greatly reduce cost and also improve productivity.
2. RELATED WORKS

As it were presently, the imperativeness of agricultural productivity to national economy cannot be relegated to the background especially with fall in oil price which Nigeria has relied too much in time past; due to this, agricultural sector has been facing some challenges which bore down to neglect by the government.

[3] x-rayed current situation of agricultural productivity in Nigeria; low quality of infrastructure has been identified as a bane of agricultural productivity in Nigeria; rural infrastructural development has been neglected and as a result of this, rural population has limited access to services such as schools, good road network & health centers. Due to this, there is reduction in the productivity of agricultural produce. Equally, insensitivity of the government to the plight of farmers contributes in no small measure to this menace. The poor tends to live in isolated villages that can become inaccessible during the rainy seasons and as a result, there is experience of substantial loss of productive time, low productivity and poverty in Nigeria.

[4] identified some constraints to agricultural productivity in Nigeria some of which include aging and inefficient processing equipment, inability to install new processing equipment due to high offshore costs, high costs of production inputs and farm machinery, inadequate and untimely funding of the agriculture, agricultural Pricing policies, low access to Agricultural Credit, low and unstable investment in Agricultural Research amongst others.

[5] stated that sustainable increased rice production in the near future requires substantial improvement in productivity and efficiency. The use of innovative genetic improvement including hybrid rice and possibly transgenic rice could increase the yield ceiling, where yield gaps are nearly closed.

He also reported that a direct relationship existed between the amount of irrigation water and evapotranspiration rice yield indicating the dependence of yield improvement or (shortage) on the quantity of irrigation water administered and by extension the crop water use. Therefore, water application, being a dominant factor affecting growth and grain yield of rice needs to be properly scheduled for improved rice production. This scheduling of water and other factors responsible for rice growth can be done by the application of sensors in the field.

Going by the subject under review which is precision farming with concentration on Wireless Sensor Network, several technologies were used in the precision farming such as Remote Sensing (RS) proposed by [6], Global Positioning System (GPS) by [7], and Geographic Information System (GIS) by [8]. The most important step in Precision Farming is the generation of maps of the soil with its characteristics. These included grid soil sampling, yield monitoring, and crop scouting. Remote sensing coupled with GPS coordinates produced accurate maps and models of the agricultural fields. The sampling was typically through electronic sensors such as soil probes and remote optical scanners from satellites. The collection of such data in the form of electronic computer databases gave birth to the GIS. Statistical analyses were then conducted on the data, and the variability of agricultural land with respect to its properties was charted. These technologies apart from being non-real time involved the use of expensive technologies like satellite sensing and manual labour is usually employed [9].

[10] designed a project called Lofar Agro. It deals with fighting a fungal disease called phytophthora in a potato field; the development and associated attack of the crop depends strongly on the climatological conditions within the field such as temperature, relative humidity, luminosity, air pressure, precipitation, wind strength and direction, and the height of the groundwater table were the environmental parameters sensed in the work. The WSN data and statistics were sent to a field gateway, then to the Lofar gateway which is a simple PC for data logging via WiFi connection, then through a wired connection they were sent to the Internet to Lofar server and a couple of other servers under XML format.

[9] introduced a wireless mesh network in is work titled AGRO-SENSE The work comprise of sensors placed at different locations in a crop field where the intended characteristics of the soil or atmosphere (soil pH, soil moisture, electrical conductivity, soil temperature) need to be captured. The actuation is done based on the readings supplied by the sensors, upon exceeding a threshold, the system will generate automated alert messages on the console, upon which appropriate action can be taken.
[11] designed a preliminary study on the development of WSN for paddy rice cropping monitoring application in Malaysia. It introduced standard measurement parameters sensors such as ambient air temperature and humidity, soil pH and moisture were integrated in all nodes, there were two directions the data will go, which is first linked to server data based system to be recorded and revealed on Internet web page and real-time alert system using SMS system via GSM modem to the person in charge cell phone.

[12] designed a WSN based and Internet system for monitoring a field-environment factors in an automatic manner and dynamically transmitting the measured data to the farmer or researchers. The main part of the network acquiring unit mainly includes the sensors of temperature and moisture in air and soil, CO2, and illumination.

3. PROPOSED SOLUTION

**Proposed distributed wireless sensor network**

Fig. 2 shows the framework of a wireless sensor network system to monitor various parameters on agricultural farmland in order to improve the yield. The sensors on the field are to sense environmental parameters which are transmitted to the base station and stored in the database. The database is linked to the internet so that farmers can access this information remotely either through their mobile phones or laptops. The farmers phones or laptop are equipped with application which helps in making decisions such to actuate irrigation scheduling, fertilization scheduling or any other farming practices based on the information obtained from the database.

**Sensing Parameters on a farmland**

Growth can be defined as the progressive development of an organism. It is usually expressed as dry weight, height, length, and diameter. Let growth (G) be expressed as

\[ G = f (X_1, X_2, X_3, ..., X_n) \]  \hspace{1cm} (1)

where Xi are the growth factors.

The factors that affect plant growth can be classified as genetic or environmental [22]. A farmer has control over the genetic factor by his choice of variety. Also generic engineering at research institutes are constantly finding ways of improving the yield of crops through the genes. The farmer does not have control on the environmental factors such as temperature, moisture supply, radiant energy, and composition of the atmosphere. Other factors that cannot be controlled by farmer include soil aeration and soil structure, soil reaction, biotic factors, supply of mineral nutrients, absence of growth-restricting substances and pest and diseases that can destroy crops planted. Controlled of these factors can greatly enhance crop productivity. This research focuses on these environmental parameters which is broadly categories into three groups as shown in Fig. 3.

**Fig. 2. Architectural framework**

**Fig. 3. Factors affecting growth of crops**

Temperature can be defined as a measure of the intensity heat. The Plant growth occurs in a fairly narrow range - 60 - 100 degrees F. Temperature directly affects photosynthesis, respiratory and transpiration. The rate of these processes increases with an increase in temperature. Temperature also affects soil organisms. Nitrifying bacteria inhibited by low temperature. PH may decrease in summer due to activities of microorganisms. Soil temperature affects water and nutrient uptake.
Water is a primary component of photosynthesis. It maintains the firmness of tissue and transports nutrients throughout the plant. In maintaining firmness of tissue, water is the major constituent of the protoplasm of a cell. By means of firmness of tissue and other changes in the cell, water regulates the opening and closing of the stomata, thus regulating transpiration. Water also provides the pressure to move a root through the soil. Among water’s most critical roles is that of a solvent for minerals moving into the plant and for carbohydrates moving to their site of use or storage. By its gradual evaporation of water from the surface of the leaf, near the stomate, helps stabilize plant temperature.

Relative humidity – Relative humidity (RH) is the amount of water vapor in the air compared to the amount of water vapor that air could hold at a given temperature. A hydrated leaf would have a RH near 100%, just as the atmosphere on a rainy day would have. Any reduction in water in the atmosphere creates a gradient for water to move from the leaf to the atmosphere. The lower the RH, the less moist the atmosphere and thus, the greater the driving force for transpiration. When RH is high, the atmosphere contains more moisture, reducing the driving force for transpiration. Plant growth restricted by low and high levels of soil moisture can be regulated with drainage and irrigation. Good soil moisture improves nutrient uptake.

Light, a visible portion of the solar radiation or electromagnetic spectrum, is a climatic factor that is essential in the production of chlorophyll and in photosynthesis, the process by which plants manufacture food in the form of sugar (carbohydrate). Other plant processes that are enhanced or inhibited by this climatic factor include stomatal movement, phototropism, photomorphogenesis, translocation, mineral absorption, and abscission [13].

Soil pH can be defined as a measure of the acidity or alkalinity of the soil. It is one of the most important soil properties that affects the availability of nutrients. Macronutrients are usually less available in soils with low pH while micronutrients are usually less available in soils with high pH [14]. Fig. 4 shows the plant nutrient availability chart [15].

 Hungry birds are a major factor in the growing of crops in Nigeria. Farmers considered birds as the major constraint in crop production. Study shows that up to 75% of total output could be consumed by birds, and up to 50% of production costs went into bird scaring [16]. [16] also noted that many scaring devices exist on the international market. A few of them have been tried in Nigeria but without success because of the tendency for the birds to habituate to them after a few days. The devices that seem to be worth testing are the reflective ribbons and the black threads stretched across the fields. This had been very successful in area investigated by the researcher. The reflective ribbons reflect light when sun rays falls on it. A light reflecting system making use of sun rays could be developed to reflect light in order to scare away the birds.

Sensing modalities and Sensor node hardware

The choice of sensing hardware is prompted by through study in section 3.2. This sensing hardware is can be divided into 3 categories:

1) Sensor node: There are various sensors such as temperature, light intensity, relative humidity and pH sensor. A typical soil moisture sensor is as shown in Fig. 5.
Other sensors that can detect the presence of soil nutrients like Nitrogen and phosphorus can be obtain and attached to the sensor node in order to extent its sensing ability. The sensor nodes are setup on the farmland to monitor the chosen environmental factors.

2) Base Station: Nano Arduino board as shown in Fig. 6, can provide a USB Interface for data communications between the base station and the database.

3) Database: the personal computer will be used to for the database. The PC will have the monitoring software such as Arduino Sketch. This provides topology map, data export capability, Mote programming and a command interface to sensor networks.

4) Fig. 5 Soil moisture sensor

Sensor node deployment

There is a need for optimum sensor node placement in a monitored area in order to have a cost-effective node deployment. Also, the positions of sensor nodes in a monitored field must be able to provide maximum coverage with longer lifetimes. This can be done by utilizing an effective planning mechanism in arranging the limited number of sensor nodes. Recent research focuses on artificial intelligence (AI) approach particularly on biologically inspired techniques in solving optimization problems in WSN. The sensing model of a sensor node determines its monitoring ability. This is important in the optimum deployment of sensors in a field. There are two types of sensing model in WSN: binary sensing model and probability sensing model [17].

The binary sensing model assumes that the events can be detected by the sensor nodes if they are within sensor range ($Rs$) [17]. However, in the actual application environment, the detection ability of the sensor nodes is unstable due to the interference of environmental noise and the decrease of the signal intensity. The probability sensing model assumes that sensor nodes are distributed in a certain probability as proposed by [6].

Based on this model, the common method of irrigation farming in Nigeria entails dividing irrigation farmland in to sections. This division can be used to distribute sensor nodes uniformly, and nodes localization.

Determining the number of sensor nodes

Number of sensor nodes to be deployed is varied. The minimum number of sensor nodes can be determined by using equation 1 which was derived by [18].

$$\text{Number of Sensor Nodes} = \frac{A}{3\sqrt{3}R_s^2} \quad (3)$$

where $A$ is the monitoring area and $R_s$ is the sensing range of the sensor node.

Determination of a suitable Communication Protocol

There is a need for networks to respond immediately to the changes in the sensed attributes. WSNs should also provide the end user with an ability to dynamically monitor and control the trade-off between energy efficiency, accuracy, and response times. Precision Farming solution needs a comprehensive, easy-to-use querying system, so that reliable and accurate answers can be obtained with minimal delays.

Several routing protocols had been proposed by researchers. XMesh [23], is a multi-hop routing protocol developed by Crossbow to run on the MICA family of motes using the TinyOS environment. It is an ad-hoc mesh networking protocol capable of network formation without the need for human intervention. It is also capable of adding and removing network nodes automatically without having to reset the network. It uses a routing beacon from the base station to establish route paths back.
In the XMesh routing algorithm, the cost metric is one that minimizes the total number of transmissions in delivering a packet over multiple hops to a destination and is termed the Minimum Transmission (MT) cost metric. This differs from the traditional cost metric of distance vector routing which is hop count. In highly reliable links, retransmissions are infrequent and hop count would suffice in capturing the cost of packet delivery. However, with links of varying quality, a longer path with fewer retransmissions may be better than a shorter path with many retransmissions. That is, the energy required to transmit a packet over a distance with a single hop will be far greater than the energy required transmitting a packet over that distance with multiple hops.

**Decision Support System (DSS)**

A decision support system for precision farming is needed to assist farmers, agricultural experts, research workers or any intellectuals with guidance in making various farming related decisions and help them to access, display and analyze data that have geographic content and meaning. According to [19], the concept of precision farming is not only related with the use of technologies but it is also about the right use of input such as nutrients, water, fertilizer, money, machinery and so on, at the right time, at the right place, in the right amount and in the right manner. There is need to have accurate information and suitable decisions regarding the right inputs required for the farming practices and to initiate the step towards the precision farming.

The proposed DSS calculates irrigation, fertilizer and other farming practices scheduling such as crop rotation that will be required on the farmland. Fig. 8 shows the architecture of decision support system. The proposed DSS mainly consist of a knowledge base, reasoning engine, user interface and developer interface which are explained thus:

1) **Knowledge based**: This database stores such knowledge as empirical rules, analyzed cases, parameters sensed from the agricultural field, and other information used while reasoning.
2) **Developer interface**: The developer interface allows system developer to modify the knowledge database and reasoning engine from external resources
3) **User interface**: This interface allows users to interact with the system through a user-friendly operation.
4) **Reasoning engine**: This engine uses information from the knowledge database to diagnose questions asked by users and search for suitable solutions.

4. CONCLUSION AND FUTURE WORK

This paper shows the importance of using the wireless sensor network in precision farming field. Also this paper sheds the light on the agriculture in Nigeria and how precision farming using wireless sensor network will help to solve a lot of Nigerian agricultural problems by improving the crops yield and reduce wastage of resources.

This paper presents the design Wireless Sensor Network that can monitor environmental factors such as soil temperature, humidity, ambient light intensity in a crop field, and soil pH. This can help the end users such as farmers in the better understanding of agriculture practices to be adopted for crop management. Since, hungry birds are a major factor in crop production in Nigeria, bird detector and scarcer system suitable for this part of the world had been proposed. The Graphical User Interface of the decision support system has been proposed to be very user-friendly keeping in mind that the system will be used predominantly by farmers. Energy is a major constraint in rural and remote areas in Nigeria, thus the need to run this system on solar energy.

As a future work, it is planned that proposed system will be deployed in a rice field and the feasibility of the network will be tested by evaluating the field results. The proposed system to be implemented will addresses a wide range of agricultural concerns from detecting sensor node failure, power management and data reliability considerations.
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Authors’ Brief

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An Expert System For HIV Screening Using Visual Prolog

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ABSTRACT

Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency syndrome (AIDS) is one of the most challenging health problems of this era. Since the first incidence of AIDS was reported in Nigeria in 1986, the number of persons infected with the deadly disease had risen remarkably. By the end of 2010, it was estimated that over 3.1 million people in Nigeria were living with the virus. Globally, 17-51% of people living with HIV know of their status. Thus the need to design a system that would assist physicians in medical screening has become imperative and hence cannot be over emphasized.

In this work, a user-friendly medical expert system for screening HIV was designed using Visual Prolog, to aid medical practitioners and health care workers in the process of screening individuals of HIV. This would in turn help in solving the challenges faced by people most especially in communities where there is shortage or unavailability of medical personnel, as it provides very rapid method of prognosis with much accuracy and reduces the hours patients spend in hospitals and boring routine tasks associated with the existing method of HIV screening. This expert system is user-friendly and carries out prognosis based on patients’ symptoms.

Keywords: Expert Systems, HIV, AIDS, Prognosis, Visual Prolog.

1. INTRODUCTION

Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency syndrome (AIDS) is one of the most challenging health problems of this era. HIV is a retrovirus that infects cells of the immune system, destroying or impairing their function [11]. As the infection progresses, the immune system becomes weaker, and the person becomes more susceptible to infection. As early as 2-4 weeks after exposure to HIV (but up to 3 months later), people can experience an acute illness, often described as “the worst flu ever.” This is called acute retroviral syndrome (ARS), or primary HIV infection, and it’s the body’s natural response to HIV infection. During primary HIV infection, there are higher levels of virus circulating in the blood, which means that people can more easily transmit the virus to others. After the initial infection and seroconversion, the virus becomes less active in the body, although it is still present. During this period, many people do not have any symptoms of HIV infection. This period is called the “chronic” or “latency” phase. This period can last up to 10 years—sometimes longer. When HIV infection progresses to AIDS, many people begin to suffer from fatigue, diarrhea, nausea, vomiting, fever, chills, night sweats, and even wasting syndrome at late stages [17]. Since the first case of AIDS was reported in Nigeria in 1986, the number of persons infected with the deadly disease had risen remarkably. By the end of 2010, it was estimated that over 3.1 million people in Nigeria were living with the virus. Globally, 17-51% of people living with HIV know of their status [18].

During medical screening of HIV, physicians ask patients question and try to find out possible disease based on the answers supplied during the interview. Physicians then write prescription for the patient or advise the patient to go for a medical laboratory test confirming his suspicion. The existing method of medical screening and diagnosis employed by physicians for the analysis of HIV infection uses manual method characterized by inability to comprehend large amounts of data quickly, retaining large amount of data in memory and recalling the information stored in memory.

However, the recent advances in the field of Artificial Intelligence (AI) have led to the emergence of expert systems for medical applications. Major initiatives to improve the quality, accuracy and timelines of healthcare data and information are improving all over the world with the integration of expert system into the healthcare data analysis. An expert system is a computer system that performs a task that would otherwise be performed by a human expert. They are designed to solve complex problems in a particular field by reasoning like an expert in that field. Some expert systems are designed to take the place of human experts, while others are designed to aid them.
In this study, a user-friendly medical expert system for screening HIV was designed using visual prolog, to aid the work of medical practitioners and health care workers in the process of screening individuals of HIV. The application uses in-built Visual Prolog clauses, predicates and fact engine. It permits users to enter their bio-data and respond to questions asked by the system during the screening. Afterwards, the system provides a prognosis.

2. PROBLEM STATEMENT

To understand the problem statement, a medical personnel at Osun State Control for AIDS/HIV (O-SACA) was interviewed. It was found that the current system has a few flaws, stated thus:

- Osun State’s primary health centers do not have enough available experts in the field so a patient may have to keep coming back till the expert is available before the screening exercise can take place.
- Human experts are unable to retain large amounts of data in memory.
- They are also unable to comprehend large amounts of data quickly and are slow in recalling information stored in memory.
- Human experts may be subjected to deliberate or unintentional bias in their actions.

3. RELATED WORKS

Intelligent systems have become vital in the growth and survival of the healthcare sector. A good number of expert systems have been developed to manage tropical diseases and some medical expert systems have been developed and playing a major role in assisting and providing support in common clinical problems like prediction of diseases, prevention of diseases, diagnosis of diseases, providing patients with medical information, etc. Latha et al., (2007) in a study developed an Intelligent Heart Disease Prediction System using the Coactive Neuro-Fuzzy Inference System (CANFIS) and Genetic Algorithm, which combined the neural network adaptive capabilities and fuzzy logic qualitative approach integrated with genetic algorithm to diagnose the presence of the disease. The objective of the study was to develop a prototype Intelligent Heart Disease Prediction System with CANFIS and genetic algorithm using historical heart disease database to make intelligent clinical decisions which traditional decision support system cannot. The result showed a better accuracy in data analysis than the diagnosis carried out using traditional methods.

Adekoya et al (2008) developed an expert system on tropical diseases to assist paramedical staffs during training and in the diagnosis of many common diseases presented at their clinics. The system was flexible, friendly, and usable by people without much background in computer operations. The study concluded that the implementation of the system reduced doctor’s workload during consultation and eased other problems associated with hospital consultations.

Imianvan et al (2011) developed an Expert system for the Intelligent Diagnosis of HIV using Fuzzy Cluster Means Algorithm. The focal point of this research was to describe and illustrate the application of Fuzzy Cluster means system to the diagnosis of HIV. In another study (Imianvan and Obi 2012), a Neuro-Fuzzy Expert Systems for the Probe and Prognosis of Thyroid Disorder was developed using sets of fuzzified data set incorporated into neural network system. It was an interactive system that tells a patient his/her current position as regards Thyroid disease.

Obanijesu and Emuoyibofarhe,(2012) developed a Neuro-fuzzy system for early prediction of Heart Attack and was able to show the risk level of patient classified into four different risk level: very low, low, high and very high. This system was used as a supportive tool for the diagnosis of Heart disease. In agreement, Ephzibah and Sundarapandian (2012) designed a Neuro-Fuzzy Expert System for Heart Disease Diagnosis. This system uses the genetic algorithms for feature selection so that diagnosis can be done with limited number of tests. This expert system helped Doctors to arrive at a conclusion about the presence or absence of heart diseases in patients. It is an enhanced system that accurately classifies the presence of that heart disease. In another study, Ojeme and Maureen developed an expert system for HIV Diagnosis Using Neuro-Fuzzy Expert System. The system uses a synergistic combination of Neural Network (NN) and fuzzy inference systems (Neuro-Fuzzy) to generate a model for the detection of the risk level of patients with HIV.

4. METHODOLOGY

This section describes the methodology adopted during the development of the system.

4.1. Knowledge Acquisition

The domain knowledge was acquired from a visit to Osun State Action Committee on Aids (O-SACA), Osogbo. Extensive interviews were conducted in order to understand the domain problem properly and be able to extract objects, facts and sets of rules on the domain investigated. Also various books and journals on HIV/AIDS, HIV/AIDS screening, diagnosis and treatment were consulted.

4.2. Knowledge Representation

The domain knowledge acquired is represented in the knowledge base. The objects in the domain are represented by constants and variables, and the properties of these objects and the relations that exist over them are represented by predicates.

4.3. Implementation

The knowledge obtained and its representation is implemented using Visual Prolog, a Microsoft application that can be used to build GUI (Graphical User Interface) applications, Console applications, DLLs (Dynamic Link Libraries) and CGI (Computer Generated Image) programs. The choice of Visual prolog is due to its user friendliness and ease of use.
4.4. Evaluation

The competency of the system was evaluated and tested by the medical personnel, patients and individuals. The chart below shows testing steps during the evaluation of the system.

![Flowchart](chart.png)

**Figure 1: Flowchart**

![Diagram](diagram.png)

**Figure 1: Expert system components and human interfaces**

Source[5]
5. THE EXPERT SYSTEM

5.1 Analysis and Design

1) System Input
   ▪ It requires information about the patient.
   ▪ Requires answers to the questions the system asks.

2) System Output of the proposed system
   ▪ It gives the result of the screening exercise which is the likelihood or unlikelihood of the user being infected with the virus.
   ▪ If there is a possibility that a group of symptoms produce more than one disease then the system will display the name of all diseases, relating to the symptoms.

Functional Requirements
   1) Data Input: Accept user information using a question and answer format
   2) Processing: Data processing will be carried out after the user provides a Yes or No answer.
   3) Data Output: Use the information provided by the user to produce result from the screening exercise.
   4) User Interface: The system will communicate with the user through the console.
   5) Operating System: The system will run on Microsoft Windows XP or higher with Visual Prolog platform

3) Non-Functional Requirements
   1) User-Friendliness: The system must be user friendly so as to allow users with little or no computer or IT training use the system.
   2) Usability: The system must be easy to use, understand and learn
   3) Portability: The system must be portable, i.e. it must be easy to move from one system to another. Factors like size of the software will determine its portability; it is preferable if the software is of a small size.
   4) Reliability: The system must maintain its performance over time.

Figure 2: Use Case diagram showing the actions that can be performed by the user.
5.2 Development

The system was developed using Visual Prolog, a Microsoft application that can be used to build GUI (Graphical User Interface) applications, Console applications, DLLs (Dynamic Link Libraries) and CGI (Computer Generated Image) programs. Figure 4 below shows part of the code and knowledge base for the system.

```
class clinicalScreeningForm : clinicalScreeningForm
    open core

    predicates
        display : (window Parent, string Firstname, string Lastname, string PhoneNumber, string Gender, integer Age, integer RiskAnalysisCumulative, integer STIScreeningCumulative) - > clinicalScreeningForm ClinicalScreeningForm.

    constructors
        new : (window Parent, string Firstname, string Lastname, string PhoneNumber, string Gender, integer Age, integer RiskAnalysisCumulative, integer STIScreeningCumulative).

    end class clinicalScreeningForm

implement clinicalScreeningForm
    inherits dialog
    open core, vpiDomains, stdio, string

    clauses
        display(Parent, Firstname, Lastname, PhoneNumber, Gender, Age, RiskAnalysisCumulative, STIScreeningCumulative) = Dialog :
        Dialog = new(Parent, Firstname, Lastname, PhoneNumber, Gender, Age, RiskAnalysisCumulative, STIScreeningCumulative),
        Dialog:show().

    facts
        firstname : string.
```

Figure 4. Part of the Expert System's source code and knowledge base

5.3 Testing/Interacting with the System

The system provides the users with instructions on how the system works. It informs the users on how to interact with the system. This also serves as a guide to train users in order to aid the use of the system. Figure 5 below show the usage instruction.
Figure 5: Usage Instruction

Figure 6: Bio-data Form
Figure 6 above shows the Bio-data Form where the user enters his/her personal data. The form also displays a check box which when clicked implies the user accepts the terms and policies of the application that the data provided in the course of the screening exercise will not be disclosed.

Figure 7 to 9 contains the questions that the user will provide a YES/NO answer to. The questions however, are categorized into three (3) groups; Risk Analysis, S.T.I Screening and Clinical Screening

![Figure 7: HIV Risk Analysis Screening Form](image)

![Figure 8: S.T.I Screening Form](image)
Figure 9: Clinical Screening Form

Figure 10 shows the screening result that is displayed for the user or patient's with no symptoms of HIV, while Figure 11 shows the screening result that is displayed for the user/patient's suspected of having HIV.

Figure 10: Screening Result of a patient with no symptoms of HIV.
5.4 Evaluation
The system was evaluated using a questionnaire. Fifty (50) copies of the questionnaire were distributed to people while providing them access to the system. Forty Five (45) copies were returned and the evaluation result is based on the copies filled and returned. Figure 12 below shows the evaluation result using bar chart.

Figure 12: Bar Chart Depicting the Evaluation Results
For Question 1, it was found that most users agree that a person with no computer skills can use this system. Therefore this system can be deployed in rural areas. The users commented that it is a good idea to have yes or no answer rather than asking a user to enter full answers or sentences. This aspect is important because most people in rural areas have little or no computer skills, therefore, full textual answers will not work for them. For Question 2, it was found that most users agree that the system can help medical assistants to learn more about HIV. Thus the system could be utilized to decrease the rate of late diagnosis of HIV most especially in rural communities. For Question 3, most users strongly agree that the system can be very helpful and could reduce some of the workload for medical assistants especially during peak times by decreasing the long queues in clinics because other patients can still use the system without assistance.

For Question 4, it was found that most users strongly agree that the system will be very useful in rural communities where there is a shortage of medical expertise and medical facilities in rural areas. Therefore the system gives suggestion to the user’s information that is of relevance to them. For Question 5, it was similarly found that most users stand a neutral ground that the system looks at some vital areas that need to be considered before giving the result of the screening exercise. For Question 6, it was found that most users stand a neutral ground on recommending the system to their friends if necessary. For question 7, it was found that most users strongly agree that the system provides correct and helpful advice. Similarly for question 8, it was found that most users agree that the advice given by the system can be understood by patients with poor literacy. Finally, for the last question, most users agree that it is a good idea that the system uses a YES/NO format rather than asking users to enter full answers or sentences.

6. CONCLUSION

The need to design a system that would assist medical personnel in medical screening has become imperative and hence cannot be over emphasized. This work presents an expert system to help in the prognosis of HIV using a series of symptoms in medical domain. This would in turn help in solving the challenges faced by people most especially in communities where there is shortage or unavailability of medical personnel, as it provides very rapid method of prognosis with much accuracy and reduces the hours patients spend in hospitals and boring routine tasks associated with the existing method of HIV screening. This expert system is user-friendly and carries out prognosis based on patients’ symptoms.

7. FUTURE WORK

As a direction future work on this system can take, the use of a standard reporting tool to generate report of all the patients that have used the system and their results will be an improvement and ensure system optimality and efficiency. Also, security measures should be implemented such that unauthorized users cannot view the generated report sheet of patients. In addition, modules can also be added if it is determined that they will increase the system’s functionality without leading to a trade-off in response time and load time. These would help improve the overall system security, efficiency, convenience and ease of use.
REFERENCES


Authors Biographies

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Reverse Probability Weight (RPW): An Optimization Technique for k-Nearest Neighbours Algorithm for Imbalanced Dataset

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ABSTRACT

K-Nearest Neighbors Classifier experiences performance drawback when dealing with imbalanced dataset due to the majority vote technique used for classification. This research work examined and analyzed the effect of imbalanced dataset on k-NN, proposed and implemented a Reverse Probability Weight (RPW) technique as an optimization technique for dealing with imbalanced dataset in k-NN. All implementations and experiments were done using MATLAB and the result of optimized k-NN using Reverse Probability Weight (RPW) technique compared with k-NN, Logistic Regression and Support Vector Machine (SVM) shows that (1) The Reverse Probability Weight (RPW) optimizes k-NN in the presence of imbalance dataset and behave exactly as k-NN in the presence of balanced dataset (2) The Reverse Probability Weight (RPW) Technique for k-NN Outperforms k-NN, Logistic Regression and Support Vector Machine (SVM) in the presence of imbalanced dataset.

Keywords- k-Nearest Neighbors, Reverse Probability Weight (RPW), Optimization Technique

1. INTRODUCTION

K-Nearest Neighbour is a non parametric method utilized for classification and regression, a type of instance based or lazy learning algorithm where the function is only approximated locally and all computation is differed until classification [1][2]. K-NN is arguably one of the simplest and yet effective classification algorithms in the domain of Machine Learning (ML) [3]. When dealing with imbalanced dataset, k-NN algorithm tends to have a performance drawback due to the suboptimal classification of the minority class in the dataset as a result of the majority vote technique used in classification. There have been several recommended approaches to dealing with imbalance datasets in k-NN where some focused on the “data space” [4] while others focused only on “feature space”[5].

The data space approach is based on sampling strategies, oversampling the minority class and under sampling the majority class. This approach is prone to over fitting because the feature space is not taken into consideration, as a result, the over sampling features clusters around the minority class in the feature space or the under sampling removing important samples [4]. The SMOTE approach and its optimized variants is the most popular in the “feature space” approach, where over-sampling data are chosen based on the minority class distribution in the feature space to avoid over fitting and under fitting [5].

Over the years, as the ever-evolving areas of technology application increases, data sizes also increases both in volume, variety and dimension. Classification of data becomes more difficult due to unboundedness of data size and the resulting imbalanced nature of datasets. Most of the data samples used in classification are naturally imbalanced, a good example is credit card fraud where fraud is not common, the breast cancer data used in this research is also a very good example of such natural occurrence, where majority of the classes are negative i.e. “patient do not have breast cancer”.

Majority of the proposed optimization techniques to dealing with class imbalance dataset in k-NN either considers only the “data space” or the “feature space”. The proposed Reverse Probability Weight (RPW) technique for dealing with class imbalance dataset in k-NN considers both the class distribution in the “data space” and “feature space”. The result of experiment shows that the Reverse Probability Weight (RPW) technique for k-NN is optimized for dealing with imbalanced dataset compared to Support Vector Machine (SVM) and Logistic Regression.
2. REVIEW OF RELATED WORK

K-Nearest Neighbor Optimization

Due to the simplicity and efficiency of the k-NN Algorithm, it has attracted attention in the Machine Learning domain. Several optimization techniques has been proposed to compensate for the computational draw back as a result of neighbor search and a more efficient algorithm to selecting optimal neighbor.

The Weighted Voting Technique as an alternative to the Majority Voting Technique in k-NN is an optimization technique to dealing with imbalanced dataset, where the distance between the sample to be classified and its k-Nearest Neighbors are used as a weighted-measure for voting decision rather than the class majority [6].

K-NN suffers from the problem of high variance in the case of limited sampling, however, SVM does not suffer same but SVM involves time-consuming optimization and computation of parametric distance and thus a hybrid of SVM and k-NN is proposed in this case [7]. The use of Outlier Detection Using Indegree Number (ODIN) Algorithm that utilizes k-NN graph is another improvement on the k-NN algorithm but the performance is only benchmarked using small number of observations and its performance on huge dataset is not explicit in the literature [8].

Fuzzy Sets Theory was introduced in k-NN as Fuzzy k-Nearest Neighbor Algorithm as an optimization technique to address the resulting difficulties in utilizing k-NN technique in pattern recognition - where instead of each labeled samples given equal importance in determining class membership of patterns to be classified regardless of the typicalness, a fuzzy optimization is introduced to fuzzify the typicalness of each labeled samples [9].

Dempster-Shafer theory is used to address the problem of classifying an unseen pattern on the basis of its nearest neighbors in pattern recognition; where the degree of support of the membership of a pattern is defined as a distance function between the sample to be classified and its nearest neighbor and the resulting k-Nearest Neighbors is pooled by the means of Dempster-Shafer rule [10]. The branch and bond algorithm is an efficient algorithm used to reduce the number of neighbor search in large datasets, it facilitate rapid computation of the k-Nearest Neighbor by totally eliminating the need for computation of many distances such that only 60 neighbors-distance computation out of 1000 samples suffices to give optimal classification [11].

Multi-step query processing strategy in k-NN as a nearest neighbor search algorithm is used to address the efficiency requirements of high-dimensional and adaptable distance function, which occur as a result of increasing databases application, and complexity of objects such as images and videos in multimedia databases [12]. A new version of Approximating and Eliminating Search Algorithm (AESA) is used for finding nearest neighbor in metric space where distance computation is highly expensive.

This algorithm only requires an inexpensive linear-programming approach instead of the usual AESA high-memory-demanding and computationally expensive quadratic programming [13].

K-Nearest Neighbor Optimization For Imbalanced Dataset

The above different optimization techniques to k-NN algorithms does not solve the class imbalanced problem in kNN. For example, in an imbalanced data set, if a sample is to be classified at the boundary region in the feature space, all selected k-Nearest Neighbors are guaranteed to be at approximate equal distance, the class proportion $P_m$ for the minority class and $P_M$ for the majority class in the feature space $F(x)$ is such that $P_m(x)$ tends to zero at the boundary and thus the distance weighted k-Nearest Neighbor technique and its optimized variant will not be applicable [14].

There are different techniques available for classification of imbalanced data sets, which can be summarized as follows: [15]:

1. Data preprocessing approach: Over and under sampling of data in “data space” and “feature space”
2. Algorithmic approach: Applying cost in making decision
3. Feature selection approach: Dimensionality reduction

The over and under sampling strategies has attracted several attention with conflicting viewpoints on usefulness. The random over and under sampling have their short comings - the random under-sampling technique can potentially remove important samples from the datasets while the random over-sampling can lead to over-fitting by oversampling data points clustering around the minority data samples [16]. Several techniques have been proposed to tackle these shortcomings in data preprocessing approach to classification of imbalanced dataset, such as the use of one sided selection to selectively under-sample the original population [17]. The use of Condensed Nearest Neighbor (CNN) rule to remove examples from the majority class that are far away from the decision boundary [18]. The Neighborhood Cleaning Rule (NCR) to remove the majority class samples using the NCR technique [19].

The SMOTE (Synthetic Minority Oversampling TExchnique) is a technique used to generate synthetic examples by operating in the “feature space” rather than the “data space” where the minority class is oversampled by taking each minority class samples and introducing synthetic examples along the line segment joining any/all the & minority class nearest neighbors using the SMOTE Algorithm [20]. An improvement of the SMOTE Algorithm is the incorporation of Locally Linear Embedding (LLE) Algorithm. The LLE algorithm is first applied by mapping the high-dimensional data into a low-dimensional space (Dimensionality reduction) where the input data is separable and thus oversampled using the SMOTE algorithm, the resulting generated synthetic data points by SMOTE are mapped back to the original high-dimensional input space through the LLE Algorithm [21].
The Fuzzy-rough k-Nearest Neighbor Algorithm is an algorithmic approach for dealing with imbalanced dataset in k-NN to eliminate the bias of traditional method to the majority class by producing poor detection rate of the minority class - this approach takes into consideration the fuzziness and roughness of the nearest neighbors before making classification decision [22].

The Reverse Probability Weight (RPW) technique is an algorithmic technique for dealing with imbalanced dataset in k-NN. A very simple but highly effective algorithm for dealing with problem of imbalance dataset in k-NN.

**K-NN Optimization Technique**

**Reverse Probability Weight (RPW) Technique**

The Reverse Probability Weight (RPW) technique is a technique whereby the independent prior probability of a minority and a majority sample being selected in the data space is computed and project into the feature space, with the assumption that the prior probability of a sample being selected in the “data space” is the same as the probability of the same sample being selected in the “feature space”.

For example, an imbalanced dataset of 100 samples S with 80 majority class \( c_0 \) of class label “0” and 20 minority class \( c_1 \) of class label “1” as shown in Fig.1. The probability of a minority class \( c_1 \) and majority class \( c_0 \) being selected in the data space \( D_0 \) and feature space \( F_0 \) can be computed as follows:

a) \( P(c_0 | D_0) = \frac{x_{c_0}}{x_{c_0} + x_{c_1}} = 0.8 \)

b) \( P(c_1 | D_0) = \frac{x_{c_1}}{x_{c_0} + x_{c_1}} = 0.2 \)

Assume the same probability holds in the feature space:

\[ P(c_0 | F_0) = \frac{x_{c_0}}{x_{c_0} + x_{c_1}} \]
\[ P(c_1 | F_0) = \frac{x_{c_1}}{x_{c_0} + x_{c_1}} \]

Where \( k_{c_0} \) and \( k_{c_1} \) are \( c_0 \) and \( c_1 \) nearest neighbours in the feature space.

The Reverse Probability Weight (RPW) is estimated by reversing the probability in the feature space and this can be refers to as “weight of fairness”. This is an intuitive way of compensating for the sparsity of the minority class in the data space in feature space during classification.

\[ RFW_{c_0} = 1 - \frac{x_{c_0}}{x_{c_0} + x_{c_1}} \]
\[ RFW_{c_1} = 1 - \frac{x_{c_1}}{x_{c_0} + x_{c_1}} \]

The RPW \( c_0 \) and RPW \( c_1 \) will be used to weigh each \( c_0 \) and \( c_1 \) nearest Neighbors \( k_{c_0} \) and \( k_{c_1} \) before class assignment and thus:

a) \[ RFW_{c_0} > RFW_{c_1} \] Then Sample \( S = c_0 \)

b) \[ RFW_{c_1} < RFW_{c_0} \] Then Sample \( S = c_1 \)

c) \[ RFW_{c_0} = RFW_{c_1} \] Then Sample \( S = c_1 \) (Giving priority to the minority class)

In Figure 2.1 below, k-NN classification with \( k = 9 \) as shown, using the majority vote will misclassify the sample as belonging to the majority class “0” instead of the minority class “1”.

![Illustration Of Class Imbalanced Dataset in k-NN](image)

**Figure III.1:** Illustration Of Class Imbalanced Dataset in k-NN

Applying the RPW technique such that:

1) \( P(c_0 | D_0) = \frac{x_{c_0}}{x_{c_0} + x_{c_1}} = 0.8 \)
2) \( P(c_1 | D_0) = \frac{x_{c_1}}{x_{c_0} + x_{c_1}} = 0.2 \)

This implies:

a) \( RFW_{c_0} = 1 - 0.8 = 0.2 \) from equation (3.1)

b) \( RFW_{c_1} = 1 - 0.2 = 0.8 \) from equation (3.2)

\( k_{c_0} = 7 \) and \( k_{c_1} = 2 \) as shown in Figure 2.1 above.
Applying the RPW we obtain:

4) \(\text{RPW}_c \cdot k_c = 0.2 \cdot 7 = 1.4\)

2) \(\text{RPW}_c \cdot k_c = 0.8 \cdot 2 = 1.6\)

With the RPW technique the sample is thus classified correctly as belonging to the minority class \(c_2\). The Optimized k-NN is able to deal effectively with imbalanced dataset using the reverse probability weight technique. The performance of RPW technique is first benchmarked with k-NN using three datasets prepared by increasing the minority class to analyse the sensitivity of the algorithm to the degree of imbalances in a dataset. The result of the experiment shows that RPW is a highly effective technique for dealing with imbalanced dataset in k-NN. The RPW Algorithm is presented below.

The box-plot is used as a tool to visualize and measure the performance of the Optimized k-NN when benchmarked with k-NN, Logistic Regression and Support Vector Machine (SVM).

3. EXPERIMENTS

All experiments are performed on MATLAB using a “breast cancer diagnostic” dataset with 30 features and two class labels. Class “0” is the majority class (The negative class) which implies that patient have no cancer of the breast and “1” which is the minority class (The positive class) and implies that patient have cancer of the breast. The breast dataset is divided into four categories for training and testing as follows:

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Features</th>
<th>Total Samples</th>
<th>Class Zero</th>
<th>Class One</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imbalanced</td>
<td>30</td>
<td>200</td>
<td>180</td>
<td>20</td>
</tr>
<tr>
<td>Slightly Imbalanced</td>
<td>30</td>
<td>200</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>Balanced</td>
<td>30</td>
<td>200</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Test</td>
<td>30</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

A balanced dataset of 100 samples (50 for class zero “0” and 50 for class one “1”) is used as test dataset to be able to visualize how the different classifiers classify the minority class and majority class in the presence of imbalanced dataset.

The accuracy of a classifier is also important, it shows the overall performance of the classifier in correctly classifying both the positive and the negative classes.

\[\text{Accuracy} = \frac{(TP + TN)}{(TP + FN + FP + TN)}\]  \hspace{1cm} (5)

Performance measures (F-value, ROC and Box-plot)

The overrepresentation of the negative class in the imbalanced dataset poses problems in accurately evaluating the performances of the classifiers, however, since error rate may not be a very good metric for skewed datasets, the classification performance of algorithms in an imbalanced dataset is measured by precision and recall [20].

\[\text{Precision} = \frac{TP}{(TP + FP)}\]  \hspace{1cm} (3)

\[\text{Recall} = \frac{TP}{(TP + FN)}\]  \hspace{1cm} (4)
The sensitivity of the optimized k-NN algorithm to imbalanced dataset is observed as we move from imbalanced to slightly imbalanced and to balanced dataset.

Imbalanced Dataset (k-NN and Optimized k-NN using RPW Algorithm)
The confusion matrix obtained from the first experiment as shown in Figure 4.1(a) shows that the Optimized k-NN has higher True Positive (TP) while the False Positive (FP) remain constant as we varied k from 1 to 50. While the k-NN generally have a very low TP rate and the TP rate decreases as k increases which is as a result of the biasness of the k-NN algorithm to the minority class. This shows an improvement on the classifiers precision in classifying the minority class in the presence of an imbalanced dataset as compared to k-NN.

![Figure 4.1(a) True Positive and False Positive Vs K-Value](image1)

![Figure 4.1(b) False Negative and True Negative Vs K-Value](image2)

Figure 4.1: Imbalanced Dataset (k-NN Vs Optimized k-NN)

Figure 4.1(b) shows that the FN for the Optimized k-NN is also lower with lower variance, which shows an improvement in the recall, minimizing the number of incorrectly classified minority class while the FN of k-NN increases and TP decreases as we increase the value of k. TN remains constant for both k-NN and optimized k-NN as we increase the value of k. This is expected, because the negative class (class “0”) is the majority class and thus, both classifiers have no bias on the majority class.

Figure 4.2 shows that the f-value of the Optimized k-NN is remarkably higher and recorded a lower error rate with less variance compare to the f-value and the error rate of k-NN Algorithm.
Figure 4.2: Error Rate and F-value for k-NN and Optimized k-NN

Slightly Imbalanced Dataset (k-NN and Optimized k-NN using RPW Algorithm)

Both k-NN and the Optimized k-NN recorded an improvement on both precision and recall as we reduce the degree of imbalanceness in the training dataset as shown in Figure 4.3(a) and (b) below. But overall, the RPWk-NN outperforms k-NN.
Figure 4.4 shows that the f-value of the k-NN and optimized k-NN are higher than the one obtained from the imbalanced dataset confirming the sensitivity of the classifiers to data imbalanceness. Overall, the f-value of the Optimized k-NN is remarkably higher than that of k-NN and recorded a lower error rate with less variance compare to the error rate of k-NN Algorithm.

Balanced Dataset (k-NN and Optimized k-NN using RPW)

As seen from Figure 4.5(a), the result of both k-NN and Optimized k-NN are exactly the same which shows that the Reverse Probability Weight (RPW) Algorithm only optimizes k-NN in the presence of imbalanced dataset but behaves exactly as k-NN when the dataset is balanced. Figure 4.6(b) also shows that the same f-value and error rate were obtained for both k-NN and optimised k-NN in the presence of a balanced dataset.
(b) False Negative and True Negative Vs K-Value
Figure 4.5: Balanced Dataset (k-NN Vs Optimized k-NN)

(a) k-NN And Optimized k-NN Error Rate Plot

(b) k-NN And Optimized k-NN F-value plot
Figure 4.6: Error Rate and F-Value for k-NN and Optimized k-NN

K-NN, Optimized k-NN, Logistic Regression and SVM
The four classifiers were tested on the Three datasets and the results were analyzed using box-plot as shown in Figure 4.7(a), (b) and (c) below. We varied k from 1 to 50 for both k-NN and optimized k-NN. For logistic regression and SVM we varied the number of iterations from 1 to 50 and compute the Average Error Rate. We observed that the optimized k-NN performs best on the imbalanced dataset as shown in Figure 4.7(a) with the lowest error rate, followed by Logistic Regression, SVM and finally k-NN.

Also, the Optimized k-NN performs best on the slightly imbalanced dataset as shown in Figure 4.7(b) which shows that the Optimized k-NN using Reverse Probability Weight (RPW) technique is a better classifier to deal with imbalanced dataset compared to Logistic Regression, SVM and k-NN. The SVM performed best on the balanced dataset as expected, followed by the Optimized k-NN and k-NN.

Figure 4.6: Error Rate Boxplot for k-NN, Optimized k-NN, Logistic Regression and SVM
4. ANALYSIS

The results of the experiments show that using Reverse Probability Weight (RPW) Algorithm optimizes k-NN in the presence of imbalanced dataset. The optimization is majorly visible in the increased True Positive (TP) Rate by correctly classifying the minority class and reduction in the False Negative (FN) rate by reducing the number of misclassified minority class - this is the major goal of the optimization. The RPW for the minority class is usually higher than the RPW for the majority class with a factor of their respective prior probabilities.

Analysis of the imbalanced dataset used shows that for a sample to be classified as belonging to the majority class, the number of the majority class \( k_{c_0} \) nearest neighbors must be at least 9 times the number of the minority class \( k_{c_1} \) as shown below:

The total number of samples in the data space \( D_2 = 200 \) and the number of positive minority class is 20 while the majority class has 180.

\[
RPW_{c_0} = 1 - \frac{\sum k_{c_0}}{\sum (k_{c_0} + k_{c_1})} = 1 - \frac{\sum k_{c_0}}{\sum (k_{c_0} + k_{c_1})} = 1 - 0.1 = 0.9
\]

\[
RPW_{c_1} = 1 - \frac{\sum k_{c_1}}{\sum (k_{c_0} + k_{c_1})} = 1 - \frac{\sum k_{c_1}}{\sum (k_{c_0} + k_{c_1})} = 1 - 0.9 = 0.1
\]

The ratio between sample \( k_{c_2} \) and sample \( k_{c_0} = \frac{9}{10} = 9 \)

This means for any value of \( k \) in the imbalanced dataset, for a sample \( c \) to be classified as \( c_0 \) there must be at least Nine \( 9 \) times the number of \( k_{c_2} \) as there are \( k_{c_1} \) in the \( k \) nearest Neighbors. This account for the reason why increase in \( k \)-values lead to increase in True Positive (TP) because for every sample of the minority class \( c_1 \) in the \( k \)-nearest Neighbors there must exist a minimum of \( 9 \) majority class \( c_0 \) and this becomes more difficult to arrive at as we increase \( k \), since the probability of having \( c_1 \) in the \( k \)-nearest Neighbors increases as we increase \( k \) and the probability of having 9-times \( k_{c_1} \) reduces as we increase \( k \). If \( k \) is very large, there is a higher chance of classifying correctly the minority class since \( k \)-nearest neighbors will extend beyond the boundary in both directions.

A better performance is observed in both k-NN and the Optimized k-NN when we reduce the level of “imbalanceness” in the dataset because the Reverse Probability Weight (RPW) has a linear relation with the degree of imbalance in the dataset – \( RPW_{c_0} \) decreases as the number of sample \( c_0 \) increases and \( RPW_{c_1} \) increases as the number of sample \( c_1 \) decrease thus converging the RPW at the optimal.

\[
RPW_{\text{optimum}} = \left[ \frac{\sum k_{c_0}}{\sum (k_{c_0} + k_{c_1})} \right] \times \frac{1}{2}
\]

The performance of k-NN and Optimized k-NN are the same in the presence of a balanced dataset because the prior probability of both classes are the same in the data space, meaning all samples in the \( k \)-nearest Neighbors have same Reverse Probability Weight (RPW) which is equal to

\[
RPW_{\text{optimum}} = \frac{\sum k_{c_0}}{\sum (k_{c_0} + k_{c_1})} \times \frac{1}{2}
\]

5. CONCLUSIONS

We have been able to show that the Reverse Probability Weight (RPW) Algorithm optimizes k-NN in the presence of imbalanced dataset and also behave exactly as k-NN in the presence of balanced dataset. We have also been able to justify empirically through experiment that the prior probability of selecting a sample in the data space \( D_2 \) is approximately equal to the probability of selecting the same sample in the feature space \( F_2 \).

\[
P(c_0 | D_2) = P(c_0 | F_2) \text{ and } P(c_1 | D_2) = P(c_1 | F_2)
\]

In the experiment, we optimized k-NN based on majority vote technique, another approach would be to optimize based on weighted voting and compare the results. Since we observed increased performance in the slightly imbalanced dataset, another approach would be to use the SMOTE algorithm to reduce the level of imbalanceness in the dataset before applying RPW Algorithm and compare the result. The performance of \( RF_{k-NN} \) (Reverse Probability Weight k-NN) could also be benchmarked with other novel techniques of dealing with imbalanced datasets in both k-NN and other classification algorithms.
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ABSTRACT

In response to the prevalence of lost limbs in our society due to accidents, health problems, wars and age, this work is aimed at designing and constructing a battery-powered microcontroller-based wheelchair for paraplegics, which will alleviate the difficulty users experience when using crutches or manually operated wheelchairs. Such wheelchairs, commonly called power wheelchairs, are not uncommon in the society today. The system components draw power from a rechargeable deep-cycle battery which is designed to be discharged to up to 20% of full charge without damage and to be used in recreational vehicles (RVs). The Microcontroller Unit is the hub of the system as it receives input commands from the Drive Input Unit, processes these commands and issues appropriate control signals to the Motor Driver Units which drive the DC motor actuators. The microcontroller is programmed using Assembly Language which is a low-level programming language. The mechanical section of the project is comprised of the chair frame, rear and front DC motor compartments, circuit compartments, wheels, axles, gears and peripheral casing.

Keywords: Wheelchair, microcontroller, DC motor, assembly language, programming, deep-cycle, battery.

Fig. 1: The block diagram of the proposed wheelchair.

1. INTRODUCTION

It is quite appalling the prevalence of lost limbs today due to accidents, health problems, wars and age. Victims of such circumstances cannot comfortably move from one location to another, be it indoors or outdoors. There is therefore the need to solve this problem by designing an alternative means of transport. This is the idea behind the design and construction of a battery-powered microcontroller-based wheelchair for paraplegics. A paraplegic is one who is paralyzed from the waist downwards, and can thus make use of the upper limbs. The proposed project solves the problem of indoor and outdoor movement the paraplegics have by providing a medium-power, easy-to-control wheelchair.

2. BACKGROUND OF PROJECT

The proposed project consists of electronic and electromechanical sections. The electronic section is pivoted on the microcontroller Integrated Circuit (IC) which receives input commands from buttons on a keypad, processes them, and issues out appropriate control signals. Also included is a charge controller that prevents the battery from overcharging beyond a certain predefined extent. The electromechanical section is comprised of two worm geared, brushed DC motors with their interfacing circuitry.
The block diagram explains the principle of operation of the project: The Battery Charging Unit (BCU) consists of a rectifier circuit that converts 240V AC mains to 14V DC sufficient to charge the 12V deep cycle battery. Also included in the BCU is a Charge Controller that prevents the battery from overcharging. The Power Supply Unit (PSU) is made up of the 12V battery and a voltage regulator. The output of the regulator is used to power the microcontroller. The Drive Control/Input Unit comprises buttons and levers for direction and speed control. The Microcontroller Unit (MCU) is comprised of the microcontroller IC and the required circuit components for its proper functioning. The Motor Driver Units (MDU) consist of transistors, diodes and relays. The MDU receives signals from the MCU, amplifies them and finally drives the DC motors accordingly. The MCU receives signals from the Drive Input Unit (DIU). The Peripheral Unit consists of a horn and a bright LED light source for improved vision when wheelchair is driven in poorly lit areas.

3. REVIEW OF RELATED WORKS

This section is aimed at reviewing previous works done on microcontroller-based wheelchairs. In their design of a low-cost intelligent wheelchair, [1] built the control circuitry around the PIC16F877A microcontroller. They also included in their design a voice recognition system and an obstacle detection system. For their motor driver circuitry, they used the ULN2003A (Darlington Transistor array) IC and four relays to give all direction movements and also stop. The Darlington Transistor array circuit is responsible for converting the microcontroller’s output signal of 5V to the relay operating voltage of 12V. They chose two DC motors each of which carry 25kg so the two collectively carry 50kg including the wheelchair components. They used a membrane keypad which made it easier for the buttons to be pressed. Also included in their design is a small Liquid Crystal Display (LCD, 2 x 16) used to display the command given by the user. It also shows the response of the intelligent wheelchair and gives feedback to the user regarding a scenario such as detection of an obstacle.

[2] did a similar work to [1] in their design of a Microcontroller-based intelligent wheelchair. The major difference being the use of a different microcontroller, the PIC18F452 and the use of four (4) stepper motors. In the works of [3] [4] and [5] it was gathered that they incorporated into their design, voice recognition systems. Oral commands are stored in memory using a keypad and uttered when a specific function is required. Various drivers were used to drive the DC motors; [3] used electromechanical relays, [4] used the L298 motor driver IC, [5] used the L293D motor driver IC. In the work of [6] on an automatic wheelchair for disabled persons, they used accelerometers as one method of direction control input to the system and speech recognition as the other. They also used ultrasonic sensors for automatic obstacle detection.

For the motor control assembly, they used the L293D dual H-bridge motor driver. It is dual in that with one IC, two DC motors can be controlled if they rotate in two directions (i.e. forward and reverse). However four DC motors could be driven by the same if the motors are to rotate in a fixed direction. They made use of an ARM 7T microcontroller which was programmed in C using Keil µVision4 Integrated Development Environment (IDE) and simulated on Proteus Virtual Systems Modelling (VSM) software. In the design of [7], the source of input to the system is a joystick. The PIC18F4520 microcontroller is used in their project to process inputs from the joystick and drive the geared DC motors. They also used optocouplers in-between the microcontroller and the H-bridge motor driver to prevent the higher voltage on the motor side from affecting the microcontroller.

4. METHODOLOGY AND SYSTEM OPERATION

4.1 Methodology
This project is comprised of two sections viz:

i. Mechanical section;
ii. Electronic section.

The mechanical section is comprised of the chair frame, rear and front DC motor compartments, circuit compartments, wheels, axles, gears and peripheral casing. The chair frame typically is made up of the headrest, backrest, cushion, leg rest and a panel for the control buttons. The motor compartment is a casing for the DC motors. There are two of such, one for the rear and the other for the front. The battery and Vero boards which make up the system circuitry are contained in the circuit compartment. The axle, gears and wheels are assembled in such a way that friction is reduced. This is achieved using bearings.

The chair frame and wheels were procured from Onitsha Main Market in Anambra State and reconstructed, by welding, into a standard wheelchair with the other compartments included. The system circuits were designed on Proteus Virtual Systems Modelling (VSM), a Computer Aided Design (CAD) system, which is comprised of, among other tools, the Schematic Capture Tool (SCT) as a means of design entry into the system as well as the Simulation Tool for verification of the modelled system under analysis. Afterwards, the components were bought. The different electronic units that make up the entire electronic part of the system were first constructed on a breadboard. After the various electronic circuits had been tested and certified to work, the circuits were soldered onto Vero boards.

The program that would drive the system, written in Assembly language, was burnt onto the microcontroller. Further tests for open and short circuits were carried out. After the construction of the mechanical and electronic sections of the system were certified to be working properly, they were assembled into a functional power wheelchair.

---

1 Advanced RISC Machine, RISC stands for Reduced Instruction Set Computer
Other parts of this project follow the systematic way of achieving the aim of the project starting from component review and design, calculation of component values and their choice thereof, analysis and implementation (with simulations and schematic captures), assembling and packaging as well as the testing of the entire system. The choice of programming language to be used was determined by the AT89C51 microcontroller architecture; hence Assembly programming language was used in developing the firmware embedded in the microcontroller.

4.2 System Functional Operations

This section is aimed at presenting detailed and functional insight into the constituents of each of the blocks of the system (shown in Fig 1)

Battery Charging Unit (BCU): The Battery Charging Unit (BCU) is responsible for converting the 220V AC mains to 14V DC which is capable of charging the 12V DC battery. It is also responsible for increasing the lifetime of the battery; it does this by preventing the battery from overcharging.

The BCU is made up of a rectifier and a charge controller. The rectifier circuit is responsible for converting the 220V ac mains supply to the 14V dc capable of charging the 12V battery. The block diagram is shown in Fig. 2

![Fig. 2: The Block Diagram of the Rectifier](image)

The Transformer block contains the transformer. It is wound in such a way as to accept 220V ac mains at its input and give out 20V ac at its output. This 20V is still alternating and is rectified by the bridge rectifier contained within the Bridge Rectifier block. The rectified 20V is still pulsating in the positive sense and is then smoothed by a smoothing capacitor connected in shunt before being regulated by the voltage regulator (LM338T). The capacitor and the voltage regulator are contained in the Voltage Regulator block. The regulator gives a regulated output of 14V DC which is then suitable for charging the battery. The rectifier circuit is shown in Fig.3.

![Fig. 3: The Rectifier Circuit](image)

The charge controller circuit is responsible for preventing the battery from overcharging. The block diagram is shown in Fig 4.

![Fig. 4: The Block Diagram of the Charge Controller](image)

The charge controller is a form of two-position control response where the controller compares an analogue or variable input with instructions (reference input) and generates a digital (or two-position) output. In this case, the controller is the comparator. It compares the variable input signal corresponding to the battery voltage level to the fixed reference input signal and generates an output based on the comparison. The trigger is the actuator and is responsible for turning off or on the charging of the battery. The circuit schematic is shown in Fig 5.

![Fig. 5: Charge Controller Circuit](image)

Here, the LM358N IC is configured as a voltage comparator. The fixed reference input is achieved using the zener diode. The value of the fixed reference signal is equal to the zener voltage \( V_z \) rating of the zener diode. The potentiometer is used to calibrate the variable input signal in such a way that a little over the fixed reference input voltage \( V_z \) corresponds to about 12V indicating a full battery.

The mode of operation of the charge controller is based on the electronic shutdown characteristic of the LM338T adjustable voltage regulator [8]. When the battery is fully charged, the voltage at pin 3 of the op-amp exceeds the fixed voltage at pin 2. Thus a HIGH is obtained at the output of the op-amp.
This signal biases the NPN transistor which then shorts the \textit{ADJ} pin of the LM338T to GND. According to the electronic shutdown characteristic, when the \textit{ADJ} pin is shorted to GND, it ceases to give output. This then discontinues the charging of the battery.

**Power Supply Unit (PSU):** The Power Supply Unit (PSU) is responsible for supplying regulated power to the various blocks of the system. It is comprised of the 12V DC source and a voltage regulator.

The power wheelchair gets electrical energy from the 12V DC source. This is a deep–cycle battery. Deep-cycle batteries are used where power is needed over a long period of time and are designed to be “deep cycled”, or discharged down to as low as 20% of full charge (80% DOD, or Depth of Discharge) [9]. The deep-cycle battery used in this project is rated 12V, 62AH (amp-hour). The 62AH rating means that if 1A is drawn from the battery, it will last for 62 hours before being fully discharged.

The voltage regulator is responsible for converting the 12V DC from the battery to 5V DC capable of powering low voltage circuit components, which include the microcontroller and operational amplifiers. The voltage regulator circuit is pivoted on the LM317T adjustable voltage regulator IC. The circuit diagram is shown in fig 6.

**Peripheral Unit (PU):** The peripheral unit (PU) of the power wheelchair is made up of a horn and a bright LED light source. These two draw power from the 12V dc source without any signal conditioning. The horn and light source are rated at 12V and so are connected in parallel to the battery. The circuit diagram is shown in fig. 7.

**Microcontroller Unit (MCU):** The microcontroller unit is the nucleus of the power wheelchair. The MCU receives input signals or commands from the Drive Control/Input unit, processes it according to the program burnt unto it, and gives out conditioned signals to the Motor Driver Unit. The MCU is made up of the microcontroller IC and other circuit components required for its proper configuration.

The microcontroller used is Atmel’s AT89C51 microcontroller IC. It is a low-power, high-performance CMOS 8-bit microcontroller with 4 kilobytes of Flash programmable and erasable read only memory (EPROM) [11]. The AT89C51 is a 40-pin microcontroller numbered in an anticlockwise manner with reference to the notch. See fig 8.
cycles. This resets the microcontroller. The logic behind this is that the product of the capacitor and resistor is the time constant of the capacitor charging circuit.

During charging, a HIGH is on the reset pin. When C1 is fully charged, R1 acts as a pull-down resistor and pulls the reset pin low. The duration of the HIGH on the reset pin is the time constant τ.

The values of C2 and C3 (33pF each) are as recommended for use with a crystal from the AT89C51 microcontroller’s datasheet [11]. This configuration is to configure the inverting buffer as an on-chip oscillator. The resistors R2, R3, R4, and R5 are connected as pull-up resistors. They also limit the current sunk into pins p1.0, p1.1, p1.2 and p1.3 respectively.

**Motor Driver Unit (MDU):** The Motor Driver Unit (MDU) is responsible for driving the DC motors; it is comprised of all circuitry used to interface the microcontroller unit to the rear and front DC motors. The MDU is made up of transistors, electromechanical relays and diodes. The circuit is shown in fig 10.

It operates such that the Normally Closed (NC) terminals of the relays are both connected to GND, the Common (COM) terminals are connected to the DC motor and the Normally Open (NO) terminals are connected to the 12V source. Then for one direction of rotation of the DC motor, one transistor is biased by a signal from the microcontroller. This switches ON the corresponding relay which in turn allows power to the motor and the motor rotates. If the motor is to turn in the opposite direction, the other transistor is biased.

The diodes act as freewheeling or flyback diodes protecting the transistors from the voltage build-up when the relays are switched off.
**Drive Control/Input Unit (DIU):** The user gives direction and speed control commands to the wheelchair through the Drive Control/Input Unit. The unit comprises buttons and interfacing circuitry for direction and speed control. These commands are fed to the MCU which processes and issues out appropriate control signals to the MDU. See fig 11.

**DC Motors:** In this project, two brushed DC motors are used. The front motor is for left and right directions whereas the rear motor is for forward and reverse directions.

The system circuit diagram is shown in [Error! Reference source not found.], and the program flowchart in fig 12.

---

**Fig. 11: System Unit Diagram**

**Fig. 12: Program Flowchart**
5. SYSTEM IMPLEMENTATION

This section is concerned with the stepwise approach to constructing the project. It is subdivided into Mechanical and Electronic subsections.

Mechanical subsection: The mechanical and structural components for the project were procured from markets in Anambra State. See Figure 3.

![Figure 3: Mechanical and structural components](image)

These components include the chair frame, rear and front wheels, rear and front DC motors, ball bearings, chains for linking gears, metal panels, hollow rectangular metal rods, nuts and bolts. First the rear wheel was put in place. Bearings, rear axle, nuts and bolts were used. The rear axle gear was affixed and the chain linking the rear DC motor to the gear was put in place.

![Fig. 14: Rear Wheel Implementation](image)

Then the front wheel was put in place. The front DC motor was affixed to the supporting frame and linked to the front wheel via pulley. See Figure 15.

![Fig. 15: Front Wheel Implementation](image)

Electronic subsection: The electronic section implementation of the project is subdivided into several sub-circuits namely: Battery Charging circuitry, Power Supply circuitry, Microcontroller circuitry, Direction Control circuitry and Motor Driver circuitry. All electronic implementation was carried out using a standard Vero board and all components where soldered onto the Vero board. For the circuit before the transformer was installed and was placed in its compartment. Shows the composite circuit placed in its compartment. After the individual system components making up the design have been tested individually both through simulation and physically, the various sub systems were incorporated together and the final full system testing was carried out. This testing was also carried out through simulation first before physical implementation and testing. Several persons of varying weights were used to test how the overall system responded to various body weights and the system responded optimally. See for the final stages of implementation of the project.

![Fig. 16: Circuit on Vero Board](image)

6. PERFORMANCE ANALYSIS

In this section, an account of the project is presented as being compared to the specific objectives of the project. Likewise, the performance of the system is obtained based on mass-current and mass-speed measurements.
Objectives: Specific objectives versus actual characteristics of the system are reported in Table 13.

Table 13: Objectives compared with actual system characteristics:

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Actual characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery-charging circuit and charge controller for recharging battery</td>
<td>Battery-charging circuit and charge controller working properly.</td>
</tr>
<tr>
<td>powering system.</td>
<td></td>
</tr>
<tr>
<td>Use a suitable geared, brushed DC motor capable of carrying a mass of 80kg</td>
<td>This was achieved as the DC motor (Subaru WM-1220-2S) carried a mass of 90kg</td>
</tr>
<tr>
<td>(approx. 800N).</td>
<td>(wheelchair and user).</td>
</tr>
<tr>
<td>Use lightweight materials in wheelchair frame so as to reduce weight of</td>
<td>This was achieved as the wheelchair weighs about 7kg (without battery).</td>
</tr>
<tr>
<td>system.</td>
<td></td>
</tr>
</tbody>
</table>

Performance: The mass-current relationship observed is reported in Table 2.

Table 2: Mass-current performance

<table>
<thead>
<tr>
<th>Mass (kg)</th>
<th>Direction</th>
<th>Motor Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (no load, wheelchair</td>
<td>Forward</td>
<td>2.3</td>
</tr>
<tr>
<td>only)</td>
<td>Reverse</td>
<td>3.3</td>
</tr>
<tr>
<td>65</td>
<td>Forward</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Reverse</td>
<td>3.35</td>
</tr>
<tr>
<td>85</td>
<td>Forward</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Reverse</td>
<td>3.4</td>
</tr>
</tbody>
</table>

The performance in Table 2 is represented graphically in Error! Reference source not found.17.

Table 3: Mass-speed performance

<table>
<thead>
<tr>
<th>Mass (kg)</th>
<th>Direction</th>
<th>Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (no load, wheelchair only)</td>
<td>Forward</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Reverse</td>
<td>1.14</td>
</tr>
<tr>
<td>65</td>
<td>Forward</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>Reverse</td>
<td>0.96</td>
</tr>
<tr>
<td>85</td>
<td>Forward</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>Reverse</td>
<td>0.79</td>
</tr>
</tbody>
</table>

The performance in Table 3 is represented graphically in 18. From the foregoing analysis, it is observed that when a larger mass is placed on the wheelchair, a larger current is drawn by the rear motor. Also, a larger mass results in the wheelchair running at a lower speed.

System Specifications: The system electrical and mechanical specifications are given in Table 4.
Table 4: System specifications

<table>
<thead>
<tr>
<th>ELECTRICAL</th>
<th>INPUT: 220V-240V, 50Hz AC mains (charging).</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT:</td>
<td>12V, 90W (discharging or in use).</td>
</tr>
<tr>
<td>MECHANICAL</td>
<td>LOAD: 100 kg (max.).</td>
</tr>
<tr>
<td></td>
<td>SPEED: 1.25 m/s (max.).</td>
</tr>
</tbody>
</table>

7. CONCLUSION

In designing this project we set out to achieve some objectives, the core of which is to design a Battery-Powered Microcontroller-Based wheelchair that will be a low-cost alternative to the current market offerings. The idea is so that paraplegics in our society, especially those who cannot afford the expensive models currently available today, might have a chance at buying one if this project is commercialized. We achieved this primary objective hence showing that by using the components readily available to us in our environment today, we can manufacture these Battery-Powered Microcontroller-Based wheelchairs and hence give the paraplegics in our society a chance to live a better life.

REFERENCES

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Mining Social Media for Conflict Prevention and Resolution

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ABSTRACT

The power of social media such as Twitter, Facebook, Instagram, LinkedIn, etc. in our daily lives cannot be underestimated. Governments have been toppled and countries destabilized as a result of sentiments expressed by citizens on social media. In this paper, we show that mining Twitter Follower/Friend network structure and data can be a powerful method to recognize the needs, sentiments, opinions and interests of the citizenry. Hierarchical clustering and Partition around Medoids were used. It was discovered that the Twitter community in Ghana takes delight in discussing political parties and personalities instead of pressing issues like corruption and unemployment. Follower/Friends network analysis was used to discover influential “e-people” who could serve as potential mediators during conflict situations. This method is aimed at identifying the most influential people in the Ghanaian Twitter Community and to discover what most people are complaining about through their tweets. This can be used to avoid a replication of the “Arab Spring” elsewhere. Possible Mediators can also be discovered. We propose an inexpensive but effective method to help prevent and resolve the rampant conflicts in the World that arise due to neglect of citizens by their governments. Advertisers, policy makers and political parties also stand to benefit from this approach.

Keywords: Social Media, Data Mining, Conflict Resolution, Social Network, Betweeness, Centrality, Eigen Vector.

1. INTRODUCTION

Most countries in the world; especially third world countries, are vulnerable to wars due to poverty, unemployment, corruption and bad governance. It has been established that about 60% of the population in many of these countries are made up of the youth [1] who are largely unemployed and very active on social media [2]. The Arab Spring [3], [4] in North Africa was fueled by the use of social media which has left in its wake conflicts in the region. As most African countries embrace democracy, it is common occurrence for tensions to rise during elections. We propose the use of unsupervised clustering algorithms and social network analysis to mine Twitter with the aim of identifying issues that could be potential starting point(s) for conflict during elections. Our method can also identify users who could serve as possible mediators during conflict situations. Ghana is used as a case study since 2016 is an election year in the country. Even though majority of social media users in Ghana are on Facebook, the middle class and decision makers prefer to use Twitter to express their opinions on important issues; hence our decision to choose Twitter for analysis.

1.1 Clustering

Clustering is a machine learning technique that group data based on their similarity. Clusters that are formed are distinct and no data point is categorized in more than one cluster. The method is widely implemented as unsupervised. Unsupervised clustering does not need training/test data when making clusters as the algorithm is guaranteed to discover the relationship between objects. The objective is to maximize the similarity between data points of the same cluster while at the same time minimizing the similarities between data points of different clusters. Algorithms such as K-Means [5] and Hierarchical clustering are implemented as unsupervised algorithms. Distances between objects in a cluster, between objects and other clusters, and between clusters are very important for correct placement of an object in the appropriate partition. Several measures can be used to calculate the distances between objects in a cluster.
A good distance measure is a function \( f(x, y) \) that takes two data points \( x \) and \( y \) such that all the following conditions are satisfied:

1. Symmetry: \( f(x, y) = f(y, x) \).
2. Equality: if \( x = y \) then \( f(x, y) = 0 \).
3. Triangular inequality symbolizes the shortest path property of clustering distance measures and is given by: \( f(x, y) \leq f(x, z) + f(z, y) \).
4. No negative distances \( f(x, y) > 0 \).

The following distance measures are commonly used in clustering algorithms:

1. **Manhattan distance**: It takes the absolute difference of the distances between objects \( x \) and \( y \)
   \[
   d_m(x, y) = \sum_{i=1}^{p} |x_i - y_i|
   \]
   (1)

2. **Euclidean distance**: It evaluates the distances of alternate paths between given objects in a cluster and takes the path with the shortest distance. It is the most widely used distance metric for clustering. Assuming the objects are \( x \) and \( y \) at distance \( D \) apart, then
   \[
   d_e(x, y) = \sqrt{\sum_{i=1}^{p} (x_i - y_i)^2}
   \]
   (2)

3. **Minkowski distance**: It Generalizes the Euclidean distance to provide some flexibility in choosing the parameter \( p \), which is 2 in the Euclidean distance. The expression for the Euclidean distance can be rewritten as:
   \[
   d_e = \left(\sum_{i=1}^{p} |x_i - y_i|^p\right)^{1/p}
   \]
   (3)
   Generally,
   \[
   d_{max} = \left(\sum_{i=1}^{p} |x_i - y_i|^p\right)^{1/p}
   \]
   (4)

4. **Cosine similarity measure**: It measures the cosine of the angle between the two objects/vertices with integer/boolean components. It is widely used when clustering transactional data.

In hierarchical clusters, the distances between clusters can be determined either by finding the distance between the nearest points in the two clusters called **single linkage**, or the distance between the farthest points in the cluster called **complete linkage**, or average linkage which is the average distance between all the points in the cluster. Clustering algorithms have their own internal mechanisms used to evaluate performance. For instance, the k-means clustering algorithm finds the squared distance of the data point to the cluster center (sum of squares error) to determine how acceptable a cluster is. In addition, external methods of evaluation could be employed. A separate set of data could be used to measure how representative the clusters are. Parameters such as F-measure, purity, entropy, and random index can then be calculated. A delicate but difficult issue during cluster generation is determining the appropriate number of clusters [6] for the dataset.

Proposed solutions [7] to this problem include *rule of thumb*; i.e. finding the square root of half the number of objects \((dp)\) as a rough estimate to the number of clusters \((c)\):

\[
\hat{c} = \sqrt{dp/2}
\]

Other methods include Elbow Method, Cross-Validation Method, Silhouette Method and the Aligned Box Criteria (ABC) [8].

### 1.2 Social Network Analysis

Social Networks are depicted as graphs. They are made up of entities that may (may not) share common characteristics in a given locality. They have been applied in Society [9] long before social media giants such as Facebook, Twitter, etc. emerged. These Social Networks are a repository of vast amounts of data; mining of which could result in unearthing relationships that could impact real life situations. Aside this, the structure of the social graph could also be mined. For instance, the concept of centrality is used to determine how important a given individual (node) is in the network. Degree centrality of a directed network can be computed for both in-degree and out-degree. For an undirected graph, the degree centrality \(d_i\) of the \(j\)th node \(v_j\) is given by the number of edges \(d_i\) adjacent to \(v_j\):

\[
d_i(v_j) = \hat{d}_i\]

This measure indicates how popular an individual is in a network; that is the higher the degree, the popular the individual. However, it is not entirely accurate to use degree centrality to measure “social status” in a network, since it is not all the connections that link to important nodes. To take into consideration the status of the node(s) to which \(v_j\) is connected in the network, we useEigen vector [10] centrality \(e_i\) to generalize the degree centrality measure:

\[
e_i(v_j) = \frac{1}{\hat{\lambda}} \sum_{i=1}^{n} A_{ji} e_j(v_i)
\]

(5)

where \(\hat{\lambda}\) = some eigenvalue (a constant), and \(A_{ji}\) = adjacency matrix. Letting \(E_i\) be the \(nx1\) matrix (transpose) of the above quantity, we can rewrite it as \(E_i = A^T E_i\). Notice that for an undirected network, \(A\) is the same as \(A^T\). \(E_i\) tells us which edges the individual is likely to be using after a long time. The Perron-Frobenius theorem [11] is used to avoid negative Eigenvector centrality values. Katz Centrality measure [11] avoids the limitation of Eigenvector centrality that occurs in directed acyclic graphs. It introduces the parameter \(\beta\) to prevent zero centrality values:

\[
e_k(v_j) = \alpha \sum_{i=1}^{n} A_{ji} e_j(v_j) + \beta
\]

(6)

A limitation of the Katz Centrality measure is solved by PageRank, which does not permit a central node to pass its importance to adjacent nodes. To share the centrality to each adjacent edge, PageRank divides the centrality among the outgoing edges of the node in a directed network:

\[
R_k(v_j) = \alpha \sum_{i=1}^{n} A_{ji} \frac{R_i(v_i)}{\sum_{j=1}^{n} A_{ij}} + \beta
\]

(7)
The idea is that, connections will converge at the PageRank centrality node if nodes in the network were chosen randomly, and random out links were followed. Notwithstanding, PageRank has to contend with spider traps and dead ends [12]. To consider the importance of a node in a network, we can consider how often it is used as a bridge on the shortest path to connect other nodes; referred to as Betweeness centrality:

$$B_v = \frac{\sum_{p \neq a \neq p} \sum_{\sigma_{ap}}}{\sum_{p \neq a \neq p}}$$

where $\sigma_{ap}$ is the number of shortest paths from node $a$ to $p$, and $\sigma_{ap}(v)$ is the previous quantity but for the ones that pass through node $v$. When $v$ is on all the shortest paths between $a$ and $p$, $B_v$ assumes its maximum value. Betweeness centrality can be computed using Dijkstra’s algorithm or Brandes’ algorithm [13]. These centrality measures could be applied to a group of vertices.

Clustering can be used to find communities in a social network. In defining a distance measure for social network clustering, triangular nodes should be taken into account. Using the k-Means clustering algorithm, a network could be clustered into communities [12]. A node will only be assigned to a cluster if it has the shortest average distance to all the other nodes in the cluster.

2. RELATED WORKS

Paul et al. [14] proposed a probabilistic topic model called the Ailment Topic Aspect Model (ATAM) used to monitor the spread of ailments that are discussed on twitter. The model was able to group symptoms and treatments for ailments into the appropriate public health related topics. Johansson et al. [15] describes a semi-automatic system involving the automatic harvesting of online data from humanitarian organizations’ reports, Twitter, Facebook and Blogs to forecast where the next conflict will be and on what issue. Park et al. [16] analyzed depressive moods of users portrayed in tweets.

They concluded that users who tweeted depressive sentiments were actually depressed, and that social media could be an important source of data for clinical studies. In [17], the researchers used indegree, retweets, and mentions to study the influence of a user on twitter. The behavior of social network users was characterized in [18]. [19] Used frequent sets in association rules to predict the outcome of events. Ediger et al. [20] proposes GraphCT: a Graph Characterization Toolkit used to represent social network graph data. It has the ability to determine the network centrality measures on large datasets. There are numerous literature [21], [22], [23], [30] involving the mining of social media data such as tweets for one reason or the other. This paper adds to the works already mentioned by mining both social media data and its network structure for conflict prevention and resolution.

Table 1 presents the list of search terms used to collect tweets. This last sample was made up of 8,951 tweets. It was collected between 3rd to 11th September 2015 and used for clustering.

Table 1: A List of Search terms used to collect tweets

<table>
<thead>
<tr>
<th>Term</th>
<th>Average Number of tweets</th>
</tr>
</thead>
<tbody>
<tr>
<td>npp ghana</td>
<td>447</td>
</tr>
<tr>
<td>new patriotic party ghana</td>
<td>37</td>
</tr>
<tr>
<td>new patriotic party</td>
<td>259</td>
</tr>
<tr>
<td>ndc</td>
<td>560</td>
</tr>
<tr>
<td>ndc ghana</td>
<td>3000</td>
</tr>
<tr>
<td>corruption in ghana</td>
<td>300</td>
</tr>
<tr>
<td>unemployment in ghana</td>
<td>350</td>
</tr>
<tr>
<td>national democratic congress</td>
<td>250</td>
</tr>
<tr>
<td>national democratic congress ghana</td>
<td>7</td>
</tr>
<tr>
<td>ghana politics</td>
<td>1084</td>
</tr>
<tr>
<td>politics in ghana</td>
<td>260</td>
</tr>
<tr>
<td>political parties in ghana</td>
<td>8</td>
</tr>
<tr>
<td>ghana political parties</td>
<td>11</td>
</tr>
<tr>
<td>John mahama</td>
<td>1023</td>
</tr>
<tr>
<td>president john dramani mahama</td>
<td>229</td>
</tr>
<tr>
<td>president jdm</td>
<td>29</td>
</tr>
<tr>
<td>akuffo addo</td>
<td>142</td>
</tr>
<tr>
<td>nana akuffo addo</td>
<td>41</td>
</tr>
<tr>
<td>ruling party Ghana</td>
<td>3</td>
</tr>
<tr>
<td>opposition party Ghana</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>8,951</td>
</tr>
</tbody>
</table>

3. METHODS

3.1 Data Description

R’s twitter [24] package was used to collect tweets based on the search terms in Table 1. This was carried out every week from 3rd September 2014 to 11th September, 2015. The same search terms were used and purposely chosen in the Ghanaian context. A minimum of 8,120 tweets were collected each time within the said period. They were made up of original tweets, retweets and replies. Figure 1 depicts, on the average, the number of re-tweets each of the most influential users obtained throughout the period.

Over the 32 weeks that data was collected, the eight users in Figure 1 were found to be the most influential users based on retweet count with a statistic of 0.90. Based on 95% confidence interval, a 0.10 margin of error was obtained.
This indicates that the probability that the eight users chosen are the most retweeted for all the 32 samples is between 0.80 and 1.00. The level-1 Friends and Followers of the eight most retweeted users were collected. A total of 1062 Friends and Followers were obtained for the eight users. The network diagram of Friends/Followers using re-tweet count as a measure of influence on twitter [17] is shown in Fig. 2. Figure 3 shows the degree distribution of the network on a Log-Log scale. The average degree was 1.028.

Re-tweets were not ignored during clustering. It is assumed that a user who re-tweets another user’s tweets would have tweeted same if the idea had come to them first. Screen names of the most re-tweeted users were masked for anonymity. Users whose tweets were most replied-to were also obtained, however it is difficult to interpret because another user may reply to a tweet to show their approval or disapproval. Unwanted characters such as punctuations, tabs and numbers were replaced with spaces and the corpus stemmed.

Fig. 1 Re-tweet count showing how many of each of the eight users’ tweets were re-tweeted by others

Fig. 2 Force Atlas Layout algorithm applied on Friends and Followers network

Fig. 3 Degree distribution of the network

Hyperlinks and references were removed from the corpus. Stop words such as the, etc. were also removed from the corpus.

4. DISCUSSION OF RESULTS

R’s igraph [25] package was used to build a graph of Friends and Followers of the eight most retweeted users. The network has 1039 nodes and 1068 edges. Since the depth of the graph from the most re-tweeted users to their Followers/Friends is one, links to both friends and followers can be treated as undirected links. In addition, our interest is in finding the centrality measures of the eight most re-tweeted users. Fig. 2 depicts the resulting network with the Force Atlas Layout algorithm. This algorithm allows linked nodes to attract each other than non-linked nodes. Fig. 4 shows the degree centrality for the network under consideration. The user represented with the largest node in the network has the highest number of edges. This could be explained with the preferential attachment model [26]; i.e. the probability of a new user following an existing user is proportional to the number of followers the existing user already have.
According to [17], in-degree is not a good measure of influence; however it can be used as a measure of how rapid a node can diffuse information. Based on Clustering Coefficient and the transitive nature of following; (i.e. the “Followers of my Followers” are also my Followers), user GD in Fig. 4 will be a good starting point for information propagation in the network beyond what is shown here. Fig. 5 shows how important some nodes are in serving as the shortest paths between nodes on the network. We notice that, user eyd has high betweeness centrality than GD who has high degree centrality from Fig. 4. Assuming we were considering a business network, eyd’s position in Fig. 5 would be that of a broker.

As a political network, eyd can serve as a mediator between the different communities that uses it as a bridge. eyd also serves as a better medium for information diffusion across sub-networks due to its betweeness. PageRank centrality (Fig. 6) shows that a random surfer on this network will spend a large fraction of time on user Okwabena685 than any other user. This means that, Okwabena685 is the appropriate user who is best suited to preach peace to any new user who has not already taken sides in the network during conflict. Hierarchical clustering was used to cluster the network. Eight communities were detected as shown in Figures 7.
4.1 Clustering of Words and Tweets

The dataset was cleaned using the \textit{tm} package \cite{27} in R. In order to visualize the most important words in the corpus, a word cloud of words of frequency not less than 1000 was generated with its associated bar chart as shown in Fig. 8. Hierarchical clustering using three cluster centers (k=3) was applied to cluster the words forming the Tweets. It can be seen from Fig. 9 that “ndc” being the ruling party is in its own cluster. The current “president”, “john” “mahama” are in the same cluster, whilst the opposition “npp”, its flag-bearer “nana” “addo” and the newly elected Nigerian president “buhari” are in the same cluster. The last cluster is intuitive because when president “buhari” was elected, people started using his age to justify why “nana” “addo” could still be a president despite his age. During the period data was being collected for this work, changing the Ghanaian voter’s register and corruptions in the judiciary were hot topics under discussion. However, none of these issue-based topics featured in Figures 8, 9 and 10. This may suggest that Ghanaians are more interested in discussing political parties and personalities rather than issues.

The tweets were clustered using Partition Around Medoids (PAM) with the Euclidean distance metric. The aim was to determine if group of tweets were discussing the same topic or person. PAM; a form of k-Medoids algorithm was chosen for the clustering due to the fact that it is robust to noise such as outliers.

PAM cluster centers are represented by objects (Medoids) closer to the center of the cluster instead of Means as in k-Means algorithm. Specifically, a variant of PAM called PAMK \cite{28} was used since it does not have the limitation of letting the user choose the number of clusters. Fig. 10 is a 2-dimensional cluster plot of applying PAMK on the corpus. 10 clusters were generated. An average silhouette width of 0.55 was obtained suggesting that the partitions obtained by the clusters are separated from one another. Particularly, clusters 6, and 8 were well separated as shown by their silhouettes. However, cluster 4 overlaps all other clusters and tweets belonging to this cluster could not fit well into the other clusters. Clusters 1, 2, 3 and 7 contains tweets on “npp”, its opposition leader “addo” “nana”, etc. The rest of the clusters were centered on “john” “mahama” and “buhari”. These clusters also confirm the assertion that Ghanaians discuss political parties and personalities instead of core issues of “bread and butter”.

4.2 Limitations

Data was collected from Twitter using the Ghanaian political environment as a case study. However, Twitter is not so popular with the ordinary internet user in Ghana like Facebook \cite{29}.
As at the time data was collected, Twitter has a limit to the number of words a user can use to express their opinion on a subject. As a result, jargons and characters can be used to express valuable information in tweets. It is also not everyone who has access to the internet. Despite these limitations, this work has shown that it is possible to obtain valuable knowledge from social media to enable policy-makers act before things go out of control.

5. CONCLUSIONS AND FUTURE WORK

This paper has demonstrated that the structure of social media can be mined to identify influential people who could serve as mediators or information propagators during conflict situations to avoid a repeat of the “Arab Spring” elsewhere. Advertisers can take advantage of the methods outlined in this paper to enable their product information reach wide audiences. Application of unsupervised clustering algorithms revealed that people, rather than issues are mostly discussed in Ghanaian politics; meaning that if elections were to be held in Ghana today, people may not vote based on issues but instead on personalities and party affinities. As future work, it will be desirable to fully automate the methods outlined in this paper.

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Author’s Biographies:

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Secure Approach for Healthcare System with Integration of NFC and Cloud Computing

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ABSTRACT

Main anxiety in the data sharing based systems is security and efficiency. Online network of Healthcare system is also comes under its shelter. Cipher Text-Policy Attribute-Based Encryption (CP-ABE) and use of Near Field Communication Technology (NFC) handles these aspects effectively. NFC Technology is a small-range high-frequency wireless communication technology. RFID technology (Radio Frequency Identification Technology) has been used in NFC tag. This NFC tag stores some amount of information in it with a unique identification number, therefore, it is useful in many different real-time applications like transport system, the smart postures system etc. One main issue in data sharing systems is the application access policies and support for policy updates. Using NFC in Healthcare Application System (HAS) and the key attribute of NFC Tag ID for Cipher Text-Policy Attribute-Based Encryption removes existing disadvantage of key escrow problems. NFC technology allows intelligent devices; NFC Tag, NFC Enable Smart Phone, MIFARE card in hospitals is a big step for the automation of the healthcare system.

Keywords: CP-ABE, NFC, RFID, HAS, MIFARE card

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

In the hospital during patient’s treatments doctor needs to operate on every patient differently because every patient may have a different illness and different symptoms are chances of getting confusion between patient's disease and treatment. Along with this issue patient, health records [1] which depict patient treatment history and reports are retained on paper which is difficult to maintain and unreliable for a longer period. Building healthcare system [2], [3], [4], [5], [6] using NFC Technology it may protect patients record and helps the doctor to side out such fatal mistakes while doing treatment. But security is a major concern in data storage. CP-ABE provides a cryptographic solution for data security on the cloud network. Use of NFC technology makes the insurance claim nation faster with complete transparency and credibility by connecting it with unique ID of NFC tag and CP-ABE encryption standard for security.

NFC is a high frequency secure wireless communication technology [7]. NFC works in a short range of about 4 inches between two devices. NFC operates at 13.56 MHz NFC operates several data broadcast rates; 106 kbps, 212 kbps, and 424 kbps. NFC enables communication between the tags and electronic equipment, which means that reader and writers [8]. NFC is already used for applications related to financial payments [9] and ticketing. We are proposing a new use of NFC mobile devices to access medical external tags to identify patient health cards.

NFC allowing users to do safely contactless transactions, the spontaneous digital content, access and connect electronic devices simply by touching or in close taking devices proximity [8]. NFC technology allows three modes: read/write mode, peer-to-peer mode, and card emulation mode [10]. Radio Frequency Identification Technology (RFID) has been used in NFC tag. This RFID technology and various wireless technologies are able to support users in different service sectors [11]. An application on an NFC device can read data from and write data to the tag detected using read-write mode operations [8]. This tag also has to run different applications with the support of NFC device.

The supported data rate in this mode is 106 Kbit / s. The second mode is peer to peer mode. In this mode, data are exchanged between the two devices. This mode is based on ISO 18092 standards and rope two communication modes: passive and active. In passive mode, it begins by creating the communication RF signal and the target respond to the command of the sender. In the active mode, to start communication, it must generate their RF signals. The NFCIP-1 initiator starts communication session and target responses to the control of the initiator. The third operating mode is the emulation mode of the card. In emulation mode, the camera will stop producing a RF wave and convert into passive mode. NFC has two types of communication. One is the active communication mode and the passive communication.
In the active mode of communication throughout the data transmission procedure and the parties themselves generate a carrier. In active mode communication information are sent using the modulation amplitude shift keying (ASK). This means that the base signal RF (13.56 MHz) is moderate with numbers in accordance with a coding arrangement. If the baud rate is 106 bauds, the encoding device is the encoding said, modified Miller. If the transmission rate is greater than 106 k Bauds Manchester coding device is applied. Attribute-based encryption (ABE) is a promising approach that achieves a cryptographic access control to fine-grained data [12], [13], [14]. It provides a way to set access policies [15], [16] based on different attributes of the requester, the environment, or the data object. In CP-ABE Standard encryptor defines their own attribute set over a group of attributes that must be possessed with decryptor in order to decrypt the ciphertext [17], [18], [19] and enforce it on the contents [20], [21]. Thus, each user with a different set of attributes is authorized to decrypt the individual data items by the security policy. It eliminates the need to depend on the data storage server to prevent unauthorized data access. Also, it removes existing disadvantage of key escrow problems [22].

2. RELATED WORKS

2.1 BSW CP-ABE

In BSW CP-ABE [13] scheme, If user inputs valid set of attributes then only he will be able to retrieve encrypted data. But, secure element concept has not been considered in this scheme.

2.2 YWRL-CP-ABE

In YWRL CP-ABE [23] scheme has suggested a solution to give rights to revoke user with different attributes in less effort. It uses proxy re-encryption with CP-ABE standard scheme to achieve expected output.

In the previous health surveillance system, the doctor needs to attend patients when they take medication at home. NFC medium formed the NFC Data Exchange Format (NDEF) and NFC tag operations. NFC tags are contactless cards based on RFID architecture [24]. NFC phone may communicate with RFID tags distributed by [25] environment. Little research has focused on improving the value of patients’ treatment. For example, storage of the separate drug dosing information and the avoidance of a pharmacy out of stock in the Voter circumstances [26]. Smart poster applications are one of the biggest important applications of this mode. In this application, users are able to read data from NFC posters and spend their NFC mobile strategies. Review of Literature Survey [27], depicts NFC has been used in different service sectors like smart posters system, payment services system, electronic wallet system, loyalty management system etc.

2.3 Existing Systems Based On Nfc Technology

Following are some application areas where NFC Technology has been used for automation.

- Public Transport System
- Mobile Payment Using NFC Technology [28]
- Entrance Control System
- NFC in Tourism
- Smart Postures

2.3.1 Public Transport System

Nowadays many countries are using NFC in public transport systems. Tapping your phone with kiosk gives you up-to-date information about schedule and delays. Contactless cards which used for ticketing options. Many transport agencies from worldwide countries have been using NFC-enabled mobile phones.

2.3.2 Mobile Payment System

The system provides adequate security level for payments [28], ubiquitous implementation using new available technical components.

2.3.3 Entrance Control System

Entrance controls system validates the entry into transport control system, monitoring in the railway station, corporate offices etc. It reduces efforts required for manually checking. NFC enables the right way to control and validate or invalidate tickets or passes in the entrance control system. Tickets can be checked or validate it by touching a control device (like an RFID, NFC Tag etc.) with your mobile phone.

2.3.4 NFC In Tourism

NFC technology is a key point for various stakeholders in tourism industry sector. NFC device provides more information on the spot about different places and makes all things easier for tourists. NFC tags placed on monuments for checking can give more information about its monument. NFC technology will be a key point for various stakeholders in the tourism industry.

2.3.5 Smart Postures

NFC smart posters are the objects in or on which readable NFC tags have been placed. Various smart posters are developed using secure NFC tags. It can be done by using web server for securely retain the details of the poster.
3. ARCHITECTURE OF PROPOSED HEALTHCARE APPLICATION SYSTEM WITH NFC TECHNOLOGY, CP-ABE ENCRYPTION STANDARD AND CLOUD NETWORK

If the patient comes first time in the hospital for treatment, his information will be filled at the receptionist counter such as names, addresses, phone numbers and relatives phone number, initial amount to be filled in the card, ward number; bed number etc. such way the patient will be admitted. After registration, the patient will be given the NFC enabled wristband tag and MIFARE card. At the same time all that information will be stored in encrypted form with CP-ABE standard scheme. If in case the admitted patient has been registered earlier, then he will be given the wristband with unique ID contains in it and MIFARE card directly and will be allotted with an appropriate bed number. NFC tag ID will become the patient's unique identification number for further reference and CP-ABE Standard to provide security for all data over the cloud.

During patient registration his/her claim nation sends to the respective insurance agency via SMS and Email for speed up the claim nation procedure, increasing transparency and credibility in the healthcare. While claiming insurance when the patient admitted to the hospital, his detail information includes his Policy No, Name, Disease, Hospital Name etc. will be sent to the respective insurance agency. When doctor will go for the checkup he will just tap his NFC-enabled mobile phone to the patient wristband and he will get all the details regarding patient's disorder or disease, consultation with the doctor, prescriptions given previously, the test conducted etc.

After checkup new prescription given by doctor will be stored on the server for further reference. Doctor himself can see the patient's previous treatments reports on his NFC enable smartphones and write which test to be conducted. Detail Architecture Representation of the system as shown in Figure 1. To take medicine from the store he can use his MIFARE card for payment. Medical manager taps his/her NFC enable mobile phone to retrieve information of which medicine has to give to the patient. He also receives SMS about which medicines have to give a patient. The MIFARE card will be swapped and the respective charges will be deducted from amount and changes will be stored on a server at regular interval.

Medical manager and the pathologist can only retrieve information about prescription and tests to be conducted respectively. When the patient will be discharged all his dues like rent of the bed etc. for appropriate number of days he or she spent in the hospital, and doctors consulting fees will be calculated. After clearing all the dues, he will be discharged from the hospital. This all patient's record will be accessible in any hospital for their reference. It results into reduces the headache of patients to keep their previous treatments record with him and the doctor can refer it with a single touch. This globalizes accessibility makes the healthcare very effective and it takes less time and efforts.
3.1 Work Model Of Healthcare Application System

Nurse/Receptionist will launch the application of NFC Based Hospital Management System by providing the IP address of the server. Once connected to the server, NFC Tags’ unique identification number of the affected patients is permanent and stored in the server. The doctor must log successfully to view the patient's request. The doctor is able to see the patient's application form and patient information. If the patient is already registered, then the doctor can also see patients’ previous symptom and medication prescribed for this symptom. Doctor prescribed the patient and sends the prescription to the mobile phone of the nurse and medical manager. Lastly, Nurse will check the payment and if it is paid, receptionist will clear the account.

Thus, each user with a different set of attributes is authorized to decrypt the individual data items by the security policy.

5. Data Sharing Architecture

Following Fig. 3 shows the architecture of the data sharing system and their entities.

5.1 Key Generation Center (KGC)

It is a key authority which is use to give public and secret parameters. It also has control for revoking, issuing, and updating the attribute set for different users [35]. It gives different authorized access rights to users based on their attributes.

5.2 Data Storing Center

Data Storing Center provides a data sharing service. It is responsible for monitoring external user access to data storage and provision of corresponding content services. The data storage center is another key authority that generates custom user key with the KGC. It also issues and revokes attribute group keys for users attribute, which is used to apply a thin validated user access control.

5.3. Data Owner

It owns data information. Data Owner wanted ease of sharing or cost-saving, therefore, it uploads data into the external storing center for ease of accessibility. It defines access policy and encrypts data before it is delivered to storing center. To access information of user’s encrypted content, decryptor needs to possess a set of attributes, only then, he will be able to receive and decrypt the text data.

5.4. Healthcare Management

HAS has depended on the following entities for the good management of patient data:

- Cloud Service Provider (CSP): a CSP has important resources to manage distributed cloud storage servers and to direct its database servers. These services can be used by the HAS to manage patient data stored in the cloud servers.
emerging NFC technology, all hospitals can better track patient's treatment information. It makes the Healthcare sector patients with reducing medication errors.

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Authors’ Brief

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Affective Education With Enhanced Affective Information Technology

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ABSTRACT

Technology and technological innovation is rapidly changing the way humans perceives the world, redefining our ways of life and values, the very foundation of mankind is built on constant improvement and vital instructions. Technology and its application is growing at a tremendous rate but notably the education domain and technology is not pairing evenly, more so there is a severe drawback in the correlation between affect in both concepts. In recent years, the drive of the existence of our values and way of life is rapidly eroding. Computing dynamics is moving from just ordinary machines to human-like abilities with emotions as the underlying concept, by extension computers by design should be adapting to people rather than people adapting to computers and the pedagogy derived from the educational system. The research is conducted among four universities in the southern region of Nigeria adopting affect as latent variable in the Technology Acceptance Model (TAM) to analyse user acceptance of a recommender system. The experiment involves 840 students systematically selected from the four institutions, the research is a follow up of the same institution's research work conducted with respect to the lecturers. The outcome further substantiates the lecturers result that perceive ease of use has more impact than perceive usefulness to motivate acceptance of the recommender system. Likewise user emotional affects toward the system strongly influence perceive ease of use which directly impacts on perceive usefulness of the system. Without over stressing words the out pouring results further emphasises the role affective modelling in system design, development and administrators of recommender system to maximize users' efficiency.

Keywords — Perceived affect, Machine learning algorithms, TAM, Recommender system.

African Journal of Computing & ICT Reference Format:
Afri J Comp & ICTs Vol 8, No.3 Issue 2 Pp 177-182

1. INTRODUCTION

Bloom's taxonomy of educational objectives was created by Benjamin Bloom during the 1950s. The concept deals with the levels of reasoning and skills required in effective teaching and learning in the classroom environment. The taxonomy as viewed by Bloom as educational goals and objective were framed into three domains: a) The cognitive which is knowledge based. b) The affective which is attitudinal based and, c) The psychomotor that is skills based domain [4]. Among the domain the cognitive and psychomotor has been consciously and widely adapted in the educational setting as Bloom's taxonomy has stood the test of time, ignoring or unnoticeably avoiding affect in curriculum and systems designs. In a monthly e-Newsletter: A dialogue platform for doctoral scholars of Jain University reaffirm role of affect which governs emotions [6].

He noted that higher order activities in human endeavour are ruled by emotions and emotions play a very vital role in human intelligent, perception, memory, creativity including teaching and learning. Among the Bloom's classification of educational outcome, the affect is remarkable a factor that governs and rule our day to day activities. The undertone that "being emotional" or "acting emotional" are not valid proofs and excuses for ignoring the study and research of emotions in its application to teaching and learning and our better half the technology or computer systems. It is the right time to make our systems affective oriented, and examine how emotions can be incorporated into models of intelligence. Computers should be adapting to people rather than people adapting to computer. The shortfall on the subject matter may be conceived in various ramifications adopting different approaches and models but this work deem it necessary to employ the Technology Acceptance Model for standout and most widely used [5].
2. PREVIOUS WORK

1) Virtual community recommender recommends optimal virtual communities for an active user using behavioural factors suggested in TAM using a filtering function based on user needs type [3].
2) TAM model is used to evaluate the adoption of a recommender system in retail industry and banking sector [1].
3) TAM model to evaluate an existing personality based recommender system and considered that music and other factors such as emotion and mood have to be considered [7].
4) TAM and partial least squares regression are used to investigate learners’ acceptance of a learning companion recommendation system [LCRS] in Facebook [2].
5) TAM used to review the state-of-the-art about user experience and user acceptance research in recommender system [8].
6) TAM applying ICT in teaching and learning ability on students in Federal College of Education (Technical) Omoku-Nigeria [7].
7) TAM a model using ICT to improve teaching and learning (lecturer’s perspective) using VBSE Omoku-Nigeria [7].
8) Applying TAM to evaluation of recommender systems using machine learning approach [6].

3. METHODOLOGY

The research work is an extension of students perception as earlier work has been published with respect to lecturers responds. The work as conducted invites students from same universities in the southern region of Nigeria. Introduction of new latent variables were deployed into the TAM model as a test to verify the impact of learning outcome of the users of the recommender system. To achieve this dataset was drawn from both science and arts related disciplines. Questions structured adopted the Likert-5 scale format corresponding to " Strongly Disagree" and 5 corresponding to "Strongly Agree".

The questions presented to participants along with the associated TAM variable are detailed as follows:

- **AICT₁**:Internet services provided by the university (Afrihub & Others) are adequate.
- **AICT₂**:Internet services provided by the university are reliable.
- **AICT₃**:The university’s digital library is efficient.
- **AICT₄**:Links to educational resources websites like e-journals, e-books can be found on the College’s website.
- **AICT₅**:Computers and other ICTs are adequately provided.
- **AICT₆**:Digital Video Disk prayers, Flash drives/External Hard drives and software are adequately provided
- **PITL₁**:Effective utilization of ICT facilities improves students’ performance.
- **PITL₂**:The use of ICT facilities for teaching and learning give better understanding to students.
- **PITL₃**:Effective teaching will improve if all teachers have access to Internet facilities in their offices.
- **PITL₄**:Teaching is very interesting when performed with any ICT equipment such as laptops, power point projector, clever board etc.
- **PITL₅**:The practical approach of ICT in teaching and learning increases students’ learning/achievement.
- **PITL₆**:ICT facilities provide all the materials needed for the students at the right time.
- **PE₁**:Computer/internet can be easily used for teaching/Learning
- **PE₂**:Computer/Internet are efficient to use
- **PE₃**:Sourcing for academic information through the internet is preferred to books
- **PE₄**:Computer application makes teaching versatile
- **PE₅**:Refer students to the internet to solve assignment
- **PE₆**:Use computer simulations to aid teaching and learning
- **PPAD₁**:Teaching and learning is more controlled with ICT facilities
- **PPAD₂**:There is arousal in teaching or learning in the use of ICT facilities
- **PPAD₃**:Using ICT facilities in teaching or learning gives me energy to proceed on and on
- **PPAD₄**:ICT facilities create pleasure when using it in teaching or learning
- **PPAD₅**:I have effective control when using ICT facilities in teaching or learning
- **PPAD₆**:Using ICT facilities in teaching or learning gives me joy and pleasure

Key
AICT - Availability of ICT infrastructure  
PE - Perceived Ease of Use of ICT  
PITL - Perceived Impact of ICT in Teaching and Learning  
PPAD - Perceived Pleasure/Arousal/Dominance of ICT facilities
4. EXPERIMENT

TAM is a theoretical model with latent variables in this work in addition to Davis foundational variables "Perceived Affect" and "Perceived availability" are introduced as variables not directly observed but reviled by the items on the questionnaire. The content of the model is unveiled through the questionnaire by using the machine learning algorithm and a structural model. As indicated by the previous work the classification model specifies the relationships amongst the latent variables. A reliability and validity test the consistency of the item-level within a single factor. A "reliable" set of variable will consistently load on the same factor, [7]. Measuring reliability and internal consistency of test item Cronbach's alpha is often used as a measure this work adopt same. Cronbach's alpha is a function of the number of test items average inter-correlation among the items. It measures how closely related a set of items are as a group.

Table 1 below shows the Cronbach's alpha coefficient correlation. The factors Cronbach-alpha is 0.736 which exceeds the average limit as recommended and this indicates for all factors, implies that the reliability test is successful.

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>Cronbach's Alpha Based on Standardized Items</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.736</td>
<td>.738</td>
<td>5</td>
</tr>
<tr>
<td>HYPOTHESIS PATH</td>
<td>SVM REGRESSION (5-Point Likert Scale)</td>
<td>RANDOM FOREST TREE % (If than Rule)</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>AICT PPAD</td>
<td>3^- Undecided</td>
<td>Nil</td>
</tr>
<tr>
<td>PE PPAD</td>
<td>4^- Agree</td>
<td>RSUST 81.8 (4&amp;5) Arts 65.7 (5&amp;5) Science UNIPORT 52.6 (4&amp;5) Arts 63.6 (4&amp;3) Science</td>
</tr>
<tr>
<td>AICT FCET</td>
<td>3^- Undecided</td>
<td>Nil</td>
</tr>
<tr>
<td>PE AICT</td>
<td>4^- Agree</td>
<td>Nil</td>
</tr>
<tr>
<td>PE PITL</td>
<td>4^- Agree</td>
<td>Nil</td>
</tr>
</tbody>
</table>
Table 2 reveals the result of an overall model fit analysis test of SVM regression analysis, Random forest tree, correlation coefficient, Multiple regression analysis and t-value.

A general structural model used to test the simple bivariate relationships between the constructs included in the model. Hypothesis was tested within the context of the structural model. This simplified the review of the results because a relationship between two constructs could be examined while holding constant other constructs in the model. SVM scatter plot of the universities based on perceived pleasure reveals a high cluster of data on universities agreeing to strongly agreeing significant relationship and in contrast as accepted by the institutions, there is an opposition to a backdrop in the availability of ICTs materials for effective teaching and learning in the institutions. From the revelation of figures of the analysis perceived inhibitors showcase a negative relationship with both perceived usefulness and perceived ease of use of ICTs, this call for adequate provisions of ICTs facilities to enhance teaching and learning. The same results speak loudly viewing the Random forest tree results that ICTs availability is not availed in any of the institutions also while inhibiting factors has negative impact on teaching and learning.

There is a strong overall fit of the five algorithms used to analysis the dataset regarding perceived pleasure against perceived ease of use, perceived impact (usefulness). Rivers State University Science and Technology (RSUST) with Random forest tree with the if than rule with (81.8% Arts Students, 65.7% Science Students) agreeing and strongly agree respectively. While University of Port Harcourt (UNIPORT) reveals a (52.6% Arts Students, 63.6% Science Students) in the university. The relationships among the constructs were all significant except for parameter estimate from ICTs availability (r=0.20, t= -0.08, SVM=3), perceived pleasure and perceived pleasure to ICTs inhibitors (r=0.23, t= 0.08, SVM=3). In contrast both perceived usefulness and ease of use were found significant in affecting user attitude toward perceived pleasure. Perceived usefulness (r=0.55, t=15.82, SVM=4) had the largest relationship on user affection or pleasure, perceived ease of use with (r= 0.41, t=5.29 SVM=4). More so, systems availability was found to be non-significant of all construct except for perceived usefulness. Considering the above results, perceived pleasure (affect) rank one of the most important variable, followed by perceived usefulness, in influencing the behavioral intention to use ICTs.

5. RECOMMENDATION AND CONCLUSION

This work is a an abstract from an ongoing research from four higher institutions in the southern geo-political region of Nigeria to reveal the availability and impact of a recommender system (ICTs) adopting a new latent variables based on TAM to enhance the effectiveness teaching and learning. With a similar research conducted and published for lecturers in the stated institutions, the researchers performed an experiment with some commonly used ICT facilities to enhance teaching and learning.

Participants responded to a post-treated questionnaire related to a set of variables that influence each latent variable in TAM and new latent variables corresponding to "Perceived affection or arousal, availability and inhibitors" were in use of the recommender system as previously published.

It further strengthen the confirmatory evidence that validate the fact that the data fit adequately in the proposed model. nevertheless some new latent variables in some universities varies as the case may be. The experiments confirmed the previous work viewing that perceived usefulness plays a predominant role for users to accept a new recommender system, as proposed in TAM. More so, ICT availability is a key player in the institutions evolution to improve teaching and learning as perceived ease of use is agreed upon by these institution in the use of ICTs. The result speak and reveals that at least an institution reflex the fact that perceived affection has a strong correlation with perceived impact that is usefulness in the analysis. The bottom line is that get the required affective technology and affectively motivate user through effective institution and a heart warming results achieved.
REFERENCES


1. INTRODUCTION

The Internet as an application development platform emerged rapidly from obscurity to the dominant position it now holds in enterprise and inter-enterprise computing. Over the brief life of the Internet, Web applications have grown in prominence and capability. Each successive wave of client and Web server technology has upped the ante on the previous generation, increasing capability, integration and responsiveness. Text and video conferencing have gained popularity as they allow instantaneous human friendly communication. Save and edit contacts, storage of conversations and other user information are some common features in these applications.

Many of these chat applications are based on server-client architecture. That is, a centralized server is used to maintain all the information necessary to authenticate the user and relay data or connection information between users. Most of the chat applications existing today require user created profiles containing personal information before being able to chat. All this information is stored on a server. This method of connecting users leads to the server being a store-house of personal information.

Such a system has many potential disadvantages. It creates a performance bottle-neck as vast amounts of data must be processed by server. Connectivity issues between the clients and the server can interrupt connections between users that could otherwise be avoided. Likewise, in a corporate environment, hospital or schools' libraries, where noise of any form can cause a lot of disadvantages ranging from distraction which reduces productivity, distorted recuperation process, distractions from understanding concepts explained in textbooks etc., the widely used intercom telephone line is undesirable, and coupled with the fact that the cost of procuring this communication device and its maintenance is relatively high, the need for a cheaper and less intrusive means of communication is imminent and expedient.

Thus, we need a chat application that overcomes these drawbacks; one which can work without the complications of having a centralized server.” [1]. This research designs and implements internet Chat application as a Solution to Reduce Cost of Procuring and Maintaining a PABX Phone in an Enterprise. Two-tier client server architecture is employed in the design of the internet chat application. And it is implemented using Visual basic programming under Microsoft Visual Studio 2013 development environment.
2. RELATED WORKS

The need for communication in an enterprise is of utmost importance as the different departments of the enterprise need to share and transfer information between themselves. A Private Branch eXchange, or PBX, is a circuit-switching system which provides service to one user organization. Usually located at the users' sites, PBXs have traditionally provided basic voices witching services.

The PBX usually routes incoming calls to attendant positions, from which they may be extended to station users; allows for station-to-station calling without the use of the telephone network; and allows station users to access the telephone network for outgoing calls.

A lot of researches has been conducted in internet chatting. Peris et al. perform study of interpersonal relationships in cyberspace using the chat channel as an interaction medium [2]. Results suggest that relationships developed online are healthy and a complement to face-to-face relationships. In addition, Dewes et al. performs an analysis of Internet chat systems [3]. They show how to separate chat traffic from other Internet traffic and present the results of an extensive validation of their methodology. Further, A Study of Internet Instant Messaging and Chat Protocols has been conducted [4]. This analysis helps bridge this gap by providing an overview of the available features, functions, system architectures, and protocol specifications of the three most popular network IM protocols: AOL Instant Messenger, Yahoo! Messenger, and Microsoft Messenger.

3. METHODOLOGY

Client/Server architecture is used in this research instead of Server/Client architecture. Client/Server computing involves two or more computers sharing tasks related to a complete application. Ideally, each computer is performing tasks appropriate to its design and stated function. This implies that computing resources and data storage resources are located where they will do the most good in fulfilling the computing task at hand.

Client/Server describes a program architecture and development process and is not tied to any particular operating system, database engine, programming language or networking environment. The main advantages of client/server applications are task specificity and independence.

The proposed system’s architecture is a two-tier client-server architecture. A two-tier client/server application architecture is implemented when a client talks directly to a server, with no intervening server. It is typically used in small environments of less than 50 users. Generally two-tier architecture separates the user interface and the business logic onto one computer (Tier1) and the database server is onto another computer (Tier2). This can be shown in figure 1.
4.1.1 Use Case Diagram

A use case [6] is a sequence of transactions performed by a system that yields an outwardly visible, measurable result of value for a particular actor. A use case typically represents a major piece of system functionality that is complete from beginning to end [7].

Figure 2 is a User Interface Representation of the user. It shows the interactions with the user interface. On the user interface, each user can login with already registered credentials or can register if a new user. Once the authentication credentials have been verified to be correct, the user can have access to any of the following options like adding a new contact, deleting old contacts, selecting a contact from the list to chat with. In addition, one-to-one communication with users can be shown in figure 3.

![Use Case Diagram](image1.png)

**Figure 2: A Use-Case Diagram showing the interaction of the user with the application.**

![Use Case Diagram](image2.png)

**Figure 3: A Use-Case Diagram showing one-to one communication between two users through the chat application.**

4.1.2 Activity Diagram

Activity diagrams are mainly used as a flow Chat consisting of activities performed by the system. But activity diagram are not exactly a flow Chat as they have some additional capabilities. These additional capabilities include branching, parallel flow, swimlane, etc. Activity diagram showing what happens at each stage of the process is shown in figure 4. For the user authentication, the proposed system gives limited number of tries for a wrong login combination. If after 3 trials, the combination still isn’t correct, the system locks out. Some recovery questions inserted when registering would be asked and if the user still can’t access the account due to wrong input, the system administrator would have to be called upon to validate the user with his priority password. Last login attempt would be displayed to the user, so, in case of any account breach, the user can raise an alarm over the issue in order to vet the system for compromise of user’s data.
5. IMPLEMENTATION OF THE PROPOSED INTERNET CHAT SYSTEM

During the implementation, the actual system is built. Building a successful information system requires performing some steps like Hardware requirement, Software Requirement, Implementation Procedure, Algorithms and Input and Output Snapshot.

5.1 Hardware Requirement

i. At least 2.2GHz Processor
ii. 1GB of RAM
iii. 20GB Hard drive
iv. Local Area Network
v. CD/DVD ROM

5.2 Software Requirements

i. Operating System
   Windows
ii. Microsoft Visual Studio 2013

5.3 Implementation Procedure

There are two important classes implemented in this program that made it possible for the two parties to communicate. These classes are:

i. TCPListener: This is the channel through which both parties communicate. It specifies the IP address of the server along with the Port number. The port number is the exact location where communication would be taking place. This is a number between 0 and 65535 and it is specified by the server user.

ii. TCPClient: This is like the TCPLient, but used by the client user. This takes the destination IP address and Port number from the client of the server to complete the half-duplex channel of communication.

Some system’s libraries were also employed (imported) in the program, without which basic operations of the chat application like text, network address with port number and other basic simple Input/Output operations will not be possible.

i. System.Net: Used to initiate the network properties of the machine. This allows us to specify the IP address.

ii. System.Net.Sockets: This allows us to specify the port address on which the server would be listening to for data from the client.
Figure 5: A sequence diagram showing the activities performed at each stage of the application

1. **System.Text**: This initializes the text properties of the system, since our chat application is a text based application.
ii. **System.IO:** This initializes the basic input and output operations. This allows us to give inputs as text to be sent to the other party on the network and also expect outputs as text in reply the message sent.

The activities performed at each stage of the application, starting from when the client connects till when data is being sent by the client can be shown in figure 5. Also activities performed by the server since when connection has been received till when data is being sent by the server can be shown in figure 6. Lastly, a system generated sequence diagram showing how the module interfaces with both the client and the server can be shown in figure 7.

![Figure 6: A sequence diagram showing the activities performed by the server](image)

When the parameters for the two independent communicating parties have been set up, there has to be a module between the two parties that does the work of connect, get data and data forwarding. This module is called the ClientConnection. For the purpose of this project, a random name of generated for each of the clients connected to the server, with their IP addresses appended to their names. This is done by getting some ASCII characters that falls between 65 and 89. Also, when a client’s chat window is closed, it is disconnected from the server and the name is no longer seen on the listbox.

The listbox holds the array of clients connected to the server. Once the client’s window is closed, an Event (disconnected) is raised and the client is delisted from the listbox. Another event used in this module is the GotMessage event which takes the message from the connected client. To ensure that the message is well read, the message is read line by line into a buffer called ReadData. The read data will be read by the streamreader, which is a function of the System.IO library of the system and the message is transferred to the streamwriter of the same library for onward dispatch of the message to the appropriate address.
Figure 7: A sequence diagram showing how the module interfaces with both the client and the server
Sample snapshot of the system can be shown in figure 8(a) – (c). Figure 8(a) is a Server Window showing the input area for the port specification, and message input. Also showing the listbox for the clients connected to the server, and also chat history. Figure 8(b) is the client window showing the specified IP address and the Port location specified for communication. Figure 8(c) is the client connecting to the specified port by the server and after connecting, it is showing on the server as a connected client in the listbox with the IP address of the client displayed along with the randomly generated name of the client.

Figure 8 (a): Server Window

Figure 8 (b): Client Window

Figure 8 (c): A client connecting to the specified port by the server and after connecting
6. CONCLUSION AND RECOMMENDATION

The development and implementation of this chat application proposed an alternative way in how we run our corporate environment is much better when compared with the old way of communicating through Intercom lines, which is quite intrusive, costly to acquire and maintain. Due promises proposed by this chat application, we therefore recommend that banks, hospitals, schools’ administrative body, governmental organizations and non-governmental organizations, who are looking for means of cutting cost and budgets, can look in the line of this proposed system, build on the existing knowledge it portrays and adapt it to their mode of operations in their respective organizations.

It can also be observed that staffs’ productivities are increased since they can keep working while attending to a chat message, with little or no distraction.

REFERENCES

Authors’ Profile

ODIAGBE, Justus Oluwaseun, was born on the 7th of April, 1990, in Ijebu-ode Local Government of Ogun state. He hails from Edo state of Nigeria. He obtained his Primary school leaving certificate at St. Anthony’s Nursery and Primary school, Ijebu-Ode, between 1993-2001. He proceeded to Sacred Heart Catholic College, also in Ijebu-Ode, between 2001 and 2007, thereby obtaining his Secondary school leaving certificate. He has just completed his Masters’ degree in Information Technology at National Open University of Nigeria and he is currently rounding off his Masters’ in Educational Leadership and Administration, at University of Nicosia, the course which being taken in an online environment. He is currently an ATM Engineer (NCR and Hyosung brands) at Inlaks Computers Ltd, a position he has held since 2013.

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Bello Alhaji Buhari was born on 20th October 1974 in Sokoto North Local Government of Sokoto State. He obtained his Primary certificate at Model primary school Wurno road Sokoto from 1981 – 1987. He proceeded to G.S.S S Yelwa Yauri where he obtained his junior leaving certificate from 1988 – 1990. He also obtained his senior secondary school certificate at Nagarta College Sokoto from 1991 – 1993. He then obtained a B.Sc Degree in Computer Science at Usman Danfodiyo University Sokoto from 1996 – 2000. He further obtain an M.Sc. Degree in Computer Science at Ahmadu Bello University Zaria from 2006 – 2009. He is now undergoing Ph.D in Computer Science Research at Ahmadu Bello University Zaria. He started his career as a lecturer at Sokoto Polytechnic from sept 2003 to Dec 2003. He is presently lecturing at Usman Danfodiyo University Sokoto from Jan 2004 to date.
Smart Antenna at 300 MHz for Wireless Communications

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ABSTRACT

As Radio Frequency spectrum is increasingly choked, there is need for the extension of communications system with higher capacity and higher bandwidth. Signal transmission over the radio frequency are mitigated by the transmission impairments. Antennas play a prominent role in the transmission of signal over the radio frequency. This work examines how a smart antenna with its dynamic physical antenna arrays can mitigate the bandwidth limitation and expand wireless communications coverage. At higher radio frequencies wave, the effects of interference cannot be overemphasized as the quality of signal is reduced drastically. To overcome this drawback on the propagation of signal, smart antenna offers the mitigation of interference on signal transmission and reception as it combines its different elements and digital signal processing capacity. To avoid interference at these frequencies, beamforming plays a prominent role in the smart antenna system. The beamforming varies the radiation beam pattern of an antenna in a particular direction. This research work presents an innovative approach of designing smart antenna using a waveguide-fed pyramidal horn antenna for wireless communication systems.

Keywords—Azimuth, Beamforming, Digital Signal Processor, Interference, Smart Antenna, Radio frequency, Wireless communication

1. INTRODUCTION

The radio frequency spectrum has been jam-packed with the coalition of personal and commercial communications, thereby causing signal interference. In the past two decades, wireless communications industry have witnessed tremendous growth in the numbers of subscribers globally and demand for high speed data transmission. In addition to these, high bandwidth, mobility, and on-line connectivity have become the requirements for the wireless communications networks [1, 2]. A Signal transmitted at radio frequency range always faces interference which reduces the quality of signals at the receiving end. Starting from radio frequency (RF) and above, wireless communications systems require innovation of smart antennas for the transmission of signals that will mitigate interference at the electromagnetic spectrum range.

Radio frequency is a portion (range) of an electromagnetic (EM) radiation spectrum that has a frequency between 3 KHz and 300 GHz which is equivalent to the frequency of radio waves and correlates to the frequency of alternating current electrical signals used to produce and identify radio waves. A radio frequency system includes; a point of supply of electromagnetic (EM) wave; a designated destination for that message; and the frequency at which the message is being transmitted [3, 4]. The radio source is the transmitter, while the radio destination is the receiver.

In the contemporary communication industry, antennas play a prominent role in the creation of communication link. For effective performance application of wireless communication such as mobile, radio, aircraft, satellite, and missile application at higher frequencies, a smart antenna has being a succor to their expansion in bandwidth, data rate, and quality of wireless transmission, which has been confined by interference, local scattering, and multipath propagation [5, 6]. Furthermore, for the effective transmission of radio frequency signals, antenna that can mitigate transmission impairments is required. To overcome this drawback on the propagation of signal, smart antenna offers the mitigation of interference on signal transmission and reception as it combines its different elements and digital signal processing capacity.

Smart antennas is an array of antennas that incorporate various elements of an antenna array together with the signal processing efficiency with a view to enhance its radiation beam arrangement dynamically in response to the signal environment [7, 8]. Smart antenna amalgamates signal processing and antenna array for its optimization in order to automatically change the direction of the radiation of beam pattern in response to the received pattern. The fundamental principle of the smart antenna is shown in Figure 1 [9].
When smart antenna received a signal, beamforming weight can be decided by an adaptive process by making use of reference signal (temporal information) or user’s direction (spatial information). In modern wireless communications, Smart antennas gain more space by using the property of spatial filtering [10, 11]. Das [12], through the techniques of adaptive beamforming approach stated that using beamforming algorithms, adjusted the antenna array’s weight to form typical amount of adaptive beam to track corresponding subscribers automatically. This can be simultaneously minimized interference coming from another users by the introduction of nulls in their respective directions.

Zalawadia et al. [13] formulated a basic approach for evaluating the realization of a beamformer as the feedback for a given N-by-1 weight vector \( \mathbf{W}(n) \) as objective, known as the beam response and computed for all possible angles from \(-90^\circ \leq \theta \leq +90^\circ\) that is the angular response:

\[
R(\theta) = \mathbf{w}^H(n)\mathbf{s}(\theta)
\]

(1)

Where \( \mathbf{s}(\theta) \) is the N-by-1 steering vector. The steering vector on \( \theta \) is defined as:

\[
\mathbf{s}(\theta) = \left[1, e^{-j\theta}, e^{-2j\theta}, \ldots, e^{-(N-1)j\theta}\right]^T
\]

(2)

Assuming the actual angle of incidence of a plane wave, measured with consideration to the normal and to the linear array,

\[
\theta = \frac{2\pi d}{\lambda} \sin \phi, \quad -\frac{\lambda}{2} \leq \theta \leq \frac{\pi}{2}
\]

(3)

Where \( d \) is the array configuration between sensors and \( \lambda \) is the wavelength of the incident wave. The array factor used does not depend on the nature of antenna used for N-element linear arrays. The smart antenna system as shown in figure 1, tries to shape and locate the beam of the radiating antenna element and the desired user or the target through the upper signal separated. With the combination of beamformer and digital signal processor (used to identify spatial signal), the users 1 to 3 can clearly receive their desired signals without any interference [14]. Smart antennas incorporate various elements of an antenna array together with the signal processing efficiency with a view to increase its radiation beam pattern dynamically in feedback to the signal environment [7]. One of the fundamental elements of smart antenna is the waveguide-fed pyramidal horn antenna, as it has a wide gain.

Due to its good electrical distinctive, the horn can be used as feed for antenna reflectors [15]. As a result of these peculiar features of waveguide-fed pyramidal horn antenna, this technique is used in this work.

The organization of the paper is as follows. The brief description of physical antenna waveguide-fed pyramidal horn antenna array for smart has been described in section II. In section III, the physical antenna has been designed using the estimated parameters. Section IV describes the estimated performance of the modelled antenna at various frequencies. Finally, the section V concludes the work and recommends the future works.

2. DESCRIPTION OF THE PROPOSED ANTENNA

The smart antenna systems consist of four assemblages: the physical antenna, radio unit, beamforming, and the signal processor. These are shown in Figure 2. The physical antenna consists of the array of antenna system. Smart antenna is a combination of multiple antenna arrays spatial signal processing algorithms used to analyze the spatial signal parameters like direction of arrival of signal; adopt it to estimate beamforming vectors track and spot antenna beam on the target [16]. One of the smart antenna arrays chosen for this work is waveguide-fed pyramidal horn antenna.
Wave-guide pyramidal horn antenna is a microwave horn antenna that has a flickering metal waveguide configured to optimize radio waves in a beam. The horn antenna is designed to transmit radio waves from a waveguide and feed it into space. Mostly, it consists of short length of the waveguide, closed at one end, flaring into an open-ended pyramidal shaped horn on the other end [17]. The waves then radiate out the horn end in a narrow beam. Wave-guide pyramidal horn antenna was chosen as our physical antenna for this work because its popularity at UHF (300 MHz – 3 GHz) and higher frequencies it is somewhat intuitive and relatively simple to manufacture. Some horn antennas do operate as high as 140 GHz. For the design of antenna, some of the factors to be considered are frequency to be used either ISM and other bands, one-way or two-way systems, modulation, range, power supply, cost, protocols, and antenna. This type of Antennas have a controlled radiation pattern with a high gain, which can range up to 25 dB [18]. Horn antennas have a wide impedance bandwidth since there is no resonant elements, implying that the input impedance is slowly varying over a wide frequency range.

The bandwidth for practical horn antennas can be on the order of 20:1. Some of the antenna’s properties such as type, size, shape, and direction can have a considerable influence on the design and performance of a system. Since form factor can be an extensively driving in any ISM application, antenna characteristics may determine what frequency range is chosen and basically, which radio is available. Antennas take many patterns, from simple \( \frac{1}{4}\lambda \) monopoles and \( \frac{1}{2}\lambda \) dipoles, to loop, F, and others. They can also be classified as E-field or H-field, depending on which arrangement of current classic they employ. The first step in choosing an antenna is to take the largest dimensional length allowed within limits of the application and peradventure to use a trace or a physically connected antenna. During the design, we observed that the gain of horn antennas often increases as the frequency of operation is increased. Hence, the gain is directly proportional to the frequency. This is because the size of the horn aperture is always measured in wavelengths \( (0.5\lambda); \) as the operation frequency is increasing, the horn antenna is “electrically larger”; this is because at higher frequency the wavelength of antennas are small. Since the horn antenna has a fixed physical size, the aperture is has additional wavelengths across at higher frequencies. In antenna design, larger antennas are referred to as antenna with large wavelength. If any antenna with large wavelength, such antenna will have higher directivities. The directivity of a horn antenna is approximately equal to its gain because it has little loss [19].

Horn antennas are generally fed by a portion of a waveguide as shown in Fig. 3. The waveguides are used to guide the electromagnetic energy from one place to another.

### 3. DESIGN OF THE PHYSICAL ANTENNA

Radio frequency coverage from any base station is determined by three factors (a) the height of the antenna, (b) the type of antenna used, (c) and the radio frequency power level emitted. The type of antenna is crucial to an antenna designers. The type of antenna chosen for this work is smart antenna using a waveguide-fed pyramidal horn antenna as its physical antenna. The frequency of operation of the designed antenna is 300 MHz. The modelled antenna synthesizes a linear array that has a broadside null that mitigates interfering signals and having a specified directivity on both sides of the null and excitation taper. With the specification of the excitation paper for the ultra-wideband and tightly coupled antenna arrays [20], this allows the sidelobes of the antenna to be controlled. The array was designed with the arrangement of the parameters through any of the three capital axes in conjunction with the producing pattern. The resulting beam pattern is being rotated in symmetric manner around the axis being chosen while the null which in the plane is being held normal to the axis of the plane.
The optimum designed inter-element spacing in the array is 0.5λ. Fig. 4 shows the proposed modelled antenna design’s side view and end view.

\[ a_E = \sqrt{2\lambda L_E} \quad \text{and} \quad a_H = \sqrt{3\lambda L_H} \]  
\[ (4) \]

Where \( a_E \) and \( a_H \) are the aperture width in the direction of E-field and H-field respectively, and \( L_E \) and \( L_H \) are the slant length side in the E-field and H-field direction respectively. \( \lambda \) is the wavelength of operation. The distribution of the E-field across the horn antenna aperture takes the responsibility for the radiation.

4. DESIGN PARAMETERS

\( W_g \) is width of waveguide section (23.53 mm), \( H_g \) is height of the waveguide section (11.77 mm), \( L_g \) is length of waveguide section (44.97 mm), \( W_a \) is aperture width (69.24 mm), \( H_a \) is aperture height (50.71 mm), \( L_f \) is Length of flare section (26.66 mm).

The selected frequency of operation is 300 MHz. To obtain maximum gain and minimum reflection, the flare angle between \( 0^0 \) and \( 90^0 \) must be maintained. The chosen dimensions for the design optimum horn is obtained using the following equation [19].

5. ESTIMATED PERFORMANCE OF THE MODELLED

The designed antenna has simulated in antenna software using the specifications stated in the Section III, and its performances are shown as below. Fig. 7 shows the plot of the far-field radiation effects of the antenna as a transformation of spatial co-ordinates indicated by azimuth and elevation angle (\( \Phi, \Theta \)). The azimuth angle is the compass direction from which the signal is coming. The azimuth angle varies from \( 90^0 \) to \( 270^0 \) as shown in Fig. 7.
The far field pattern specified the angular dependence of the radio waves from the antenna. As shown in Fig. 7, the directional dependence are $0^\circ$, $5^\circ$, $10^\circ$, $15^\circ$, and $30^\circ$.

Fig. 8 shows the frequency of operation at 300 MHz. At this frequency, the beamwidth cannot be calculated for elevation angle of $60^\circ$. The outer ring is $2.57$ dB having a slice maximum gain of $2.13$ dB ref at azimuth angle of $90^\circ$. The front/back (F/B) for the plotted azimuth antenna array at an angle of $260^\circ$ is $0.07$ dB with sidelobe gain of $2.06$ dB.

Fig. 9 shows the array radiation frequency at 100 MHz. The beamwidth cannot be calculated at an elevation angle of $60^\circ$, having an outer ring of $2.57$ dB and slice maximum gain of $0.88$ dB ref at an azimuth angle of $270^\circ$. The front/sidelobe is $0.24$ dB with sidelobe gain of $0.64$ dB ref at azimuth angle of $90^\circ$. Figure 10 shows the frequency radiation pattern at 150 MHz, the beamwidth is $139.5^\circ$, the front/back lobe gain has increased by $2.47$ dB, and the front/sidelobe has also increased by $2.47$ dB the sidelobe gain has decreased to $-1.7$ dB at azimuth angle of $90^\circ$.

Figure 11 shows that the beamwidth at a frequency of 200 MHz is out of range. The sidelobe gain has increased to $0.3$ dB at an angle of $270^\circ$. This means that as the frequency is increasing, the sidelobe will be increasing, while the front/sidelobe will be decreasing.

Figure 12 shows that the beamwidth at a frequency of 250 MHz is out of range. The sidelobe gain has increased to $1.24$ dB at an angle of $270^\circ$. 
This means that as the frequency is increasing, the sidelobe will be increasing, while the front/sidelobe will be decreasing. In conclusion, as the frequency is increasing there is an improvement in gain.

Fig. 13. The polar plane cut axes (a) XY-Plane cut, (b) XZ-Plane cut, and (c) YZ-Plane cut at 300 MHz

Fig. 14. The cartesian plane cut axes of the antenna at 300 MHz

From figure 13, the XY-plane cut at an angle of 187.5° at 15 dBi and at an angle of 62.5°, 112.5°, 240°, and 290° the gain is -34 dBi. In the XZ-plane cut, the highest 15 dBi gain occurs at -87.5° and 87.5° respectively. The lowest gain at -40 dBi occurs at -175° and 175° respectively. The ZY-plane cut gives its lowest gain of -40 dBi at -175°, -5°, 0°, 5°, and 175°. At -112.5°, -70°, 112.5°, and 70° the gain is 0 dBi which is the highest gain for the frequency. Figure 14 shows the Cartesian plane cut axes of the antenna at 300 MHz.

\[ E(\phi) = 2E_0 \cos \left( \frac{\alpha}{2} - \frac{\pi d \sin \phi}{\lambda} \right) \]  

(5)

Equation 5 characterizes the array pattern in the xy-plane, in which the angle \( \theta \) of a three-dimensional coordinate system is constant (\( \theta = \pi / 2 \)). Angle \( \theta \) is constant, that is why it doesn’t come out in equation 4. Three-dimensional pattern can obtained by revolving the xy-pattern about the y-axis, that is the line of the array.
This can be made possible since the xy-pattern is identical in shape and size at any value of rotation in the yz-plane. The pattern in the yz-plane can be expressed as a function of the angle $\theta$ instead of the angle $\theta_1$. Using the other planes, all the angles are included. The expression for the complete three-dimensional pattern is given by [17],

$$E(\theta, \phi) = 2E_0 \cos \left( \frac{\pi d \sin \theta \sin \phi}{\lambda} \right)$$ (6)

Using the waveguide-fed pyramidal horn antenna designed in this work as one of the several antenna elements, the signal received from this antenna and the other antennas will be combined [21]. The combination will be processed adaptively in order to exploit the spatial domain of the mobile radio channel. Signals from the individual elements are down-converted and A/D-converted in the radio unit to baseband signals. Then after digitization of signals at the radio unit, it will be fed into a digital signal processing (DSP) where the direction of arrival of signals calculation algorithm will be carried out. Smart antennas itself are not smart. The system that combines the array of antenna with a digital signal processing capability to transmit and receive signals dynamically, change the direction of its radiation pattern and then optimize it automatically in response to the signal [6]. This system is called a smart antenna system. The system depends on the capability of a good antenna elements being received from the arrays of the antenna for the transmission of signal. When the antenna arrays configurations are used correctly, it increases range coverage and reduces multipath fading [7]. The basic block diagram of the conceived smart antenna system is shown in Figure 2. The antenna array is the physical antenna designed in section III.

The formation of the radiation beam pattern towards the desired user and nulling out interfering signals depends on the premises of direction of arrival of desired signal and interfering signals are known to the smart antenna system [22]. Smart antenna system estimates the direction of arrival (DOA) of the signal using various finding algorithms techniques [23]. Some of the techniques used are multiple signal classification (MUSIC), Eigen structure methods, estimation of signal parameters via rotational invariance techniques (ESPIRIT).

Direction of arrival and beamforming are the two main task need to be met by smart antenna system along with main function of propagation and reception of radio signals. Beamforming is technique used to establish the radiation beam pattern of the antenna arrays [24, 25].

6. CONCLUSION AND FUTURE RECOMMENDATION

This work examines how a smart antenna with its physical antenna can be used for data transmission at various frequencies of operation, the beam radiation pattern at various levels of frequencies and adaptive beamformed for smart antenna at their respective frequencies of operation. As most of the current research is on high data transmission [26-30], smart antenna can be as one of the chosen antennas for transmission and reception of signals due to its ability to mitigate interference and multipath signals at higher frequencies with the aid of antenna arrays. The future work recommends that array of antenna should be a half-wavelength dipole antenna. The dipole antenna exhibits an exceptional radiation pattern. In free space, the radiation pattern of a dipole antenna is highly active at right angles to the wire.

REFERENCES


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