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Dr. Longe Olumide PhD
Department of Computer Science
University of Ibadan, Ibadan, Nigeria
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. 1, March, 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
March, 2015
End-User Satisfaction Assessment Approach for efficient Networks Performance Monitoring in Wireless Communication Systems

Joseph Isabona
Department of Basic Sciences
Benson Idahosa University
Benin City, Edo State, Nigeria
Email: jisabone@biu.edu.ng
Mobile: +234-703-918-1006

Moses Ekpenyong.
Department of Computer Science
University of Uyo
Uyo, Akwa Ibom State, Nigeria
E-mail: mosesekpenyong@{uniuyo.edu.ng,gmail.com}
Mobile: +234-708-003-9681

ABSTRACT

GSM network performance and service quality evaluation are the most important steps for the mobile operators as the revenue and customer satisfaction is directly related to network performance and quality. Network service satisfaction assessment especially from the end user perspective is necessary to judge the network performance and maintain service quality standards. In this paper, we appraise the service quality being rendered by mobile telephone operators in Nigeria from the end user satisfaction perspective, using four core GSM networks as case studies. Two key performance measures which are Quality of Service (QoS) and Grade of Service (GoS) and their impact on the end user satisfaction in the studied networks were analysed and discussed. In all, results show a fair network performance and end user satisfaction rate.

Keywords: Quality of service, Grade of service, end user satisfaction rate.

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I. INTRODUCTION

Mobile telephony has become one of the fastest growing and most demanding telecommunications applications. Currently, the Global System for Mobile communications (GSM) technology cellular mobile phone is one of the fast growing and most demanding telecommunication application. Today, it represents a continuous increasing percentage of all new telephone subscription around the world. In Nigeria, it has assumed a dominant position in the telecommunications market and become the main driver of growth in the country. To maintain the above growth and retain existing customers, as well as attracting new ones, the wireless service providers need to deliver its’ services, consistently, reliably and economically. More importantly, mobile telephony service providers must be ready to continue to maintain the highest quality of service (QoS) to both residential and industrial subscribers. In fact, new services for mobile phones, like email, web browsing, audio and video streaming demands a lot from the underlying network.

If the telephone mobile operators do not deliver what these services demand, the performance and the user satisfaction will be unsatisfactory. Therefore, once a radio telephone network is designed and operational, its performance should be monitored. That is where network performance monitoring for QoS assessment, analysis of faults and corrective actions comes in. In addition to monitoring network faults, the operator also needs immediate information on how the network performs, especially from the end user perspective. The end user network performance report can be used as source of information for corrective actions or for evaluating the utilization of resources. When the utilization of the network resources is evaluated, both the overall performance of the network system and the performance of individual network elements can be handled. This in turn enables the mobile telephone operators to optimize traffic and investigate critical areas where the network performance could require adequate changes.
1.1 Research Motivation and Focus
In recent times, it has been observed that not all the telecom operators are giving due attention to the quality of service (QoS) in Nigeria. Quality of the mobile telephone networks instead of being improved has been following a deteriorating trend. With the increase of the subscriber base, the customers' complaints has also been increased. Frequent call drop, poor network coverage and unsatisfactory customer care support are the common issues faced by the subscribers. As a result, customers' dissatisfaction is increasing and complaints against the network are also increasing. In some cases, operators are implementing new features in their networks without performing proper pre-trial which is also a reason for poor QoS.

In this paper, our primary focus is to appraise the service quality being rendered by mobile telephone operators in Nigeria from the end user satisfaction perspective, using four core GSM network operators as case studies. The intention is to investigate the how Quality of Service (QoS) and Grade of Service (GoS) provided by the GSM network operators' impact the end user satisfaction. Particularly, we intend to quantitatively assess the end users' satisfaction rate from the general network performances of the studied GSM telephone operators.

As a result of the primary purpose presented above, the following research questions arise:

- Does seasonal variation have an effect on end user satisfaction rate and performance of wireless mobile networks?
- Is there a link between end satisfaction rate and the general network performance?

Our research methodology presented below seek out to answer the above highlighted research questions.

2. METHODOLOGY

It is clear from our introduction that network monitoring offers the ability to quantitatively assess, predict and ensure the end-to-end performance of a wireless communication network, however, it can only be achieved if stringent methodology is applied. Three actors are involved in network performance monitoring for satisfaction assessment. These are:

- Regulators: A key role of the telecommunication regulators is to assess and control the QoS delivered by network licensees. That is, it ensures compliance by network operators through the specifications of their license conditions including the service quality. Regulators evaluate the QoS of the networks through a set of parameters (called Key Performance Indicators – KPIs) the objective of which is to reflect the quality of experience perceived by a user of the network service. This evaluation requires the testing of QoS KPIs through analysis of the capabilities of the network. Test data is collected using appropriate tools and procedures in a controlled environment.
- Operators: monitor and optimize their networks in order to meet these specifications. They satisfy their subscribers and maximize returns on their investments.
- End Users: constitute the third party exploring various ways to objectively evaluate the quality of service (QoS) provided by network operators [1].

In this paper, the focus is on end users’ satisfaction assessment. Firstly, we start by discussing the two basic performance measures in wireless mobile networks, which are quality of service (QoS) and grade of service (GoS). Secondly, our source of data used for this piece is presented; this is followed by identifying the QoS/GoS based KPIs and derivation of some formulas that will enable us to quantitatively assessed the end user satisfaction rate in a typical GSM network.

In this paper, we employ a data mining process which is a part of knowledge delivery in database (KDD) to acquire QoS KPIs data and systematically analyze the data to assess GSM network performance and end user satisfaction. Data mining is the science and technology of exploring data in order to discover previously unknown patterns [2]. The objective of data mining is to identify valid novel, potentially useful, and understandable correlations and patterns in existing data [3]. Data mining is also refers to as the nontrivial technique of extracting implicit and potentially useful information from existing data sets.

Thus, the data set we explore in this research was obtained from the Nigeria Communication Commission (NCC) QoS KPI database (ncc.gov.ng). A total of eight months data within the periods of February to September, 2013 were obtained, showing a reasonably detailed research operation. The NCC database contains performance statistics of service quality KPI data of various mobile network operators (i.e. GSM and CDMA operators) in Nigeria. We preferred using the NCC data base to give a fair comparison of the QoS provided by the mobile network operators. It also provided us with the opportunity to use raw and more authentic data. For confidential and legal purposes, the names of the four network operators will be designated as Operator A, B, C and D respectively throughout the paper.

2.1 QoS and GoS Network Performance Measures

In telecommunication engineering, and in particular teletraffic engineering, the quality of voice service is specified by two measures [4]: the Grade of Service (GoS) and the Quality of Service (QoS). Once the network is operational, continuous monitoring of the QoS and GoS are required.
• **Quality of Service (QoS):** In design of any system, QoS is one of the important concerns from both customers and providers point of view. That means customers expect the service of best quality from the system providers and providers want to give best quality of service to the customers from the system. All the parameters related to QoS are having different importance for all customers and applications. Therefore, QoS encompass one of the most important aspects that should be monitored in a GSM network. It is a measurable set of parameters that define the level of service that a service provider can be accountable. The QoS goals have to be shared throughout the service provider business to make sure that everyone has a clear understanding of the objectives and strategy in order to achieve the desired QoS level.

In the ITU-T Recommendation E.800, QoS is defined as the collective effect of service performance, which determines the degree of satisfaction of a user of the service. In this paper, we define QoS as the capability of the cellular network providers to provide a satisfactory service to end users which includes good transmission quality, signal strength, low call blocking and dropping probability, high data rates for multimedia and data applications etc. That is, QoS is the quality provided to the customers which describes ability of the network with an assured service level. By quality here, we mean the totality of characteristics of an entity that bear on its ability to satisfy stated and implied end users’ needs. Fundamental performance areas of QoS include:

- Availability: Is the service available in an area?
- Accessibility: Within an area, is the service available to all who request it?
- Retainability: Is the service retained throughout the requested period?
- Reliability: Does the service work at a consistent level?
- Performance: How well do services perform?

Accordingly, for QoS to be truly useful and practical enough, it must be meaningful from following four viewpoints as highlighted if figure 1.

---

**Figure 1: Four meaningful four viewpoints of QoS as defined by ITU**

• **Grade of Service (GoS):** In well-established wireless communication systems, GoS is measured as the instances when there is unacceptable quality of service and/or there are no resources available to serve a call. The GoS is defined in several ways. In [6], [7], and [8], GOS is defined as the number of unsuccessful calls relative to the total number of attempted calls. In ITU-T Recommendation E.800 [5], GoS is defined by a number of traffic engineering variables to provide a measure of adequacy of a group of resources under specified conditions. The aggregate calls including call attempts offered or carried by some defined parts of a network, such as a group of circuits or switches with account being taken of both the number of calls and their duration is referred to as traffic [9][10]. The concept of traffic offered, traffic carried, and traffic lost is illustrated in Figure 2.

In traffic engineering, any occupancy of a circuit or device caused directly or indirectly by a subscriber (i.e., end user) making or attempting to make use of the system is regarded as a call. Farr, (1998) [11] described GoS as that proportion of calls that are lost due to congestion in the busy hour. It is the percentage of incoming calls denied or turned away during the busy hour owing to lack of resources. It is typically given as the likelihood that a call is blocked or the likelihood of a call experiencing a delay greater than a certain queuing time. GoS is determined by the available number of channels quality and used to estimate the total number of users that a network can support. It is also a measure of the call blocking in voice traffic or the throughput in data traffic, where resources allocation is deterministic (allocation and switching of channels). The smaller the value of GoS, the better is the service. A GoS of 2% means that two calls in one thousand calls or one call in every five hundred calls may be lost.
A higher grade of service guarantee to the customer means ensuring low blocking probability during the busy hours. The task of teletraffic theory is to specify methods to ensure that the actual GOS is fulfilling the requirements. Thus, GoS can be referred as the mechanism for controlling the performance, reliability and usability of a telecommunications service.

KPIs are divided into two important service categories [5]:

- **End-to-end metrics** (or end-user metrics): these provide an evaluation of the network performance as it is perceived by the network end-user. That is, the metrics enable both the network operators and regulators as well as the end users themselves to monitor the performance of delivered service to individual users as well as determining the overall service delivery quality averaged over all users.

- **Network metrics**: these concern the network administrator and monitor the behaviour of the system during the service.

The former provide a direct means to evaluate the grade of satisfaction of the network user. The latter do not straight provide an indication of the QoS provided by the network, but can indirectly affect the end-user metrics. On the other hand, they allow the operator to keep under control the network resources allocation and, thus, to fully exploit them.

A wide range of KPIs are available in literature for GSM radio network benchmarking to achieve remarkable QoS.

The most essential KPIs include [21]:
- a. Call Success Setup Ratio (CSSR)
- b. Call Drop Ratio (CDR), and
- d. Standalone Dedicated Control Channel (SDCCH)
- e. Handover Success Rate (HOSR).

These KPIs can be worked out in different ways depending on the network vendor and the operator. For concision of purpose in this paper, we are focusing on CSSR and CDR to evaluate end user satisfaction rate in the GSM networks.

### 2.2 Key Performance Indicators

The most robust approach to measure QoS and GoS in any operational network is to define a certain set of Key Performance Indicators (KPIs) and monitor them over the time (Isabona and Peter, 2014). KPIs are a minimum set of metrics for tracking system progress towards a performance target. KPIs provide a quantitative and objective solution to compare the obtained quality performance with the desired ones and are used for both traffic classification and network analysis. Quality can be evaluated from the point of view of the end-user, as perceived quality which refers to the experience in the use of a service, or from the point of view of the operators, as offered quality which refers to the policies of service provisioning, the sustained costs and the capacity to maintain service availability. It can be also intrinsic if refers to technical network performance parameters, such as delay, jitter, packet loss, and throughput. It can be specified either quantitatively or qualitatively.

Once a KPI will exceed predefined threshold, then a certain action should be performed in the network in order to bring this KPI back to normal behavior. This process very often called “Optimization”.

Figure 2: Traffic offered, Traffic carried and Traffic lost [9]
are successful while the remaining 30 are unsuccessful. CSSR is defined as the ratio of established (successfully completed) calls to call attempts, expressed as a percentage:

\[
\text{CSSR} = \frac{\text{successfully completed call attempts}}{\text{call attempts}} \times 100 \quad \text{(1)}
\]

In call setup, established calls mean the following events have happened:

(i) Attempt is made
(ii) The traffic channel (TCH) is allocated and
(iii) The call is routed to the outwards path of the concern MSC.

CSSR is related to blocking probability by [14]:

\[
\text{CSSR} (1 - \text{blocking probability}) \times 100\% \quad \text{(2)}
\]

Rearranging equation (2) gives

\[
\text{Blocking probability} = \left(1 - \frac{\text{CSSR}}{100\%}\right) \quad \text{(3)}
\]

The higher the value of CSSR, the easier it is to set up a call. Thus, CSSR is one of the key performance indicators (KPI) used by the network operators to assess the performance of networks and have direct influence on the customer satisfaction with the service provided by the network and its operator. For instance, a CSSR of 70% means that out of every 100 call attempts, only 70 are successful while the remaining 30 are unsuccessful. CSSR is defined as the ratio of established (successfully completed) calls to attempts:

\[
\text{CSSR} = \frac{\text{successfully completed call setups}}{\text{call setup attempts}} \times 100 \quad \text{……….(1)}
\]

Established calls means the following events have happened in call setup:

• Circuit switched (high-speed circuit switched data)
• Packet switched (GPRS)

Circuit switching provides the customer with a dedicated channel all the way to the destination.

For circuit switch services in GSM, blocking probability can be successively used as a performance measure for the evaluation of GoS. Thus, expression in equation (3) can be rewritten as:

\[
\text{GoS (blocking probability)} = \left(1 - \frac{\text{CSSR}}{100\%}\right) \quad \text{(4)}
\]

The customer has exclusive use of the circuit for the duration of the call, and is charged for the duration of the call.
The GoS for circuit switch services is very well represented by the blocking probability as indicated in the expression in equation (4) in GSM. However, for the packet switch services, blocking is not the performance measure: indicators such as throughput and delay are more representative of users’ satisfaction. Here, the GoS for packet switch services is expressed in terms of throughput which represents the long-run throughput per service. The throughput is derived by considering the long-run rate at which the user enters the air interface and the data rate per user by employing the following formula [15]:

\[
\text{Throughput} = \frac{R}{\lambda(1 - \text{blocking probability})}
\]

where

\( \lambda \) is the arrival request rate of service and R, the data rate of service blocking probability.

With packet switching, the operator assigns one or more dedicated channels specifically for shared use. These channels are up and running 24 hours a day, and when you need to transfer data, you access a channel and transmit your data. The standard data rate of a GSM channel is 22.8 kbps.

2.2.2 Call Drop Rate (CDR)

The term “dropped call” is commonly used to describe a wireless mobile phone call that is terminated by the network unexpectedly as a result of technical reasons, including entry into a dead zone. Some of the reasons advocated for dropped calls occurring include: (i) moving out of range of a wireless network, an active call cannot usually be maintained across a different company's network, resulting in the termination of the call once a signal cannot be maintained between the phone and the original network. ii) Handoff is another reason - this happens when calls are dropped between cells within the same provider’s network. If the new cell site is at capacity, it cannot accept an attempt by the network to "hand in." any additional call. It may also be due to the way the network has been configured. Network ability to retain call conversation when it has been established or set up is measured by Call Drop Rate (CDR) indicator. A value of 5% of CDR means that, out of every 100 calls established or set up, 5 will drop before any of the calling parties voluntarily terminate the set up call. The indicator is calculated using the expression:

\[
\text{CDR} = \frac{\text{No of dropped call}}{\text{Total No of call attempts}} = (1 - \text{Call complete probability}) \times 100\%
\]

3. RESULTS AND ANALYSIS

The merit of figures we will consider in the results and analysis cover the different phases of GoS aspects during service use from the customer's point of view. They are here defined:

- Network Performance (NP): It is defined as the ability of a network portion to provide the functions related to communication between users

Technically, NP is related to GoS by [12], [16]:

\[
\text{Network Performance, NP} = \frac{1}{\text{GoS}}
\]

Therefore, from the user’s point of view, in order to improve the performance of a network, the value of GoS should be minimised, while from the network service provider’s point of view, the objective is to decrease the cost of the network by increasing the utilisation of the total available channels.

-Satisfaction rate (SatR): it summarize the degree of voice user satisfaction, by considering altogether Service Access, Service Retainability and Service Integrity. A call is considered satisfied if it isn’t blocked, nor dropped, nor it didn't feel outage [17]:

\[
\text{SatR} = (\text{CSSR} \times (1 - \text{DCR + OutR}))
\]

where OutR describes the ratio between the number of calls which, although normally released, perceived an unacceptable outage time lasting more than 5% of the duration of the call, and the overall number of call releases (that is both the normal and the abnormal releases)

Considering outage calls being equivalently taken as drop calls as in [18]), then drop call rate can used as outage rate. Therefore, the expression in equation (8) can be rewritten as

\[
\text{SAT R} = \text{CSSR} \times (1 - \text{DCR + DCR}) = \text{CSSR} \times (1 - \text{DCR})
\]

Here, we start by examining the CSSR quality of the studied GSM networks over the assessment period as shown in table 1 and figure 4.
According to Nigeria Communication Commission (NCC) as contained in Federal Republic of Nigeria Official Gazette, (2012) [19], a well-performing network should have a CSSR of or above 98% benchmark. That is, the target is to achieve at more than 98% of connection on the first attempt. Using this standard value and referring to the graphical representation in Figures 2, it can be seen that none on the operators excepting operator D in the months of march to September met up to the 98% CSSR standard within the evaluation period. A fall in the CSSR below the 98% benchmark could be as a result of an increased demand for establishment resources whiles resources were fixed and limited, i.e., blocking increases proportionally to demand. Approaching high congestion situations and maximum handling of traffic, services” requests begin not to be served, thus decreasing TCH Blocking and Handover Failure rates. This results in an increased TCH success rate because the network runs out of call establishment resources (SDCCH mostly). The real call traffic is reduced (as users terminate calls) and TCHs become available. It is worth noting that in cellular networks, TCHs out numbers SDCCHs in every single Transceiver (TRX) [20].

A significant observation made from the analysis was the possibility of below standard performance recordings for CSSR being caused by other reasons for which measurements were not available. The most common reasons for such failures are the inadequate radio signal propagation conditions (problems in radio channel in the air interface). The failures in radio channel are usually due to bad signal quality, i.e., the transmitted data includes too many bit errors. Also, the radio signal quality is mostly affected by two components. Firstly, the propagation environment causes attenuation to the transmitted radio signal due to path loss, shadow fading and multipath fading. Secondly, the radio signal may be attenuated by the other radio signals originating from other BTSs having a TRX on the same physical frequency (interference).

### Table 1: Call Setup Success Rate (CSSR) quality from the month of February to September

<table>
<thead>
<tr>
<th>CSSR</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
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<th>July</th>
<th>August</th>
<th>September</th>
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<td>96.58</td>
<td>96.43</td>
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<td>97.68</td>
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<td>96.46</td>
</tr>
<tr>
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<td>97.73</td>
<td>94.6</td>
<td>96.57</td>
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<td>96.67</td>
<td>96.49</td>
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<td>98.79</td>
<td>99.01</td>
<td>98.5</td>
<td>99.14</td>
<td>98.84</td>
<td>98.75</td>
</tr>
</tbody>
</table>

**Figure 4: Call Setup Success Rate (CSSR) quality from the month of February to September**
Figure 5: Call drop Rate (CDR) quality from the month of February to September

Shown in figure 5 is a bar chart displaying CDR quality within assessment period. It can be observed from the chart that all the operators met CDR QoS 2% standard target as in contained in Federal Republic of Nigeria Official Gazette of 2012.

Figure 6: GoS quality for the network operators in each month.

As earlier pointed out, GoS is the traffic related part of network performance (NP), characterizing the ability of a network or network portion to provide the functions related to communications between users. The smaller the value of GoS, the better is the service. In any well established network, a GoS of 2% is the acceptable performance benchmark (i.e., GoS acceptable = 0.02 or 2%). Shown in figure 6 is a bar chart displaying the Grade of Service (GOS) level attained in each month. It is observed from the chart that only operator C met this standard 2% target. This means that congestion by the users in this network is low. Other operators fail to meet this target and this could imply that congestion by the users in the networks is high.
Therefore, there is high number of subscribers experiencing block calls in operator A, B and C. It can be said also that difficulty by which the user seizes a traffic channel to set up a call after a signalling seizure is high. An important aspect of a statistical procedure that drives a representation from empirical data is to fit in a regression model in order to predict more results. Thus, to investigate each of the GSM network’s performance trend within the assessment period, a regression line was fitted into GoS-based network performance data. The results as shown in figures 7 to 10 deplete an improvement trends for only operators A and D within the evaluation period.

![Figure 7: Network performance level for operator A](image)

![Figure 8: Network performance level for operator B](image)
The service quality levels exhibited by the studied GSM networks shows that inadequate provisioning or poor management of radiofrequency spectrum resources can have adverse effects on the performance of any operational mobile network. Typically, the greater density of cell sites a network has, the greater its capacity to manage the varying loads experienced by the network. During peak demand, having an adequate density of cell sites gives the network greater flexibility to either accommodate the traffic or distribute the load with an available adjoining cell. In addition to the density of cell sites, provisioning each cell with the appropriate spectrum capacity is an important aspect of network management. It’s important to note that while carriers can gain access to spectrum to deploy their mobile networks, the amount of spectrum available is finite and must be shared among the carrier’s end-users.
To further investigate how satisfied the subscribers are with regards to QoS being provided in each of the studied GSM networks, a graph of end user satisfaction rate was plotted against the assessment period. Again, from the graphs only operator A and D shows a better end user satisfaction rate as compared to operators B and C. see table 3 for the results. Also trend lines were fitted in the graphs to enable us predict novel empirical results.
Figure 13: End user satisfaction rate for operator C

Figure 14: End user satisfaction rate for operator D

Table 2: Network Performance Level (%) in each month

<table>
<thead>
<tr>
<th>NP</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>27.70</td>
<td>28.16</td>
<td>29.23</td>
<td>28.01</td>
<td>34.72</td>
<td>31.84</td>
<td>30.03</td>
<td>44.24</td>
</tr>
<tr>
<td>B</td>
<td>24.93</td>
<td>44.05</td>
<td>41.15</td>
<td>37.59</td>
<td>29.94</td>
<td>43.10</td>
<td>30.86</td>
<td>28.24</td>
</tr>
<tr>
<td>C</td>
<td>28.24</td>
<td>44.05</td>
<td>18.51</td>
<td>29.15</td>
<td>31.54</td>
<td>29.85</td>
<td>30.03</td>
<td>28.49</td>
</tr>
<tr>
<td>D</td>
<td>20.87</td>
<td>78.12</td>
<td>82.64</td>
<td>101.01</td>
<td>66.66</td>
<td>116.27</td>
<td>86.20</td>
<td>80.00</td>
</tr>
</tbody>
</table>
Table 3: End-user Satisfaction rate (%) in each month

<table>
<thead>
<tr>
<th>SATR</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93.76</td>
<td>93.47</td>
<td>93.74</td>
<td>93.34</td>
<td>94.51</td>
<td>93.99</td>
<td>94.11</td>
<td>95.25</td>
</tr>
<tr>
<td>B</td>
<td>94.33</td>
<td>96.22</td>
<td>95.95</td>
<td>95.72</td>
<td>95.03</td>
<td>95.82</td>
<td>95.32</td>
<td>94.99</td>
</tr>
<tr>
<td>C</td>
<td>93.97</td>
<td>94.23</td>
<td>91.25</td>
<td>93.19</td>
<td>93.59</td>
<td>93.44</td>
<td>94.02</td>
<td>93.63</td>
</tr>
<tr>
<td>D</td>
<td>93.76</td>
<td>96.25</td>
<td>96.65</td>
<td>97.34</td>
<td>97.35</td>
<td>97.25</td>
<td>97.79</td>
<td>97.26</td>
</tr>
</tbody>
</table>

Figures 15 to 18 are plotted to examine the correlation between the GSM network performance and end user satisfaction rate. From the figures, we observed that the end user satisfaction rate increases as the network performances improves. This implies that the QoSs provided by the network operators are directly proportional to the end user satisfaction. Therefore, we can conclude here that a network can be rated as performing when end-users satisfaction rate is high. This is, a network is said to be performing when the end users are able to access its applications and carry out given task without undue perceived irritation.

![Figure 15: A comparative investigation of NP and SATR correlation for Operator A](image-url)
Figure 16: A comparative investigation of NP and SATR correlation for Operator B

Figure 17: A comparative investigation of NP and SATR correlation for Operator C
Figure 18: A comparative investigation of NP and SATR correlation for Operator D

4. CONCLUSION

In any deployed mobile telephone networks, the end users’ satisfaction is always a major concern for the operators and regulators. Therefore, there is need for the networks’ subscribers to continue to monitor its services because it enables the operators to optimize traffic and investigate critical areas where the network performance could require adequate changes. With end-user analysis report, telecom service providers can refine their systems to run at the maximum efficiency to handle customer demands. Also, a continuous monitoring of network utilization, performance, and ceaseless curiosity about what useful information the network can yield and dynamic performance analysis infrastructures are a must for operators to improve network quality.

In this paper, we evaluated the service quality being rendered by four mobile telephone operators in Nigeria from the end user satisfaction perspective, using GSM networks as case studies. On the average, results show a fair network performance and end user satisfaction rate. Also from our results, we observed a fluctuating end user satisfaction rate in the whole period under assessment, showing that seasonal variation may not have influence the general performances of the studied GSM networks.

All in all, operators need to step up their efforts as end users continue to demand better services and as they continue to understand and demand their rights as consumers.

REFERENCES


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**Author’s Brief**

**Dr. Joseph Isabona** is a Senior lecturer in the department of Basic Sciences (Physics Unit), Benson Idahosa University, Benin City, Nigeria. He received Ph.D and M.Sc. degrees in Physics Electronics, 2013 and 2007 from the University of Benin and Uyo respectively, and a B.Sc in Physics in 2003, from Ambrose Alli University, Ekpoma, Edo State. He is a member of the Nigerian Association of Mathematical Physics (NAMP) and Nigeria Institute of Physics. He has published both nationally and internationally in the area of wireless communications. His area of interest is signal processing and radio resource management in wireless networks. My mails are: jisabona@biu.edu.ng, josabone@yahoo.com

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**Dr. Moses Ekpenyong** is a Senior Lecturer at the Department of Computer Science, University of Uyo, Nigeria. He obtained a Bachelor of Science degree in Computer Science/Statistics from The University of Uyo, Nigeria, in 1995; a Master of Science degree in Computer Science from The Abubakar Tafawa Balewa University, Bauchi, Nigeria, in 2004; and a Ph.D. degree in Speech Technology from The University of Uyo (in supervision collaboration with The Centre for Speech Technology Research, University of Edinburgh, Scotland), in 2013. He has enjoyed fruitful research collaborations with colleagues within and outside Nigeria and has published widely in his area of specialty: Intelligent Systems, Speech and Wireless Communications Technologies. He belongs to several professional bodies and can be reached through the following contacts: Mobile: +234 708 003 9681, E-mail: mosesekpenyong@uniuyo.edu.ng, gmail.com
The Impacts Of Information Culture on E-Learning Innovation Adoption In Learning Institutions In Nigeria

Osubor, V. O. & Chiemeke, S. C.
Department of Computer Science
University of Benin
Benin City, Nigeria.
schiemeke@yahoo.com

ABSTRACT

This study examines the impacts of information culture (individual, institutions, technological and national) on e-learning innovations adoption in Nigeria learning institutions within the context of Technological Acceptance Models (UTUAT and Delone and McLean IS model). The model’s explanatory power differs across institutions due to the level of acceptance or usage behavior of the learning stakeholders. Data are collected from ten (10) universities in six geo-political zones in Nigeria using special criteria such as availability of ICT centers, dynamic web portals for course work management, e-payment, e-admission and e-result processing. The purpose of this study is to examine individual, institutions and national information cultural practices influences on TAMs determinants towards the adoption of e-learning innovations in teaching-learning activities. Further, this study also examines critical core cultural indices and TAMs determinants that influence most learning stakeholders’ intention. This study is analyzed with reliability analysis, correlation analysis and Standardized Regression Weight (using Structural Equation Modeling). The authors’ findings contribute to understanding the effects of cultural contexts in influencing technology acceptance behaviors, and demonstrate the need for research into additional cultural factors that account for technology acceptance.

Keywords: Cross-Cultural Technology Acceptance, Perceived Usefulness , core determinant, Social Influence,TAM2.

I. INTRODUCTION

Several researchers (Ali, 2004; Couts and Tucker, 2012; Nwabufo et al, 2012) had identified several problems, issues and challenges in the implementation of e-learning in developing nations. These include lack of awareness amongst population, low adoption rate, bandwidth and connectivity limitations, computer illiteracy, lack of quality e-learning content, difficulty in engaging learners online and language barrier. Limitation in bandwidth and connectivity will affect the response time of e-learning system among developing nation institutions. Slow response from the e-learning system will create frustration and boredom among users and leads to low satisfaction (Almutairi and Subramanian, 2005). Other researchers are of the opinion that high cost of bandwidth connectivity, poor electricity, lack of manpower to maintain the technology, poor level of literacy and awareness and the fear of the unknown were the major factors to measure the use of technology and Information system such as e-learning. All these problems and challenges sum up to the poor cultural practices that inhibits the adoption of e-learning innovations and system at the individual, institutions, and national levels. Culture can have an impact on an individual’s decision to adopt and use a specific system (Myers and Tan, 2002). Some cultural aspects such as gender, which is a fundamental aspect of culture, were found to affect the IT adoption process (Gefen and Straub, 1997; Venkatesh and Davis, 2000). Furthermore, TAM by David (1989) was found to hold only in US and Switzerland but not in Japan, implying that TAM may not predict technology use across all cultures in the world (Gefen and Straub, 1997). In other words, this finding is an example of culture that does impact on IT adoption and use. It has now become more imperative to examine the role culture play on the acceptance of e-learning innovations by learning stakeholders.
2. LITERATURE

2.1 cultural implications

Recently, there has been an increase in the amount of cross-cultural research associated with the impact of culture on IT acceptance/adoption especially in Asia and Europe (Kitsiou et al., 2010). In developing countries, it is important to adopt a holistic approach to cultivate a more mature Information Culture in education system so as to increase the adoption level of the technological innovation. This means that to adopt such a holistic approach, it is necessary to build conditions and capacities for interpreting, evaluating and utilizing information resources (Zheng, 2005). Curry and Moore (2003) considered Information Culture as a culture in which the value and utility of information in achieving operational and strategic success is recognized, where ICT is readily exploited as an enabler for effective information systems.

Moreover, Martin et al. (2003) defined Information Culture as a system of shared meanings and knowledge that are enacted through people, processes and technology. Braa et al. (2004) argued that the organizational/institutions and environmental determinants are related to the Information Culture within the context of a given country. Therefore, the organizations which are able to both share information freely and develop cultures of information perform at much higher levels than those that are unable to share information or develop cultures of information. To further this, the development of a locally driven Information Culture is the key to sustainable development (Williamson et al., 2001).

Cultivation of an Information Culture in an institution can create an atmosphere that enables safety professionals to realize the importance of knowledge about and appropriate attitudes towards using ICT in information processing (Yang, 2012). Looking at Information Culture from the perspective of developmental outcomes, one can argue that there are better ways of using information resources than what is currently the case in many parts of the world. This implies that what has been investigated in Information Culture in a certain context of the world may not be applicable to investigating the same area in another context of the world. As previously argued by Braa et al. (2004), that investigating Information Culture in a given country is determined by the environmental and the organizational factors within the context of a given country. Moreover, it was argued by Braa et al. (2004) that analyzing the data at facility level in a given country is an important aspect of creating a ‘culture of information use, which means that it is important to analyze the data at the local level in a given country. This implies that the institutions readiness for ICT must be visible. Choo et al. (2008) regarded Information Culture as those elements of an organization’s culture that influence its management and use of information.

Thus, Information Culture is manifested in the organization’s values, norms and practices that have an impact on how information is perceived, created and used. Values are the deeply held beliefs about the role and contribution of information to the organization as well as the principles that define how information ought to be created and used. Norms are rules or socially accepted standards that define what information behaviors are normal or to be expected in the organization.

Riyaz (2009) argued that the concept of Information Culture is relevant to the ways in which people value, use, handle information and approach. Riyaz (2009) citing Grandier (1999) considered Information Culture as one of the six elements of an information infrastructure model. Riyaz stated that misuse of information, the general lack of spatial awareness shown by many decision makers, the widespread fear of information and knowledge and the general lack of good information management practices were the four forces that work against developing and sustaining an Information Culture. Leidner and Kayworth (2006) stressed the importance of understanding a culture in information technologies in that the culture at various levels including national, organizational and group can influence the successful implementation and use of information technology. Learning institutions need to focus on growing an Information Culture underpinned by a performance management framework that is meaningful to stakeholders and supports them in their daily work (Hanson, 2011). Organizational and environmental determinants are related to the Information Culture within the context of a given country. In supporting this opinion, in Africa, the new Information Culture is a hybrid of the new and the old. Therefore, the adoption of the Anglo-American model imposed on the African libraries was inefficient as reported by Plessis (2008). Plessis (2008), added that the Information Culture in Anglo-American societies differ from that in Africa.

Travica (2005) studied the influence of Information Culture on the adoption of a self-service system and he argued that a tendency toward criticizing new things refers to one of the derived information cultural aspects. He pointed out that people in their company like to criticize and complain a lot. Criticizing is the first reaction to almost anything new that occurs in the corporate life. This is especially when the new thing is an Information System as this custom drives attention to downsides of a new system, while pushing potential benefits out of the attention span. Therefore, the adoption of the Information Culture requires senior management support with an emphasis on coordinated leadership rather than merely imposition from the top to down bearing in mind the close links between the organizational culture and Information Culture (Curry and Moore, 2003). Based on these perspectives, four cultural aspects were investigated to see if they have any impacts on TAMs determinants adopting e-learning innovations. The individual aspect was gender and experience on the use of e-learning innovations (computer and Internet). The technological aspect includes ICT and supporting technologies installations.
The institution aspect includes university readiness to use e-learning innovations (e-university plan) and motivations policies on usage of e-learning innovations (such as training, workshop, rewards). The national aspect includes languages (Yoruba, Hausa and Igbo) as a national language normally used in the country.

### 2.2 Technology Acceptance Models

**Unified Theory of Acceptance and Use of Technology (UTUAT):** Melanie (2011) citing Venkatesh *et al* (2003) identified four core determinate of intention and usage and up to four moderators of key relationships. These determinant were performance expectance, effort expectancy, social influence and facilitating conditions. Although, attitude toward using technology, self-efficacy, and anxiety are theorized not to be direct determinants of intention, the key moderators in the model are gender, age, voluntariness, and experience.

**DeLone and McLean (D&M) IS model:** The distinction of use and intention of any information technology and system was showed in DeLone and McLean (2003) model and it suggest that intention to use may be a worthwhile alternative measure in some contexts, intention is an attitude whereas use is a behavior. Use must precede user satisfaction in a process sense, but positive experience with use will lead to greater user satisfaction in a causal sense. Similarly, increased user satisfaction will lead to increased intention to use. As a result of this use and user satisfaction, certain net benefits will occur.

### 2.3 TAMs Core Determinants

The TAMs above have key cultural determinant that collectively affects and impacts on the usage and continuous intention of using and deploying e-learning innovations for effective learning. These core determinant constructs are:

**Self-efficacy/Perceived Ability/Attitude (SE):** is the degree to which an individual believes that he or she has the ability to perform specific task/job using computer technology. It is the individual preferences and interests regarding the use of e-learning system. (Venkatesh *et al*, 2003) and Melanie, 2011

**Perceived Usability (PUusa):** is the extent to which a product can be used by specific users to achieve specific specific goals with effectiveness, efficiency and satisfaction in a specific context of use. Three factors are identified in usability: Usefulness, ease of use and compatibility (Chiu *et al* (2006) and Wang (2008)). Hsu *et al* (2004) theorized that people build positive attitudes towards computerized systems based on cognitive evaluation of how it will improve their performance.

**Social Influence (SI):** is the degree to which an individual perceives that important others believe he/she should use the new system (Kholoud, 2009)

**Perceived Usefulness (Puse):** Perceived usefulness is defined as the degree of learning stakeholders’ believes from using e-learning innovations and systems that brings enhance learning outcomes and performances and the measurement adapted from Melanie, 2011. In addition, they stated that perceived usefulness was found to have a strong influence on people’s intentions.

**Facilitating Multimedia and Interactive Activities (MI):** is the believed that there exist organizational and technical infrastructure for supporting the use of the system (Kholoud, 2009).

**Perceived Ease of Use(PEOU):** is the degree to which a user aspects the use of e-learning innovations to be free of effort and was measured by Davis (1989). According to Chang *et al.*, (2005), perceived ease of use also found to have a significant impact on attitude, thus affects behavior intentions.

**Quality of e-learning Information (IQ):** is concerned with timeliness, relevance and accuracy of information generated by an information system. DeLone and McLean (2003) show that information quality had a significant effect on user satisfaction which in turn was significantly related to user acceptance.

**Quality of e-learning Service (SEVQ):** is concerned with whether or not there are bugs in the system, ease of use, reliability of the user interface, response rates in interactive systems, quality documentation and quality and maintainability of the software. (Hsu *et al*, 2004; Lee and Lee, 2008; Liaw, 2008).

**Quality of e-learning System (SQ):** is derived from the comparison between what the user feels should be offered and what was actually offered. (Hsu *et al*, 2004). The continuous improvement in ICT devices and applications have continue to demand more expanded role of IS department and the importance of information systems in government, commerce and in the academics have continue to increase which have made researchers to comprise service quality as a measure of IS satisfaction and therefore its success.

**Perceived Value (PV):** in the context of learning is the users’ overall assessment of the product utility based on perceptions of what is received and what is given (Kholoud, 2009). Chiu *et al*, 2004 citing Rokeach (1973) classified values into terminal and instrumental. Terminal values are concerned with preferred final stage (goals) while instrumental values are related to the ways of behaving to obtain goals such as standards, policies and procedures (Kholoud, 2009).
3. RESEARCH METHODOLOGY

3.1 Study Sampling Procedure
The population of this study covered learning stakeholders (students and lecturers) from ten (10) Nigeria federal universities from six geopolitical zones. Criteria for selection was university has internet presence (website) for online transactions, e-registration, result processing and educational administration; and there is a viable ICT centre(s) installed in the university. The universities covered were University of Benin, Benin City, Edo State (SOUTH SOUTH Region), National Open University of Nigeria, (NOUN) (SOUTH WEST Region), Federal University of Technology, Yola (NORTH EAST Region), Usman Danfodyo University, Sokoto (NORTH WEST Region), Federal University of Technology, Ilo State (SOUTH EAST Region), Federal University, Otuoke, Bayelsa State. (SOUTH SOUTH Region), University of Jos, Plateau State (NORTH CENTRAL Region), University of Ibadan, Oyo State (SOUTH WEST Region), University of Lagos, Lagos State (SOUTH WEST Region), Obafemi Awolowo University (OAU), Osun State (SOUTH WEST Region). Data was extracted via questionnaire which was administered for a duration of four (months) (Jan-April, 2012).

3.2 Instrumentation
The questionnaire has two sections namely demographic section and core determinant for technology acceptance in a learning institution. The instrument of this study is based on Krippanont, (2007). It presents a new set of instrument with some modification according to eleven core determinant variables and five (5) latent variable using five-point Likert scale. The core determinant (independent variables) consist of Perceived Usability (PUSA), Service Quality(SQ), Information Quality (IQ), Service Quality (SEVQ), Perceived value (PV).Interactive Learning/Multimedia Activities(ILA), Perceived Ease of Use (PEOU), Perceived Usefulness(PUSE), Effort Effectiveness(EE), Social Influence (SI), Self Efficacy (SE). the latent net benefit construct (dependable variables) are Learning stakeholder usage of e-learning innovation in teaching and learning (UTL), Learning stakeholder continuous intention of using e-learning innovation in teaching and learning (CITL), E-learning innovation improves professional practices (PPRAC), E-learning innovation improves personal development (PDEV), and E-learning innovation improves quality of education (PQEDU) (Krippanont, 2007; DeLone and McLean, 2003).

Demographic section consists of gender, education level, level of computer and internet usage, e-university plans, A total of 2500 admissible questionnaires (respondents) consisting of 500 staff (lecturers and IT experts) and 2000 students was randomly selected from the surveyed schools. 2441(97.6%) of the total questionnaire was successfully retrieved comprising of 2156 (86.24%) valid questionnaire and 285(11.4%) invalid questionnaire. 59(2.36%) questionnaires was never returned or lost. Based on the available fact, we can conclude that the data collected is fit for use in this study in terms of the 86% of valid respondent.

3.3 Research Questions
RQ1: Will information culture of the individual moderate TAMs core determinants influence learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities?
RQ2: Will information culture of the institution moderate TAMs core determinants influence learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities?
RQ3: Will information culture of the technological installations in the institution moderate TAMs core determinants influence learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities?
RQ4: Will information culture of the nation moderate TAMs core determinants influence learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities?
RQ5: Will information culture of the individual moderate TAMs core determinants influence learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities?
RQ6: Will information culture of the technological installations in the institution moderate TAMs core determinants influence learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities?
RQ7: Will information culture of the institution moderate TAMs core determinants influence learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities?
RQ8: Will information culture at the national level moderate TAMs core determinants influence learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities?
RQ9: Will Usage behavior and continuous intention influence the adoption of e-learning innovations for positive professional academic practices, personal development and quality education.

4. RESULT

4.1 Data Analysis and Results
Table 1 shows the demographic data of the respondents. Based on Table 1, a total respondent of gender was fairly accounted (50.5%;49.5%). Most of the respondents are student (90.9%), Lecturer(5.7%), Non academic staffs(3.5%). Most of the respondents was first school certificate holder(71.3%), diploma holder(23.3%), degree holder (3.4%); followed by post graduate holder (2.1%). On the level of computer literacy, there was even distribution among the expert, average, beginner and none users of over 24% each.
On the level of internet literacy, most of the respondents indicated that they are expert in their level of using internet (29.1%), average and beginner (19.9% and 19.4% respectively) and 31.6% have a poor level of the internet. Most of the respondents indicated that 89.8% had used the internet once a month, week and several times daily; and 10.2% have not used it at all. 57.1% indicated that there is no functional information and communication technology (ICT) installed in the institution while 42.9% indicated a functional ICT centre installed in the institution. On the type of usage of e-learning innovations in the institutions surveyed, 53.6% indicated that it is mandatory while 46.4% indicated that it is voluntary.

### Table 1: Demographic data of respondents

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group</th>
<th>Cases</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of Respondents</td>
<td>Student</td>
<td>1960</td>
<td>90.9</td>
</tr>
<tr>
<td></td>
<td>Lecturer</td>
<td>122</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Non Academics (Administrator, Directors,</td>
<td>74</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Technical/IT Personnel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>1089</td>
<td>50.5</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1067</td>
<td>49.5</td>
</tr>
<tr>
<td>Highest Academic Qualification:</td>
<td>WAEC/GCE</td>
<td>1537</td>
<td>71.3</td>
</tr>
<tr>
<td></td>
<td>Diploma (ND, OND, NCE)</td>
<td>501</td>
<td>23.2</td>
</tr>
<tr>
<td></td>
<td>First Degree (B.Sc., HND, B.ED)</td>
<td>73</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Post Graduate (PH.D, M.Sc. Post Graduate D)</td>
<td>45</td>
<td>2.1</td>
</tr>
<tr>
<td>Level of computer literacy</td>
<td>Expert</td>
<td>528</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>572</td>
<td>26.5</td>
</tr>
<tr>
<td></td>
<td>Beginner</td>
<td>528</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>528</td>
<td>24.5</td>
</tr>
<tr>
<td>Level of internet literacy:</td>
<td>Expert</td>
<td>628</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>429</td>
<td>19.9</td>
</tr>
<tr>
<td></td>
<td>Beginner</td>
<td>418</td>
<td>19.4</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>681</td>
<td>31.6</td>
</tr>
<tr>
<td>How often do you use the Internet</td>
<td>Don’t use at all</td>
<td>220</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Once a month</td>
<td>253</td>
<td>11.7</td>
</tr>
<tr>
<td></td>
<td>Few times a month</td>
<td>275</td>
<td>12.8</td>
</tr>
<tr>
<td></td>
<td>Once a week</td>
<td>330</td>
<td>15.3</td>
</tr>
<tr>
<td></td>
<td>Use few times a week</td>
<td>176</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>Use five to six times a week</td>
<td>286</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>Use about once a day</td>
<td>275</td>
<td>12.8</td>
</tr>
<tr>
<td></td>
<td>Use several times a day</td>
<td>341</td>
<td>15.8</td>
</tr>
<tr>
<td>Functional ICT centre is installed in</td>
<td>Yes</td>
<td>924</td>
<td>42.9</td>
</tr>
<tr>
<td>the institution</td>
<td>No</td>
<td>1232</td>
<td>57.1</td>
</tr>
<tr>
<td>Type of usage</td>
<td>Voluntary</td>
<td>1001</td>
<td>46.4</td>
</tr>
<tr>
<td></td>
<td>Mandatory</td>
<td>1155</td>
<td>53.6</td>
</tr>
</tbody>
</table>
Table 2 present the Reliability Analysis, Cronbach’s Alpha reliability coefficients of the entire study and 11 core determinants (dependent variable). A 0.94 (94.1%) of reliability coefficient for the entire study indicated high consistency in the measures used. All the determinants were all above 0.7 except SQ and ILA which were above 0.6. That could be attributed to the state of the e-learning innovations usage and adoption in the country. It seems that this study provides quite reliable instruments for the core constructs in this study. For example, the Perceived Ease of Use (PEOU) is 0.75, Perceived Usability is 0.83, Service Quality 0.81. Reliability less than 0.6 is considered poor, those in the 0.7 ranges, acceptable, and those 0.8 good (Sekaran, 2003). It is of evidence that the Cronbach’s alpha value for the eleven factors in this study ranged from 0.62 to 0.90. Therefore, the internal consistency reliability of the measures used in this study can be considered to be good.

<table>
<thead>
<tr>
<th>Core Construct</th>
<th>Cronbach's Alpha</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Usability (PUSA)</td>
<td>.831</td>
<td>3</td>
</tr>
<tr>
<td>System Quality (SQ)</td>
<td>.623</td>
<td>3</td>
</tr>
<tr>
<td>Service Quality (SEVQ/SV)</td>
<td>.810</td>
<td>3</td>
</tr>
<tr>
<td>Perceived Value (PV)</td>
<td>.736</td>
<td>3</td>
</tr>
<tr>
<td>Interactive Multimedia &amp; Interactive Learning Activities (ILA)</td>
<td>.661</td>
<td>3</td>
</tr>
<tr>
<td>E-Learning Effort Effectiveness (EE/PQ)</td>
<td>.850</td>
<td>3</td>
</tr>
<tr>
<td>Perceived Usefulness (PUSE)</td>
<td>.789</td>
<td>3</td>
</tr>
<tr>
<td>Perceived Ease Of Use (PEOU)</td>
<td>.750</td>
<td>3</td>
</tr>
<tr>
<td>Social Influence (SI)</td>
<td>.890</td>
<td>3</td>
</tr>
<tr>
<td>Information Quality IQ</td>
<td>.904</td>
<td>3</td>
</tr>
<tr>
<td>Self-Efficacy (SE)</td>
<td>.890</td>
<td>3</td>
</tr>
<tr>
<td>Cronbach’s Alpha (Instrument)</td>
<td>0.941</td>
<td></td>
</tr>
<tr>
<td>No. of Items</td>
<td>57</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Structural Equation Modeling

To seek answers to research questions in this study that are purely behavioural in nature, a careful choice for an accurate statistical techniques that are not subjective to certain assumption must be consider. Here, usage behaviour and continuous intention are behavioural factors that need analytical framework with unique capabilities but yet advance tool like Structural Equation Modeling (SEM). SEM, a statistical technique that is particularly useful for analyzing non-experimental data (Byrne, 2001) has gained an increasingly popular data- analytic technique in socio sciences and humanity. Azleen et al (2008) reported that recent innovations have allowed SEM to become a broad data-analytic framework with flexible and unique capabilities.

4.3 Model-estimation

Analysis of Moment Structure (AMOS) Version 16 was used to estimate the model using SEM with observed and latent variables. Recognition of the reliability of AMOS computations has been established by its increasing use in published studies in reputable journals over the last few years (e.g. Zuroff et al., 1999). Prior to model estimation, each of the multi-item constructs were transformed into totaled scores using equally weighted scales developed from the results of the Confirmatory Factor Analysis (CFA).
Figure 1: Structural Model
4.4 Model Testing Results

The structural models were assessed by using established measures and evaluative criteria for model fit. Several goodness-of-fit indices are commonly used to evaluate how well the structural model fits the data. The chi square goodness-of-fit test is one of the most commonly used indices. In SEM, a non significant chi square value is an indication that the hypothesized model has a good fit with the data. The problem with using chi square, however, is that it is hypersensitive to sample size (Ullman, 2001). Because SEM is grounded in large-sample theory, finding well-fitted hypothesized models, where the chi square value approximates the degrees of freedom, has proven unrealistic, leading SEM methodologists to develop additional practical or ad hoc indices of fit. One approach is to divide the chi square ($\chi^2$) value by the degrees of freedom. According to Carmines and McIver (1981), $\chi^2/df$ ratios in the range of 2:1 or 3:1 indicated an acceptable fit between the hypothetical model and the sample data. The most popular alternative measures of fit for SEM analysis, however, are the goodness-of-fit index (GFI), the normed fit index (NFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA).

The GFI, NFI, and CFI all have values ranging from 0 to 1; a good fit is indicated by values greater than .90 for GFI and NFI and .95 and greater for CFI. For RMSEA, a value of 0 is interpreted as an exact fit; values less than .05 are a close fit, values between .05 and .08 are a fair fit, values between .08 and .10 are a mediocre fit, and values more than 10 are a poor fit. Regarding the precision of the RMSEA estimates, AMOS reports a 90% confidence interval around the RMSEA value. MacCallum et al (1996) indicated that a small RMSEA and a very narrow confidence interval suggest good precision of the RMSEA value in reflecting model fit in the population. Finally, Martens (2005) indicated that chi square/df, GFI, and NFI tend to be substantially affected by sample size and number of indicators per factor and do not generalize well across samples. Marten (2005) recommended using CFI and RMSEA as the primary goodness-of-fit indexes.

The results suggest that the data fit the current conceptual model well, with a $\chi^2$ of 16.318(df =15, $p =0.089$), $\chi^2/df =1.087$, CFI =0.743, NFI =0.716, and RMSEA =0.093.

4.5 Hypotheses Testing

The current study proposed to test nine (9) hypotheses in identifying the critical determinant in TAMs that contribute most to influence learning stakeholders’ usage and continuous intention. Details of the hypotheses are stated below:

H1: Information culture of the individual moderates TAMs core determinants towards influencing learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities.

H2: Information culture of the institution moderate TAMs core determinants towards influencing learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities.

H3: Information culture of the technological installations in the institution moderate TAMs core determinants towards influencing learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities.

H4: Information culture of the nation moderate TAMs core determinants towards influencing learning stakeholders’ usage behavior of e-learning innovations in teaching-learning activities.

H5: Information culture of the individual moderate TAMs core determinants towards influencing learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities.

H6: Information culture of the technological installations in the institution moderate TAMs core determinants towards influencing learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities.

H7: Information culture of the institution moderate TAMs core determinants towards influencing learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities.

H8: Information culture at the national level moderate TAMs core determinants influence learning stakeholders’ continuous intention to use e-learning innovations in teaching-learning activities.

H9: Usage behavior and continuous intention influence the adoption of e-learning innovations for positive professional academic practices, personal development and quality education.
The results of the hypotheses testing are accessible in Table 3 and figure 1. It can be clearly shown in the table that two (2) hypotheses (H1 and H2) shows significant in Model A—all Data, Model B-Student and Model C-teaching staff for most TAMs core determinant on usage and continuous intention as indicated by S under the HT column.

For the third hypotheses, it was very clear that for model A-All data comprising of student and teaching staff and Model B-Student, E-learning innovations usage in teaching and learning (UTL) and continuous intention of using e-learning innovation (CITL) will improve professional practices (PP/PPRAC), personal development (PD/PDEVE), and qualitative education (PQ/PQEDU) except CITL vs PD/PDEVE.

For model C-Teaching Staff, E-learning innovations usage in teaching and learning (UTL) will improve professional practices (PP/PPRAC) and personal development (PD/PDEVE), and not qualitative education (PQ/PQEDU) and continuous intention of using e-learning innovation (CITL) will not improve professional practices (PP/PPRAC) and personal development (PD/PDEVE) but will improve qualitative education (PQ/PQEDU).

5. CONCLUSION

This study is assured to have strong reliable determinant to assess learning stakeholders’ intention and continuous intention in using e-learning innovations in teaching learning activities. This is based on the result of Cronbach Alpha that was performed by reliability analysis for eleven core determinant (independent variables) and five latent construct (dependent variable). The empirical results of our study can provide support for Davis (1989), Venkatesh et al (2003), DeLone and McLean (2003) models.

Furthermore, this study proves strong and positive relationship between TAMs determinants with learning stakeholders’ usage and continuous intention of using e-learning innovations in teaching learning activities. The usage behavior (UTL) on e-learning innovations was influenced by all core determinant while continuous intention (CITL) for all data (student and teaching staff) was influenced by all determinant except for Effort efficiency (0.881), Perceived Usability (0.106) and Service Quality (0.995). This study suggests that learning stakeholders’ usage and continuous intention of using e-learning innovation can be improved if the e-learning innovation is flexible and easy to use towards improving their professional practices, personal development and qualitative education. Once learning stakeholders’ usage behavior improves, the eleven core determinant of TAMs will in turn influence the learning stakeholders continuous intention for using e-learning innovations for professional practices, personal development and qualitative education. This study is an explanatory study of TAMs particularly in e-learning innovation adoption in learning institution in developing country.

However, it is quite difficult to be generalized since the study did not consider all the universities including private and state universities. In future, the sample of the study should consider both federal, state and private universities student and teaching staff in Nigeria.

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Performance Study and Analysis towards Discrete System Introducing Jury Test Simulator

Biswarup Neogi, Susmita Das, Swati Ghosh, Nilotpal Manna & Swapan Bhattacharyya
JIS College of Engg
WB, India
biswarupneogi@gmail.com, susmitad2011@gmail.com, mistiswati@gmail.com, nmanna324@gmail.com,
Tanmoy Singha
Modern Institute of Engg. & Technology
WB, India;
tanmoy.singha@mietcollege.org

ABSTRACT
Jury stability analysis technique is one of the best suited tools in z domain and it is being applied in industrial and research fields to determine the stability of discrete system. This paper presents the proper Jury stability analysis algorithmic approach and also the advanced Jury’s test simulator effectively. Here the stability of a discrete intelligent control system stability analysis is presented through the simulation software and this presentation will be potential enough to ascertain the stability in z domain. It is an intelligent system in the domain of Computer Aided Control System Design (CACSD). For the betterment of the performance of the system the worst case time complexity and space complexity of the algorithm is given with big oh, theta and big omega notation. The Jury test software support approach and mainly engineering based advancements are focused in this study.

Keywords- Jury stability, Advance Jury Test Simulator algorithm, Time complexity, Space complexity, Simulating software.

I. INTRODUCTION
Applications of Jury stability test in the field of electronics industry have a great position. The problem of determination of the root distribution problem of a real polynomial with respect to the unit circle, in terms of the coefficients of the polynomial, was solved by Jury (1964). The calculations were presented in tabular form (Jury's table). This result is now classical and is as important in the stability analysis of digital control systems as its continuous time counterpart. The Jury’s Technique, a potential and generally accepted method can make available appropriate knowledge on the stability of a digital system In case of Biological system the output response is necessarily non deterministic. In such a system the output may be sampled and digitized accordingly [1]. Then, utilizing the application of the Jury’s technique system, the stability can be easily projected. Technologists have distinguished these special cases in which the stability of biological system can be established by the application of the Jury’s stability testing. There are several applications of Jury’s stability testing. Microcontroller-Based Temperature Monitoring and Control is an essential and practical guide for all engineers involved in the use of microcontrollers in measurement and control systems [2].

The application of Jury stability test is the research on high-order accurate finite-difference time-domain (FDTD) method for the solution of Maxwell's equations is very popular [3]. Determination of root distribution of univariate polynomials with real or complex-valued coefficients, the Bistriz tabular form offers a significant computational advantage. Stability studies of two-dimensional (2-D) discrete-time systems involve univariate polynomials possessing parameter-dependent coefficients, where the parameter takes values on the unit circle in the complex plane. The only use those coefficients of the characteristic polynomial equation for stability analysis instead of directly solving it. Such treatment can greatly simplify the procedure of stability analysis. The Jury's Stability Test can be used to analyze the stability of the system without explicitly solving for the poles of the system. Stability analysis of microcontroller-based real-time systems is the one of the important application of Jury test [4]. Therefore, it is used to determine the bounds on the parameters which result in a stable transfer function in the z-domain. Three-dimensional (3-D) signal processing offers many advantages over two-dimensional (2-D) processing, because it preserves 3-D correlations. In this paper the design and the stability of 3-D rotated filters are considered.
These filters are designed by rotating a one-dimensional (1-D) digital filter in 3-D space. The rotated filters are valuable in the design of various 3-D filters which possess prescribed spectral specifications. An efficient algorithm for the design of 3-D low pass (LP) digital filters, with approximately spherically symmetric magnitude responses, is introduced [5]. To achieve the desirable spectral characteristics, a number of 3-D rotated filters are cascaded. The stability of the spherically symmetric filters designed is considered, and stable realizations are proposed. The stability of a linear transfer function is fundamental in its real time realization. Several tests have been developed in the past to test whether a given transfer function is stable. Invariably these tests rely on the Jury-test.

The Jury test in automatic control theory is introduced, which only use those coefficients of the characteristic polynomial equation for stability analysis instead of directly solving it polynomial equation for stability analysis instead of directly solving it. Such treatment can greatly simplify the procedure of stability analysis. This type of treatment can greatly simplify the procedure of stability analysis. Numerous applications such as air-traffic handling, missile interception, and anti-submarine warfare require the use of discrete-time data to predict the kinematics of a dynamic object are based on Jury’s stability test. The uses of passive sonobuoys which have limited power capacity constrain us to implement target-trackers which are computationally inexpensive. Based on Jury stability test, an Advanced Jury Test Simulator (AJTS) is developed. Also the emphasis is given on performance analysis of the AJTS software.

### 2. CLASSICAL OVERVIEW OF JURY’S STABILITY

The root detection of a characteristic polynomial \( F(z) = 1 + G(z)H(z) \) inside the unit circle for resolve of system stability of a sampled-data control system is performed by Jury’s stability criterion[4]. Considering the following nth order polynomial in

\[
F(z) = a_0 z^n + a_1 z^{n-1} + a_2 z^{n-2} + \ldots + a_n \geq 0
\]

(1)

Sufficient conditions for the roots of the above polynomial \( F(z) \) to lie within a unit circle in z-plane are specified by:

\[
|a_0| < |a_n| \\
|b_0| > |b_1| \\
|c_0| > |c_2| \\
|p_1| > |p_0| \\
|p_2| > |q_0| \quad \text{with (n-1) constraints.}
\]

Table 1: Array representation of Jury’s test

In the above mentioned array, the elements of 2nd, 4th, 6th etc. up to \((2n-4)\) rows are respectively the elements of 1st, 3rd, 5th,... etc. up to \((2n-5)\) rows in reverse order. The elements of 3rd, 5th, etc. up to \((2n-3)\) rows are determined by following second order determinants.

- \(b_k = \det [a_0, a_{n-k}, a_n] \) for 3rd row, \(k=0,1...(n-1)\)
- \(c_k = \det [b_0, b_{n-k}, b_n] \) for 5th row, \(k=0,1...(n-2)\)
- \(d_k = \det [c_0, c_{n-2-k}, c_{n-2}] \) for 7th row, \(k=0,1...(n-3)\)
- \(q_2 = \det [p_3, p_0, p_0, p_3] \)
- \(q_1 = \det [p_3, p_1, p_0, p_2] \)
- \(q_0 = \det [p_3, p_2, p_0, p_3] \) for \((2n-3)\) row
3. PRIMARY ALGORITHM & FLOWCHART
GENERATION OF THE ADVANCE JURY
TEST SIMULATOR (AJTS)

ALGORITHM:

STEP 1: START THE PROGRAM

STEP 2: READ THE VALUE OF ‘n’ (ORDER OF THE POLYNOMIAL)

STEP 3: REPEAT STEP 4 FOR n (1) 0

STEP 4: READ THE CONSTANT COEFFICIENT \( a_i, i=0(1)n \)

STEP 5: BUILD THE FUNCTION \( F(Z) = \sum a_i z_i, i=0(1)n \)

STEP 6: COMPUTE \( F(1), F(-1) \)

STEP 7: CHECK \( F(1) > 0, F(-1) > 0 \)

STEP 8: IF STEP 7 SATISFIED THEN GOTO STEP 9 ELSE GOTO STEP 14

STEP 9: REPEAT STEP 10 UPTO ‘2n-3’ ROW

STEP 10: COMPUTE

\[
(a_0 * a_k) - (a_n * a_{n-k}) \text{ As } b_k \quad \text{ FOR } k=0(1)(n-1)
\]

\[
(b_0 * b_k) - (b_{n-1} * b_{n-1-k}) \text{ As } c_k \quad \text{ FOR } k=0(1)(n-2)
\]

\[
(c_0 * c_k) - (c_{n-2} * c_{n-2-k}) \text{ As } d_k \quad \text{ FOR } k=0(1)(n-3)
\]

\cdots

\[
(p_0 * p_k) - (p_{2n-4} * p_{2n-4-k}) \text{ As } q_k \quad \text{ FOR } k=0(1)(2n-3)
\]

STEP 11: CHECK

\( |a_0| < |a_{n-1}|, \)

\( |b_0| > |b_{n-1}|, \)

\( |c_0| > |c_{n-2}|, \)

\( |q_0| > |q_{2n-4}|. \)

STEP 12: IF STEP 11 SATISFIED THEN GO STEP 13 ELSE GO TO STEP 14


STEP 14: PRINT: THE REQUIRED NECESSARY AND SUFFICIENT CONDITIONS ARE NOT SATISFIED, HENCE THE SYSTEM IS NOT STABLE STOP THE PROGRAM.

STEP 15: STOP
The Jury’s Technique would be more advantageous than the existing Davis’ Method in many ways. In the first place, the stability test in z-domain can be established with an algorithmic approach, following Jury’s Technique something that cannot be achieved in the Davis’ System. Due to introduction of too many variables, make the Davis’ System complicated and also risk of errors would be moved up. Jury’s Technique, on the contrary, provides a simpler solution by an array representation. The Jury’s Technique is far more exact with stability preserving method being its priority. Comparing with the existing recent developments for discrete system’s [7] stability test, the new method is more straight-forward than Harn and Chen’s work. Also, this method is much easier than the continued fraction method.

3. FLOWCHART OF THE JURY TEST SIMULATING SOFTWARE
4. FRONTEND REPRESENTATION OF ADVANCE JURY TEST SIMULATOR(AJTS) WITH SUCCESSFUL TESTING

In order to test the efficacy of the technique a ninth order transfer function has been considered, which is the standard transfer function of a biological prosthetic arm in z domain [6].

\[
T(z) = \frac{C(z)}{R(z)} = 0.0000z^2 + 0.0222z + 0.0143z^9 + (-1.8441)z^8 + 0.6365z^7 + 0.5541z^6 + (0.3747)z^5 + 0.0054z^4 + 0.5070z^3 + (-0.6453)z^2 + 0.0841z + 0.1138 \quad \text{-------- (1)}
\]

Characteristic polynomial: \( F(z) = z^9 + (-1.8441)z^8 + 0.6365z^7 + 0.5541z^6 + (-0.3747)z^5 + 0.0054z^4 + 0.5070z^3 + (-0.6453)z^2 + 0.0841z + 0.1138 \quad \text{-------- (2)}

Figure 1. Design view for entering the order of polynomial

Figure 2. Design view for entering the co-efficient of polynomial
Algorithm Efficiency is measured through complexity analysis. Algorithm has both time and space requirements called complexity. The main issues related to the efficiency of algorithms are Speed of algorithm (determined by the number of elementary operations: addition, subtraction, multiplication, division, comparison and the number of elementary operations are dependent on problem size & nature of input data) and Efficient memory allocation. Time complexity (Time required for executing the algorithm) and Space complexity (How much memory space is required to execute the algorithm?) are the two types of complexity. The measuring of either time/space complexity of an algorithm. Measuring of time complexity is more important. Actual time can’t be computed for the algorithm. The function of problem size that is directly proportional to time requirement called growth-rate function. How the time requirement grows as the problem size grows, measured by this function. Usually worst-case time complexity is considered. **Worst case efficiency** is the maximum number of steps that an algorithm can perform for any collection of data values. **Best case efficiency** is the minimum number of steps that an algorithm can perform for any collection of data values. **Average case efficiency** is the efficiency averaged on all possible inputs and a distribution of the input must be assumed. It is also a uniform distribution supposed to be assumed (all keys are equally probable) and if the input has size n, efficiency will be a function of n.

5.1 "Big Oh" - Upper Bounding Running Time:
For the Asymptotic Big O notation,

Let f and g be two functions such that

\[ f(n) \in O(g(n)) \]

if there exists positive constants c and \( n_0 \) such that

\[ f(n) \leq c \cdot g(n), \text{ for all } n > n_0 \]

or if \( 0 \leq \lim_{n \to \infty} \frac{f(n)}{g(n)} = c \leq \infty \) when \( n \to \infty \)

Then we write \( f(n) = O(g(n)) \)
So \( g(n) \) is an asymptotic upper-bound for \( f(n) \) as \( n \) increases \((g(n) \text{ bounds } f(n) \text{ from above})\). \( cg(n) \) is an approximation to \( f(n) \), bounding from above "Big Oh" - Upper Bounding Running Time.

5.2 "Theta" - Tightly Bounding Running Time:
Let \( f \) and \( g \) be two functions such that \( f(n) : N \to R^+ \) and \( g(n) : N \to R^+ \)
if there exists positive constants \( c_1, c_2, \) and \( n_0 \) such that \( c_1 g(n) \leq f(n) \leq c_2 g(n), \text{ for all } n > n_0 \)
or if \( \lim_{n \to \infty} f(n)/g(n) = c < \infty \) then we write \( f(n) = \Theta(g(n)) \)
So \( g(n) \) is an asymptotic tight-bound for \( f(n) \) as \( n \) increases.

5.3 Big-Omega Notation:
Let \( f \) and \( g \) be two functions such that \( f(n) : N \to R^+ \) and \( g(n) : N \to R^+ \)
if there exists positive constants \( c \) and \( n_0 \) such that \( f(n) \geq cg(n), \text{ for all } n > n_0 \)
or if, \( 0 \leq \lim f(n)/g(n) = c \leq \infty \) where \( n \to \infty \) \[10\] then we write \( f(n) = \Omega(g(n)) \)

So \( g(n) \) is an asymptotic lower-bound for \( f(n) \) as \( n \) increases
( \( g(n) \) bounds \( f(n) \) from below)
\[ f(n) = \Omega(g(n)) \]

Figure 6: Asymptotic lower-bound for \( f(n) \)[12]

6. MEASUREMENT OF THE WORST CASE TIME COMPLEXITY OF JURY’S STABILITY TEST ALGORITHM

6.1 Computation of worst case Time complexity of Algorithm:

Constant time is considered to read variable \( n \). So, \( O(1) \) time is required \( \text{------}(1) \)
Constant time \( O(1) \) is required for the statement
Set \( I = n \) \…………. (2)

The statement \( i \geq 0 \) is executed \( (n+1) \cdot O(1) \) times.
\[ = n \cdot O(1) + O(1) \]
\[ = O(n) \] \[……………(3) \]

The statement \( \text{Read } a_i \) is executed \( (n+1) \cdot p1 + (t_n + t_{n-1} + t_{n-2} + \ldots + t_1 + t_0) \) times.
I.e. \( (n+1) \cdot p1 + \sum t_i \)
\[ = (n+1) \cdot p1 + O(1) + O(1) + \ldots + O(1) \text{ (n+1) times.} \]
\[ = (n+1) \cdot (p1 + O(1)) \]
\[ = n \cdot (p1 + O(1)) + 1 \cdot (p1 + O(1)) \]
\[ = O(n) \] \…………….. (4)

[Since, \( p1 \) time (constant time) is required for each \( \text{Read} \) statement. \( \text{Read} \) statement repeatedly executed \( (n+1) \) times. So, total \( (n+1) \cdot p1 \) times are required. Secondly, \( t_i \) constant time is required for each \( a_i \). For \( i=n, n-1, \ldots, 1,0, \) \( t_n \) time is required for \( a_n \). \( t_{n-1} \) time is required for \( a_{n-1} \ldots \ldots \ldots t_i \) time is required for \( a_i \). All \( t_i \) \((i=n,n-1,\ldots,1,0)\) are constant.]

The statement \( i = i-1 \) is computed in following ways.

Let \( T(n) \) denotes the time for decreasing from \( n \) to \(-1 \) and \( T(n-1) \) be the time for decreasing from \( (n-1) \) to \(-1 \). So, a recurrence relation is formed as follows:
\[ T(n-1) = T(n) - 1 \]
\[ T(n) = T(n-1) + 1 \]
\[ = T(n-2) + 1 + 1 \]
\[ = T(n-3) + 1 + 1 + 1 \]
\[ = T(n-n) + 1 + 1 + 1 \ldots \text{ n times.} \]
\[ = T(0) + n \]
\[ = 1 + n \]
\[ T(n) = O(n) \] \[……………(5) \]

\( T(n) \) time is required to compute \( F(1) = a_n + a_{n-1} + a_{n-2} + \ldots + a_0 \)

Therefore,
\[ T(n) = T(n-1) + t_n \]
To compute (-1)^n F(-1) = a_n - a_{n-1} + . . . +(-1)^1 a_0
Firstly, it is needed to compute (-1)^{n-i} for i=n to 0.
So, (n+1).p times are required.

Therefore, time is required to compute (-1)^{n-i} for i=n to 0.
= O(n)  …….. ……….. . . . . . .  (7)

where p is constant time taken to compute (-1).

To compute \[ \sum (-1)^{n-i} a_i \] for i=n to 0, where T(n) time required to add (n+1) elements \[ \text{starting from } a_n \text{ to } a_0 \]

C_n time is required to add (-1)^n a_n , C_{n-1} time is required to add (-1)^{n-1} a_{n-1} , C_1 time is required to add (-1)^1 a_1 and C_0 constant time is required to add (-1)^0 a_0

Therefore, T(n)=T(n-1)+C_n
= T(n-2) +C_{n-1} + C_n
= T(0) + C_n + C_{n+1} + . . . + C_1 , put T(0)=C_0
= O(1) + O(1) + . . . +(n+1) times.

=O(n)  ……………… (8)

To compute |a_0| and |a_n| O(1) time can be required.. . (9)

Check if F(1) >0 and (-1)^n F(-1) >0 & a_0 <= |a_n|, O(1) +O(1) +O(1) = 3. O(1) time is considered  ……….. (10)

constant time O(1) is required to Set I=n and to test
I<=2n-3respectively

for each operation b_k = (a_0 * a_k) - (a_n * a_{n-k}) , P_k time is required for k=0 , 1 , 2 , . . . , n-1. [each P_k is constant time.]
So, the time is mandatory to compute (n) operations =P_0 + P_1 + . . . + P_{n-1} = (n). O(1)

Similarly, for c_k = (b_0 * b_k) - (b_{n-k} * b_{n-1-k}) operations,
(n-1).O(1) time is required for d_k = (c_0 * c_k) - (c_{n-2} * c_{n-2-k}) operations, (n-2).O(1) time is required.

……………………….  . . .  . . . . . . . . . .  . .. . . . .
for Q_k = (p_0 * p_k) - (p_{2n-2} * p_{2n-k}) operations, 3O(1) time is required.
So, total time = \[ n + (n-1) + (n-2) + . . . + up to (2n-3)th terms. \] .O(1)
= \[ n + (n-1) + (n-2) + . . . + up to (n-2) times. \] .O(1)
= \[ n^2 + n + . . . + up to (n-2) times - (1+2+3+ . . . + up to (n-3) times) \] .O(1)
= \[ n^2 - (1+2+3+ . . . + (n-3)) \] .O(1)
= \[ n^2 - (1+2+3+ . . . + (n-3)) / 2 \] .O(1)
= \[ n^2 / 2 \] .O(1)

= \[ n^2 / 2 + (n/2) \] .O(1) < O(1) n^2 , for n>2
=O(n^2) . . . . . . . . . . . . . . . . . . (12)
To compute following statements
\[ |a_0| < |a_n|, \]
\[ |b_{k_1}| > |b_{n-1}|, \]
\[ |c_{l_1}| > |c_{n-2}|, \]
\[ \ldots \ldots \ldots \ldots \ldots \]
\[ |q_{o_1}| > |q_2|, \]

Required time = \( O(1) + O(1) + O(1) + \ldots \) up to \((n-1)\) times.
\[ = (n-1) . O(1) \]
\[ = O(n) \quad (13) \]

To get total time in worst case it is need to aggregate \((1), (2), (3), \ldots, (13)\).
Time_{worst} = O(1) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n) + O(n)
\[ = O(n^2) \]

7. MEASUREMENT OF SPACE COMPLEXITY OF THIS JURY’S STABILITY TEST ALGORITHM

The space complexity of an algorithm \( X \) can be defined as \( S(X) = C(X) + I(X) \) where \( C(X) \) is required constant space whereas, \( I(X) \) is the instantaneous space requirement for algorithm \( X \).

Here, \( n, I, F(1), z, k \) [where \( z \) denotes \((-1)^n \) \( F(-1) \)] are constant variable.

If the space required for a single constant variable is \( k \) bytes then the total space required for all the constant variables used in this algorithm is \( C(X) \) = space requirement of \((n, I, F(1), z, k) = (k + k + k + k + k) \) bytes = \( 5k \) bytes. The space required for array \( a[\] \) depends on \( n \) and \( n \) is either equal to or less than array size. So, space required for the array is at least \((n \cdot k)\) bytes, if \( k \) bytes of space are required for each array content. Similarly, the space required for array \( b[\] \), \( c[\] \), \ldots, \( q[\] \) depends on \((n-1)\), \((n-2)\), \ldots, \( 2 \) respectively. So, the space required for array \( b[\] \), \( c[\] \), \ldots, \( q[\] \) is at least \((n-1) \cdot k \), \((n-2) \cdot k \), \ldots, \( 2k \) respectively.

So, the space complexity of this algorithm is
\[ S(X) >= 5k + n \cdot k + (n-1) \cdot k + \ldots + 2k \]
\[ = 5k + (n + n-1 + n-2 + \ldots + 2) \cdot k \]
\[ = 5k + \left(\frac{n \cdot (n+1)}{2} - 1\right) \cdot k \]
\[ = (n^2 + n + 8) \cdot k \] bytes.

8. CONCLUSION

The programming for the system is done with Visual Basic technique which could be universally applied for any digitized system transfer function. However, it should be mentioned here that with the increment of degrees of the characteristic equation, the time-space complexity enhances. For optimization of the application for larger degrees of characteristic equation the authors are keen to conduct further researches on the problem so that it becomes more simplified than now. In this manner, this application software working on visual basics platform, of Computer Aided Control System Design (CACSD) serves as a bridge between Control System and Computer based Algorithm. The speed of this algorithm is computed in terms of time and space complexity.

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AUTHORS’ BRIEF

Dr. Biswarup Neogi is awarded PhD (Engineering) from Jadavpur University, India. He received M.Tech degree in ECE from Kalyani Govt. Engg. College in 2007. Before that He obtained B.E in ECE from UIT, The University of Burdwan in 2005. He has a experience on various project of All India Radio attach with the Webel Mediatronics Ltd, Kolkata. He was a lecturer in ECE Dept, Haldia Institute of Technology, WB, India. He was working as a faculty in ECE Dept, Durgapur Institute of Adv. Tech. & Mgmt. Currently he is engaged with JIS College of Engineering, Kalyani as a Faculty member and flourished R&D related activity. He is also engaged as a consultant executive engineer of YECOES Ltd, Hooghly, and attached as an advising body of different Engineering College under WBUT. Several Government Funded project have been coordinated by him as a Personal Investigator. He is successfully registered one Indian Patent about Odour Effect Creation. His research interest includes Prosthetic Control, Biomedical Engineering, Digital Simulation, Microcontroller based Embedded System. He is guiding five Ph.D theses in this area. He has published about fifty several papers in International and National Journal and Conference conducted both in India and abroad. Additionally, he attached as a reviewer of several journals and yearly conference.

Ms. Susmita Das is presently engaged as an Assistant professor of Electronics & Instrumentation Engg. Dept. in JISCE, Kalyani. She is awarded the degree of M.Tech in Instrumentation & Control Engg. from Calcutta University (UCSTA) in 2011. Before that she received the B.Tech degree in Electronics and Instrumentation Engg. Dept. from WBUT in 2008. She has been engaged as a successful examiner of WBUT curriculum. Presently she initiates her Ph.D. curriculm (Engineering) under the supervision of Dr. Biswarup Neogi. Her research interest includes Control Theory, Process control, Biomedical Engineering etc.
Mr. Tanmoy Singha received the B.Tech degree from I.M.P.S C.E.T, Malda in Electronics & Communication Engineering in 2008 & M.E degree from Jadavpur University in ETCE Department in Control Systems Engineering specialization in 2012. In 2008, he joined R.P.B.M.J.C.E.T, Jiaganj as a Lecturer in ETCE Department and in the year 2010, he become H.O.D & Teacher-In-Charge. After that he joined K.I.E.M, Mankar as an Assistant Professor (ECE) in 2012. In 2013, he joined M.I.E.T, Bandel as an Assistant Professor in ECE Department and still continuing. His research interests include evolutionary optimization, machine learning, artificial intelligence, fuzzy and control system. He has more than 6 years of Teaching Experience. He has published 01 paper in FICTA 2013 (Springer).

Ms. Swati Ghosh, M.Tech final year student in Mobile Communication & Network Technology (MCNT) under WBUT. Before that she received the B.Tech degree in Electronics and Communication Engineering from WBUT in 2006. Presently working as a Teaching Assistant at JIS College Of Engineering, Kalyani in the Department of Electronics and Communication Engineering since 2013. She has experienced in various companies like, CESC Ltd. and various IT MNCs. She has worked with various Software development and Testing platforms in IT industry and also experienced in designing and implementation of Software Systems. Her domain of work at the time of B.Tech degree was Embedded Technology and Microcontroller. Presently she initiates his M.Tech final year project under the supervision of Dr. Biswarup Neogi. Her major work is in the domain of Micro Controller based Embedded System and Tactile-Display.

Mr. Nilotpal Manna obtained B.E degree in Electronics and Telecommunication Engineering in 1979 from Bengal Engineering College, Shibpore, Kolkata, now renamed as Bengal Engineering and Science University and received M Tech degree in 1981 from Indian Institute of Technology Madras (Chennai). He has wide industrial experience of twenty-two years from semi-government sectors like Instrumentation Ltd, Kota and several private industries like Toshniwal Instruments Manufacturing Pvt Ltd and others. He served mostly in the Research and Development wings and was associated in development of various electronic and communication instruments meant for military application as well as development of analytical instruments. At present he is Head of the Department of Electronics and Instrumentation Engineering of JIS College of Engineering, Kalyani, West Bengal, India. He has several research publications in national and international journals and conferences, and authored four technical books.

Swapan Bhattacharyya (M’06) received his B.Sc. (Hons.) degree in Physics from the University of Calcutta in 1982, the Integrated M. Tech. (B. Tech & M. Tech) degree in Radio Physics and Electronics in 1987 and the Ph. D. degree, all from the University of Calcutta. In 1988, he joined the Tata Group of Companies (TGC) at Jamshedpur, India as a Senior Customer Support Engineer, where he became the Branch Manager (Customer Support) in 1998 and in the next year he joined the Corporate Office-Mumbai as a Corporate Manager (Customer Support). In May 2004, he joined the Asansol Engineering College (India) as a System Manager, where he is the Head of the Department of Computer Science and Engineering since December 2004. At present he is the Head of the Department of Electronics & Communication Engineering at JIS College of Engineering (An Autonomous Institute). His field of research in the area of Semiconductor nanostructures with special focus on Quantum dots for information and communication applications. He has also special interest in natural language processing, and use of IT for rural development. From January 2007 to June 2007 he worked as a visiting faculty at ICFAI Institute, India.

Dr. Bhattacharyya was a recipient of a National Scholarship. He worked in academic administration of several reputed technical institute and universities in India. He has published many technical research papers in international journals, in national and international conferences. He also served as a conveyer of technical committee for several national conferences and seminars. He is a member of IEEE, Photonics Chapter and life member of IE (Institute of Engineers, India).
Anomaly Detection in Dataset for Improved Model Accuracy Using DBSCAN Clustering Algorithm

A.R. Ajiboye, A.G. Akintola & A.O. Ameen
Department of Computer Science
University of Ilorin
Ilorin, Nigeria
ajibraheem@live.com, abimbolar@yahoo.com, aminamed@unilorin.edu.ng

J. Abdul-Hadi
Department of Mathematics
Bauch State University
Gadau, Nigeria
jamcy98@gmail.com

ABSTRACT

The purity of the dataset used for model construction plays important roles in the accuracy and reliability of model building; outliers are often caused by noisy data as a result of mechanical faults, changes in system behaviour, or due to human error. This is why it is essential to pre-process dataset prior to modelling, in order to differentiate between data that appears normal or abnormal within the sample space. One important reason for removing outliers is to prevent contaminating effect on the dataset which can lead to bad consequences and serious disaster if not removed. An effective measure that automatically clusters outliers in the dataset using Density-Based Spatial Clustering of Applications with Noise (DBSCAN) technique is proposed in this paper. Rapidminer, an open source software tool is used to experiment on some sample dataset and based on the characteristics of these data objects, some clusters are formed which filter out outliers from the dataset being explored. The experimental results from this study show that, the DBSCAN algorithm is a suitable technique for outliers detection and capable of filtering the abnormal data from a combination of noise and normal dataset.

Keywords: Anomaly detection, DBSCAN, clustering, model-building, algorithm, noisy data.

1. INTRODUCTION

A dataset is said to consist of anomalies if it shows some patterns that do not conform to a well-defined notion that depicts normal behaviour. This may be as a result of the presence of noise. Noise is a random error or variance in a measured variable [1]. A serious problem with any form of automatic detection of apparently incorrect data is the fear of removing legitimate data along with the abnormal data. One-class classification is often used to differentiate between data that appears normal and abnormal with respect to the distribution of the training data [2]. The generic statistical approach to one-class classification is to identify outliers as instance that lie beyond a distance $d$ from a given percentage $p$ of the training data. Alternatively, estimating the probability density for the target class by fitting a statistical distribution, such as Gaussian, to the training data; any test instances with a low probability value can be marked as outliers [2], however, it is a big challenge to identify an appropriate distribution for the data. Three approaches to anomaly detection are fundamental: The detection of outliers without having prior knowledge of the data. This is synonymous to a learning approach using unsupervised technique such as clustering; the second approach is modelling both normal and abnormal data and using a pre-labelled data as target. This is supervised learning such as in classification problem. The third approach is to model only normal data or in some few instances, model the abnormal data [3], this is analogous to a semi-supervised recognition or detection task, authors generally referred to this approach as novelty detection or novelty recognition [4].
The removal of Outlier detection is a critical task in many safety environments as the presence of outlier is a clear sign of abnormal running conditions from which significant performance degradation may be the consequence [4]. The concept of Semi-Discrete Decomposition (SDD), can be used to decide which objects or values are outliers, as SDD is a transformation in a geometric space [5]. For instance, nodes in the hierarchical clustering that contain one, or just a few objects might be considered to describe outliers. However, in a situation where the hierarchical clustering extend far, then, every object is in a node by itself, therefore, it is only the nodes with small number of object near the root of the tree that are really outliers [5].

In using the clustering technique to detect outliers, where similar values are organized into group or clusters, intuitively, values that are not within the set of clusters may be considered outliers [1]. In a statistical regression, outliers is usually obvious if, for instance, a straight line is being fitted to data that lies on a bell curve, however, most problems cannot be easily visualised. A good solution can be found by applying several different learning techniques to filter the data and anomalies detected by the filter can then be examined by a human expert [6]. Other way to characterize outliers in a dataset is their participation in many bumps as such objects have attribute values that overlap with other common attribute values but usually few in number [5]. Also, efforts are made at removing outliers in [7], the study minimizes the cost function using standard optimization techniques; the study also suggested that, if the residual error is too great, the offending measurement can be removed and optimization can continue.

In data mining applications, such as clustering, outlier analysis, and nearest neighbour classification, these techniques helps to make comparison of objects to determine the degree of their similarities. There are several ways by which the concept of outliers detection can be put to use. The concept is applicable in areas such as: fraud detection, discovery of the intrusion to a network, video surveillance, medicine, pharmaceutical test, weather forecast etc.

The notion that constitutes anomalies has been observed as what differs for different application domains. Chandola et al. [8] illustrates instances in the medical domain where a small deviation from normal such as little rise in body temperature might be an anomaly, while, similar deviation in the stock market domain such as fluctuation in the value of stock might be seen as normal. Thus, applying a technique developed in one domain to another is not usually straightforward.

The clustering approach that is based on density-based distribution of data is proposed in this study to detect the outliers in a dataset with a view to improving model accuracy and reliability. The rest of the paper is organized as follows: In the next section, the dense-region modelling of clusters is discussed. In section 3, some works related to this study is reviewed, while in section 4, the material and methods used for the study is discussed. The experimental results is displayed and discussed in section 5 and the paper is concluded in section 6.

2. DENSE-REGION CLUSTERS MODELLING

The strategy behind density-based clustering method is to model clusters as dense regions in the data space, separated by sparse region [1]. The most important task in this technique is to find the dense regions in dataset based on density. Generally, the density of an object say d can be measured by the number of objects that is close to d. DBSCAN finds the core objects that have dense neighbourhoods. These core objects and their neighbourhoods are then connected to form group of dense regions as clusters. In order to determine which instances belong together in a cluster, DBSCAN uses the Euclidean distance metrics [9], but, unlike k-means, there is no need to supply the number of desired clusters as it clusters data automatically, find arbitrarily shaped clusters and incorporate a notion of outliers [2]. A cluster is defined as containing at least a minimum number of points, every pair of points which either lies within a user-specified distance ε connected by a series of points in the cluster that each lie within a distance δ of the next point in the chain. Smaller values of δ yield denser clusters, this is due to the fact that instances must be closer to one another to belong to the same cluster [2]. Depending on the value of δ and the size of cluster that is minimum, it is possible to have some instances that will not belong to any cluster but will only appear scattered around, these are considered as outliers [2].
Although, DBSCAN can cluster objects given input parameters such as $\varepsilon$ (the maximum radius of a neighbourhood) and $Minpts$ (the minimum number of points required in the neighbourhood of a core object), it expect the user to select parameter values that can lead to discovery of acceptable clusters. Unfortunately, such parameter settings are usually empirically set and difficult to determine, as most algorithms are sensitive to the choice of parameter values. It is more tasking most especially when dealing with real-world, high dimensional dataset.

Input:
$V$: a data set containing $n$ objects or values
$\varepsilon$: the radius parameter
$Minpts$: the neighbourhood density threshold.

Output:
Density-based clusters

Method:
1. mark all objects as unvisited
2. do
3. select an unvisited object $R$, randomly;
4. mark $R$ as visited
5. if the $\varepsilon$-neighbourhood of $R$ has at least $Minpts$ objects
6. create a new cluster $C$, and add up $R$ to $C$;
7. let the set of objects be $N$ in the $\varepsilon$-neighbourhood of $R$;
8. for each point $R'$ in $N$
9. if $R'$ is unvisited
10. mark $R'$ as visited;
11. if the $\varepsilon$-neighbourhood of $R'$ has at least $Minpts$ points, add those points to $N$;
12. if $R'$ still does not belong to any cluster, add $R'$ to $C$;
13. end for
14. output $C$;
15. else mark $R$ as noise;
16. until no object is unvisited;

Figure 1. DBSCAN algorithm adapted from [1].

3. RELATED WORK

Anomaly detection in dataset is widely reported in the literature. It mainly focuses on determining the patterns in data that do not conform to expected behaviour; most times, the non-conforming patterns are often referred to as outliers, discordant observations, exceptions or contaminants in many application domains [8]. Study in [7] proposed Linfinity norm for removal of outliers. The main drawback of using Linfinity norm minimization as identified in the study is its weak robustness to outliers.

Jiang et al. [10] proposed a two-phase clustering algorithm. The study first modified the traditional k-means algorithm by using heuristics. The results from the heuristics showed that the data points in the same cluster may be most likely all outliers or all non-outliers.

The small clusters in the study and the tree with less number of nodes are selected and regarded as outliers. Also, in the course of mining outliers in database with a view to removing exceptional objects that deviate from the rest of the dataset, Jin et al. [11], proposed ranking of outliers based on a symmetric neighborhood relationship. According to the authors, the proposed technique was to avoid the likely problem of having a wrong estimate when outliers are in the location where the density distributions in the neighbourhood are significantly different. The study reported results analysis that shows the effectiveness of the technique in the ranking of outliers. In a study to isolate outliers in dataset [12], an automated detection of outliers that models the human perception of exceptional values was proposed, using the concept of fuzzy set theory. The paper discussed the procedures for detecting outliers in both discrete and continuous data.
In contrary to low frequency of a value which usually may be classified as outliers when found in a large dataset, the study identify some additional factors from human perceptions of an outlying discrete value. These include the number of records where the value occurs, the number of records with a non-null value, and the total number of frequent occurrence of distinct values within an attribute.

Similarly, the novelty detection reported in the study proposed in [13] has the same concept has outliers detection, as authors normally use the word novelty detection or novelty recognition interchangeably. Augustejn and Folkert [13] explored the applicability of a probabilistic neural network technique to detect the novelty or patterns. The study is not strictly on outlier detection, but is a classification problem that applied the concept deviation from a specific pattern using the machine learning technique to remotely classify sensed data.

Hawkins et al. [14], proposed replicator neural networks which provide a measure that detects outliers from data records. The study construct model using a sample dataset and the model was used to develop score for outlyingness. The paper identifies cluster labels for each data record which help to interprete the resulting outliers. The present study uses DBSCAN algorithm to detect outliers using the density-based clustering approach. The study has demonstrated the use of the algorithm in a rapidminer software environment.

4. MATERIAL AND METHODS

In this section, the approach used for the detection of outliers is discussed. Dataset from an open repository, UCI [15] is modelled for this study.

4.1 Experimentation

The dataset originally stored in excel file is read into the main process environment of Rapidminer Software. Four operators are used for the model construction as shown in Figure 2. While the import operator read the source file into an excel file, the export operator writes the outputs result into another excel file.

The DBSCAN is sensitive to missing value, therefore, an operator is introduced to replace the missing values using the average of the existing values. The complete sets of data is received by the clustering operator which uses the DBSCAN algorithm to deduce relevant clusters. Unlike some other clustering techniques such as k-means and k-medoids that needs to be told about the number of clusters they should look for, DBSCAN only need to infer the number of clusters that are present, thus, it generate the clusters automatically. The resulting clusters in this paper apart from being represented graphically as shown in Figure 3, the output is also written to excel file in order to clearly show the noisy and clean data values present in each cluster. The parameter settings used for clustering operator in the setup is shown in Table 1.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Parameters</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBSCAN</td>
<td>Min points</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Epsilon</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Measure type</td>
<td>Mixed measure</td>
</tr>
<tr>
<td></td>
<td>Mixed measure</td>
<td>MixedEuclidean Distance</td>
</tr>
</tbody>
</table>
For clustering of dataset, DBSCAN essentially needs input parameters such as the maximum radius of a neighbourhood ($\epsilon$) and the minimum number of points that is required in the neighbourhood of a core object ($Minpts$). Table 1 shows the detail parameter settings of DBSCAN operator in Rapidminer.

5. RESULTS AND DISCUSSION

In this section, the output results from the experiment is presented. The algorithm clustered the dataset into three. Clusters 1 and 2 appears very compact, which indicate that each of the cluster has high degree of similarities with itself and shares some features in common. The “cluster 0” is automatically assigned by DBSCAN and it corresponds to anomalies data, the data points appears scattered. These are the points in whose epsilon-neighbourhood that is less than minimum points are found. The normal data are separated from outliers, the noise that is so few and appears scattered as shown in Figure 3.
Figure 3. The clusters generated

The individual outlier is further represented in a chart (see Figure 4); the content of cluster 1 and 2 forms the desired clean data set.
8. CONCLUSION

In this paper, the anomalies are detected in a dataset using the clustering approach. The DBSCAN algorithm automatically detects data that appear abnormal, while others that show some closeness in density and free of noise are clustered as normal data. Since there are several other features that need to be considered in the clustering process, normal data points may not necessarily be in the same cluster. The main goal of clustering dataset is to understand the microscopic structure of objects and the actual relationships that exist among the objects. The most promising way to achieve this is through the use of relevant clustering techniques. Most of these techniques can be divided into three categories: those based on distances among objects, those based on density of objects or those based on probability distributions; these are otherwise referred to as distance-based, density-based and distribution-based clustering respectively [5].

Regular geometrical clustering technique such as k-means is sensitive to non-numeric data since it based its clustering strategy on distances among objects, it is therefore, not a usual choice for anomaly detection. The present paper has demonstrated a density-based clustering techniques to unveil anomalies or outliers in datasets. The importance of removing outliers from sets of data is so enormous; one important reason for embarking on such task is to serve as a preventive measure so as not to contaminate the original dataset. The consequence may even be disastrous when noisy dataset is relied upon for model building.
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Service Level Analysis of Video Conferencing over Wireless Local Area Network

B.O. Sadiq, E. Obi, A.S. Abubakar, Y. Ibrahim & S. Saidu
Department of Electrical and Computer Engineering
Ahmadu Bello University
Zaria, Nigeria
sadiqbashirolaniyi@gmail.com, abubakaras@abu.edu.ng

ABSTRACT
This paper modelled an effective video conferencing application over an existing wireless network. The topology of an existing wireless network was obtained and simulated using the Riverbed Modeler 17.5 software with a view to determining if the existing wireless network was capable of running a video conferencing application. The Riverbed Modeler 17.5 software was used to model and simulates the behavior of network in a wireless environment. The Result analysis showed that, the modeled network has highest delay of 0.1225 bytes and lowest delay of 0.01, which resulted to severe throughpu t degradation. The throughput result was just 80 (Mbps), which is below the required throughput of 100 (Mbps) for an efficient Video Conferencing application over wireless network. From the results obtained from this simulation work in comparison with the requirement, it showed that the modeled network does not provide sufficient requirements for video conferencing application.

General Terms: Delay, Traffic, Throughput

Keywords: Wireless LAN IEEE 802.11, Riverbed

1. INTRODUCTION
A wireless local area network (WLAN) is a moderate high-speed flexible data communication system implemented as an extension to, or an alternative for a wired local area network (LAN). WLANs also implements shared access technology in their communication network. [1] With the advent of mobile portable computing devices like laptops and PDAs and the Internet revolution have made wireless networks so wide spread in common places. Many people also use wireless networking frequently called Wi-Fi at home to share printers and provide Internet access anywhere within the house. Benefitting from the mobility of broadband internet services of wireless network, the wide spread reliance on networking in every sector of the economy and the rapid growth of the internet and online services are strong indication of shared data and resources. Base on social impact of multimedia sharing, People are growing in demanding to access internet for transferring and receiving multimedia messages over wireless networks. [2]

Wireless Local Area Networks (WLAN’s) became widespread, especially IEEE 802.11 standard, which is a standard network equipment in every domestic or establishing premises [3]. 802.11 standards are mostly used as an extension to Ethernet (IEEE 802.3) [4], which is used as a backbone part of local area network (LAN). However, WLAN can also be used as an alternative to wired LAN in cases were physical interconnection is not possible. With introduction of new multimedia contents, including streaming of high quality audio/video signal over WLAN networks and the emergence of internet TV services have put huge demands on bandwidth, that is to be provided to end user for efficient data delivery.

2. RELATED WORKS
Some of the related works on transmission of multimedia content over wireless local area networks are as follows: The authors [5] presented a research work where a new system that reinstalls the relation between the QoS elements (e.g. routing protocol, sender, and receiver) during the multimedia transmission was proposed. An alternative path was created in case of original multimedia path failure.
The suggested system considers the resulting problems that may be faced within and after the creation of rerouting path. Finally, the proposed system was simulated using OPNET 11.5 simulation package. Simulation results showed that the proposed system outperforms the existing one in terms of QoS parameters like packet loss and delay jitter. The authors [6] presented a paper on multimedia traffic, which was implemented using Real Time Protocol (RTP) and an implementation using Transmission Control Protocol (TCP). The findings was that, the RTP packet encapsulation scheme resulted in on average smaller network packets, which entails some overhead in network efficiency. This overhead is dependent on the encapsulation efficiency of the streams. For TCP this overhead is considerably smaller. The authors [7] showed that a high level of QoS is required for multimedia transmission over wireless networks.

Riverbed Modeler was used to measure various network data such as end-to-end delay between packet sending and arrival times, throughput of traffic sent, jitter of packets received, and packet loss that occurs in the network. The authors [8] presented an MPEG-4 video transfer, over IEEE 802.11 WLAN which explores the possibilities of using existing IEEE 802.11b and 802.11g networks to stream video content. The objective was to evaluate Wi-Fi network as a means of transporting video services. Experiment performed on the private network showed some issues that manifest as breaks in transmission and unstable throughput and quality of a streamed video. Due to the shortcomings of the reviewed literatures, there is a need to design an effective video conferencing application over wireless local area network with the view to reducing delay, packet loss, and jittering.

3. METHODOLOGY

The methodology adopted for the research is itemized as follows

i. Obtaining the network topology that will run the video conferencing application
ii. Create and configure the topology in the Riverbed Modeler software project editor.
iii. Run the simulation
iv. Collect the output result of this simulation
v. Validation

The workflow model is shown in Figure 3.1. The workflow model is a representation of how the overall results are obtained.

3.1 Initializing Network Setup

The main objective of this design is to use Riverbed simulation to model the behavior of video packets over WLAN with respect to different performance matrices i.e. General Statistics: packet delay variation, packet End-to-End delay(sec), Traffic Received (Packets/sec), Data Dropped(bits/sec) and Objects Statistics which include: Delay (Sec), throughput (bits/sec) according to the network design. The structure of the network is shown in Figure 3.2.

The network topology obtained consists of the ground floor, first floor and the second floor. The simulated diagram of the connection of the floors are shown in Figures 3.3, 3.4 and 3.5.
3.2 Choosing Individual Statics
Individual statistics needs to be chosen with respect to the performance metrics. However, Riverbed modeler does not automatically collect all the statistics in the system. Before running the simulation using Riverbed modeler, the individual statistics dialogue box is used to specify the parameters that constitutes the performance metrics. Figure 3.6 shows the individual parameters selected in the case of this paper.

3.3 Run Simulation
The final stage of the setup was configuring the parameters of Discrete Event Simulation (DES) and running them. Although there are two types of results that can be obtained using the Riverbed Modeler which are the DES graphs and the flow analysis. But the DES graphs was chosen in this work because it does thorough analysis than the flow analysis. Also Before running the simulation, configuration needs to be made to the attributes which is, specifying the length of simulation and the values per statistics.

4. RESULT AND DISCUSSIONS
This paper is limited to the General Statistics of the network which includes wireless LAN Delay (sec), packet End-to-End delay (sec), wireless LAN Media Access Delay (sec), Data Dropped (bits/sec), Traffic Received (Packets/sec), Traffic sent (Packets/sec), and Objects Statistics such as wireless LAN Delay (Sec), throughput (bits/sec) graphs and description of the network are presented in the following sub-section.
4.1 Performance Delay

Delay is an essential metric to characterize the QoS of any network, especially for Video Conferencing application. The delay is defined as the time taken by the system for data to reach the destination after it leaves the source [5]. The delay for any network can be measured at three layers, end-to-end delay, wireless LAN delay and MAC (media access control) delay. Wireless LAN delay depends on used frequency band and media access delay on media access technique and physical characteristic of the standard, while end-to-end delay includes both wireless LAN delay and MAC delay [7]. Figures 3.7, 3.8 & 3.9 showed the results of wireless delay test and MAC delay test.

![Figure 3.7 Average (in wireless LAN Delay (sec))](image1)

![Figure 3.8 Average (in wireless LAN media Access Delay (sec))](image2)

![Figure 3.9 Time Average (in video conferencing: packets-End-to-End Delay (sec))](image3)

The graphs showed that video conferencing application over this network will undergo an amount of delay of 0.1225 bytes per sec. the delay presumes duration for this simulation. The summary of delay performance of the network is shown in Figure 3.10

![Figure 3.10 Delay Graph](image4)

4.2 Traffic Performance

One of the parameters that can influence the overall performance of the Wireless Local Area Networks (WLANs) is traffic analysis. Traffic analysis includes traffic sent, traffic dropped and traffic received. Traffic sent determines the capability of the system to transmit amount of data from the source point, while traffic received determines the amount of the data received at the destination.
The traffic drop in applications such as video conferencing is often caused by the buffer overflow and the amount of data dropped can be determined from the amount of data transmitted and received. Various tests for traffic performance of the modeled network have been conducted and the result is presented in Figure 3.11.

4.3 Throughput Performance

Throughput is defined as the average rate of successful message delivery over a communication channel. Figure 3.12 showed the graph of the throughput of the entire network.

5. CONCLUSION

The motivation behind the paper presented was to investigate the performance of an existing Wireless LAN, strictly for an application which have high bandwidth requirements such as video conferencing application. Consequently, various tests were performed using Riverbed 17.5 simulator. Performance tests conducted were Delay Performance, Traffic Performance and Throughput Performance. In Delay Performance test, the results were observed for three cases: End-To-End Delay, Wireless LAN Delay and MAC Delay, which indicate that the network under test has high delay. Traffic performance test included three cases: Traffic sent, Traffic Received and Data Dropped.

The results of this test showed that the network has huge amount of data drop, which consequently leads to low amount of data received. Throughput test shows that under heavy loads such as video conferencing, the network data throughput is lagging the required throughput which is 100(Mbits/sec) [9]. It has been observed from the overall obtained results of this simulation that the wireless LAN under consideration is not a better choice, especially for the applications requiring high bandwidth. This can be due to the fact that there exists many access points on the network.
REFERENCE


Free Riding in Peer-to-Peer Networks: Review and Analysis

Mohammed Onimisi Yahaya
Department of Mathematical Sciences
Abubakar Tafawa Balewa University,
P. O. Box 0248,
Bauchi, Nigeria
mdonimisi@gmail.com
mdonimisi@atbu.edu.ng
Phone Contact: +966556210175

ABSTRACT

Abstract—The popularity of P2P network paradigm due to the inadequacy of the traditional client-server model to handle increasing exchange of resources amongst millions of users worldwide comes with lots of challenges. One of these challenges is the problem of free riding. Free riding has been identified as a threat to the existence of P2P networks, as it degrades utilization and network performance. The ability to properly understand free riding is vital and critical in order to develop effective countermeasures. In this paper, we examine and discuss the problem of free riders in P2P networks, review the state of the art approaches to combating them and the challenges facing them.

Keywords; free rider, peer-to-peer

1. INTRODUCTION

Peer-to-Peer (P2P) networks have received significant attention in recent years due to the advancement in the world of information technology. P2P networks have inspired the design of social networking sites that made large scale interaction of people and businesses possible. The availability of new forms of P2P paradigms such as B2C (Business to Consumer), B2B (Business to Business), B2E (Business to Employee) and B2G (Business to Government) has made simultaneous exchange of resources among numerous users through the traditional client-server model almost impossible.

The severe limitations of the client-server model in terms of memory, bandwidth, storage and CPU, led to the current rise in the utilization of P2P networks for storage sharing, processing power sharing and large scale content distribution such as video streaming, file sharing, and music sharing. Researchers in [1] reported that in 2010, the P2P traffic made up 53.3% of all upstream and 13% of all downstream traffic in the Internet.

This increase in the use of P2P networks also comes with challenges, which has made it an area of current research. Most of the earlier research efforts on P2P concentrated on the design of efficient search mechanisms, improving resource indexing methodology and performance issues. The original intent of P2P paradigm for large scale content distribution, communication, distributed computation and collaboration is being threatened by the problem of free riding. Researchers in [2][3][4] have identified the existence of free riding in a P2P environment.

The statistics in [2] show that 25% of the peers provides about 99% of the resources in Gnutella. In [5], researchers found the existence of free riding in Gnutella 0.6. The authors in [4] corroborated the result of [2], by confirming that 7% of the peers contributed more files than others in file sharing networks. In [3], the authors reported the effects of free riding on the performance of the networks. These research results exposed the level and the seriousness of the problem, as they found that free riding has increased to 85% in Gnutella. There are good numbers of other measurement studies to confirm the existence and seriousness of free riding such as [6,7]. In [6], the authors performed a measurement study on the traffic of PPlive [8], SOPcast [9] and PPstream [10].

They reported the imbalance between peers file streaming consumption and contribution level. The existence of low fairness ratio in Joost [11] is reported in [7]. In [12], the researchers presented the result of log analysis from Roxbeam Media Networks [13] and confirmed that some peers consume more than their contributions. There is a need for more research effort to develop robust algorithms and techniques to identify free riders if not to completely eliminate the problem, but at least to reduce its effects to the barest minimum.
The remaining part of this paper is organized as follows. Section II describes the P2P networks paradigm. In section III, the problem of free riding is explained in detail. Some factors affecting solutions mechanisms devised to counteract free riding are discussed in section IV. Section V highlights the effects of free riding in P2P networks. Section VI presents a review of the existing solutions and the challenges facing each solution. We propose a taxonomy for free riding mitigation techniques in section VII, while section VIII concludes the paper.

2. PEER-TO-PEER PARADIGM

Peer-to-Peer is a distributed system where all participants have equal standing, that is, every peer can act either as a server or client ("servent"). P2P system is described as a system that relies on computing power and bandwidth of nodes at the ends of a connection rather than concentrating on low number of servers within the network [14]. In [15], the authors defined P2P systems as any network that exhibits the following characteristics: distributed control, self-organized and symmetric communication. There are many types of P2P networks, mostly used for large scale content distribution, file sharing, platform sharing, communication, distributed computation and collaboration. The concept of P2P system is different from that of client-server model in the organizational principles. Each peer in the networks has intermittent connectivity. This ad hoc nature requires self-organization, since there is no central management as in client-server model. The principles of resource sharing are based on voluntary collaboration which provides enabling environment for a large number of peers to participate. Though, every peer has equal standing, there is high degree of entry and exit, high degree of autonomy from central server and exploit resources such as storage, files and CPU cycles at the edge of the network. There are several classifications of Peer-to-Peer networks [16] [17], such as classification based on structure of the network, degree of centralization, level of access and type of service shared. Structural classifications of the network depends on how the nodes on the overlay networks are connected together.

3. FREE RIDERS PROBLEM IN P2P NETWORKS

Free riders exploit loop hole in the design or the objectives and the characteristics of P2P networks such as self-organization, since there is no central management, voluntary collaboration and all peers are of equal standing with intermittent connectivity to carry out their intent. The activities of free riders constitute a serious threat to the existence of P2P as it affects network performance and peer utilization [2][24]. Free riders do not play with the rule of the game of P2P networks, which is supposed to be a cooperative game. These non-cooperative players, that is, free riders, if not checked, will subvert the overall objectives of the networks to satisfy their selfish needs. The first step in an effort to counteract the effects of free riders is accurate identification.

Identification of free riders in a peer-to-peer is a complex problem. There are no general rules for identification of free riders [25], hence, the best approach for tackling the problem depends on some factors such as, the requirement of the network, the design of the network, users’ behaviour, performance requirements of the network, the number of users and the nature of resources shared in the network. For example, a selfish peer that downloads files from other nodes in a file sharing network can easily be identified based on the contribution to consumption ratio. But peers that upload a malicious content so as to deceive other peers to download equal content are also free riding. Also, a peer that deliberately uploads useless files that do not benefit others, but hide under that cover to download file from others is also a free rider [26]. Misreporting of bandwidth by peers to deceive other peers is also free riding [27]. Recent works identified trustworthiness as a vital component in the quest to track free riders [23], [28]. The authors proposed taxonomy based on trustworthiness of a peer, described the possibility of flip-op behaviour of a free rider at any time t and at a particular situation. Hence, they categorized a malicious free rider based on some conditions such as, time, need, region, that is, specific group of users in the networks and always.

4. FACTORS TO CONSIDER IN FREE RIDING

AND SOLUTIONS

The problem of free riding in a P2P networks is a complex problem of economics and rational behaviour amongst people of diverse interest whose utmost interest is to maximize utility. There are wide ranges of factors that need to be considered in the modeling, identification and providing solutions to the problem of free riding in P2P networks. These factors also determine the extent of the impact of free riders on the network, which generally deplete performance and utilization. In [29], the authors suggested that a free riders counter measures should be simple, abuse-proof, low overhead and decentralized. We discuss below far reaching factors that, in most of the cases, tamper with these specifications and other requirements.
(i) **Type of Service:** The type of services offered by a particular P2P network affects the solution or mechanism designed to curb free riding. For instance, file sharing, mostly is not real time, gets all or nothing, since an incomplete file is mostly not useful but, live video streaming services is mostly real time, with delay of few seconds at most. In this case, developing the same free riders mechanism for both services will not yield the same performance.

In BitTorrent file sharing system, tit-for-tat mechanism [30], [31] reduces the problem of free riding, though it still exists. In live video streaming services such as PPstream [10], bidirectional exchange of services is rear. In this case, User A provides to user B and user B provides to C. In this case, User B and C not providing to User A and B respectively is not a deliberate free riding. In this scenario, tit-for-tat and direct reciprocity techniques will not be suitable, though free riding may still exists [6][32].

(ii) **Human Behaviour:** Users’ behaviours such as selfishness, rational thinking and generosity pose another challenge to the quest to fully understand and model the problem of free riding in order to proffer effective solutions to the problems [33][34]. In [34], the authors argued that in P2P networks, if not for “altruism” of some peers, all users will have been free riders. Researchers in [35], described the challenges of modeling a rational behaviour in P2P networks. They reiterated that the traditional assumption of the original design of P2P networks is that of obedient user. Such an assumption without considering the divergent reasoning of users’ selfish interest is unrealistic. Sometimes users hide their actions, misreport their bandwidth and lie about their identity. All these characteristics that are complex to model undermine mechanisms designed to track free riders.

(iii) **Client Structure:** The design and structure of P2P networks client can significantly affect mechanism to inhibit free riding. For example, client modification as in BitThief [17], [36]. This was a client designed to free ride on BitTorrent by modification of its structure through the use of some known weaknesses of BitTorrent such as uploading garbage, downloading from seeders only-those peers that already have complete files and aggressive connection opening by querying the tracker continuously [16].

(iv) **Location of peers in the Networks:** The physical positioning of a peer can affect the interaction of peers in the networks. In [5] and [37], the authors reported that placement peers together to form a community of interested peers can enhance cooperation and sharing.

(v) **Network Structure:** The design of the network topology and structure affect free riding mechanisms. One of the challenges facing the monetary incentive technique is the issue of accounting information. To be able to track all transaction in the network, there is a need for central authority to manage the account. In pure P2P networks such as Gnutella, tracking free rider can be a herculean task due to the unstructured nature and low degree of centralization. However, later versions of Gnutella, Napster and Morpheus have some level of centralization where a set of computers referred to as super peer or ultra-peers maintains the list of available resources in the database. This has some level of centralization which eases monitoring and hence tracks free riders.

5. EFFECTS OF FREE RIDING IN P2P NETWORKS

A Although, most of the popular P2P systems such as BitTorrent, Gnutella, Napster, and KaZaa have mechanisms for discouraging free riders, the problem of free riding still poses a serious threat to the existence and survival of P2P systems. The impact of free riding differs from one network to the other. It ranges from simply annoying the networks or so severe that could bring down the whole system, depending on the networks [38]. For instance, in [39], the authors posited that free riding affects robustness, expandability and availability of P2P networks. They asserted that a network without a free rider counteracting mechanism will have a short life time. This assertion is supported in [40], as the authors argued that if the degree of free riding exceeds the benefits of contribution, the system can be brought to a standstill.

Furthermore, it is reported in [41] that if the menace of free riding is not checked, P2P networks will be reduced to Client-Server paradigm. As the number of free riders increases, the network performance is degraded by the increase in traffic generated by free riders to the networks. The few altruistic peers will become ‘server’ to the free riders constituting a bottleneck to the networks. However, in [42], the authors argued that though without external incentives, the level of contribution might be below the socially desirable optimum, file sharing P2P networks can tolerate some degree of free riding due to altruism of some peers. In summary, the effect of free riding in P2P systems cannot be over emphasized as evident in the following recent research work in the literature, summarized as follows; performance degradation [43], increases system stress, degradation of user experience and denial of service [44][45], degrades scalability [46][47], and destroys the philosophy of P2P file sharing network[48].

6. FREE RIDERS MITIGATION MECHANISMS

**Incentive-Based Scheme**

Incentives have been identified to encourage cooperation amongst participating peers in P2P networks. These incentives could be monetary or other kind of non-priced incentives that designers deem fit such as service, delay times, network membership, peer rating and trust [49]. Moreover, most of the incentives approaches differ in the type of incentive used and the methods of managing the incentives. There are several incentive-based techniques proposed in literature. For instance, in monetary incentive scheme, incentive schemes, users are expected to pay for the services received and be paid for services provided in the P2P community.
This approach involves the use of virtual currency or digital coins such as XPay [50], KARMA [51], Mobojation [52] and tycoon [53]. The basic idea is that, attaching an economic value to resources in a social community will serve as incentives to encourage peers to contribute more of their resources and get rewarded. It will also serve as punishment for peers that refuse to contribute resources. Pricing is considered to be an effective means of enhancing peer cooperation in P2P networks [54][55]. Stock market auction based pricing approach is proposed in [56][57]. While the authors in [58] proposed a lottery based pricing approach. Most monetary incentive based techniques are similar. Some of the fundamental differences are the pricing methods and the exchange mechanisms for the virtual currency between peers in a transaction. In [24], the authors suggested flat rate prices for every peer, but this did not effectively discourage free riding due to the availability of cheap pseudonyms and the difficulty in tracking peers’ identity. In [51], the authors proposed a scalar unit currency called KARMA. KARMA is exchanged between peers in exchange for file. This is different from [24] in that the peer does not store the karma. The exchange is made by bank-set, a group of peers that stores the karma. The drawback of this technique is that it is only suitable for structured P2P networks, due to requirement of central administration.

In Ppay [50], the digital coins are with brokers who open and close account for peers. Exchange of these coins is managed through a broker, that is a central authority. In this scheme, peers purchase digital coins with its sequence of unique identifiers. An exchange of resource, in which a peer holding a coin transfers the coin to another peer with its assigned identifier, the broker has to be informed of the new owner. Thus, with the identifier of that coin with the new owner, this can utilize it to make its purchase following the same procedure.

In [24], the authors suggested flat rate prices for every member, but this did not effectively discourage free riding due to availability of cheap pseudonyms and difficulty in tracking peers identity. Stock market auction based pricing approach is proposed in [56][57]. The problems with this approach are; it requires infrastructure for accounting and micropayment [35][50], in this case, there is a need for central authority for administration and control. Communication overhead is also a serious challenge facing the implementation of these schemes.

**Reciprocity**

Reciprocity or barter system involves exchange of services between peers based on peers’ contribution level to each other. The ability of a peer to predict future need from another peer that it contributed a resource to, is central to this approach. It is peers ability to agreeing to offer service based on the possibility of future need from that peer [59]. Tit-for-tat [30][31] in BitTorrent is an example of barter-based approach. There are two types of reciprocity; direct reciprocity which is based on repetition of transactions between peers and indirect reciprocity that is based on reputation through referral or recommendations of other peers that have interacted with a particular peer of interest.

Tit-for-tat in BitTorrent [30][31][60]. In this scheme, peers are enforced to have a repeated transaction with other peers by dividing the files into chunks to be held by different peers. This is to ensure exchange of resources since peers have to provide the chunk it has to receive the remaining chunks from other peers. Choking limits how fast a peer can downloads if it is unwilling to upload files for others. Pure tit-for-tat has been flawed for its inability to ensure fair exchange of files, especially for new comers in a dynamic system environment like P2P. Other mechanisms are proposed to be used together with tit-for-tat in Bit torrent to increase its performance. For instance, source coding approach is proposed in [61]. The rest of the exchange is considered to be a sequence of alphabets. This technique helps in discouraging malicious peer from taking advantage of pure tit-for-tat. Other form of tit-for-tat called Optimistic Unchoking is proposed in [62][63]. In this approach, a peer is randomly selected so as to allow new entrants into the networks to download at faster rate initially, so that in long run they would contribute resources to the network, by the time they have files to share.

Odd-for-even approach proposed in [64], is a slight modification of tit-for-tat. In this scheme, files are divided into two pieces of odd and even, where a peer negociates to exchange the pieces is not in possession of. If a peer sends it odd piece and does not receives the even piece from its partner, hence that peer is choked for free riding.

In [65], the author proposed Treat-before-Trick for BitTorrent-like P2P network. A peer providing a file in this scheme encrypts the files with keys and the decrypting keys of the chunks are shared among the peers. Peers are forced to exchange the keys with one another to download their missing chunks, hence making free riders downloaded files unreadable. The main drawback of this approach is that it does not scale to larger population of peers, as there is no guarantee of repetitive transactions as the number of peers in the network increases. Other serious implementation issues are the peer identity management. The availability of cheap pseudonyms would make tracking peers identity a herculean task.

**Reputation and Trust-Based Scheme**

Reputation and trust of peers have been used to enhance cooperation in a P2P networks by detecting and punishing unwanted behaviour as well as appraising and rewarding good behavior. These have also been employed in tracking free riders, which is an example of bad behaviour in a network. In these schemes, there is need to have trust information and past histories of peers’ behaviour to be able utilize reputation-based approaches. This is based on indirect reciprocity. Reputation based schemes have been proposed for other networks such as mobile and ad hoc networks, P2P storage and P2P multicast. It can also be employed in conjunction with other techniques for identification and control of free riders. Reputation is a means of building trust between peers.
in a distributed environment like P2P. Most reputation-based approaches are similar, the difference are mainly in the methodology of trust inference to determine the trustworthiness of a peer, accuracy and complexity [66].

There are two types of reputation-based systems: global and autonomous. In global reputation systems, all the peers in the networks have reputation database of all other peers, while in autonomous reputation schemes, every peer keep only the reputation information of the peers it had earlier interactions. There are several trust and reputation-based systems for identification of free riders and/or for encouraging contribution. For example, see [67][48][45] Eigentrust [68][69].

In [70], the authors explored three approaches for trust based incentive as trust aware topology construction, trust-based cost searching and trust-based dynamic topology optimization. They suggested that peers be placed on the P2P topology based on the reputation. Such arrangement they claimed encourages peers to contribute more so as to be "promoted" to higher level in order to obtain better service and improved performance and utilization of the networks.

The use of appraisal and blacklist is proposed in [22][71]. The scheme used the activity set model to describe the activeness of a peer. Each peer maintains a blacklist to record any dealing with malicious peer and an appraisal is posted to every other peers in the network in case of "good deal". The authors carried out experiments with three classes of free riders; namely selfish, trustworthy contributors and untrustworthy temporal contributors. The drawbacks of this approach are that it does not scale up to higher population as the number of peers increases. Also, the assumption of honest appraisal and blacklisting by individual peer severely limit this approach.

There are a number of challenges facing these approaches for effective performance in the tracking of free riders. Whitewashing and sybil attack [72], due to availability of cheap pseudonyms in the networks, peers can always change it names and perform every transaction with a new name, so as to thwart the effort to record its bad behaviour in the networks, even though it is free riding. Others might generate several names of itself, and collude to either falsely accuse an obedient peer to tarnish its image or erroneously praise a malicious peer in other to boost its reputation. For performance of reputation based approaches, there is need for some level of centralization and persistent identity. These generate other problems such as the central authority to managing the reputation database might become a bottleneck to the networks. It may cause a single point of failure and vulnerability to attack. In persistent identity, it is difficult to track anonymous peers.

7. TAXONOMY OF FREE RIDERS MITIGATION MECHANISMS IN P2P SYSTEMS

Free riders problems in P2P networks have been addressed with different approaches as presented in section 5. Some of the techniques are designed to encourage cooperation amongst peers, other are tailored toward detecting and punishing, counteract or to mitigate the activities of free riders. We present and discuss a set of criteria we use to compare and characterize existing mechanisms for identification and control of free riding in P2P systems.

Assessment Criteria

We will compare and contrast the three classes of free riders mitigation approaches namely micropayment, reciprocity and Trust/Reputation mechanism based on the following criteria.

a) Incentives utilized: Incentives have been identified to encourage cooperation amongst participating peers in P2P systems. These incentives could be monetary such as digital coin and other kinds of non-priced incentives that designers deem fit. Incentives used in literature are TTL (Time-to-live), Bandwidth, service, delay times, network membership, peer rating and trust [73]. Moreover, most of the incentives approaches differ in the type of incentive used and the methods of managing the incentives.

b) Decision making: In P2P network sharing, decisions are made from time to time by peers. Decisions such as to share or not, decision to lie or not. This decision depends on the peer behaviour or the information available to the peer at that time.

c) Information Gathering and Storage: Decision are taken based on the information available to the peer. This information is gathered differently by various approaches. The information may be collected by the central authority or super peers and stored globally for every peer in the system, or collected and stored locally with the peer.

d) Target Objectives: The objectives of free riding mitigation mechanisms are: (1) fairness among all participating peers. (2) Enhancement of cooperation through incentives for resource availability (3) Detecting and punishing bad behaviour for authenticity of available resources. Every mechanism target one or more of these objectives.

e) Applicability: We have different structural classification of P2P systems, each mechanism for counteracting free riding is better suitable for a particular structure for performance. For instance, some methods may perform better if implemented on a hybrid or centralized unstructured P2P networks.

f) Implementation Requirement: Every mechanism for curbing free riding has a specific need for ease of implementation, application requirement and optimal performance.
8. CONCLUSIONS

Free riders problem poses a great challenge to researchers and developers of P2P networks. Though, various techniques and mechanisms have been designed to curb free riding, nevertheless continue to exist. There is no definite procedure to tackling free riding due to the complex nature of the problem. As such, both the problem and solution may vary from one network to the other. We have surveyed and presented in this paper the state-of-the-art techniques for identification and control of free riders in P2P networks and challenges facing them. We are currently working on an approach to design a finer sieve for identification and robust solution for mitigating free riders.

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Table: Comparison of Free Riders Mitigation Mechanisms
Diversity and Framework for Sustainable Energy Development in the Developing Economy: A Dynamic Hypothesis of Technology Transfer

T.K. Olaniyi PhD
Reader in Engineering
Afe Babalola University Ado-Ekiti
tkolaniyi@yahoo.co.uk

ABSTRACT

This paper describes the inherent diversity and framework for sustainable energy in the developing economy by developing the associated dynamic hypothesis. Energy systems include hierarchy of subsystems; hence its success or failure would depend of the various interconnections and interactions. Most energy programmes designed for the OECD nations often fail when applied to the DE due to the inherent feedback dynamics. Diverse parties with sometimes opposing objectives have addressed the term ‘sustainability’ to communicate different policies. However, the issue of energy usage is beyond climate change, resource scarcity to include how energy resource use reinforces inequalities and destroys the ecosystem. Technology would act as a mechanism for reducing inequality, improve the standard of living and minimise the impact of energy use on climate change if properly managed in the DE. Producers that take the initiative to produce greener products will have a competitive advantage. Energy market failures due to inappropriate resource pricing should be discouraged if DE is to pursue SED and hence the need for paradigm shifts in policy and planning formulation. Market-based energy prices, privatisation, and the possibility of independent power generation will favour investment in new and renewable energy technologies and technology transfer to the DE. Although, there is no conclusive evidence in affirm the forecasted threats of climate changes, however, renewable energy technologies would be environmentally appropriate in the DE. DE endeavours toward greater international co-ordination in energy policy are positive move towards SED and DSS would enable energy planners to make informed sustainable energy decisions even in the absence of adequate and accurate data.

Keywords: Diversity, Framework, Sustainable Energy, Developing Economy & Technology Transfer

1. INTRODUCTION

Energy systems include hierarchy of subsystems used in extraction, consumption and waste disposal. Inputs, processes and outputs are three divisions of a system; it will therefore suffice to anticipate the success or failure of an energy economy to be dependent of the various interconnections and interactions. Regrettably, the energy sector of many Developing Economies (DE) lacks the necessary control measures (feedback and feed-forward) for its sustainable development [1]. Although Decision Support Systems (DSS - as computer-based systems) can bring together information from a variety of sources and assist energy planners and their advisers, however and regrettably so, current energy planning tools adopted in the DE do not take into account the interaction of the heterogeneity and dependence of its users group – problem owners. A viable Sustainable Energy Development (SED) policy for the DE should include analysis, evaluation, and assessment and the need for feedback and feed-forward mechanisms in achieving the prerequisite policy goals.

It has been noted in [1] that most energy programmes specifically designed for the OECD nations often fail when applied to the DE because the planners focused on the internal forces while ignoring the peculiarities of the inherent external feedback dynamics of the DE. The authors in [1] postulated that System Thinking (ST) and System Dynamics (SD) share a systemic view of the problem domain. Complex requirements of Sustainable Energy Development (SED) in the DE will require (ST/SD) paradigm in understanding energy issues. It is therefore the precept of this paper that sustainable economies on a worldwide scale are difficult without the integration of planning and policy objectives. This paper describes the diversity and framework of sustainable energy in the developing economy and addresses its associated dynamics.
2. DIVERSITY AND CONFLICTING GROUPS IN SUSTAINABLE ENERGY DEVELOPMENT

Diverse parties with sometimes opposing objectives have addressed the term ‘sustainability’ to communicate different policies. This divergent and opposing opinion suggests the need for further clarifications in order to facilitate better understanding of the various policy options. Sustainable Energy Development (SED) for an oil exporting Developing Economy such as Nigeria (keen to maximise the sales of its petroleum to achieve socio-economic development) might be different from that of many other DE’s with a different energy resource endowment (Botswana, India or Sri-Lanka). The issue of energy usage is beyond climate change, resource scarcity and ecosystem disruption and touches on how human live as energy resource use reinforces inequalities and destroys the ecosystem.

When viewed from DE perspective, this paper agrees with the assertion in [2] in some respects and disagrees on others. SED touches on the framework for planning and policy formulation. Contrary to the position in [2], this article argues for the significant role of ‘technology’ in the pursuit of SED in the DE.

Technology would act as a mechanism for reduction in inequality, improve the standard of living and minimise the impact of energy use on climate change if properly managed. This paper recognises the three (consumers, producers and capitalist shareowners) human groups that are in conflict with each other without consideration of the natural environment (Figure 1). Natural environment is the source of resources from which the producers develop and produce products or services for consumers and profits for the capitalist-shareowners.

An erroneous simplified hypothesis might suggest that the planet has an organic ability to protect itself; however, the natural environment has no proactive mechanism for responding actively to the three human actors noted above! If natural environment were passive, human groups would come into conflict with each other (Figure 1) as the economic systems expand. The environment represents a constraint on human groups (that are inherently conflicting with each other) and undoubtedly, the rate of economic and technological development would bring the earth to its limits! As the natural environment cannot protect itself, viable development requires human actors through rational planning (and policy formulation). It requires imposition of costs if such activities disturb key natural processes and in extreme cases where it makes human life on earth unsustainable.

![Figure 1 Environment and the Three Conflicting Humanity Groups](image)

Consumers, producers and the capitalists-shareowners should equitably share the cost of SED. However, there are losers in the short-run due to costs that could affect employment and profit. This will come about as the pressure for more sustainable products grows - producers that take the initiative to produce greener products will have a competitive advantage over those that ignore the warning – this is not just a prophesy but the reality of the known moment!

Globalisation could increase conflict within and among nations as pollution and the associated climate-change cut across national boundaries and sovereignties. Consideration of globalisation is necessary in addressing SED. As humans are part of the ‘whole’ (environment), this makes the task harder to tackle due to inadequate knowledge of environmental impact, as the parts (human beings) cannot...
understand the whole (environment)! Traditional approaches adopted by planners in diffusing the conflicts of human activities focuses on economic, social and technical aspects. However, traditional approaches do not reflect the conflicts and imbalance in wealth and energy resources among nations or group of nations.

If the focus of SED centres on a single country or economies (such as the ‘Kyoto Convention’), the opportunity for evasion becomes even greater. Major producers and polluters with the necessary economic wealth and political affiliation can move to nations (mainly DE and transition economies) where the regulatory pressures are weak in the wrongly argued interest of joint implementation, carbon credits, employment creation etc. Regulatory framework needs to extend to all local, regional, national, and global actors. Specifically, decision makers need to set new environmental, economic, social, and technological standards and regulations with all the human actors included.

3. FRAMEWORK AND CAUSAL LINKAGE OF SUSTAINABLE ENERGY IN DEVELOPING ECONOMY

This paper proposes that the route to SED requires various dimensions such as social, political, and environmental factors (Figure 2) using technology as the main driver. SED should focus on maximising the services from a given energy input (efficiency of energy conversion). The output-input maximisation should integrate externalities to the society as a whole. In economies such as DE where the energy consumption is sub-optimal, SED should not necessarily require the reduction in amount of energy services consumed per capita.

The required policies for sustainable development are wide and diverse as it includes proposal to limit population growth and encouraging biodiversity. Traditional measures of economic growth obscure the trade-off that exists between the sustainable economic development and environmental protection policies. Such measures need to be scrutinised in their adoption for SED in DE. Experience shows political rather than resource economics or competitive market dictates energy productions (mainly fossil fuel). Energy availability will continue to be a major and a potential source of conflict, and the effect would be most detrimental in the DE. This suggests that DE would have to seek an alternative and indigenous sustainable energy sources in their pursuit for SED.

On the issue relating to technology progress and economic growth, it was positioned in [1] that for SED to manifest, the role of technology is prerequisite. Hence, the so-called ‘rational economic transformation agenda’ that were popular in many DE might not attain its intended goal without the full backing of sustainable technological integration. Figure 3 shows the position of this paper and those articulated in [1] on the directional causality between technology and economic growth via progressive learning and understanding. The figure describes the existence of a positive feedback between technology and economic growth (dash line in Figure 3).
Ignoring this assumption would indicate a negative connotation that assumes technology as a passive or an infinite resource in SED. Such position encourages waste, retard learning, promote mismanagement, glorify corruption etc. Decision makers of energy policy would have to understand the strength, causal direction, and causal relationship between key decision variables.

Figure 3: Causal Links of Sustainable Technology and Economic Growth

Realisation of SED in DE would encompass international communities’ supports. World economies can jointly produce new ideas and enact the innovative policies for SED as argued. Energy scarcity in the DE relates not only resources, but also the technologies available during the planning and policy formulation - necessary for pricing energy resources. Renewable energy sources could provide a means for a year-round electricity services and thus meeting the energy demands of remote households.

However, there is a need for further study (future work) to the increasing utilisation of renewable energy in SED. Energy market failures due to inappropriate resource pricing should be discouraged if an economy is to pursue the internationally proposed sustainability objectives [3 and 4]. International action will help force the market towards more environmentally compatible costs of natural resources, especially for the exhaustible finite-resources [5].

Development entails satisfying the basic human needs i.e. decent employments, food, health services, education, housing, running water, sewage treatment etc. Lack of access (majority) to such services is a fertile ground for political unrest (insurgents), revolution, and the hopelessness and despair in DE (artefacts of such has been witnessed in Nigeria, Tunisia, Egypt, Somalia, DR Congo etc). This often led to emigration to developed economies (in search for better standard of living). Further, much of the energy for agriculture, transportation and domestic activities in DE comes from human labour and animals. Other sources include biomass i.e. fuelwood, animal wastes, and agricultural residues. This paper reasserts the position in [1] that the political disparities within and among the DE require a paradigm shift in policy formulation and execution of planning techniques in their pursuit for SED.
4. DYNAMICS OF SUSTAINABLE ENERGY DEVELOPMENT IN A DEVELOPING ECONOMY

Increase in energy consumption in the last century is mainly due to the increase and rapid growth of fossil fuels consumption and given the current trend, DE are likely to increase their share. Past trends reveal a strong correlation between energy consumption (per capita) and GDP - economic indicator of country development [6]. Economic development objectives and inadequate scientific knowledge of climate change prevent planners in both Organisation of Economic Cooperation and Development (OECD) nations and DE from paying adequate attention to environmental impact of fossil fuel consumption. However, governmental effort has taken on a different dimension since the oil price increase in 1973. The combustion of finite reserves of fossil fuels results in their depletion over time. Economists argue that the carrying capacity of the planet as a whole is so large that new discoveries offset current production. Although this may be true on a global scale, it is unlikely to apply at the level of the individual nation-state.

The prices of natural resources do not always show the aspect of depletion; other economic factors are the main determinants. Many ‘oil-rich oil-exporting’ DE heavily subsidised the majority of their domestic oil consumption. Similar scenarios occur in many ‘oil-importing’ DE with majority of their petroleum products heavily subsidised. The price of electricity in many DE are highly subsidised, hence its price is below the long-run marginal costs of service provision. Subsidies for natural gas and coal are even more prevalent and their real prices do not reflect the actual market opportunity costs for such energy products and services. This line of policy though might be a short-term fix; its implications for SED in the DE could be catastrophic.

Local or community-based management would provide ‘efficient’ management regimes in many socio-economic environment of DE. The realisation of optimal market regimes to the socio-economic environment would require decentralisation of energy planning and management decisions in the DE. It is paramount to introduce specific measures (compatible with the energy market) using market-based instruments that attract renewable and efficient energy resources. These measures should assist DE in meeting both their implicit and explicit obligation in their pursuit for SED. Decentralisation would help local energy managers in designing and modifying energy resource regimes according to the local socio-economic environment. Non-inclusion of the socio-economic factor in the energy market would be detrimental to efficiency and SED and would leads to high energy exploitable and resource degradation. In achieving sustenance in DE, appropriateness of the chosen technology and resource regime are prerequisite.

5. TECHNOLOGY TRANSFER FOR SUSTAINABLE DEVELOPMENT IN DEVELOPING ECONOMY

Sustainable technological framework must be globally available and accessible for the successful implementation of SED. The world currently lives in an age of rapid and accelerating change that is vastly different from the way the previous generations did and there are speculations that the next generations will be different from the current ones. In many part of the world, new technologies are transforming the standard of living. Television, mobile and satellite communications has transposed many people in the DE from self-sufficient isolation to membership of a global village. The issue of technology transfer in the context of DE is an important and complex task for energy planners when non-indigenous energy technologies moves from one or more developed economy to a lesser technology DE. The concept of technology transfer is deceivingly simple. However, unless cultural, organisational, and technical aspects are fully considered, limited success is likely from its implementations (Figure 4).
DE will have to increase their efficient energy usage at an acceptable economic-cost to enable SED. Development of indigenous energy resources is a great necessity for many DE, most of which spend significant amounts of scarce foreign reserves to import fossil fuels. If DE were to adopt energy-efficient technologies, high energy-intensive growth would need avoidance. However, high energy-intensity would create a huge opportunity for cost-effective investment in the energy sector of DE. Inefficiencies had and will continue to have serious implications for sustainable development. The energy industry in the DE will be competitively disadvantaged in the global energy market when their business consume three (3) times the energy consumption as compared to modern industrial facilities in the OECD nations.

Market-based energy prices, privatisation, and the possibility of independent power generation will favour investment in new and renewable energy technologies and technology transfer to other countries. In the DE, transaction barriers hinder investments and transfers, especially those relating to capital, information, infrastructure, market institutions, human resources capabilities, and institution incentives. Decision-makers must foster proactive market intermediation and joint ventures. SED policies in the DE in respect of bilateral and multilateral agencies would facilitate market intermediation. Capacity building in energy industry should address skills in economic analysis, sustainable energy management, and finance.

Further, issues in relation to information services, regulatory development, new market intermediation institutions, stronger legal and market institutions, implementation mechanisms supporting independent power producers and policies that support energy services companies are prerequisite to SED.

Existing market conditions in the DE does not adequately encourage the adoption of renewable and efficient energy resources. It is not sufficient to rely wholly on consumer preference, hence decision makers must take a more proactive measures to ensure continue adoption of renewable and efficient energy resources. Adoption of sustainable energy policy would need criteria relating to security, long-term sustainability of fuel supplies, and the need for environmental protection. Inter-generational ethical concerns suggest that the current generation should pass on to their successors better and secure energy supplies and a cleaner environment. Clearly, this implies conservation of depleting fossil fuels and the utmost use of renewable energy. Energy policy contrary to SED threatened future human existence sometimes too far to understand in its present context. Describing the implications of climate-change as “inexact science” would cause greater hindrance to SED.
SED might not gain adequate credibility under the pretence that there is enough time to adjust to the change or that the threats and their associated problems will disappear with time - *emanated from the glacial change of human society that left plenty of time for adaptive response and evasion*. This paper and similar to the assertion in [1] does not found conclusive evidence in the literature to suggest that the current threats of climate changes would follow the past glacial change pattern. However, renewable energy technologies are environmentally appropriate and renewable-intensive policy is favourable in the DE with acceptable cost burdens. Using scientific knowledge and technological capabilities to design a sustainable energy future, decision-makers in the private and public sectors should be encouraged to reduce consumption and pollution, and increase the use of renewable energy.

6. THE WAY FORWARD FOR SUSTAINABLE DEVELOPMENT IN THE DEVELOPING ECONOMY

The need for a productive energy-planning tool that allows input of relevant variables in the energy systems gives rise to various modelling methodologies. The concerns about climate change; energy demand forecast, population growth etc (as it concerned with DE) can be stimulated and intensely diverse analytical activity in the act of energy planning. Endeavour in many DE towards greater international co-ordination in energy policy incorporating the relevant issues concerning energy demand, supply, and the environmental implication of energy usage [7] are positive move towards SED. Many economies in the developing world are witnessing a change from inherent planned national energy policies to new market structures for the energy utilities [8]. The risks, problems and competitive pressure in complex and dynamic energy-market analyses as observed in the DE are likely to pose modelling of a different sort than those observed in the OECD. It is also important to analyse the imperfect competition within the new regulatory framework such that the transition would be smooth and sustainable.

The process of SED requires a suitable model-based DSS tool as those postulated in [1]. This paper further argued for the simplification of the dynamics and complexities of energy planning and policy formulation in the DE. DSS methodological modelling approach should be uncomplicated, robust, and adaptable to various situations by employing a planning framework that utilises a rigorous set of procedures in the development of a model-based DSS. DSS can be use by energy planners to make informed sustainable energy policy judgement even in the absence of adequate and accurate data.

7. CONCLUSION - DIVERSITY AND FRAMEWORK FOR SUSTAINABLE ENERGY DEVELOPMENT

Energy systems include hierarchy of subsystems; it will therefore suffice to anticipate the *success or failure* of an energy economy to be dependent of the various interconnections and interactions. A viable SED policy for the DE should include analysis, evaluation, and assessment and the necessary feedback and feed-forward mechanisms. Most energy programmes specifically designed for the OECD nations often fail when applied to the DE due to the inherent external feedback dynamics of the DE. Hence, sustainable economies on a worldwide scale are difficult without the integration of planning and policy objectives.

Diverse parties with sometimes opposing objectives have addressed the term ‘*sustainability*’ to communicate different policies. The issue of energy usage is beyond climate change, resource scarcity and ecosystem disruption and touches on how human live as energy resource use reinforces inequalities and destroys the ecosystem. Technology would act as a mechanism for reducing inequality, improve the standard of living and minimise the impact of energy use on climate change if properly managed in the DE. Producers that take the initiative to produce greener products will have a competitive advantage. Traditional approaches adopted by planners do not adequately address the diversities in the DE and energy availability will continue to be a major source of conflicts. DE would have to seek alternative and indigenous sources in their pursuit for SED.

Energy market failures due to inappropriate resource pricing should be discouraged if DE is to pursue SED. Hence, there is a need for paradigm shift in policy formulation and execution of planning techniques in their pursuit for SED. Market-based energy prices, privatisation, and the possibility of independent power generation will favour investment in new and renewable energy technologies and technology transfer to the DE. Although, there is no conclusive evidence in the literature to suggest that the current threats of climate changes would follow the past glacial change pattern, however, renewable energy technologies would be environmentally appropriate in the DE. Endeavour in many DE towards greater international co-ordination in energy policy are positive move towards SED. DSS can be use by energy planners to make informed sustainable energy policy judgement even in the absence of adequate and accurate data.
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Imperatives for Security and Integrity Frameworks In Cloud Computing Environments

G.O. Odulaja & O.B. Alaba
Computer Science Education Department
College of Science & Technology
Tai Solarin University of Education
Ijagun, Ogun State, Nigeria
goddyseyi@gmail.com; alabaob@tasued.edu.ng

O. Awodele & S.O. Kuyoro
Computer Science Department
School of Computing and Engineering Sciences,
Babcock University
Ilishan Remo, Ogun State, Nigeria.
delealways@yahoo.com; afolashadeng@gmail.com

ABSTRACT

Of note is the fact that lately, with the conspicuous presence and domineering influence of cloud computing (cloud for short), virtual computing resources, Information technology Services, data usage and storage are all undergoing paradigm shift as several of these resources and services move from on-premises to public cloud environments. As Cloud Computing Service Providers (CSP) take advantage of virtualization technologies, combined with Do-It-Yourself (DIY) capabilities, to offer to clients cost-effective access to computing resources via the internet, one consistent but major issue in cloud computing is security and integrity and they are interrelated. Security and integrity are serious issue here because they can determine level of acceptability and success of the emerging phenomenon. An insecure outlet cannot claim to have integrity. The converse is also true. This paper reviews security and integrity concerns associated with cloud computing services and environments and offers suggestions to maintain compliance with data security and integrity using a proposed model as virtual resources move from on-premise to public cloud environments.

Keywords: Cloud, Integrity, On-premise, security, Service Providers, Third Party Auditor (TPA)

1. INTRODUCTION

Cloud computing can be described as online computing in which large groups of remote servers are networked to allow the centralized data storage, and online access to computer services or resources. Virtualization (Hypervisor) and virtual appliances are the main features on which the cloud rides. Clouds can be classified as public, private or hybrid. The cloud is private if its infrastructures, services and other resources are entirely owned, controlled and meant to serve a particular enterprise exclusively. A private cloud allows the organization to manage its resources over its own private network. The company owns the service and defines which users can access it and how. Firewall secure and prevents external intrusion into the private cloud. Security risks are thus reduced since everything is managed inside the enterprise firewall allowing a fair use of the applications and the network bandwidth. Enterprises can deploy security protocols and monitor the levels of access to the information and resources available in private cloud. Users of private cloud, the tenants have relative flexibility on policies and procedures for provisioning, usage and security. The owner also controls the maintenance schedule and the upgrades. If hardware fails, the server is automatically booted on the remaining node. It provides direct access to the support team and helps to avoid the downtime. The private cloud works well for infrastructure when it comes to virtualizing servers. It is a good platform for organizations that want to implement the compliance. (Ngongang, 2011)

On the other hand in public cloud computing, the provider makes the resources available to the customers over a public network like the Internet. It owns and runs the technology to deliver the service and the consumers have no control over the operations of the service. Usually the documents of the company which uses the public cloud are stored outside its premises by a third party which they trust and this comes at a cost (Ngongang, 2011).
Hybrid cloud combines the features of both private and public clouds in that its functions, ownership and maintenance responsibility resonates between that of private cloud and public cloud. It is the combination of some private and or community clouds functioning collectively as one cloud and can be seen by the clients as a single entity. Hybrid cloud computing is a platform which interoperates between private cloud and public cloud. It is deployed by organizations, which do not want to put everything in the external cloud (public cloud) while hosting some servers in their own internal cloud infrastructure. The cloud providers are able to process applications which can work seamlessly between those boundaries [9].

In a case where the public cloud fails to handle an application, the request can be forwarded to the private cloud as shown in figure 1. The hybrid cloud validates the fact that not all information technology resources should remain in the public cloud today. When considering the security restrictions and the performance, the need of a private cloud is a fact today. It is imperative that enterprises know which kind of data can be kept locally and what can be processed remotely.

![Fig. 1. Hybrid cloud computing (Source: Acute System Consulting )](image)

1.1 Why the Cloud gains more Attraction

1. **Infrastructural Convergence Benefits**

   Cloud computing relies on restricting sharing of resources to achieve coherence and economies of scale, over a network. At the foundation of cloud computing is the broader concept of converged infrastructure and shared services.

2. **No Requisite Knowledge of Technical Details before Deployment**

   The goal of cloud computing is to allow users to benefit from existing computing and communication technologies and paradigms without the need for deep knowledge about or expertise with each one of them.

3. **Cost Effective**

   It can prove to be cost effective when enterprises take advantage of offers made by Cloud Service Providers. The clients can enjoy the flexibility and possibility of selecting from several available cloud computing resource options offered by the cloud. The cloud aims to cut costs, and help the clients focus on their core business instead of being impeded by IT obstacles. (Hamdaqa, 2012). Put simply, cloud computing, extends an enterprise’s ability to meet the computing demands of its clients and everyday operations at much less cost. The time required to acquire, install and maintain IT infrastructure needed to run the enterprise is drastically reduced, thus saving the enterprise both time and money which can be used to improve and expand the business in other ways.

1. **Reduced Fear of Failure and Redundancy**: Fear of system failure or crash as a result of unanticipated or unpredictable down time or internal or external attack, malware attack and other probable dangers are also imperatives for leveraging unto cloud computing.

2. **Wide Range of Network Access**: Cloud Services can be accessed using desktop computer and
mobile devices such as laptop, PDA, mobile phone, smart phones, tablets etc.

3. **Resource Pooling**: Provider resources are pooled to serve multiple clients

4. **Regulated and Well-Controlled Service** – there are standards established for measuring and billing services rendered.

5. **Virtualisation Benefits**
   The main enabling technology on which the cloud rides is virtualization. Virtualization software multiplexes a physical computing device into one or more virtual copies of the same device, each of which can be easily used and managed independent of others to perform computing tasks. At operating system level, virtualization essentially brings about a scalable system of multiple independent computing devices, idle computing resources can thus be allocated and used more efficiently. Virtualization provides the agility required to speed up IT operations, and reduces cost by increasing infrastructure utilization.

6. **Autonomic Service on Demand** - Autonomic computing automates the process through which the client is provided near real-time services on-demand. By minimizing user involvement, automation speeds up the process, reduces labor costs and reduces the possibility of human errors. (Hamdaqa, 2012).

7. **Service-Oriented Architecture Benefits**
   When clients face difficult business tactical, strategic and IT problems, they could benefit from the Cloud’s adoption of concepts from Service-Oriented Architecture (SOA) that can help the clients break these problems into services that can be integrated to provide a solution.

8. **Service is Globally Available on Pay-Per-Use Model**
   Cloud computing offers all its resources as services, and follows the well-established standards and best practices of SOA to allow global and easy access to cloud services in a standardized way. Cloud computing also leverages concepts from utility computing to provide metrics for the services used. Such metrics are at the core of the public cloud pay-per-use models.

9. **Flexibility and Scalability**
   Cloud offers flexibility and choice, mobility and scalability, all coupled with potential cost savings. Since measured services are an essential part of the feedback loop in autonomic cloud computing, this allows services to scale on-demand and to perform automatic failure recovery.

10. **Dynamic and Mutually Beneficial**
    Cloud computing being a kind of grid computing that has evolved by addressing the QoS (quality of service) and reliability problems is able to provide the tools and technologies needed to compute intensive parallel applications real time at affordable prices to the benefit of the client. Resources are optimized and effectively shared resources with distance as no barrier. According to Hamdaqa (2012), “cloud resources are usually not only shared by multiple users but are also dynamically reallocated per demand.” Consequently, both service providers of cloud services and patronizing individuals and enterprises can benefit from the coalition.

11. **Capacity on Demand Offer**
    One of the significant benefits of leveraging to cloud computing include the fact that on-premise computing infrastructure can be expanded by adding capacity on demand. The model in the figure below from Wikipedia illustrates what the cloud can look like and can offer. (See figs. 2 & 3.)
Cloud Computing

Fig. 2. Cloud Computing Model (Source: Wikipedia)

Fig. 3. Another representation of the cloud computing model. (Source: Wikipedia)
2. RELATED WORKS

Saranya (2012) acknowledge that there is no guarantee that data stored in the cloud is secured and not altered by the cloud or Third Party Auditor (TPA) and suggested, in order to overcome the threat of integrity of data that the user must be able to enlist the service of a TPA. He stressed that the TPA has experience in checking integrity of the data unlike clouds users. He also suggested that for the data in the cloud to be correct, consistent, accessible and of high quality data integrity provision of cryptographic key to secure the data is necessary.

Gondaliya, 2011 confirmed that security is the major issue in cloud Computing. He identified security concerns arising in cloud computing environments and outlines methods to maintain compliance, integrity and preserve security protection. He provided a checklist of key questions to be considered by enterprise and service provider for cloud computing deployment.

Hamdaqa (2012) observed that Cloud computing extends an enterprise’s ability to meet the computing demands of its everyday operation. Offering flexibility and choice, mobility and scalability, all coupled with potential cost savings, leveraging many enterprises to cloud computing. He however noted that the area of concern, causing hesitation on the side of enterprises most when it comes to moving business workloads into public cloud is integrity and security. He spoke extensively on the several cloud services available such as IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service) and UaaS (Unified Communications as a Service), and offered some best practices suggestions to service providers and enterprises.

Ngongang (2011) recognized the security issue associated with the cloud. He stressed that the security in the cloud is a concern nowadays and security professionals are still grappling for the solution. According to him, the virtual servers have permanently in-use operating systems and applications that hold valuable data that make them attractive to malware and intruders. To him, the intruders are permanently looking for vulnerabilities in the applications and networked system to steal and destroy sensitive data.

He suggested the use of Snort, an open source Network Intrusion Detection system to help prevent malware and intruders who through invasion, wants to take advantage of the security weaknesses found in the applications and the operating system. The snort sensor can be configured in order to monitor the network activity. It sends an alert when it finds malicious traffic with the same pattern as those stored in its signature database. Using a network intrusion detection system, one can track down individual hacker after the investigation by watching the attacks that occur and the vulnerabilities that need to be addressed.

According to Smith, although cloud computing has attained a stage of technological maturity, indicating that most of the main issues with cloud computing have been addressed to a degree that clouds have become interesting for full commercial exploitation. This however does not mean that all the problems listed above have actually been solved, only that the attendant risks can be tolerated to a certain degree but there are some integrity and security concerns for the enterprises and organization (Smith, 2014.)

All these boils down to the fact that security and integrity are recognized issues of the cloud demanding serious attention.

3. UNDERSTANDING THE PLACE OF INTEGRITY AND SECURITY IN THE CLOUD

While there had been much emphasis on cloud’s delivery of service, one area of concern however that might be causing deployment hesitation on the side of enterprises when it comes to moving business workloads into public cloud is the sensitive issues of security and integrity. Security has variously been defined as “precaution taken to keep somebody or something safe from crime, attack or danger”; “something that provides a sense of protection against loss, attack or harm” and as “Freedom from worries of loss” (Microsoft Encarta Dictionary). All these definitions are considerable when it comes to enterprise moving business workloads into public cloud. While, the cloud offers various services such as IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service) and UaaS (Unified Communications as a Service) to the public, the important and relevant issues of Security and Integrity must be objectively considered by those desiring to deploy any of them. This paper looks at the security and integrity challenges and its implications on cloud deployment and offers best practice suggestions to service providers and enterprises. According to Webster’s New Collegiate dictionary (2012), integrity is defined as “steadfast adherence to a strict moral or ethical code”, with regards to data encryption, “integrity ensures that information is not altered by unauthorized person in a way that is not detectable by authorized users”.

3.1 Dimensions of Security and Integrity Issues in the Cloud

Integrity and security issues in cloud computing are multidimensional. Amar (2011) identified the following non-trivial issues:

a. Data Location : Different countries have different requirements and controls placed on access.

b. Data Access : Access control is a key concern, because insider attacks are a huge risk. A potential hacker is someone who has been interested with approved access to the cloud.
c. Regulatory Requirements: Organizations operating in the US, Canada, or the European Union have many regulatory requirements that they must abide by (e.g., ISO 27002, Safe Harbor, ITIL, and COBIT).

d. Auditing: This particular item is no small matter; the cloud provider should agree in writing to the terms of audit.

e. Employees’ Training: This is actually a rather important item, because people will always be the weakest link in security. Knowing how your provider trains their employees is an important issue of integrity to consider.

f. Data classification: Is the data classified? How is your data separated from other users? Encryption should also be discussed.

g. Data Interference: one needs to know: Is my data being used while at rest or in transit? Service Level Agreement (SLA) Terms: The SLA serves as a contracted level of guaranteed service between the cloud provider and the customer that specifies what level of services will be provided. 20/20

h. Service Provider’s Historical Record: How long has the cloud provider been in business and what is their track record. If they go out of business, what happens to your data? Will your data be returned, and if so, in what format?

i. Security Breach Eventuality: While many providers promote their services as being unhackable, cloud based services are an attractive target to hackers.

j. Disaster Recovery Plan (DRP): All physical locations face threats such as fire, storms, natural disasters, and loss of power. In case of any of these events, how will the cloud provider respond, and what guarantee of continued services are they promising?

Since the cloud principally offers three major services namely: Software as a service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS), as depicted in the figure below, this paper examines each of them in details in the light of data security and integrity each can offer.

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Cloud Clients
Web browser, mobile app, thin client, terminal emulator, ...

\[\uparrow\]

SaaS
CRM, Email, virtual desktop, communication, games, ...

PaaS
Execution runtime, database, web server, development tools, ...

IaaS
Virtual machines, servers, storage, load balancers, network, ...

Fig. 4. Cloud Computing Services – Fundamental Model
(Source: Wikipedia)
3.1 Considerable Security Issues in SaaS
As identified by Amar(2011), before deploying to Cloud’s SaaS, it is necessary for an enterprise to consider the following key security and integrity issues that are integral to SaaS deployment process: Data Security, Network Security, Data Locality, Data Integrity, Data Access, Data Segregation, Authorization and Authentication, Data Confidentiality, Web Application Security, Data Breaches, Virtualization Vulnerability, Availability, Backup, Identity Management on sign-on process.

Cloud

3.2 Considerable Security Issues in PaaS
a. In PaaS, the provider might give some control to the people to build applications on top of the platform. Realistically however, the client must admit that any security below the application level (such as host and network intrusion prevention) will still be within the scope of the provider.
b. Applications sufficiently complex to leverage an Enterprise Service Bus (ESB) need to secure the ESB directly, requiring leveraging a protocol such as Web Service Security(WSS) (Oracle, 2009). Meanwhile the ability to segment ESBs is not available in PaaS environments. Therefore metrics should be in place to assess the effectiveness of the application security programs.
c. Hackers are likely to attack visible code, including but not limited to code running in user context. They are likely to attack the infrastructure and perform extensive black box testing. The vulnerabilities of cloud are not only associated with the web applications but also vulnerabilities associated with the machine-to-machine Service Oriented Architecture (SOA) applications.

3.3 Considerable Security and Integrity Issues in IaaS
Taking virtual machines, which contain critical applications and sensitive data, off premise to public and shared cloud environments creates security challenges for organizations that have relied on network perimeter defense as the main method to protect their datacenter. It may also revoke compliance and breach security policies. Operating System Security is also a major issue in IaaS. Below are some IaaS specific integrity issues.

3.3.1. Security and Integrity Issues in Cloud IaaS
a. Denial of Service (DoS) Attacks: Some security professionals have argued that the cloud is more vulnerable to DoS attacks, because it is shared by many users, which makes DoS attacks much more damaging. A reference point is that of Twitter. Twitter suffered a devastating DoS attack during 2009.ud 20/20 Version 3.0

b. Side Channel Attacks: An attacker could attempt to compromise the integrity of the cloud by placing a malicious virtual machine in close proximity to a target cloud server and then launching a side channel attack.
c. Authentication Attacks: Authentication is a weak point in hosted and virtual services and is frequently targeted. There are many different ways to authenticate users; for example, based on what a person knows (e.g ATM PIN), has (such as ID card), or is (Biometrics). The mechanisms used to secure the authentication process and the methods used are a frequent target of attackers.
d. Man-in-the-middle Cryptographic Attacks: This attack is carried out when an attacker places himself between two users. Anytime attackers can place themselves in the communication’s path, there is the possibility that they can intercept and modify communications.
e. Network Security:
   - Network penetration and packet analysis
   - Session management weaknesses
   - Insecure SSL trust configuration.
f. Web Application Security:
   - Broken authentication and session management
   - Cross-site request forgery
   - Insecure direct object references
   - Insecure cryptographic storage
   - Failure to restrict URL access
   - Insufficient transport layer protection
   - Un-validated redirects and forwards

3.4. Non-Software Cloud Security Challenges
3.4.1 Administrative Access to Servers and Applications
One of the most important characteristics of cloud computing is that it offer ‘selfservice’ access to computing power, most likely via internet. In traditional datacenters, administrative access to servers is controlled and restricted to direct or on-premise connections. In cloud computing, this administrative access must now be conducted via internet, increasing exposure and risk. It is extremely important to restrict administrative access and monitor this access to maintain visibility of changes in the system control.
Virtual machines (Cloud Servers) are dynamic. They can quickly be reverted to previous instances, paused and restarted, relatively easily. They can readily be cloned and seamlessly moved between physical servers. This dynamic nature and potential for VM sprawl makes it difficult to achieve and maintain consistent security. Vulnerabilities or configuration errors may be unknowingly propagated. Also, it is difficult to maintain an auditable record of the security state of a virtual machine at any given point in time. In the cloud computing environments, it will be necessary to be able to prove the security state of a system, regardless of its location or proximity to other, potentially insecure virtual machines.

3.4.3 Vulnerability Exploits and VM-to-VM attacks
Cloud computing servers use the same operating systems. Enterprise and web applications as localized virtual machines have physical servers. The ability for an attacker or malware to remotely exploit vulnerabilities in these systems and applications is a significant threat to virtualized cloud computing environments. In addition, co-location of multiple virtual machines increases the attack surface and risk of VM-to-VM compromise. Intrusion detection and prevention system need to be able to detect malicious activity at the VM level regardless of the location of the VM within the virtualized cloud environment.

3.4.4 Data Integrity: Co-location, Compromise and Theft
According to the 2008 Data breach Investigation Report conducted by Version Business Risk Team, 59% of data breaches resulted from hacking and intrusions. Dedicated resources are expected to be more secure than shared resources. The attack surfing in fully or partially shared cloud environments would be expected to be greater and cause increased risk. Enterprises need confidence and auditable proof that cloud resources are not being tampered with nor compromised, particularly when residing on shared physical infrastructure. Operating system and application files and activities need to be monitored.

4. SUGGESTED SOLUTION APPROACHES - FACTORS TO CONSIDER BEFORE DEPLOYING ONTO THE CLOUD

1. Identify the Offer: it is essential to identify the assets in the cloud computing and their importance. Basically, cloud offers three major services:
   a) Platform as a Service (PaaS) – which covers various operating system platforms, database, web server, execution runtime, development tools and others
   b) Software as a Service (SaaS) – which comprises of applications (email, virtual desktop, CRM), functions and processes, games
   c) Infrastructure as a Service (IaaS) – these encompasses the necessary infrastructures of the cloud that drives the cloud (such as the technologies, virtual machines, servers, load balancers, RFID, SOA, WSN, networks protocols,), and network broadband etc. (See figure 3 below).

2. Evaluate the Offer:
   Importance - Determine how important the service is to your organization by considering the following factors:
   a) Vulnerability – What obtains if the asset became widely public and widely distributed or an employee of your cloud provider accessed the asset, and the process or function was manipulated by an outsider, or your information or data was unexpectedly altered?
   b) Down time, Service / Network failure - if the service failed to provide expected results what then? Or perhaps the assets were unavailable for a period of time what becomes of your business?
   c) Integrity and Security Implications of Cloud Reality
      a) Users are not fully aware of how cloud services are provided
      b) There is no well demarcated network security border
      c) Cloud computing implies loss of control

Amar (2011) in a white paper on Security in Cloud Computing suggested the exploitation of the following four distinct security technologies –firewall, intrusion detection and prevention, integrity monitoring and log inspection- that can be deployed as software on virtual machines to increase protection and maintain compliance integrity of servers and applications as virtual resources move from on-premise to public cloud environment can convince cloud clients of a more secure service of integrity.

3. Prevent / Reduce Vulnerabilities
   Decreasing the attack surface of virtualized servers in cloud computing environments. A bi-directional firewall, deployed on individual virtual machines can provide centralized management of server firewall policy. It should include predefined templates for common enterprise server types and enable the following:
   1. Virtual machine isolation
   2. Fine-grained filtering(Source and Destination Address, Ports)
   3. Coverage of all IP-based protocols (TCP, UDP, ICMP, …)
   4. Coverage of all frame types (IP, ARP, …)
5. Prevention of Denial of Service (DoS) attacks
6. Ability to design policies per network interface
7. Location awareness to enable tightened policy and the flexibility to move the virtual machine from on-premise to cloud resources

4. Intrusion Detection and Prevention (IDS/IPS)
It is mandatory to shield vulnerabilities in operating system and enterprise applications until they can be patched, to ascertain timely protection against known and unknown attacks. Since virtual machines and cloud computing servers use the same operating systems, deploying intrusion detection and prevention software on virtual machines shields newly discovered vulnerabilities of applications and OSs and do provide protection against exploits attempting to compromise virtual machines.

**Integrity Monitoring**
Integrity monitoring of critical operating system and application files (files, directories, registry keys and values, etc.) is necessary for detecting malicious and unexpected changes which could signal compromise of cloud computing resources. Integrity monitoring software must be applied at the virtual machine level.

5. Log Inspection
Log inspection collects and analyzes operating system and application logs for security events. Log inspection rules optimize the identification of important security events buried in multiple log entries. These events can be sent to a stand-alone security system, but contribute to maximum visibility when forwarded to a Security Information and Event Management (SIEM) system or centralized logging server for correlation, reporting and archiving. Like integrity monitoring, log inspection capabilities must be applied at the virtual machine level. Log inspection software on cloud resources enables:

- Suspicious behavior detection
- Collection of security-related administrative actions
- Optimized collection of security events across your datacentre

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**Fig. 5. Cloud Security and Integrity Model (CSIM) (Source: Odulaja 2014)**
6. CONCLUSION AND RECOMMENDATION

This paper gives an appraisal of the attractiveness of deploying to the cloud vis-à-vis the security and integrity challenges associated with such deployment. Relevant suggestions were offered both to the service providers as well as the client enterprise, as well acknowledged in cloud analytics by several cloud analysts. After discussing the security issues, the paper concludes that we should be careful about the security concerns while putting our business on Cloud. A model (Cloud Security and Integrity Model) that will ascertain the security and integrity of the deployment was developed.

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Neural Network-Based Health Personnel Monitoring System

G. B. Iwasokun, O. S. Egwuche & J. A. Gabriel
Department of Computer Science
Federal University of Technology
Akure, Nigeria
maxtunde@yahoo.com

ABSTRACT

Problems of the conventional health personnel management system include poor monitoring and evaluation. The system also suffers inadequate record-keeping, delayed personnel data aggregation and poor talent and file management. In this research, a neural network-based health personnel monitoring and management system is proposed as a solution to these problems. The system is based on a set of services and clients responsible for data management and has application and database servers as major components. The application servers hold and update the administrator’s settings as well as provide the interaction media. The database server contains all the system datasets and provides mechanism for standard and secured data access. The simulation model, theoretical framework and user interface were implemented using Java programming language. The adequacy and suitability of the proposed system were investigated based on case study of on-duty data obtained from selected health personnel at the Health Centre, Federal University of Technology, Akure (FUTA), Nigeria. Obtained results presented the new system as a good health personnel monitoring and management platform.

Keywords: Health personnel, monitoring system, neural network, human resource, system administrator

I. INTRODUCTION

In most working environment, there are several resources of which the most important is the human resource (HR). Effective and efficient management of HR will go a long way in achieving the set goals and objectives. Stakeholders in human resource management including researchers have realized that managing people proactively or reactively was no longer viable and therefore, strategic and effective human resource management is the new focus. Strategic HR management has continued to facilitates encouraging return on investment and sustainable competitive advantage. In view of this, HR professionals’ role has changed greatly from administrative to highly strategic. HR strategists are now focused on mechanisms for streamlining various functions for the overall organization’s success [1]. The traditional human resource management (HRM) has changed from people-oriented approach to knowledge and technology-based administration. This is necessitated by the competitive demand of the market place for a re-orientation of strategic human resource philosophies and practices. The upsurge of technology-based management systems has led to several and related human resource management systems for core services at global and national levels.

A computerized human resource management and control system consists of a fully integrated, organization-wide network of HR-related data, information, services, databases, tools and transaction [2]. It is good for improved HR administration, transactions and process performance. Other benefits include increased access to HR data, streamlined and standardized processes, consistent and accurate data and a higher internal profile for HR.

In the health sector, adequate monitoring and management of human and material resources is germane for good service delivering. The sector relies on its workforce for effective, efficient and high quality service delivery. Efficient workforce is also required for providing primary health and preventive services, diagnose and treat patients [3]. However, in many health care and delivery systems, human resources systems are limited, inconsistent, out-dated, or unavailable resulting in evidenced-based information for a good understanding on them. Furthermore, there is little consistency on how human resource strategies are effectively managed by most health service providers. Information Technology (IT)-based framework for the management of human resources can be a useful tool for promoting or enhancing evidence-based policy options for the health services. It is also important in ensuring that the recruitment, training and deployment of health workers are conducted in the most efficient ways.

2. REVIEW OF RELATED WORKS

The author in [4] presented a neuro-fuzzy expert system for human resource procurement and performance evaluation. The neuro-fuzzy mechanism carried out the relevant deductions and inductions on both qualitative and qualitative knowledge modeled in the databases, neural network and fuzzy logic. The system is specifically equipped to perform comparative analysis of the performance of peer personnel using hypothetical data while other major tasks of monitoring and controlling of personnel development, productivity and behavior patterns were not handled.
The authors in [5] presented a neural network-based human activity monitoring system as a means of promoting efficiency and optimization of performances. Though the system effectively classified human activity and presented detailed prescriptions, it failed with cases of over-fitting. In [6], a health services monitoring system is presented. The system facilitates the accomplishment of workforce projections, production, utilization and exit processes for enhanced capacity and contribution to meeting the health needs and objectives. The system is suitable for the determination of the sources and uses of information on human resources but its usefulness in real-life monitoring is not ascertained.

The authors in [7] presented a system for online tracking and monitoring of health personnel at their duty post. The system also provides efficient search, update and verification of prospective personnel duty, qualification, assignments, designation and status. It however lacks the mechanism for promoting unique and updated identity management which results in several conflicts, redundancies and record and data duplications. A model for effective human resource management with focus on job satisfaction, professional and organizational commitment as dependent variable is presented by the authors in [8]. The model is suitable for implementation in electronic-based human resource management but requires very complex hardware and software facilities with high human skill and financial demands.

The authors in [9] presented a multi-layered perception neural networks-based system for tracking and classification of moving objects and scene understanding. The application scenario consists of an entrance access of a touristic village crossed by vehicles and the main focus was on recognising possible presence of pedestrians in the zone. Though, the system recorded high classification rates, its performance under real-life circumstances were not investigated. In [10], a fuzzy logic-based system for linguistic description of students’ behaviour and learning characteristics elicited from teachers is presented. The system also handles the inherent uncertainty associated with teachers’ subjective assessments. Neural networks were used to add learning and generalization abilities by encoding teachers’ experience through supervised neural-network learning. The system effectively managed the inherent uncertainty associated with human expertise in diagnosing aspects of students’ learning style, especially for marginal cases but lacks the platform for real-life monitoring.

A prototype of cloud mobile health monitoring system that uses cloud computing, location data and neural network-based Wireless Body Area Sensor Networks (WBASN) and Smartphone application for patients monitoring is presented in [11]. Though, the prototype is said to have capabilities for monitoring patients’ location and health status through the use of some mobile devices, its implementation and practicality were not presented.

A semantic neural classifier-based event detection system is presented in [12]. The system screens continuous video streams and detects relevant events, specifically for video surveillance. Real-time information is automatically collected by the system for the use of security personnel and decision makers. The proposed system is able to detect and classify the movements of mobile objects but required specialized equipment and environment to function. In [13], the design and preliminary performance analyses of a multi-sensor personal navigator prototype are presented. The implementation algorithms integrate the Global Positioning System (GPS), Micro-electro-mechanical inertial measurement unit (MEMS IMU), digital barometer and compass to provide seamless position information facilitating navigation and tracking of the military and rescue ground personnel. The prototype main point is its presentation of an open-ended architecture that incorporates a simplified dynamic model of human locomotion used for navigation in dead reckoning (DR) mode. However, in its present form, it lacks navigation and imaging sensor data that can be used to monitor confined and indoor environments.

3. PROPOSED HEALTH PERSONNEL ON-DUTY MANAGEMENT SYSTEM

The architecture of the proposed neural-network-based system is shown in Figure 1. The system is based on a set of services and clients responsible for data management. The client platform directs the application logic and its interactions with the user. The application servers hold and update the administrator’s settings and also provide the interaction media for the clients and administrator. The database server is a repository of all the system datasets and provides mechanism for standard and secured access to the data.
The duty registration module (DRM) enables all authenticated personnel to register assigned duties in each working day while the duty management module (DMM) keeps daily records of all duties carried out by each registered personnel. DMM also provides to the administrator, the work schedule for a specified personnel in a given period. The neural networks (NN) module interprets data from sensors, extracts relevant information and grants or restricts access to the system based on pre-established rules. Its operation is based on back-propagation supervised learning algorithm which is widely used in training Multi-layer Perceptron (MLP) which refers to the network consisting of a set of sensory units (source nodes) that constitute one or more hidden layers of computational nodes. The input signal propagates through the network in a forward direction, from left to right and on a layer-by-layer basis. The back-propagation neural network (BPNN) provides a computationally efficient method for changing the weights in feed forward network, with differentiable activation function units, to learn a training set of input-output data.

**a. Image Value by Singular Value Decomposition (SVD)**

The NN component of the system uses SVD to convert digital image into an array of integer values by using the system’s Application Programming Interface (API). The array is used for the computation of the image value representation. The input into the network is the extracted feature values which reflect the intrinsic property of the face and lie in a certain range. Suppose $M$ is an $m \times n$ matrix with entries from the field $K$, which represents the field of real or complex numbers, singular value decomposition of $M$ is performed as follows:

$$M = U \Sigma V^*$$  \hspace{1cm} (1)

$U$ is an $m \times m$ unitary matrix over $K$, $\Sigma$ is an $m \times n$ diagonal matrix with non-negative real numbers on the diagonal and $V^*$ is an $n \times n$ unitary matrix which denotes the conjugate transpose of the $n \times n$ unitary matrix $V$. The diagonal entries of $\Sigma$ are the singular values of $M$ which are listed in descending order. The diagonal matrix $\Sigma$ is uniquely determined by $M$. The single value matrix $A$ is computed from:

$$f_M(A) = \det(A^T A - \lambda I)$$  \hspace{1cm} (2)
is the eigenvalue and I is the matrix of the input face image.

b. Network Input Data Normalization

The input data is normalized mainly for standardizing and transforming the values of all variables from dynamic into specific range by using the following formula:

\[ X_{\text{norm}} = \frac{(X_{\text{raw}} - X_{\text{min}})}{X_{\text{max}} - X_{\text{min}}} \]  

where \( X_{\text{norm}} \) and \( X_{\text{raw}} \) represent the raw and transformed data respectively while \( X_{\text{max}} \) and \( X_{\text{min}} \) are the maximum and minimum values of the dataset respectively.

c. Training and Test Data

The neural network contains two distinctive modes: training and testing. The first 80% data are taken as the training set while the remaining are taken as the test or validation set. The training cases are used to adjust the weights while the test cases are used for the validation of the network. The training datasets consist of input-output patterns which are presented to the network.

The weights are found through an iterative process, in which the back propagation learning algorithm is used to find the weights such that the difference (error) between the given and network computed outputs is sufficiently small. The statistics of the training data represent the analyses of data encountered during operation. The network is said to be bias if it results in classifiers with lower classification rates and estimators with lower prediction accuracies. Samples or feature vectors that do not have major dominant features, unrelated to the problem and common to the specific condition are selected.

In several data sets, the unrelated dominant features are not determined until a neural network is trained and checked against a validation data set. A large number of representative training samples or feature vectors are also necessary for training a neural network to ensure its smooth operation over the expected range of the input-feature space without memorizing the training data. This gives the network a better representation of the desired problem and increases the likelihood of the neural network producing the desired outputs.

d. Neural Network Architecture

The proposed system uses a feed-forward neural network model with four input neurons, two hidden layers and one output layer as shown in Figure 2. The model consists of input vectors to the first input layer of neurons, followed by inter-connected layers of neurons, the hidden layer, and finally to the final or output layer of neurons. Each layer directly supplies input to the next layer and feeds the inputs forward through the network. The management of health personnel on duty post is modeled with input layer of neurons for date, time, face, duty position, username and password. Each output indicates the final classification showing whether the input data for a personnel corresponds with the existing information.

Figure 2 Architecture of a feed-forward neural network with corresponding nodes
The input quantities are fed into the input layer neurons, which in turn, pass them on to the hidden layer neurons, $z_i$, after multiplication by connection weights, $w_{ij}$. A hidden layer neuron adds up the weighted input received from each input neuron, $x_i$ ($x_i$,$w_{ij}$) and associates it with a bias ($b_i$) based on the formula:

$$z_i = \sum_{j=1}^{n} (x_jw_{ij}) + w_{bi}$$

The same operation is performed on the neurons leading to the output layer given as:

$$z_e = \sum_{i=1}^{m} (x_iw_{ei}) + w_{be}$$

$x_i$ are the input quantities such as date and time ($x_{1i}$), face ($x_{2i}$), duty position ($x_{3i}$) for a set of given input $t$. $w_{ij}$ is the weights between the input neuron $i$ to the hidden neuron $j$, and $w_{en}$ is the weights between hidden neuron $j$ and output neuron $k$. $b_i$ and $b_e$ are the biases for the hidden and output layers respectively and they are set to a value of 1. $w_{en}$ and $w_{be}$ are the weights for the bias hidden and output neurons respectively.

e. Learning Algorithm
Back-propagation supervised learning algorithm was selected for the proposed system. Basically, the back-propagation learning involves a set of inputs presented to the network, and a set of the network’s outputs obtained by propagating these inputs through the layers of the network.

An error signal is obtained by comparing the network’s outputs with the actual marked or targeted outputs that corresponds with the set of inputs, and this error signal is used to change the network’s weights. The errors for each input-output are accumulated and the weights updated after each complete presentation of the training data set to the neural network. To avoid over-fitting of the training data, at frequent intervals during the training session, the network’s weights were frozen and the mean square error, on a separate testing data set are calculated. Training is stopped when it is determined that the network’s prediction accuracy deteriorates. In the back-propagation algorithm, the optimal weights generate an output vector $Y= (y_1, y_2, \ldots, y_p)$ as close as possible to the target values of the output vector $T=(t_1, t_2, \ldots, t_p)$ with a selected accuracy. The algorithm adjusts the weights based on the minimization of the squared error.

The network error is defined as:

$$E = \frac{1}{2}\sum_{j=1}^{m} (d_j - y_j)^2$$

$$w_{ej}^{k+1} = w_{ej}^k + \frac{\partial E}{\partial w_{ej}^k}$$

$d_j$ is the output of the neural network $j$, $y_j$ is the actual output and $j=1, 2...m$; where $m$ is the number of neuron in the output layer. $w_{ij}$ is the weight from ith neuron in the previous layer to the jth neuron in the current layer. $\eta$ equals the learning rate, $\delta$ and $\delta w_{ij}$ are the error and weight gradients respectively.

f. Learning Rate
Learning rate determines the magnitude of the changes in the weights for every iteration. At each training step or iteration, the network computes the direction in which each bias and link value (weight) can be changed to obtain a better output. The rate of improvement at that solution state is also known. The higher the learning rate (max. of 1.0), the faster the network is trained. If the selected learning rate is too large, then the local minimum may be overstepped constantly, resulting in oscillations and low convergence to the lower error state. Too low learning rate results in large number of iterations, resulting in low performance. The upward and downward adjustments of the learning rate are presented in Equation 8 and 9 respectively.

$$\delta = \delta + (\delta_{E} \times Mg)$$

$$\delta = \delta - (\delta_{E} \times Mg)$$

Some biases which are associated with some trainable weights are applied to the neurons. The biases are realized in terms of an input with some constant, say +1 or +B input, and the exact bias $b_i$ (at the ith neuron) is then given, to avoid the neuron from having 0.0 values. For this system, the bias is set at a constant value of 1.

g. Modeling Health Worker’s Duty Position
Health workers deliver health care services to members of the community depending on their employer and precise job title. The monitoring of health workers on duty post is modeled as follows:

$$P_1 = W_1 \begin{bmatrix} \frac{P_2}{\alpha_1} \end{bmatrix}$$

$$W_5 = B_2 \begin{bmatrix} O_d \ P_2 = d_e \end{bmatrix}$$

$$O_d = \sum C_{i=1}^{N}$$
P, is the duty positions of health workers in a healthcare and delivery center, T is the total time a health worker is expected to work in a month. i=1, 2, 3, … n, t=1, 2, m. D is the duty position assigned to P, P is the duty status and D is.

and N represent the required time duration for a health worker to be on duty for any particular day, and D is the precise time of the day the health worker is expected to be on duty. A health worker is said to be on duty when the time duration on duty is the same as the time of the day the worker is on duty, otherwise the worker is said not to be on duty.

h. Arrival and Departure Times Production Rule-Based Modeling
Forward chaining mechanism is applied to duty position, arrival/departure time and activities of health personnel based on the production rule defined as follows:

\[
\text{If } \langle \rangle \text{ then Normal arrival} \\
\text{Else if } \langle \rangle \text{ then Late arrival} \\
\text{Else if } \langle \rangle \text{ then Absent}
\]

T is the sign in time and d is the is the precise time of the day the health worker is expected to arrive for duty. The production rule for managing the time of departure of health personnel is given as:

\[
\text{If } \langle T_a = d, + P \rangle \text{ then Normal Departure} \\
\text{Else if } \langle T_a \geq (d, + P) \rangle \text{ then Late Departure} \\
\text{Else if } \langle T_a \leq (d, + P) \rangle \text{ then Early Departure}
\]

T is the sign out time and P is the length of time on duty in a particular day.

i. Modeling Health Personnel Activities
The on-duty activity of personnel is modeled for a period of time N as:

\[
L = \sum_{j=1}^{j_1} \sum_{i=1}^{i_1} \sum_{k=1}^{k_1} \left[ a(t) \right] \\
\]

j is the number of hours spent on the activities, k is the number of days on duty for a month, t is the number of weeks worked in a month. C indicates that the report L is generated for the employee whose details have been obtained earlier and processed successfully based on the established data processing standard.

4. Implementation
The simulation model, theoretical framework and user interface were implemented using Java programming language. Java is a high level language that supports object oriented, portable, distributed, high performance, multithreaded, dynamic and very secure programming. The simulation was on a computer system that executed both the client and server (admin) applications on 2GB RAM and 350 HDD with intel dual core T4200 2.0GHz processor and windows vista operating system. The design tools include NetBeans IDE 7.2 on JDK1.7.0 (Java Development Kit) and MySQL relational database management system (RDBMS).

a. Data Collection
Relevant data for the research were collected based on closed circuit television (CCTV) image of some selected health personnel on duty at the Health Centre, Federal University of Technology, Akure, Nigeria. Some of the services at this centre are listed below.

a. First aid
b. Surgery and its assistance
c. Operating room technician and equipment sterilization
d. Treatment of minor and major illnesses
e. Dispensing drugs
f. Pre and postnatal advices
g. Delivering babies
h. Child care advice
i. Nutrition education, monitoring and feeding
j. Education, monitoring and dispensing of immunization
k. Family planning services
l. Sanitation and hygiene promotion and education
m. Screening, monitoring, follow-up and treatment of communicable diseases
n. Health care referrals
o. Conducting seminars and workshops on school health
p. Collection of vital health statistics
q. Developing, maintaining and reporting health records
r. Home visits
s. Community meetings

The collected data were on times, activities, face, duties and schedule of different personnel and their corresponding units and functions which cover the range of inputs for which the network was designed. The collection prioritized neural network expectations and requirements for training, types and sources as well as envisaged output in response to the used data.

b. Simulation Results
The neural network is considered as a pre-processing block between the input and the first layer of the network and a post processing block between the last layer of the network and the output. The input data are date, time, face, duty position, username and password which were pre-processed before presentation to the network.
The username and password for each personnel were converted into its ASCII (American Standard Code for Information Interchange) equivalent and added up to represent the data value. In the first layer of the network, the net input is a product of the input times the weight plus the bias. If the input is very large, then the weight must be very small in order to prevent the transfer function from becoming saturated. Normalization of the data was also carried out as a way of constraining them into an investigated and approved range. The network output is reversed and transformed into the units of its original data when the network is put to use. The extraction from the raw data for some selected personnel is presented in Table 1 while a sample of the normalize values of the raw data is presented in Table 2.

Table 1: Raw values obtained from processing personnel data

<table>
<thead>
<tr>
<th>ID</th>
<th>EMAIL+PASSWORD</th>
<th>DEPT</th>
<th>SIGN IN TIME</th>
<th>FACE PICTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2585</td>
<td>376</td>
<td>1189632239034</td>
<td>111985</td>
</tr>
<tr>
<td>2</td>
<td>2359</td>
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<td>966288239328</td>
<td>962707</td>
</tr>
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<td>2578</td>
<td>214</td>
<td>1048976639611</td>
<td>112914</td>
</tr>
</tbody>
</table>

Figure 3 shows the result of the prediction error values at different learning rates for the neural network. The learning rate of 0.6025 has the lowest prediction error of 3.33% and was consequently used for the authentication of personnel’s interaction with the system.

Table 2: Normalize values for input into neural network

<table>
<thead>
<tr>
<th>ID</th>
<th>EMAIL+ PASSWORD</th>
<th>DEPARTMENT</th>
<th>SIGN IN TIME</th>
<th>FACE PICTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.68</td>
<td>0.68</td>
<td>0.62</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>0.34</td>
<td>0.49</td>
<td>0.00</td>
<td>0.18</td>
</tr>
<tr>
<td>3</td>
<td>0.23</td>
<td>0.91</td>
<td>0.12</td>
<td>0.57</td>
</tr>
<tr>
<td>4</td>
<td>0.67</td>
<td>0.00</td>
<td>0.74</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
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<td>6</td>
<td>0.09</td>
<td>1.00</td>
<td>0.11</td>
<td>1.00</td>
</tr>
<tr>
<td>7</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.51</td>
</tr>
<tr>
<td>8</td>
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<td>0.63</td>
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<tr>
<td>9</td>
<td>0.38</td>
<td>0.68</td>
<td>0.61</td>
<td>0.66</td>
</tr>
<tr>
<td>10</td>
<td>0.67</td>
<td>0.03</td>
<td>0.23</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 3 shows the result of the classification and prediction error for 8 unregistered data. The value of zero recorded in all cases for “correctly classified records” is due to the non-training of the system and consequently, non-classifications with prediction error of 100%. The system was appraised with the computation of F-score for Table 3 and obtained results are presented in Table 4. F-score is a measure of accuracy based on the precision $p$ and the recall $r$. $p$ denotes the quotient of the number of the correct and the returned results while $r$ stands for the quotient of the number of correct and expected results. The score is interpreted as a weighted average of the precision and recall and reaches its best value at 1 and worst score at 0. Precision, recall and F-score are obtained as follows:

\[
\text{Precision} = \frac{TP}{TP + FP} \tag{14}
\]

\[
\text{Recall} = \frac{TP}{TP + FN} \tag{15}
\]

\[
F - \text{score} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{16}
\]

TP, FN and FP are the true positive, false negative and false positive respectively.
Table 4: Obtained F-score Values

<table>
<thead>
<tr>
<th>S/N</th>
<th>Total Rec.</th>
<th>TP</th>
<th>FP</th>
<th>FN</th>
<th>Precision</th>
<th>Recall</th>
<th>F-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>22</td>
<td>8</td>
<td>0</td>
<td>0.733</td>
<td>1</td>
<td>0.846</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>22</td>
<td>8</td>
<td>0</td>
<td>0.733</td>
<td>1</td>
<td>0.846</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td>0.667</td>
<td>1</td>
<td>0.798</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>25</td>
<td>5</td>
<td>0</td>
<td>0.833</td>
<td>1</td>
<td>0.909</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>25</td>
<td>5</td>
<td>0</td>
<td>0.833</td>
<td>1</td>
<td>0.909</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>29</td>
<td>1</td>
<td>0</td>
<td>0.967</td>
<td>1</td>
<td>0.983</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>26</td>
<td>4</td>
<td>0</td>
<td>0.867</td>
<td>1</td>
<td>0.928</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>24</td>
<td>6</td>
<td>0</td>
<td>0.800</td>
<td>1</td>
<td>0.889</td>
</tr>
</tbody>
</table>

5. CONCLUSION

A neural network-based health personnel monitoring system that offers solution to the data association problem using feed-forward neural networks has been presented. The proposed system has advantages over the conventional personnel management, monitoring and classification schemes in its speed and simplicity. The system is suitable as a tool for effective and efficient evaluation of health personnel. It is also a good platform for providing solutions to the problem of poor record-keeping, delayed personal data aggregation and poor talent and file management in every organisation that provides health services. Area of future researches includes the integration of Radio Frequency Identification (RFID) and fuzzy logic into the system’s architecture for greater and improved personnel monitoring and evaluation. Focus will also be on the use of other biometrics data such as fingerprint as part of the input neurons.

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Development and integration of Text to Speech Usability Interface for Visually Impaired Users in Yoruba language.

O.O. Adeyemo & A. Idowu
Department of Computer Science
University of Ibadan
Ibadan, Nigeria.
E-mail: wumiglory@yahoo.com

ABSTRACT

Text to Speech system (TTS) cannot be overlooked because of the important roles it performs in enabling the user to access the voice output of the input text. Text To Speech is a system that takes text as input and produces the equivalent natural human voice of the text input. The system has been applied in different native languages outside Nigeria. In this paper, we considered development of Text to speech in Yoruba language to assist Yoruba language speaking people especially the visually impaired users, it also helps the users that want to learn Yoruba language from scratch, the aspect of how to learn, pronounce Yoruba language syllable formation from consonant and vowel. The performance of the model was also measured using a standard error metric. There are several methods which TTS system have been applied in other part of the world but concatenative method of speech synthesis through syllable construction algorithm; was implemented using C# Programming language. The performance of the system was measured and the quality of synthesized speech was assessed using Mean Opinion Score (MOS) tool and the system is found to be 4.46 and 3.82 respectively. The MOS scale interpreted the system as a good system.

Keywords: HCI, Text-to-Speech, grapheme, phoneme, waveform.

I. INTRODUCTION

Human Computer Interaction (HCI) is one of the new research areas in Computer Science, a discipline concerned with the study, design, construction and implementation of human-centric interactive system, HCI assistive and user-centric attributes is the reason for writing this paper [3]. Speech technology together with computational resources has well advanced in various dimensions. This is as a result of shifting in traditional techniques of assessing various computing functionality from the use of mouse and keyboard as a means of input for computing to the use of speech technology, especially to assist the visually impaired.

On many occasions, the source of information originates from a human being, and is ultimately to be used by human being [7]. There is thus a need for man-machines interaction, in both directions, which will be effective. A convenient way in many cases is in the form of speech, because speech is the common and most widely used mode of communication between human beings. In general, speech system can be categorized into two broad categories: Speech synthesis and Speech recognition. Speech synthesis is the process of generating spoken language succession from arbitrary text while Voice recognition is the process of converting spoken language into computer understandable text or translate it as command [13].

Some of the speech technology applications include the following: reading machine, voice interface, pocket translator, talking word processor, auto attendants, speech transcription system, voice dictionary, travel reservation agent, call centre automation and so on. The goal of the new trend is to make machines speak and hear like humans do. With this advancement, the world of human communications would be substantially expanded. Achieving the goal for local languages like Yoruba language would also provide novel knowledge about cognition, understanding, and mechanism of speech production and hearing, certainly useful for various aspects of human life.

1.1 Basics of Speech Synthesis

Speech synthesis gives us the ability to convert arbitrary text to an audible audio and natural sound format where the ultimate importance is to convey textual information to the people in natural voice. The major purposes of speech synthesis techniques is to convert a chain of phonetic symbols into artificial speech, to transform a given linguistic representation and to generate speech automatically with information about intonation and stress i.e. prosody. TTS system contains two components: they are Natural Language Processing (NLP) and the Digital Signal Processing (DSP) components [6].
Natural Language Processing (NLP) is targeted to produce phonetic transcription of the text, together with the desired intonation and rhythm. The Digital Signal processing (DSP) transforms the symbolic information it receives from the NLP module into speech [4]. With the help of these two components, TTS systems involve the following stages in the process of converting written text into speech. These steps are text analysis, phonetic analysis and prosodic analysis, and speech generation, they are explained below:

Text Analysis: text analysis involves breaking down of raw text into pronounceable words. It involves the work on the real text, where many Non-Standard Word (NSW) representations appear. For example, the text may contain numbers (year, time, ordinal, cardinal and, floating point), abbreviations, acronyms, currency, dates, URLs. All of these non-standard representations should be normalized, or, in other words, converted to standard words.

Phonetic Analysis: It is simply conversion of analyzed token into pronounceable chunk. The phonetic analysis module takes the normalized word strings from the text processing module and produces a pronunciation for each word. The pronunciation is provided as a list of phones, a syllabic structure and lexical stress. The method for finding the pronunciation of a word is either by a lexicon or by letter to sound rules.

Prosodic Analysis: This stage is where certain properties of the speech signal such as pitch, loudness and syllable length are processed. Finding correct intonation, stress, and duration from written text can be challenging, prosodic features segment speech chain into groups of syllables. This gives rise to the grouping of syllables and words in larger chunks [6].

1.2 Methods of Text to Speech System
A good speech synthesis system must exhibit intelligence and naturalness which forms major characteristics of an ideal synthesizer. The choice or the method employed depends on the language, system and the platform used. There are various ways by which speech synthesis can be carried out. Three major methods are very important and discussed in this paper. They are;
- Articulatory synthesis
- Formant synthesis
- Concatenation synthesis

Articulatory-speech-synthesis: Articulatory based speech synthesis technique attempts to parameterize the human speech production system directly, that is, it tries to model the human vocal organs as perfectly as possible in such a way that each synthetic speech will be similar to the natural speech produced by each vocal organs. This technique basically uses five articulatory parameters: area of lip opening, constriction formed by the tongue blade, opening to the nasal cavities, average glottal area, and rate of active expansion or constriction of the vocal tract. Experiments with articulatory synthesis systems have not been as successful as with other synthesis systems but in theory it has the best potential for high-quality synthetic speech. [8].

Formant Speech Synthesis: Formant synthesizer uses a simple model of speech production and a set of rules to generate speech. While these systems can achieve high intelligibility, their naturalness is typically low, since it is very difficult to accurately describe the process of speech generation in a set of rules. Formant synthesizers may sound smoother than concatenation synthesizers because they do not suffer from the distortion encountered at the concatenation point as human speech sample is not used at runtime. To reduce this distortion concatenation synthesizers select their units from carrier sentences or monotone speech. The synthesis thus consists of the artificial reconstruction of the formant characteristics to be produced [14].

Concatenative Speech Synthesis:
Concatenative synthesis is process of stringing together segments of recorded speech. It is the so called cut and paste synthesis because short segments of speech are selected from a pre-recorded database and joined one after another to produce the desired utterances. In theory, the use of real speech as the basis of synthetic speech brings about the potential for very high quality, but in practice there are serious limitations, mainly due to the memory capacity required by such a system [15]. The longer the selected speech units are, the fewer problematic concatenation points will occur in the synthetic speech. However, the limitation in concatenative synthesis is the need for more memory requirements as the speech unit increases [10]. Other sub categories of concatenative speech synthesis include unit selection, diphone synthesis and domain-specific synthesis.

2. RELATED WORKS
Noriko Umeda et al 1968 [9] built the first general English text to speech, although the first computer based speech synthesis systems were created in the late 1950s. Noriko and his colleague carried out this work at Electro-technical Laboratory, Japan. Their work was specifically based on English language. Breslow, et al. 1982 described the Texas Instruments Speak ‘n Spell toy, released in the late 70s, was one of the early examples of mass production of speech synthesis. The quality was poor, by modern standards, but at the time of creation, it was very impressive [2]. Speech was basically encoded using LPC (linear Predictive Coding) and mostly used isolated words and letters though there were also a few phrases formed by concatenation. Simple text-to-speech (TTS) engines based on specialized chips became popular on home computers such as the BBC Micro in the UK and the Apple.).

Odetunji 2008 developed a neural network model using Multilayer Perceptron (MLP) and Recurrent Neural Network (RNN) [11]. The use of neural network knowledge helped him to develop model that could recognize Standard Yoruba tone, having studied the tonal characteristics of Yoruba. The model used fundamental frequency f0 profile of standard Yoruba syllables to distinguish the high, mid and low tone level in Yoruba language.
Based on linguistic knowledge, the tonal parameters were selected carefully alongside with acoustic data. He concluded that standard Yoruba tone realization problem could be solved with MLP and RNN and that mid tone has highest accuracy, came out with performance result of 71% to 76%.

Akin afolabi, et al. 2013, developed aText – speech system for Yoruba language. Their design also shows the rate of acceptability of the TTS interface from the population of users captured for the experiment [1].

2.1 Description of Yoruba Standard Word
Yorùbá is one of the three major languages in Nigeria. The population of people speaking Yoruba language covers Southwestern Nigeria. It is widely spoken language because of its prevalence both in Nigeria and outside Nigeria like Republic of Benin, Togo and many others [11].

2.2 Yoruba Spelling and Pronunciation
Tone languages, such as Yorùbá and some others are different from languages that have no tone, example is found in languages like English and French [11]. In non-tone language, lexical items are distinguished by the stress pattern on the syllables that constitute an utterance. For example, the English words ‘record’ (verb) and ‘record’ (noun) differ in syntactic class and meaning because of the stress pattern on their component syllables. In the verb ‘record’ the first syllable is stressed [17]. In the noun ‘record’ the second syllable is stressed. In tone languages, tone is used to distinguish lexical items rather than stress. Yoruba has three distinct tones which are HIGH (do), MID (re) and LOW (mi) that can be used to distinguish syllables. The tones are associated with the individual syllables in an utterance. For example, in Yoruba: je’ (H) [to become], jë (M) [to eat], jë (L) [to receive lash] differ in meaning because of the tone associated with each syllable.

2.3 The Yoruba Alphabet
The Standard Yoruba alphabet has 25 letters which is made up of 18 consonants (represented by the graphemes: b, d, f, g, gb, h, j, k, l, m, n, p, r, s, s, t, w, y) and seven vowels (a, e, é, i, o, ø, u) while the Latin Letters ⟨c⟩, ⟨q⟩, ⟨v⟩, ⟨x⟩, ⟨z⟩ are not used. There is also inclusion of a diagraph ⟨gb⟩ which contains combination of two consonants together that form a unit.

### Yoruba Vowel

<table>
<thead>
<tr>
<th>Phoneme</th>
<th>Orthography</th>
<th>Examples</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>/a/</td>
<td>a</td>
<td>ajá</td>
<td>‘dog’</td>
</tr>
<tr>
<td></td>
<td>ìbá</td>
<td>‘motion’</td>
<td></td>
</tr>
<tr>
<td>/ɛ/</td>
<td>e</td>
<td>ewé</td>
<td>‘leaf’</td>
</tr>
<tr>
<td></td>
<td>ëtè</td>
<td>‘lips’</td>
<td></td>
</tr>
<tr>
<td>/ɛtɛ/</td>
<td>ɛtɛ</td>
<td>blood</td>
<td></td>
</tr>
<tr>
<td>/ì/</td>
<td>i</td>
<td>írí</td>
<td>‘dew’</td>
</tr>
<tr>
<td>/ọ/</td>
<td>o</td>
<td>owó</td>
<td>‘money’</td>
</tr>
<tr>
<td></td>
<td>òòdo</td>
<td>‘zero’</td>
<td></td>
</tr>
<tr>
<td>/ɔ/ or /ɔɔ/</td>
<td>c</td>
<td>òfô</td>
<td></td>
</tr>
<tr>
<td>incantation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/u/</td>
<td>u</td>
<td>ojú</td>
<td>‘eye/face’</td>
</tr>
</tbody>
</table>

Adapted from: African Studies Institute manual, University of Georgia, USA
3. METHODOLOGY

This section defines various activities and steps undertaken in the process of designing a befitting synthesizer, in as much as analysis and design frameworks provide a solid foundation for any application. Descriptions of the Yoruba language text to speech system are therefore analyzed. And we make use of concatenative method of speech synthesis. That is, linking together of pre-recorded Yoruba syllable stored in a database.

3.1 General Structure of TTS System

Text-to-Speech synthesis is an attempt to artificially produce human speech. A computer system used for this purpose is called a speech engine. TTS system transforms any text into speech in real time. It literally reads out loud any written information with a smooth and natural sounding voice.

The structure comprises a Natural Language Processing module (NLP) and a Digital Signal Processing module (DSP). NLP is capable of producing a phonetic transcription of the text read, together with the desired intonation. And whatever processing done by the Natural Language Processing unit of the system is received by the Digital Signal Processing (DSP) for transformation into speech wave form. The functional diagram of general Text to Speech is depicted below:

![Diagram of general structure of text-to-speech system.](image)

**Figure 1: general structure of text-to-speech system.**

**Yoruba Syllable Construction**

Syllable is defined to be a unit of pronunciation that has one vowel sound with or without surround consonant which form all or part of a word. The most common sequence is that of a vowel preceded by a consonant e.g. ‘wa’ meaning “come” which has the most usage in word construction. A word can start either with a vowel or a consonant. The three possible syllable structures of Yoruba are Consonant+Vowel (CV), Vowel alone (V), and syllabic Nasal (N) which means there is possibility formation of:

- CV – consonant vowel e.g. “wa” (come), “pa” (kill)
- V – vowel e.g. “a” (we), “o” (she/he – third person singular pronoun)
- N – Nasal e.g. an, un – work in combination with other consonants

A typical Yoruba must start with either vowel or consonant, and can be ended with vowel, example is “Aja” meaning (dog), “baba” meaning (father). But consonant cannot end Standard Yoruba words, for instance, saying “babaj”, “kolat” – are invalid words in Standard Yoruba language, every word must end with vowel or nasal sound only. The syllable is intended to deduce all the possible combination of syllables to enable a vast variety of words to be catered for. The reason for this syllable construction is that, if forms basic speech unit for concatenation.

1) Analysis of The Proposed System

**Synthesizer Design of the Proposed System.**

The task of speech synthesis is to map a text to a waveform. Figure 2 shows the main components designed of Yoruba speech synthesizer. It mainly constitutes the natural language processing module, the digital signal processing module and a Yoruba syllable database which augments the speech synthesis process. Given an input text, the Yoruba synthesizer performs the necessary text analysis. This includes:

- Breaking down of the text input into separate words through blank spaces and full stops.
- Tokenization process takes place which forms an integral part in the synthesizers’ design which basically normalizes numbers.
- The phonetic analysis component performs grapheme to phoneme conversion, which extracts individual phonemes making up the whole word and passes them to the prosodic analysis featuring the intonation, pitch and duration attachment.
Architectural Framework of The New System

Figure 2: Architectural framework of the new system

The structure of the new system is broken down into different modules that are designed to carry out several functions. The arrows point to the module that is used by another module in its operation, for example in the diagram above.

Description of the New System

The YorubaAlphabetManager makes use of the Alphabet module, likewise it (YorubaAlphabetManager) must check from the SoundFileManager to check if there exists such file in the sound file which it can use to concatenate syllables together.

YorubaAlphabetManager – is responsible for the processing and production of alphabet input stream from the backend, constructed from the Alphabet module.

OnscreenKeyboardManager – it is a graphic user interface on the new system that helps the user to write strings of characters.

Tokenizer – this module splits the input text into token (small chunks), which can be inform of syllable or vowel.

SoundFileManager – contains pre-recorded syllables, vowel and consonants from where any matched sound file can be read.

YorubaTTSReader – this is the module that collects tokens from the tokenizer, match it up with equivalent syllable sounds stored in the SoundFileManager module, if the tokens are the same as the sound, YorubaTTSReader reads the text aloud.

Figure 3: Data flow diagram (Dfd) of the new system.

The algorithm for splitting Yoruba words into syllable.

Start
Read in the text
Break text into characters
foreach of the char in the char array
Get the last char
If the last char is consonant and <>n or m Then
return error
Else
Continue

Get the alphabet accordingly and Create a check point
If the alphabet is consonant then
Continue
Else
Get all the alphabets from the checkpoint to the current index as a syllable
Convert the characters
end the loop
stop the program.

4. IMPLEMENTATION

In this paper, text to speech synthesizer for Yoruba language was designed and implemented. It consists of both coding and integration of class modules which are combined together to form a whole and complete system. The implementation was done through transformation of the design using C-sharp programming language for the implementation. There is therefore need to test the system, steps are taken to check the extent to which the synthesizer works, based on what to report, provides findings and suggest further research areas.

4.1 Multimedia Kit Used in Studio

The recording was done under good acoustic condition at Master Sound Studio. The voice recorded was a female voice.
We use female voice so as to have a high pitch and clear sound in the production of the text to speech system. The recording though was not easy and stressful, took up to two weeks before we can get appropriate pronunciations for all the vowels and syllables, just a single syllable can be re-recorded for several times if it does not pronounce the desired or expected sound. In the recording of the syllable, each consonant is matched with every of the vowel sounds and are recorded at length, Cubase voice station software was later used to edit and cut sounds into syllable segments.

4.2 Preparation of Voice Database via Sound Studio Recording

Building the sound file for Yoruba synthesizer is an essential aspect when building a text to speech system for Yoruba language, because from this sound database where sound will be produced to match various texts input, eventually uttered by digital signal processing component of the synthesizer. To prepare Yoruba sound file, we first created inventory of syllable pronounceable in Yoruba.

Yoruba language has 7 vowels and 18 consonants. There are 126 syllables that can be derived for a single tonal level. The three tonal level in Yoruba are “do” (high), “re”(mid), “mi”(low). If we form syllables for the three different tonal levels, we will have 126 x 3 = 378 syllables. Examples of those syllable are “ba”, “be”, “be,”, “bi”, “bo”, “bo,”, “bu”. Nasal vowels (an, en, e,n, in, on, o,n, un) were also part of the inventory created. All of them were recorded. The appropriate set of folders and files were created through recording with Cubase voice station software. All the files are stored in a .wav form with a standard approach in naming them to avoid later confusion. Speech signals are recorded by a close talking microphone using a sampling rate of 16 kHz.

<table>
<thead>
<tr>
<th>Ba</th>
<th>be</th>
<th>be,</th>
<th>bi</th>
<th>bo</th>
<th>bo,</th>
<th>bu</th>
</tr>
</thead>
<tbody>
<tr>
<td>da</td>
<td>de</td>
<td>de,</td>
<td>di</td>
<td>do</td>
<td>do,</td>
<td>du</td>
</tr>
<tr>
<td>fa</td>
<td>fe</td>
<td>fe,</td>
<td>fi</td>
<td>fo</td>
<td>fo,</td>
<td>fu</td>
</tr>
<tr>
<td>ga</td>
<td>ge</td>
<td>ge,</td>
<td>gi</td>
<td>go</td>
<td>go,</td>
<td>gu</td>
</tr>
<tr>
<td>gba</td>
<td>gbe</td>
<td>gbe,</td>
<td>gbi</td>
<td>gbo</td>
<td>gbo,</td>
<td>gbu</td>
</tr>
</tbody>
</table>

Figure 4: few of the Yoruba syllables recordings

Figure 5: Yoruba Database Recordings

Main Features of the New System

- **Welcome Interface/Home page:** it shows first point of contact with the system.
- **Main page:** The main page has features that enable user to load text file which can be read. The main page is initially disabled until text file is loaded into the main page which makes the main page to be enabled; the saved Yoruba text is displayed on the main page to be read.
**Evaluation and Result of the New System**

The performance assessment of the new system is described in this section; we carefully notice and observe the consistency of the system in terms of its intelligibility and naturalness.

*Intelligibility* – describes how accurate or correctly the system pronounces or how closer is the pronunciation to the actual word.

*Naturalness* – describes whether the system produces voice as natural as that of human voice.

The first experiment is on the performance of the system that is assessed on word level. The test consists of 61 Yoruba words selected through the help of a domain expert. We listened to one word played from the synthesizer at a time and marks on the answer sheet for the synthesized word, to know which one is correctly pronounced and the ones not correctly pronounced.

Table below shows the analysis made on the performance evaluation of the test dataset.

<table>
<thead>
<tr>
<th>Correctly Pronounced</th>
<th>Partially Pronounced</th>
<th>Not Correctly Pronounced</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>11</td>
<td>12</td>
<td>61</td>
</tr>
<tr>
<td>% of Words</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62.3%</td>
<td>18.0%</td>
<td>19.7%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The overall performance of the system is measured in terms of total number of correctly pronounced words over the total number of words played i.e. (correctly pronounced words/total numbers of word x 100%). Finally by calculating the number of words which are correctly pronounced, the performance of the system is found to be 62.3%. As observed from the analysis, words that are not found in the compiled sound file are not properly pronounced by the system (nasal vowels are not taken care of). This causes a little degradation in the performance of the system.

Second performance evaluation focuses on the *intelligibility* and the *naturalness* of the new system. Mean Opinion Score (MOS) evaluation technique was used to evaluate the synthesized Yoruba Speech. Mean Opinion Score (MOS) is an evaluation technique which provides a numerical measure of the quality of human speech. The scheme uses subjective tests (opinionated scores) that are mathematically averaged to obtain a quantitative indicator of the system performance. To determine MOS, a number of listeners rate the quality of test sentences read aloud from the new system female speakers [16]. A listener gives each sentence a rating as follows:

![Mean Opinion Score (MOS) Technique](image)

In the second evaluation, fifteen native speakers of the Yoruba language were invited. Then the evaluators provide their ranks based on the MOS scale. In both cases a questionnaire is used to collect the evaluator’s opinion. To evaluate the synthesizer’s intelligibility and naturalness five sentences in Yoruba are prepared as a test data for Yoruba synthesizer.
All words used in the sentence are found in the normal Yoruba Literature. Then the selected individuals listen to the synthesized waveform from the synthesizer and evaluate naturalness and intelligibility based on the MOS scale.

Table 3: Overall average score of Yoruba Text to Speech

<table>
<thead>
<tr>
<th></th>
<th>1st Sentence</th>
<th>2nd Sentence</th>
<th>3rd Sentence</th>
<th>4th Sentence</th>
<th>5th Sentence</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturalness</td>
<td>4.7</td>
<td>4.5</td>
<td>4</td>
<td>4.5</td>
<td>4.6</td>
<td>4.46</td>
</tr>
<tr>
<td>Intelligibility</td>
<td>3.8</td>
<td>3.7</td>
<td>3.6</td>
<td>3.9</td>
<td>4.1</td>
<td>3.82</td>
</tr>
</tbody>
</table>

The resultant naturalness of the new system using five Yoruba sentences as test data yielded 4.46. This shows that the synthesizer is “very good” according to Mean Opinion Score (MOS) Scale. While the overall intelligibility of the new system is found to be 3.82, which is interpreted on the MOS scale as “good” approaching to “good” if approximated. These values look encouraging and show that a more complex and better system of this kind is achievable.

5. CONCLUSION & CONTRIBUTIONS

By using these Speech Synthesis ideas, we were able to develop a system that pronounces common valid Yoruba words provided by a user and extended them to include sentences. Clearly a Yoruba Text-to-Speech System is a viable and an achievable task. Yoruba Text To Speech was tested and evaluated using Mean Opinion Score experimentation. During the experiment, a workable and performance effective system with 62.3% result was obtained; 3.82 MOS score in intelligibility and 4.46 MOS score for naturalness, which shows that the system is good. Also, Yoruba speech corpus was prepared from scratch in studio which made the system to give quality sounds. Finally the developed model improves interface for the visually impaired, learning system for Yoruba language, performance measure carried out to ensure reliability of the model.

6. FUTURE WORKS

Further work should be carried out to study issues on speech synthesis and provide algorithms for prosody to achieve proper synthesis. Likewise the system can be extended to handle non standard words (NSW) like numbers and dates by creating a parse algorithm.

REFERENCES

Behavior-based Retrieval of Software

Moataz Ahmed
Information and Computer Science Department
King Fahd University of Petroleum and Minerals
Dhahran 31261, Saudi Arabia

Hamza Onoruoiza Salami
Department of Computer Science
Federal University of Technology
Minna, Nigeria
moataz@kfupm.edu, ho.salami@futminna.edu.ng

ABSTRACT

Reduced software development cost and time can be achieved by reusing existing software. One of the most important activities during reuse is retrieval. In the early stages of software development, UML state machine diagrams are used to model the behavior of different system objects. This work describes the retrieval of software from a repository by comparing the state machine diagrams of new and existing software systems. State machine diagrams are converted to directed graphs, which are compared using a Genetic Algorithm-based graph matching technique. Experimental results show that the proposed approach is effective in retrieving similar software from a repository.

Keywords- UML; state machine diagram, genetic algorithm; software retrieval; software reuse

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I. INTRODUCTION

Among the benefits of software reuse are reduced risk, development time and overall cost [1]. Even though many software artifacts such as domain models, requirement specifications, designs, documentation, test data and source code can be reused, the benefits of reuse are maximized if it occurs at the early stages of software development. The reason is that when early-stage artifacts are reused, their corresponding later-stage artifacts can be reused as well [2]. Software reuse can be partitioned into four distinct tasks. It begins with the presentation of a query to the reuse system, followed by the retrieval of the software component that is most similar to the query, modification of the retrieved component to meet the needs of the new software, and incorporation of the modified component into the repository to facilitate future reuse [3].

The Unified Modeling Language (UML) is the de facto language for modeling systems in the early stages of software development such as during requirement analysis and design. UML diagrams are broadly divided into structure diagrams, which show the static nature of objects in a system irrespective of time, and behavior diagrams which show the dynamic behavior of the system over time [4]. Many of the existing work on UML-based software reuse have concentrated on class diagrams, sequence diagrams and use case diagrams. Consequently, this work focuses on the retrieval of state machine diagrams (SMDs). UML SMDs model the behavior of individual system entities such as objects (i.e., instances of classes) [4]. They show how an object responds to events according to its current state, and how it enters new states [5].

In order to compare SMDs during retrieval, they are converted to graphs, then a graph matching/similarity technique is used to determine the degree of similarity of the graph representations. Genetic algorithm (GA) is used alongside a similarity measure to perform the graph matching/similarity assessment. Experimental results show that this approach is effective in retrieving similar software from a repository.

The remainder of this paper is organized as follows: Section II discusses related work. In Section III, we propose a method of representing SMDs as graphs. The similarity measure for SMDs is presented in Section IV. We describe how similarity between states in two UML SMDs is computed in Section V. Matching using GA is the subject of Section VI. We present experimental results in Section VII and conclude the paper in Section VIII.

2. RELATED WORKS

Significant research has been carried out on UML-based software reuse. For example, class diagram retrieval has been described in [6-8], while sequence diagram and use case diagram retrieval is discussed in [9-12]. In some of the existing works, graph representations of UML diagrams have been compared during retrieval: sequence diagrams are converted to graphs in [11, 12]; whereas class diagrams are converted to graphs in [6, 13]. To the best of the authors’ knowledge, only Ali and Du [14] have considered SMDs during retrieval.
In [14], design models consisting of class, sequence, activity, collaboration and state machine diagrams were described from six perspectives using pre-defined terms. Similarity between query and repository model was computed in either of two ways: based on the distance of the shortest path between the descriptive terms in a conceptual graph; or from the degree of overlap between the descriptive terms. However, relying on only textual descriptions to compare models results in the loss of structural information contained in the UML diagrams [15].

Lately, some authors have used heuristic search techniques for matching while retrieving UML diagrams. Similarity measures have been combined with GA [13] and particle swarm optimization [6] in order to retrieve class diagrams. Furthermore, GA-based similarity assessment was used for retrieving sequence diagrams in [16]. This paper follows a similar approach to that used in our previous works (i.e., [13, 16]), by first converting SMDs to graphs, then using a similarity measure and GA to determine the degree of similarity of the graph representations.

2.1 Graph Representation of State Machine Diagrams

SMDs can be converted to labeled directed graphs in which each state other than a final state is represented by a node, and all final states are represented by a single node. Four types of edges can connect nodes of the graph: hierarchical edges labelled $H$, which connect composite states to their immediate sub states; transition edges labelled $xT$, which represent transitions between states, where $x$ is the number of transitions from one state to another; beginning edges labelled $B$, which denote transitions from the start state; and ending edges labelled $xE$, which represent transitions to the end state, where $x$ is the number of transitions from one state to any of the final states. Fig. 1 shows two SMDs $s$ and $t$. The graph and adjacency matrix representations of $s$ are shown in Fig. 2 and Table I, respectively.

3. SIMILARITY MEASURE

The degree of similarity of SMDs is computed by comparing their adjacency matrix representations. A difference matrix $DiffE$ acts as a lookup table that indicates the degree of similarity between the four different types of edges described in Section III. Table II shows $DiffE$. The non-diagonal entries of $DiffE$ are ones, indicating maximum dissimilarity. The diagonal entries for beginning edges and hierarchical edges are zero, signifying that identical types of edges have no difference between them. In the case of transition edges and ending edges, their labels indicate the number of transitions from one state to another, hence the diagonal entries take these numbers into account. For example, the difference between a $2T$ edge and a $3T$ edge is $1/2 - 1/3 = 0.17$, whereas the difference between a $2T$ edge and a $4T$ edge is $1/2 - 1/4 = 0.25$. Let $adjS$ and $adjT$ be the adjacency matrices of $s$ and $t$, respectively. $adjS$ has $ns$ rows while $adjT$ has $nt$ rows ($ns \leq nt$). Let $K$ be a permutation vector that maps all $ns$ nodes of $adjS$ to $ns$ nodes of $adjT$. In essence, $K$ is a one-to-one mapping from all the nodes of $adjS$ to some (or all) of the nodes of $adjT$. Furthermore, let $adj_{Tk}$ be a $ns \times ns$ adjacency matrix containing only the edges between nodes of $adjT$ listed in $K$.

The degree of similarity between $s$ and $t$ is given in (1).

$$sim(s, t) = \frac{\sum_{i=1}^{ns} \sum_{j=1}^{ns} DiffE_{ji} adj_{S}(i, j) adj_{TK}(i, j)}{nr} + \frac{\lambda nt - ns}{ns}$$

Eqn …………. (1)

where $nr$ is the number of times there is at least one edge at corresponding entry positions in $adjS$ or $adjTK$. $\lambda \epsilon [0, 1]$ is a weight that determines how the unmapped nodes in $adjT$ affect the degree of similarity. For example, choosing $\lambda = 0$ causes the similarity score between $s$ and $t$ to be zero (indicating maximum similarity) whenever $t$ subsumes $s$. On the other hand, a large value of $\lambda$ causes the value of $sim(s, t)$ to increase when $nt > ns$.

In the remainder of this section, we attempt to theoretically validate the formula given in Eq. (1) by determining if it a similarity metric. Similarity measures which satisfy four metric axioms (self-similarity, minimality, symmetry and triangle inequality) are referred to as similarity metrics [17].

3.1 Self-similarity

Since corresponding edges of identical state machine diagrams are the same, and the diagonal entries of $DiffE$ are either zero or reflect the differences in number of edges, the numerator of the first fraction in Eq. (1) is zero. Furthermore, graph representations of identical state machine diagrams have the same number of nodes so the numerator of the second fraction in Eq. (1) is zero. Therefore, $sim(s, s) = sim(t, t) = 0$.

3.2 Minimality

There are two cases to consider:

Case 1: if $s = t$, it follows that $sim(s, t) = sim(s, s) = 0$ from the first axiom.

Case 2: if $s \neq t$, either or both of the following conditions is true: (i) there is at least one pair of nodes whose corresponding edges in $adj_{S}$ and $adj_{TK}$ are of different types or have different multiplicities. Thus, the numerator of the first fraction in Eq. (1) is greater than zero (ii) $s$ and $t$ have different number of nodes, thus the numerator of the second fraction in Eq. (1) is greater than zero. If condition (i) and/or (ii) is satisfied, $sim(s, t) \epsilon (0, 1]$.

Thus, $sim(s, t) \geq sim(s, s)$

3.3 Symmetry

Clearly, $sim(s, t) = sim(t, s)$ since $DiffE$ is symmetric.

3.4 Triangular Inequality

We have not been able to prove that Eq. (1) satisfies triangular inequality, thus, the formula in Eq. (1) shall be referred to as a similarity measure rather than a metric.
3.5 Similarity Matrix of States

This section describes a method of computing pairwise similarities between states of two SMDs. The similarity values are kept in a states’ similarity matrix $SS$, which will be used during matching. Each state other than a final state (all final states are listed as one state) is represented by a 10-dimensional vector indicating 10 properties of the state.

These properties are listed in Table III, while their values are given in Table IV for $s$. The similarity between nodes is the Euclidean distance of their feature vectors. Table V shows $SS$ containing the pairwise similarity values between states in $s$ and $t$.

![Figure 1. Two state machine diagrams $s$ and $t$.](image-url)
TABLE I. ADJACENCY MATRIX REPRESENTATION OF $\mathcal{S}$

<table>
<thead>
<tr>
<th>$s_0$</th>
<th>$s_1$</th>
<th>$s_2$</th>
<th>$s_3$</th>
<th>$s_4$</th>
<th>$s_5$</th>
<th>$s_6$</th>
<th>$s_7$</th>
<th>$s_8$</th>
<th>$s_9$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>$B$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$s_1$</td>
<td>-</td>
<td>-</td>
<td>$H$</td>
<td>-</td>
<td>-</td>
<td>$H$</td>
<td>$H$</td>
<td>$H$</td>
<td>$H$</td>
</tr>
<tr>
<td>$s_2$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$H$</td>
<td>$H$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$s_3$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$s_4$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>$s_5$</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>$s_6$</td>
<td>-</td>
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<td>-</td>
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<td>-</td>
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<tr>
<td>$s_7$</td>
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<tr>
<td>$s_8$</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$s_9$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

$B =$ beginning edge, $H =$ hierarchical edge, $xT =$ $x$ transitions, $yE =$ $y$ ending edges, $- =$ no edge

TABLE II. DIFFE

<table>
<thead>
<tr>
<th>$B$</th>
<th>$H$</th>
<th>$yT$</th>
<th>$yE$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>$</td>
<td>1/x - 1/y</td>
</tr>
</tbody>
</table>

$B =$ beginning edge, $H =$ hierarchical edge, $xT =$ $x$ transitions, $yE =$ $y$ ending edges, $- =$ no edge, $|\ldots|$ = absolute value

Figure 2. Graph representation of $s$
3.6 Matching Using Genetic Algorithm

Determining the value of $K$ that results in an optimal (i.e., smallest) similarity value between $s$ and $t$ is a combinatorial optimization problem which may involve a huge search space. This section describes the use of GA to find a suitable value of $K$ in order to compute $s_{sim}(s, t)$. GA is a powerful heuristic search algorithm that can used to solve combinatorial optimization problems. The GA used in this paper is similar to that used for graph matching in [18].

3.7 Chromosome Encoding and Population Initialization.

The number in the $i^{th}$ gene indicates which node in $s$ is mapped to the $i^{th}$ node of $s$. In other words, each chromosome encodes the mapping of states in two SMDs.

The initial population is constructed in three steps: (i) the first individual is formed by applying Munkres’ allocation algorithm [19] on $SS$. (ii) A few additional individuals are generated by mutating the first individual. (iii) All other individuals are generated by randomly assigning values to their genes.

3.8 Fitness Values

The fitness of a gene is read from $SS$. For example, if the $i^{th}$ gene of a chromosome contains $j$, its fitness is $SS(i, j)$. The fitness of a chromosome is computed using Eq. (1).

3.9 Selection and Crossover

The selection and crossover operations are the same as those described in [16].

3.10 Mutation

Mutation involves swapping two randomly selected genes, or replacing a gene with a value that is not currently in the chromosome.

3.11 Uniqueness of individuals

When the population contains identical individuals, one of them is mutated until it becomes distinct from all other individuals in the population.

3.12 Termination Conditions

The GA terminates when any of the following three conditions is satisfied: the optimal similarity value of zero is obtained; the maximum number of generations is reached; or the population’s fitness value does not improve within a fixed number of generations.
4. EXPERIMENTAL RESULTS AND DISCUSSION

In the experiments to evaluate the proposed method of retrieving software based on a comparison of their SMDs, we created a repository of 16 SMDs belonging to three domains: 7 diagrams are from the banking/business domain; 6 diagrams are from the education domain; while the other 3 diagrams are related to personal organization tasks such as managing diaries and appointments. Table VI summarizes the characteristics of the repository diagrams. 16 queries were formed by taking each of the repository diagrams in turn. A repository diagram is relevant to a query only if they belong to the same domain.

Retrieval quality was assessed using the Mean Average Precision (MAP), which is widely used for evaluating information retrieval systems. The average precision (AP) for a query is obtained using precision values calculated at each point when a relevant document is found. MAP for a set of queries is the mean of the AP scores for each query [20]. MAP can be computed using Eq. (2):

$$\text{MAP} = \frac{1}{N} \sum_{j=1}^{N} \frac{Q_j}{\sum_{i=1}^{Q_j} P(\text{rel} = i)} \quad \text{(2)}$$

Where

$N$ is the number of queries, $Q_j$ is the number of relevant documents for query $j$ and $P(\text{rel} = i)$ is the precision at the $i^{th}$ relevant document.

The following parameters were used: size of population = 50; maximum number of generations = 100; number of generations to terminate GA if fitness value does not improve = 20; probability of mutation of genes = 0.10; and number of individuals from initial generation produced using Munkres’ algorithm = 3. $\lambda$ was set to 0.05 in order to compute fitness values using Eq. (1). The experiment was repeated 30 times. Table VII shows the mean MAP over 30 runs for the 16 queries. The standard deviation of MAP is shown in brackets. The time to search the repository is also presented in the table. The experiment was carried out using Matlab® computing language, on a personal computer having the following configuration: 2.67 GHz Intel Core 2 Quad processor; 4 GB RAM; and 32-bit Windows 7 operating system.

From the results presented in Table VII, our technique was capable of retrieving the most similar software from the repository. The standard deviation of MAP from 30 runs is very low, suggesting that our matching technique consistently produces good results.

5. CONCLUSION

This paper described an effective method of retrieving software for reuse by comparing the behavior of the software. The behaviors of software are manifested in the SMDs that show how events lead to change in state of system objects. A graph matching/similarity technique was used to determine the similarity of graph representations of SMDs. Experimental results show that the proposed method is promising.

The SMD similarity assessment technique described in this paper did not take into account the events, guard conditions and actions of transitions, as well as the names of states in SMDs. As a future work, these other pieces of information can be incorporated into the similarity assessment technique to determine if it leads to improved retrieval quality.

ACKNOWLEDGMENT

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REFERENCES


Figure 3. Chromosome encoding for comparing two state machine diagrams

TABLE VI. SUMMARY DETAILS OF REPOSITORY DIAGRAMS

<table>
<thead>
<tr>
<th></th>
<th>Banking/Business</th>
<th>Education</th>
<th>Personal Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of states</td>
<td>10 4 6 5 8 5</td>
<td>10 8 6 6 5</td>
<td>5 5 5</td>
</tr>
<tr>
<td>No. of transitions</td>
<td>14 4 5 8 15 5</td>
<td>14 12 9 7 6</td>
<td>8 8 4</td>
</tr>
</tbody>
</table>

TABLE VII. RESULTS OF EXPERIMENTS

<table>
<thead>
<tr>
<th>MAP (%)</th>
<th>time to search repository (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>73.27 (0.24)</td>
<td>1.32</td>
</tr>
</tbody>
</table>
Comparative Study of ID3/C4.5 Decision tree and Multilayer Perceptron Algorithms for the Prediction of Typhoid Fever

O.O. Adeyemo & T.O. Adeyeye
1Department of Computer Science
University of Ibadan
Ibadan, Nigeria.
E-mail:wumiglory@yahoo.com

D. Ogunbymi
Department. Of Computer Science
University of Lagos
Akoka, Lagos Nigeria.

ABSTRACT

Data mining is an essential phase in knowledge discovery in database which is actually used to extract hidden patterns from large databases. Data mining concepts and methods can be applied in various fields like marketing, medicine, real estate, customer relationship management, engineering, web mining, etc. The main objective of this paper is to compare the performance accuracy of Multilayer perceptron (MLP) Artificial Neural Network and ID3 (Iterative Dichotomiser 3), C4.5 (also known as J48) Decision Trees algorithms Weka data mining software in predicting Typhoid fever. The data used is the patient’s dataset collected from a well known Nigerian Hospital. ID3, C4.5 Decision tree and MLP Artificial Neural Network WEKA Data mining software was used for the implementation. The data collected were transformed in a form that is acceptable to the data mining software and it was splitted into two sets: The training dataset and the testing dataset so that it can be imported into the system. The training set was used to enable the system to observe relationships between input data and the resulting outcomes in order to perform the prediction. The testing dataset contains data used to test the performance of the model. This model can be used by medical experts both in the private and public hospitals to make more timely and consistent diagnosis of typhoid fever cases which will reduce death rate in our country. The MLP ANN model exhibits good performance in the prediction of typhoid fever disease in general because of the low values generated in the Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Relative Absolute Error (RAE) error performance measures.

Keywords- ID3, C4.5, MLP, Decision Tree Artificial Neural Network, Typhoid fever

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I. INTRODUCTION

Typhoid fever also known as enteric fever is an infection caused by Salmonella enterica, commonly referred to as Salmonella typhi. It is usually acquired through ingestion of food or water contaminated with excreta or urine of typhoid fever carrier cases. Typhoid fever infections continue to be a major disease of public health concerns, especially in the tropics. Accurate and error-free of diagnosis and treatment given to patients has been a major issue highlighted in medical service nowadays.

Nigeria like any other tropical and sub-tropical countries is an area of high endemicity for this infection and as a result, people living in Nigeria are at risk of contracting the disease. A major challenge facing healthcare organizations (hospitals, medical centers) is the provision of quality services at affordable costs. For a patient to be given a quality service, it implies diagnosing patients correctly and administering treatments that are effective.[8]

It is noted that poor clinical decisions can lead to disastrous consequences which are therefore unacceptable. For the well being of people in developing countries, it is important for hospitals to also minimize the cost of clinical tests and this result they can achieve by employing appropriate computer-based information and/or decision support systems [27] The healthcare environment is generally perceived as being ‘information rich’, yet ‘knowledge poor’. There is a wealth of data available within the healthcare systems and little has been done to use this available data to solve the challenges that face a successful interpretation of medical diagnosis examination result because there is a lack of effective analysis tools to discover hidden relationships and trends in data.

One way to achieve this is by using Data mining techniques for prediction. The knowledge is hidden among the medical data set and it is extractable through data mining techniques. Data mining is one of the important phases of knowledge data discovery[28].
The aim of the research work is to use Classification techniques of data mining to study typhoid fever occurrence in order to discover appropriate knowledge and extract useful patterns from existing stored data of patients. The knowledge and pattern extracted would be used develop a predictive model for that can help predict typhoid. The relevance of the study is to develop a system that will be useful in any medical institution both private and public especially for typhoid fever cases. It is envisioned that the results of this study will reduce medical errors, enhance patient safety and reduce mortality rate from typhoid fever. In addition, other medical institutions both private and public can use the result of this study for their medical decisions related to typhoid fever diagnosis. Furthermore, the public will get a proper medical care if the result of this study is used along with the existing system.

Artificial Neural Network
Artificial neural network (ANN), often just called a “neural network” (NN), is an information processing technique based on the way biological nervous systems, such as the brain, process information. It is an artificial representation of the human brain that tries to simulate its learning process. Neural networks are being applied to an increasing large number of real world problems. It is an interconnected group of artificial neurons that uses a mathematical model or computational model for information processing based on biological neural network.

Their primary advantage is that they can solve problems that are too complex for conventional technologies; problems that do not have an algorithmic solution or for which an algorithmic solution is too complex to be defined. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Another advantage of using neural networks is that they are quite robust with respect to noisy data. There are different types of Artificial Neural Network but the simplest type of artificial neural network is the feedforward neural network in which the information moves in only one direction — forwards: From the input nodes data goes through the hidden nodes (if any) and to the output nodes. The multilayer perceptron (MLP) which is an example of the feedforward neural network is being adopted in this study.

Multi layer perceptron
A multilayer perceptron (MLP) is a feedforward artificial neural network model that maps sets of input data onto a set of appropriate outputs. As its name suggests, it consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. The architecture of this class of networks, besides having the input and the output layers, also have one or more intermediary layers called the hidden layers. The hidden layer does intermediate computation before directing the input to output layer.

Fig 1: Graphical representation of an MLP
Decision Trees

Decision trees are often used in classification and prediction. It is simple yet a powerful way of knowledge representation [20]. Decision tree is defined as a structure that can be used to divide up a large collection of records into successively smaller sets of records by applying a sequence of simple decision rules. With each successive division, the members of the resulting sets become more and more similar to one another[29] Decision tree is a flowchart like tree structure, where each internal node (non-leaf node) denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (or terminal node) holds a class label. The topmost node in a tree is the root node[11].

![Fig 2:A Simple Decision Tree](image)

Decision Trees can also be interpreted as a special form of a rule set, characterized by their hierarchical organization of rules. Decision tree induction algorithms have been used in many application areas, such as medicine, manufacturing and production, financial analysis, astronomy, and molecular biology[13]. Decision tree can be constructed relatively fast compared to other methods of classification. Trees can be easily converted into SQL statements that can be used to access databases efficiently. Decision tree classifiers obtain similar and sometimes better accuracy when compared with other classification methods. Decision tree algorithm can be implemented in a serial or parallel fashion based on the volume of data, memory space available on the computer resource and scalability of the algorithm [30].

In data mining, decision trees can be described also as the combination of mathematical and computational techniques to aid the description, categorisation and generalisation of a given set of data. The four widely used decision tree learning algorithms are: ID3, CART, CHAID and C4.5. In this study, two of these decision trees were adopted ID3 and C4.5 (J48).

**ID3 (Iterative Dichotomiser 3)**

This is a decision tree algorithm introduced in 1986 by Quinlan Ross. It is used to generate a decision tree from a dataset. ID3 is the precursor to the C4.5 algorithm. It learns decision trees by constructing them top down that is it is based on the divide and conquer strategy. It is based on Hunts algorithm. The tree is constructed in two phases. The two phases are tree building and pruning. ID3 uses information gain measure to choose the splitting attribute. It only accepts categorical attributes in building a tree model. It does not give accurate result when there is noise.

Continuous attributes can be handled using the ID3 algorithm by discretizing or directly, by considering the values to find the best split point by taking a threshold on the attribute values. ID3 does not support pruning. ID3 algorithm is used in knowledge acquisition for tolerance design. This algorithm is applied to calculate logistic performance. This is applicable in the field of computer crime forensics. The ID3 is very useful and also helpful to diagnose and predict diseases.
C4.5 (J48)
This algorithm is a successor to ID3 developed by Quinlan Ross in 1993. It is also known as J48 algorithm. It is also based on Hunt’s algorithm. It is serially implemented like ID3. Using this algorithm, pruning can take place that is it replaces the internal node with a leaf node thereby reducing the error rate unlike ID3. C4.5 handles both categorical and continuous attributes to build a decision tree. In order to handle continuous attributes, C4.5 splits the attribute values into two partitions based on the selected threshold such that all the values above the threshold as one child and the remaining as another child. It also handles missing attribute values. C4.5 uses gain ratio impurity method to evaluate the splitting attribute that is to build the decision tree [17]. It removes the biasness of information gain when there are many outcome values of an attribute.

C4.5 is used in classification problems and it is the most used algorithm for building DT. It is suitable for real world problems as it deals with numeric attributes and missing values. The algorithm can be used for building smaller or larger, more accurate decision trees and the algorithm is quite time efficient. This algorithm is used to handle continuous attributes e.g. temperature. C4.5 improves computational efficiency.

2. RELATED WORKS

[2] carried out a research on prediction of breast cancer using artificial neural network. The artificial neural network was used to detect the existence of cancer in a patient. In the paper, the multilayer perceptron and two learning algorithms was implemented using java programming language. The implemented algorithms were tested on a real world problem .The result obtained after the application of the learning algorithms were reported and compared.

[16] conducted a research on empirical study of decision tree and artificial neural network algorithm for mining educational database. In the study, two classification methods – J48 decision tree algorithm and neural network are compared to determine the one that gives the best classification results as well as prediction capability in EDM. The output generated from the experiment shows that for neural network, as the number of hidden layer increases, a better result was obtained. The results obtained from the analysis clearly demonstrated a superior performance of neural network over decision tree. Neural Network performed well in classification as well as in prediction but suffered from lack of speed. Decision Tree was fast but performed badly at the classification.

[15] presented a paper titled a prototype model for the breast cancer as well as heart disease prediction using data mining techniques. A total number of 909 dataset was used for heart disease and 699 for breast cancer. The model was developed to predict breast cancer/heart disease class based on the rules created by C4.5 and C5.0 algorithms.

A total number of eight Rules were generated by using C4.5 and C5.0 from cancer data set after pruning at the Confidence level 50, while running the C5.0 on heart disease data set seven rules were generated. The result reveals that C5.0 handles missing values easily but C4.5 shows some errors due to missing values. Over running the dataset of breast cancer of 400 records C4.5 shows 5 train error whereas C5.0 show only 3 train errors. C5.0 produces rules in a very easy readable form but C4.5 generates the rule set in the form of a decision tree.

[2] presented a paper on data mining system for the quality prediction of petrol using artificial neural network. The work presents a data mining system which implemented a multilayer neural network trained with the back propagation training algorithm. The focus of the work was on petrol because of its significance and wide usage. The outcome generated by the system shows that MLP back propagation neural network could successfully classify and predict the quality of petrol.

In summary, numerous examples of data mining techniques have been applied or developed in order to help predict several medical disease cases e.g heart disease, breast cancer etc. However, very few consider predicting disease like typhoid fever, malaria fever believing that these diseases are easily diagnosed and not that deadly. But from research, it was found out that these common diseases are highly contagious and could be more deadly if not properly diagnosed.

3. METHODOLOGY

This section describes research methodology adopted for this paper. The Knowledge Discovery in Database (KDD) methodology consisting of some iterative and interactive steps was adopted to extract significant patterns from a dataset.

Data Collection and Description
The data used in this paper is the dataset of patients with typhoid fever collected from a well known Nigerian Hospital. The data consists of sex of the patients, their ages and the signs and symptoms of the patients. The data and the attributes that possibly influenced their disease were selected and analysed.
Table 1: Patient’s attributes and their description

<table>
<thead>
<tr>
<th>S/N</th>
<th>Attribute</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>Age of the patient in years</td>
<td>Numeric</td>
</tr>
<tr>
<td>2</td>
<td>Sex</td>
<td>Sex of the patient (Male/Female)</td>
<td>Nominal</td>
</tr>
<tr>
<td>3</td>
<td>Abdominal pain</td>
<td>Does the patient have abdominal pain(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>4</td>
<td>Headache</td>
<td>Does the patient have headache(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>5</td>
<td>Dizziness</td>
<td>Does the patient experience dizziness(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>6</td>
<td>Cough</td>
<td>Does the patient have cough(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>7</td>
<td>Fever</td>
<td>Does the patient have fever(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>8</td>
<td>Vomiting</td>
<td>Is the patient vomiting(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>9</td>
<td>Loss of appetite</td>
<td>Does the patient have loss of appetite(Yes/No)</td>
<td>Nominal</td>
</tr>
<tr>
<td>10</td>
<td>Diagnosis</td>
<td>Does the patient have typhoid fever(Yes/No)</td>
<td>Nominal</td>
</tr>
</tbody>
</table>

Each record in the dataset corresponds to a single patient’s results collected during the medical examination. e.g: Table 2 shows the example of an input variable which represents a patient’s record.

Table 2: A patient’s record

<table>
<thead>
<tr>
<th>S/N</th>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Sex</td>
<td>Female</td>
</tr>
<tr>
<td>3</td>
<td>Abdominal pain</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Headache</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Dizziness</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Cough</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Fever</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>Vomiting</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>Loss of appetite</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>Diagnosis</td>
<td>Tested Positive</td>
</tr>
</tbody>
</table>

Data Pre-processing

Data in the training dataset were pre-processed before evaluation by the algorithms. Data preprocessing is very tedious phase and one of the most critical steps in KDD process in that if the data to be used is not properly screened, there may be a problem arising in the result since the quality of data affects the mining results and also dirty data can cause confusion for the mining procedure. In this study, pre-processing was done based on each algorithm implemented. Some missing data were removed from the dataset to improve the classification performance and also some of the dataset were filtered so that it could be accepted by Weka.

During this phase of pre-processing, the dataset for the ID3 algorithm was filtered since algorithm doesn’t recognize numeric attributes, so there was the need to filter the attributes therefore all the attributes were made nominal that is the numeric attributes were converted to nominal attributes (NumericToNominal). Also using the MLP algorithm in Weka the dataset was filtered to binary attributes (0’s and 1’s), by selecting the (NominalToBinary) type from list of filter types in Weka. Unlike the ID3 and MLP algorithms, using the C4.5 algorithm the data set were not filtered since this algorithm accepts both categorical and continuous values.

Data Integration

This involved the combination of data from multiple sources into a coherent data store as the data collected were from different data stores. The data collected were from different data stores and so they were merged and collated together in Microsoft excel 2007.

Data Transformation

This is the stage in which the selected data were transformed into forms acceptable to Weka data mining software. The data file was saved in Comma Separated Value (CSV) file format in Microsoft excel and later was converted to Attribute Relation File Format (ARFF) file inside Weka for easy use.

Data Training

The figure above shows the system flowchart for training the data. The data is selected and converted into Attribute Relation File Format (arff) format using the arff converter and then classified using WEKA and the result is produced.
4. IMPLEMENTATION

In this paper, Weka data mining software tool was used since this software is open source software that implements a large collection of machine leaning algorithms and is widely used in data mining applications. This dataset was loaded into WEKA explorer. The classify panel enables the user to apply classification and regression algorithms to the resulting dataset, to estimate the accuracy of the resulting predictive model, and to visualize erroneous predictions, or the model itself. The ID3/C4.5 (J48) decision tree algorithm and MLP ANN algorithm were implemented in WEKA. Under the "Test options", the 10-fold cross-validation is selected as our evaluation approach. These predictive models provide ways to predict whether a new patient will have typhoid fever or not.

5. RESULTS AND DISCUSSION

After applying the pre-processing and preparation methods, we try to analyze the data visually and figure out the distribution of values. Some experiments were carried out in order to evaluate the performance and usefulness of different classification algorithms for predicting students’ placement. The following metrics were used to determine the performance of the model: Time taken to build the model, Kappa statistics, mean absolute Error, Root Mean Squared Error, Relative Absolute Error, Prediction accuracy.
Table 3: Performance of the classifiers

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>ID3</th>
<th>C45</th>
<th>MLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time taken to build the model</td>
<td>0.04 secs</td>
<td>0.01 secs</td>
<td>1.68 secs</td>
</tr>
<tr>
<td>Correctly Classified Instances</td>
<td>197</td>
<td>226</td>
<td>235</td>
</tr>
<tr>
<td>Incorrectly Classified Instances</td>
<td>76</td>
<td>55</td>
<td>46</td>
</tr>
<tr>
<td>Accuracy</td>
<td>70.1060%</td>
<td>80.427%</td>
<td>83.6299%</td>
</tr>
</tbody>
</table>

The number of correctly classified instances is often called accuracy or sample accuracy of a model. So MLP classifier has more accuracy compared to ID3 and C4.5 classifiers but from the table, it is seen that C4.5 takes the shortest time in building the model compared to others and MLP takes a longer time.

The table 4 below shows the values derived for each algorithm based on the performance errors. The values of MAE, RMSE, RAE, RRSE for MLP tends the least when compared to the values of ID3 and C4.5. This result reveals that the MLP algorithm is suitable for the prediction of typhoid fever since the lesser the error value the better the prediction.

Table 4: Training and simulation error table.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>ID3</th>
<th>C45</th>
<th>MLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kappa Statistics</td>
<td>-0.0463</td>
<td>0.1315</td>
<td>0.3352</td>
</tr>
<tr>
<td>Mean Absolute Error (MAE)</td>
<td>0.2946</td>
<td>0.2678</td>
<td>0.2226</td>
</tr>
<tr>
<td>Root Mean Squared Error(RMSE)</td>
<td>0.5338</td>
<td>0.4088</td>
<td>0.3483</td>
</tr>
<tr>
<td>Relative Absolute Error (RAE)</td>
<td>104.3721%</td>
<td>92.4545%</td>
<td>76.8512%</td>
</tr>
<tr>
<td>Root Relative Squared Error (RRSE)</td>
<td>142.2647%</td>
<td>107.7388%</td>
<td>91.7852%</td>
</tr>
</tbody>
</table>

From the table 5 below, it is seen that the number of correct positive predictions TP of MLP is high compared to other models while the number of incorrect negative predictions FN is lesser indicating that MLP model predicts the typhoid fever cases better. Also going by the precision, Recall, F-measure and ROC values, we were able to conclude that the MLP model could be used for easy prediction of typhoid fever.

Table 5: Comparison of evaluation measures by class

<table>
<thead>
<tr>
<th>Classifiers</th>
<th>TP Rate</th>
<th>FN Rate</th>
<th>Precision</th>
<th>Recall</th>
<th>F-measure</th>
<th>ROC Area</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID3</td>
<td>0.853</td>
<td>0.896</td>
<td>0.817</td>
<td>0.853</td>
<td>0.835</td>
<td>0.45</td>
<td>Positive</td>
</tr>
<tr>
<td>ID3</td>
<td>0.104</td>
<td>0.147</td>
<td>0.132</td>
<td>0.104</td>
<td>0.116</td>
<td>0.455</td>
<td>Negative</td>
</tr>
<tr>
<td>C4.5</td>
<td>0.94</td>
<td>0.837</td>
<td>0.842</td>
<td>0.94</td>
<td>0.888</td>
<td>0.534</td>
<td>Positive</td>
</tr>
<tr>
<td>C4.5</td>
<td>0.163</td>
<td>0.06</td>
<td>0.364</td>
<td>0.163</td>
<td>0.225</td>
<td>0.534</td>
<td>Negative</td>
</tr>
<tr>
<td>MLP</td>
<td>0.95</td>
<td>0.653</td>
<td>0.872</td>
<td>0.95</td>
<td>0.905</td>
<td>0.726</td>
<td>Positive</td>
</tr>
<tr>
<td>MLP</td>
<td>0.347</td>
<td>0.06</td>
<td>0.548</td>
<td>0.347</td>
<td>0.425</td>
<td>0.726</td>
<td>Negative</td>
</tr>
</tbody>
</table>

The performance of the learning techniques is highly dependent on the nature of the training data.

Based on the above Tables, the experiment shows that the model built with ID3 algorithm with all attributes correctly classified (predicted the correct outcome) 197 (70.1060%) instances while 76 (27.0463%) of the instances were classified incorrectly, the model built with J48 algorithm also with all attributes correctly classified (predicted the correct outcome) 226 (80.427%) instances while 55 (19.573%) of the instances were classified incorrectly while the model built with MLP algorithm also with all attributes correctly classified (predicted the correct outcome) 235 (83.6299%) instances while 46 (16.3701%) of the instances were classified incorrectly.
The Figures 4 and 5 below shows the graphical representation of the results.

![Comparison between performance measure parameters](image1)

**Fig 4: Comparison between performance measure parameters**

![Efficiency of the models](image2)

**Fig 5: Efficiency of the models**

5. CONCLUSIONS AND RECOMMENDATION

In this paper, different classifiers are studied and the experiments are conducted to find the best classifier for predicting the patient of typhoid fever. We propose an approach to predict the heart diseases using data mining techniques. Three classifiers such as ID3, C4.5 and MLP were used for diagnosis of patients with typhoid fever. Observation shows that MLP performance is having more accuracy, when compared with other two classification methods. MLP classifier implemented on the attributes had classification accuracy of 83.6299 % but in terms of speed, C4.5 algorithm was found to be the best as it took only 0.01 second to train the data. The best model selected for predicting typhoid fever could not exceed a classification accuracy of 83.6299 % and still much remains to fill the gap of 16.3701 % misclassified cases. This study showed that data mining techniques can be used efficiently to model and predict typhoid fever cases. The outcome of this study can be used as an assistant tool by medical experts to help them to make more consistent diagnosis of typhoid fever.
6. RECOMMENDATIONS

This study has indicated that data mining techniques can be applied in the prediction of typhoid fever and the resulting models of this study are worthy of clinical testing.

To improve the classification accuracy of the models further researches should be conducted using different classification algorithms and other data mining techniques such as, Naïve Bayes classifier, genetic algorithm etc. can be used for prediction.

Finally, expanded data set with more distinctive attributes to get more accurate results can also be used to carry out predictions to improve the classification accuracy.

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Factors Influencing the Adoption of Smart Phones by University Students – A Cross-border Approach

S. Tunmibi
School of Computer Science, Mathematics and Information Technology,
Houdegbe North American University,
Republic of Benin
padebola@gmail.com

A. Aregbesola
Centre for Learning Resources,
Landmark University,
Omu-Aran,
Nigeria.
aregbesola.ayooluwa@lmu.edu.ng

E.O. Asani
Computer Science Department,
Landmark University,
Omu-aran,
Nigeria.
asani.emmanuel@lmu.edu.ng

ABSTRACT
This study explains the factors influencing the adoption of smart phones by undergraduate students in Nigeria and Republic of Benin. Questionnaire was used as the data collection instrument, and the design was guided by Rogers’ diffusion theory of innovations. Most of the sampled students agreed that factors such as relative advantage of smart phones, complexity of the phone, trial before buying the phone, observation before buying the phone, and compatibility of smart phone with their lifestyle influence their adoption of smart phones. The study also shows that internet browsing has a major influence on the adoption of smart phones.

Keywords: Smart phones, adoption, diffusion theory of innovations.

I. INTRODUCTION

Almost half the population of the earth now uses mobile communications. A billion mobile subscribers were added in the last 4 years to leave the total standing at 3.2 billion. Given the strong growth trajectory and pace of innovation, we are confident that the next few years will see continued growth with a further 700 million subscriber expected to be added by 2017 and the 4 billion mark to be passed in 2018 (GSMA, 2013a). By the middle of 2013, there were 253 million unique mobile subscribers (and 502 million active SIM connections) in the Sub-Saharan Africa (SSA) region, 95% of whom were on prepaid tariffs. The unique mobile subscriber base has grown by 18% per annum over the last five years, making SSA by some distance the fastest growing region globally. Despite the astonishing progress of the mobile industry in Sub-Saharan Africa in recent years, the biggest impact of mobile in Africa is yet to come.

Roughly two thirds of the populations are still without a mobile subscription, leaving much room for growth; while the region is on the cusp of an explosion of mobile data as 3G and 4G deployments gain scale and advanced capabilities appear on increasingly affordable handsets. Mobile already contributes over 6% of Sub-Saharan Africa’s GDP, higher than any other comparable region globally, and this is forecast to rise to over 8% of regional GDP by 2020 (GSMA, 2013b). According to Oketola (2013), 25 percent of Nigeria’s over 105 million mobile telephone subscribers use smart phones. While citing the report of global market research firm, TNS, he revealed that Nigeria was the second biggest smart phone market in Africa, closely following South Africa.
In a study carried out on students’ adoption of mobile phone at University of Ibadan (Nigeria), Nwagwu and Odetunmibi (2011), observed that respondents in their study are mainly young people below 25. These observations motivated the researchers to carry out this study on students, using University of Ilorin and Landmark University from Nigeria, as well as Houdegbe North American University from Republic of Benin, as case study.

2. LITERATURE REVIEW

Rogers (2003) defines the diffusion of innovations as “the process in which an innovation is communicated through certain channels over time among the members of a social system”. Among the three variables identified by the model, the nature of an innovation is considered to be the most powerful predictor because it explains 49–87% of the variance in technology adoption. The nature of an innovation has two variables: innovation attributes and technology clustering. Rogers’ Diffusion of Innovation theory was first described in 1962 and characterizes people based on their likelihood to adopt technology and categorizes organizations based on their stage of adoption of a new technology. The perceived attributes of an innovation include its relative advantage, complexity, compatibility, observability, and trialability.

Several studies confirm the perceived attributes of a technology to be a significant predictor for its adoption (Chang et al., 2006; Daupagne and Driscoll, 2010; Jung et al., 2012; Lee, 2013; Rogers, 2003). For example, Daupagne and Driscoll (2010) found that perceived relative advantage, compatibility, trialability, and observability were significant predictors of the adoption of high-definition television in the U.S. Jung et al., (2012) found that three perceived attributes – relative advantage, compatibility, and trialability – were positively correlated with the intention to use e-books in South Korea. Li’s study (2013b) demonstrated that perceived ease of use was a significant predictor of a user’s intention to adopt terrestrial digital television in Taiwan.

Technology clustering as described by Rogers (2003) is the compatibility between a technology’s functions and a user’s needs. Past studies have found that people adopt technologies because the functions fulfilled their needs. Individual’s ownership of different types of technologies allows researchers to predict technology adoption because individuals are likely to adopt functionally similar technologies due to the compatibility of the technologies’ functions with the consumers’ needs (Daupagne and Driscoll, 2010; Jung et al., 2012; Lin, 2009, Lin, 2010, Rogers, 1995 and Rogers, 2003).

Atkin (1995) classified all communication technologies as entertainment, information, or interpersonal technologies. Based on the concept of technology clustering, he predicted that people were more likely to adopt technologies within similar functional categories. Lin (2010) examined the adoption of satellite radio in the U.S. and found that the ownership of fluid digital media technologies was positively correlated with the respondents’ adoption evaluation, which consequently positively affected their intention to adopt. Jung et al. (2012) found that the degree of digital media ownership was a significant predictor for the adoption of e-books in South Korea. Daupagne and Driscoll’s study (2010) found that the owners of HDTV possessed significantly more communication technologies than non-owners. Lin (2009) found that compared to non-adopters, online radio adopters in the U.S. owned a significantly higher number of digital media devices including iPods, cellular phones, and satellite radio technologies.

3. RESEARCH METHODOLOGY

This study was carried out, using accidental sampling method. A total of 200 undergraduate students were sampled, using questionnaire, from both schools. Undergraduate students were chosen as the target sample in the study because the likelihood of them using smart phone is high as well as considering a strategy to facilitate easy access to the respondents.

This study used a questionnaire-based survey method, as many similar studies conducted earlier have also used this method for data collection such as (Chang et al., 2006; Daupagne and Driscoll, 2010; Jung et al., 2012; Lee, 2013). The questionnaire design was guided by Rogers’ diffusion theory. For face validity, the questionnaire was circulated to faculty members in Centre for Learning Resources, Landmark University for their comment and observations. Their observations were considered in designing the final copy of the questionnaire before they were administered to the students in February 2014.

A total of 95 copies of the questionnaire were usable from those returned from Nigeria (University of Ilorin, Ilorin and Landmark University, Omu-Aran); and 85 copies of questionnaire were usable from those returned from Republic of Benin (Houdegbe North American University). Descriptive statistical method (use of frequency tables and charts) was adopted for analysis.
4. RESULT

Demographics
The figures below represent the gender and age of respondents. The responses on gender show that sampled male students accounted for 70.5% and 75.3% for the school in Nigeria and Benin Republic, respectively. Female respondents accounted for 28.5% and 24.7% for the school in Nigeria and Benin Republic, respectively. For age, majority of the sampled students (61.2%) are above 26 years in the school in Benin Republic, while majority (74.8%) are 20 years and below in the school in Nigeria.

![Figure 1: Gender of Respondents](image1)

![Figure 2: Age of Respondents](image2)

Perceived Characteristics of Smart Phones
Before asking the questions under this section, respondents were asked if they have a smart phone. A total of 75.8% of the sampled students in the Nigerian school answered yes while all the sampled students (100%) from the school in Benin Republic answered yes.

Questions on perceived characteristics of mobile phone were divided, according to Roger’s theory, into relative advantage, complexity, trialability, observability and compatibility of smart phones.
Relative Advantage of Smart Phones
A higher percentage 55.3% and 54.1% of the sampled students, of the school in Benin Republic, respectively disagreed on smart phones are easily available and smart phone is cheap while majority 50.6% and 63.5%, respectively agreed that smart phone is safe and smart phone is easy to use.

Likewise, 50.5% of the sampled students in the Nigerian school disagreed on smart phone is cheap; but, majority 67.4%, 67.4% and 83.2% respectively agreed that smartphones are easily available, smart phone is safe, and smart phone is easy to use. Figure 3 shows a graphical representation of the results.

Complexity of Smart Phones
Most of the sampled students (69.5%) from Nigeria disagreed on it is difficult to understand how to use smart phones. This is unlike their counterpart from Republic of Benin (51.8%) who agreed that it is difficult to understand how to use smart phones. Majority from both groups, 87.4% from Nigeria and 78.8% from Republic of Benin, agreed that they operate smart phones on their own.
Trialability of Smart Phones

Majority of the respondents from Nigeria (87.4% and 76.8%) agreed that it is easier to use smart phone after trying it out, and it is better to test smart phones before buying one, respectively. This is similar to the responses from Republic of Benin, where 69.4% and 78.8%, respectively agreed on the two subjects. However, 64.2% of the Nigerian students disagreed on it took time to try before buying smart phone; while 65.9% of their counterpart from Republic of Benin agreed on the same subject.

![Figure 5: Trialability of smart phones](image)

Observability of Smart Phones

Higher percentage (56.8% from Nigeria and 52.9% from Republic of Benin) disagreed on being influenced by others to buy a smart phone. Also, 74.7%, 89.5% and 90.5% respectively, from Nigeria; as well as 69.4%, 72.9% and 81.2% from Republic of Benin agreed that they were influenced by observed benefits of smart phones, they are satisfied with the result of using smart phones, and smart phones are worth their values.

![Figure 6: Observability of smart phones](image)
Compatibility of Smart Phones with Lifestyle

Majority of the sampled students from Republic of Benin (67.1%, 75.3%, 55.3%, 57.6% and 87.1%) respectively agreed that using smart phone fits into their social life; they enjoy using smart phones because of the applications; they are interested in the durability of smart phones; using smart phones has helped to manage their time; and using smart phones fit into their academics. Nevertheless, 65.9% and 62.4% respectively disagreed that they used smart phones because of their shapes/look; and they use smart phones because of their brand names. These responses were similar to their Nigerian counterpart.

A higher percentage of the sampled students from Nigeria (86.3%, 88.4%, 74.7%, 46.3%, and 63.2%) respectively agreed that using smart phone fits into their social life; they enjoy using smart phones because of the applications; they are interested in the durability of smart phones; using smart phones has helped to manage their time; and using smart phones fit into their academics. However, 47.4% and 49.5% respectively disagreed that they used smart phones because of their shapes/look; and they use smart phones because of their brand names. It is important to state that 13.7%, 10.6%, and 13.7% respectively failed to choose between agree and disagree for using smart phone has helped to manage my time, I use smart phone because of its shape/look, and I use smart phone because of its brand name.

Communication Factors

Mass Media Influence

The highest percentage of sampled students from Republic of Benin (80.0%) agreed that internet browsing influenced their adoption of smart phones. This was followed by 61.2%, 54.1% and 47.1% who were influenced by listening to/watching television; newspaper report; and listening to radio respectively. These were not all the same for their Nigerian counterpart. A total of 82.1% and 47.4%, from the sampled Nigerian students, agreed that internet browsing influenced their adoption of smart phones; and listening to/watching television influenced their adoption of smart phones. However, majority of 61.1% and 50.5% respectively disagreed that listening to radio; and newspaper report influenced their smart phones adoption.
Influence Due to Relationships
Most of the sampled students from Republic of Benin (87.1%, 83.5%, 71.8% and 58.8%) respectively agreed that interaction with friends, interaction with family members, interaction with community members, and interaction with people in the general population influenced their adoption of smart phones. Similarly, 86.3%, 81.1%, 62.1% and 49.5% of their Nigerian counterpart respectively agreed that interaction with friends, interaction with family members, interaction with people in the general population, and interaction with community members influenced their adoption of smart phones.
4. CONCLUSION

This study shows that about two-third of the total number of sampled students might have adopted smart phones because smart phones are easy to use, although their opinions vary on other relative advantages of smart phones. More than two-third of them also operate smart phones on their own. This indicates that smart phones may not be that complex. This study also show that most of the sampled students might have tried smart phones before buying one and were influenced by the observed benefits of using smart phone. Lastly on the perceived characteristics of smart phones, a good number of the sampled students noted that smart phones are compatible with their lifestyles.

The study shows further that internet browsing has a major influence on adoption of smart phones by students. The opinions of the students vary on listening to/watching television, newspaper report and listening to radio. In addition, interaction with family and friends were also observed to be another major influence for the adoption of smart phones by students. It is assumed that the difference in opinion between the two set of students might have been influenced by age, as students from Nigeria are younger than those from Republic of Benin.

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Users’ Perception of the Effects of Viruses on Computer Systems – An Empirical Research

S.S. Oyelere
Department of Computer Science
Modibbo Adama University of Technology
Yola, Adamawa State Nigeria.
E-mail: Solomon.oyelere@mautech.edu.ng

L.S. Oyelere
Windows Click Computers
SMIT Commercial Area
Modibbo Adama University of Technology
Yola, Adamawa State, Nigeria
E-mail: lydiailuggu2005@gmail.com.

ABSTRACT

A computer virus is a piece of software which attaches itself to another program causing undesirable effect on the program. It is attached similar to the way in which biological virus affect other organisms. The synonymous way it works with that of the human virus gave rise to the term computer virus. Computer viruses infect personal computers (PCs) and server. Some viruses create mere annoyance, but others can do serious damage: delete or change files, steal important information, load and run unwanted applications, send documents via electronic mail (e-mail) or even cripple a machines operating system (OS). Random sampling technique on respondents was performed while the data used for the study is collected from primary sources using a well-structured questionnaire. Data collected were logically analyzed using descriptive tool such as percentages and charts and inferential statistical tool such as chi-square. Based on the administered questionnaires the result indicated that viruses can infect computer system through a number of ways such as exchange of flash drive, hard disk and network medium.

Keywords: Virus, Antivirus, Computer system, Security, Program

I. INTRODUCTION

The importance of virus free computer system cannot be over looked due to many factors surrounding and facilitating system management such as cost of implementing a computer based information system, cost of gathering data, processing it and producing a meaningful information, risk of losing important information and lots more. Viruses therefore constitute a reasonable percentage of various threats that computer based information system faces. In recent time, especially in the early part of 21st century, the word virus was closely associated with the state of health of human beings i.e. the biological virus. Presently the word comes up both in biological and health sciences as well as computer sciences. However, it is distinguished in the computer field as “computer virus”. Although its biological counterpart preceded it, it is not less important too. In the field of computer science, its effect cannot be undermined, as it has become a major threat to many computer professionals and users. The rapid development of information technology has undoubtedly brought about the advent of the computer virus. This project work would look into the heart of computer virus infection and prevention.

1.1 What is a computer virus?
A computer virus is a unique type of program that has the ability of self-replicating and it stores a copy of itself in another part of a computer system (usually on hard or floppy disk). According to [1] computer virus are instructions that are hidden within a computer program and are designed to cause faults or destroy data. A computer virus is capable of perpetuating itself with the basic objective of performing certain activities that could range from annoyance to serious vandalism. This means that the virus will try to replicate itself and carry out certain operations without letting the computer user even know of its ability to be inconspicuous in its existence.

Also the activities of any virus in its existence depend on the imagination, skill and knowledge of its author [2]. In some cases, however, a virus is referred to as a program which exploits loopholes in the way the computer perform its various operations. The target is usually the computer operating system - which manages computer resources. The operating system performs file management, processor management, and device memory and information management.
This shows that attacking the operating system, virus has attacked every part of the computer at large. Computer viruses have a lot of similarities with their biological counterpart and basic similarities arise even from their definitions. A biological virus is a submicroscopic organism that invades living cells and reproduces only within the living cell. Most precisely, they are defined as obligate intracellular parasite containing either DNA or RNA (the hereditary material) and they cause diseases as a result of their replication assembly and releasing of infectious particles.

From the foregoing both forms of virus require a host for activation and survival. The computer virus requires a ‘host’ program in order to be activated while its biological counterpart must invade a living cell. The computer virus requires an executable path to penetrate a computer and spread. There is need for a way of protecting a system from infections by making sure that only legitimate, virus-free code is executed. And this is also true for the biological virus, which requires a mode of transmission, which could either be water or air.

Both the computer and biological viruses replicate and spread to other parts within their different host. They also both attempt to do this inconspicuously, providing side effects that are undesired by the host. The computer virus often causes direct harm to the infected system by performing hostile acts such as erasure of files, obliteration of the boot block etc. they are both disseminated. Computer viruses are products of people known as virus authors. These people write and distribute their programs both intentionally and unintentionally. The programs are written for various reasons as for terrorist action, to demonstrate skills, smartness, and experimentation.

In order to inactivate a virus, it must be captured and analyzed. Analysis involves full disassembly and extraction of hexadecimal pattern for future identification. Virus researchers that produce antivirus products do these. The biological virus is even more difficult to inactivate and this is because of its host during replication and often it is difficult to find drug that will inactivate the virus without affecting the host [3].

There are various examples of both viruses [4]. The BRAIN, JERUSALEM, MELISSA, TEQUILA, MALTESE, AMOEBA, LEHIGH, VIENNA, I LOVE YOU, KISS ME, TIMER, BRONTOK, are typical examples of the computer virus while some examples of the biological virus are SMALL POX, CHOLERA, POLIOMYELITIS, TUBERCLOSIS, and HIV.

From the foregoing, computer viruses can be characterized as follows;

1. Self-replication
2. Side effects
3. Executable path
4. Disguise

Henceforth, in this research work, the word virus refers to the computer virus and all references to the biological viruses will be stated closely.

1.2 Stages of virus infection

The existence of a computer virus typically encompasses four stages. That is to say this class of programs differs from the conventional computer programs in four aspects namely [5]:

a. Dormancy
b. Propagation or replication
c. Trigger
d. Damage

Upon infecting a new machine or a new program, the virus may remain dormant to avert suspicion. A virus penetrates a computer system when it is executed and running a contaminated program does this. The duration of dormancy varies with the type of the virus. While some awaits a certain number of executions of the host program, others await a certain period of time of elapse; yet some others watch out for a date in the year before delivering the payload i.e. before it is triggered.

When a computer system becomes infected, it now starts to replicate itself. A virus may be a fast infector or a slow infector. A fast infector spreads rapidly within a computer by infecting everything that is accessible. If a fast infector is in memory, every file that is opened gets infected. On the other hand, a slow infector does the opposite. The logic is that, if it spreads slowly, it is less likely to be noticed and killed. A classic slow infector aims to deceive a change detector as an antivirus measure. It therefore infects only those files that are intended to be changed.

As the system becomes infected and the virus self-replicates, most viruses try to determine whether they have infected an executable file by testing for some infection signature or virus maker. When an uninfected program is detected, the virus infects it by copying itself to the file. Therefore when an infected program is executed, the virus code receives control and performs the work appropriate for the stage that it is in. It then returns control to the host program to carry out its normal operations. In this way, the virus can hide its existence all the way through to the triggering stage. The triggering stage is the stage in which the payload is executed. It triggers the side effects of the virus. It is at this stage that the user usually notices that his PC is infected. The triggering damage done by viruses can be categorized into different groups according to the severity of the damage.
Computer virus poses a serious ache to any computing installation. However, it is important to emphasize at this stage that computer viruses are not alone in the menace on the computer system. Other common forms are Trojan horse, logic bombs, and worms. There are bound to be more active virus writers and there will also be a continuous development and improved sophistication in virus writing. Therefore an understanding of the various techniques will enhance the production of antivirus software that will successfully combat the survival of viruses. As in most situations in life, prevention in the case of viruses remains the best options for protection. Common preventive measures include scanning of the newly acquired software, scanning the disks, frequent backups, cold booting the system when a storage occurrence is noticed.

The problem at hand deals with issues pertaining to computer system information security. Computer virus still seems to be infancy stage in developing African countries despite the fact that some measures have been taken on the control of viruses by introducing anti-viruses. Based on the above facts there is need to study the effect of virus on a computer system and its tremendous impacts.

This research work intends to plough out some basic facts about the computer virus and its effect on computer system. However, the objectives of this research work are:

i. To demonstrate the effect of computer virus
ii. To enlighten computer users on what attract the virus to the computer system
iii. To also enlighten computer users on how to control the effect of computer viruses
iv. To provide a framework for discussing a wider variety of virus related issues.

The very aim of this research work is to provide a security measure against threats facing information technology. The design will benefit the management of any organization, individual users, professional, and enhanced computer system life span.

In order to achieve the objectives of this research work, the following questions are to be considered:

i. Have you ever experienced virus infection before?
ii. Does your system get infected with virus through flash drive or external memory?
iii. Does your computer system get infected with virus anytime you browse in the café?
iv. Do you encounter hardware component failing to function as a result of virus infections?
v. When virus affects your system, does it corrupt the operating system?

2. RELATED LITERATURE

The boot sector code is run whenever you start up the computer with a diskette in drive A as opined in [2], they realized that they could replace this code their own program and that this could be memory resistant program and that it could install a copy of itself on each floppy diskette that it accesses in any drive. The program copied itself, they called it a virus. Today's computer virus was conceived and demonstrated by Fred Cohen in 1983. Worm originated from John Shoch and Jon Hupp when conducting an experiment on mobile software at Xerox PARC in 1979 [6].

According to [7], Franz Suloboda became aware that a virus was being spread in a program called Charlie. He called it the Charlie virus, he made a lot of noise about the virus and badly bitten as a result. At this point, there are two version of the story, Burger claim that he obtained a copy of this virus from Swoboda, but Swoboda denied in any case he obtain a copy and give it to belt FX, who disassemble it (this was the first time anyone had disassemble a virus).

Swoboda include the disassemble in his book after patching out a couple of areas to make it less infecting and changing the normal pay load of Vienna is to cause one file inn eight or reboot the computer (virus patches the first time bytes of the code). Swoboda replace this reboot code write file spaces. The effect was that patches hang the computer instead of rebooting this isn’t really an improvement [7].

There is contribution in [8] that in US Cohen had completed his doctoral dissertations which was on computer viruses, Cohen provide that you cannot write a program that can with 100% certainty look at file and decide whether it is a virus, of course no one thought that you could, but make good use of an existing mathematical theorem and earned a doctorate, he also did some experiment he released that a virus on a system and discovered that it traveled further and faster than anyone had expected.

Virus was defined as any binary file that meets the following criteria [9]:

1. It requires direct human intervention in order to spread. Unlike a worm, which spreads automatically, a virus requires a user to download and double-click a binary file, or transfer it using an infected medium, such as a floppy disk
2. It has a payload, which can be destructive behavior (deleting or altering files), or annoying messages left on the screen, or both
3. A virus spreads quickly to all documents in an operating system. A virus never spreads itself to other systems automatically.

In [1], the origin and history of virus was revealed. It was opined that people create viruses. A person has to write the code, test it to make sure it spreads properly and then release the virus. A person also designs the virus's attack phase, whether it's a silly message or destruction of a hard disk.
The differences between computer viruses and worms was enumerated [10]. A worm is a computer program that has the ability to copy itself from machine to machine. Worms normally move around and infect other machines through computer networks. Using a network, a worm can expand from a single copy incredibly quickly. For example, the Code Red worm replicated itself over 250,000 times in approximately nine hours on July 19, 2001. A worm usually exploits some sort of security hole in a piece of software or the operating system. For example, the Slammer worm (which caused mayhem in January 2003) exploited a hole in Microsoft's SQL server. Worms used up computer time and network bandwidth when they are replicating, and they often have some sort of evil intent.

There are numerous types of computer viruses some of which are as follows [12];

- Macro virus
- Multipartite virus
- Stealth virus
- Files infected virus
- Cannabis virus
- Boot virus
- Trojan horse virus
- Amercing virus
- Internet virus

Macro virus; written using a simplified macro programming language, these viruses affect Microsoft office applications, such as word and excel and count for about 75 percent of virus found in the world. Multipartite virus; this is a portion of the infected boot files and the boot sector, a double whammy that can re-infect your system dozens of times before it’s caught. Polymorphic virus; these are charges code whenever it passes to another machine; in theory these viruses should be more difficult for anti-virus scanners to detect; but in practice they are usually not that well written. Stealth virus; thee destroy the component of the system and recovery from the damage caused these virus is extremely difficult, if not impossible. File infector virus; these are viruses that add code to files that run program so that the virus is activated it spread to another program files.

Cannabis virus; this is the type of virus that infect floppy disk boot record. It means that record that is been store into the floppy disk that contact how your operating system starts when you turn on your computer. A boot sector virus replace the disk original boot sector with its own carrying the virus into the memory once is in the memory, the virus can spread to the disk.

Trojan horse virus; these are program that are not described in their specification. The user run what they think is a legitimate program allowing it to carry out hidden, often harmful infections. For example Tro/Zulu claim the millennium bug but actually over writes the hard disk. Trojan horse is sometimes used as a means of infecting a user with a computer virus.

Amercing virus; this popular viruses infect the exe files only. This means that no access to this files or extensions, when you need it. Internet virus; these are virus which attack any net user immediately. Affect computers when connected to the internet.

2.1 Control of computer virus: computer antivirus

Standard antivirus software normally carryout the detection of viruses, anti-virus arte program designed to detect, clean virus and rehabilitate the damage caused by viruses. There are numbers of anti-virus software available to detect and remove virus from the computer for example virus scan from Dr Solomon, MACFEE, Norton and PC-Cillin, etc. anti-virus software checks the RAM and the files and virus and report it. Each anti-virus software can only detect and clean virus that have been programmed to clean only, most compiler industries making anti-virus software offers periodic upgrade that are equipped to detect and remove the virus that has been since the last upgrade.

The following steps were enumerated to check viruses [11]. Establish routines: Unless organizations and single-users have established internal routines for data handling, the chance for running a virus-free computing environment is not likely to succeed. We have seen that when strategies and routines for data handling are initiated at management level, the organization is less exposed to virus infections. And when they occur, routines make it easier to root out the infected files before they spread.

When people think of anti-virus solutions, they normally think of scanners. Scanners are the most readily available types of anti-virus solution, but they are not the only type. A virus can be detected using either generic methods or specific methods. Generic methods look for virus-like behavior rather than specific viruses. As a result, even new viruses can be detected, and there is little need for frequent updates to the tool that is being used. Because generic methods look for behavior rather than specific viruses, the name of the virus is normally not given. Instead users are simply warned that a virus is likely to be present. Some shy away from this method because it can give false alarms. Examples of generic detection methods are: check summing and integrity checking, heuristics, decoys, behavior blocking.

Specific methods, on the other hand, rely on having prior knowledge of the virus. In this case the tool is able to both detect that the virus is present as well as identify it. As a result, frequent updates to the tool are necessary. Most users like to know what they’re “up against” if a virus is found, and the best way to do that is to determine the exact nature of the beast. For this reason, many users prefer this method, but they do not ultimately appreciate how often the tool must be updated. Examples of specific detection methods are: on-demand and scheduled scanning, on-access (real-time) scanning.
3. RESEARCH DESIGN AND CONTEXT

This section presents the description of the research design, area of the study, population of the study, sample size, sampling techniques, instrument for data collection, validity and reliability of instrument, method of data collection, and method of data analysis. The study analyzes the effect of virus on computer system of Modibbo Adama University of Technology (MAUTECH) Yola Adamawa State Nigeria by sampling the opinion of computer literate individuals selected at random. The research study which is based on analyzing the effects of virus in computer system is carried out of some selected number of staff and students of MAUTECH. The sample size for this research is fifty five (55) numbers of respondents which includes student, lecturers and non-academic staff. The sampling technique for this research is carried out randomly such that the respondents cut across the different opinions in the university. The data to be used for this study is collected from the primary source using a well-structured questionnaire. The questionnaire is administered to staff and students of MAUTECH. The questionnaire is supervised by the researcher to determine whether the questionnaires were able to measure what they are supposed to measure. Data collected purposely for this research work is logically analyzed through the use of both descriptive and inferential tools. Descriptive tool such as percentages and tables is utilized while inferential statistical tool such as chi-square is employed.

4. RESULTS

This section covers the presentation and analysis of data collected for the purpose of the study. The results were based on the various data obtained from the use of questionnaires. These findings provide solution to the problems outlined in the statement of the problem of this research work.

Section A: Demographic data
As shown in figure 1, 45% are female while 55% are male, thus indicating that there were more male respondents compared to females.

Fig. 1: Gender demographic profile of respondents

This shows that there are more male than female in the university environment. Figure 2 shows the different age groups that participated in the research.

Fig. 2: Age demographic profile of respondents

Majority of the respondents were between 26-35 years old which has 55%. In figure 3, the occupation information of the respondent is presented.

Fig. 3: Occupation profile of respondents
It could be identified that most of the respondents are students while 18% are lecturers, 14% are non-teaching staff. The various educational levels of the respondents are presented in figure 4.

From figure 5, most of the computers are not used for desktop publishing while few people do use their systems for desktop publishing. This indicates that respondents used their systems for other use. On whether virus infections have been encountered, the result is presented in figure 6.

**Section B: Topical questions**

The first aspect shows whether computer is use for desktop publishing in the research area as presented in figure 5.

This shows that most of respondents have experienced virus infections while only few opined otherwise. This implies that virus infections are common. The aspect of finding out whether boot sector, Trojan horse, file infections are normally experienced is presented in figure 7.
From the analysis of response, only small percentage of the respondents do normally experience boot sector, Trojan horse, file infection while most of the respondents replied the opposite. This means that most virus infections are not caused by boot sector, Trojan horse, file infection. Figure 8 reveals whether computer systems get infected with virus through flash drive.

![Computer systems get infected with virus through flash drive](image)

**Fig. 8: Experience with virus infection through flash drive**

Among the 55 respondents, most are of the view that system get virus through the use of flash drive while only few replied the opposite. This means that flash drive transfer virus to computer systems. Figure 9 shows whether the computer system get virus infections with the use of external memory drive.

![Computer system get virus infections with external memory drive](image)

**Fig. 9: Experience with virus infection through external memory drive**

From figure 9, few of the respondents’ computer get virus through external drive while most of the respondents’ computer did not get virus through external drive. This means that the use of external drive should be encouraged among computer users. Figure 10 shows whether there is difficulty in booting the system infected with virus.

![Difficulty in booting the system infected with virus](image)

**Fig. 10: Difficulty booting virus infected computer system**

Most of the respondents stated that there is difficulty in booting system when infected with a virus while only few responded otherwise. This implies that substantial measures should be taken on virus infected system. The next aspect of this research work as presented on figure 11 shows whether hardware component fail to work as a result of virus infection.

![Hardware component fail to work as a result of virus infection](image)

**Fig. 11: Hardware component failure on virus infection**
Larger populations of the respondents are of the opinion that virus infection does not cause hardware failure while few of the respondents did not share this opinion. This suggests that virus infection do not cause system hardware failure. Figure 12 shows whether virus infection corrupt the operating system.

![Fig. 12: Virus infection corrupt the operating system](image)

From figure 12, most of the respondents agreed that virus do corrupt the operating system of a computer while few disagreed. Therefore, it means that stronger anti-virus need to be installed on computer system to prevent the operating system from corrupting. Figure 13 reveals whether if sound is heard or unexpected message is displayed on the screen when virus affects the system.

![Fig. 13: Sound is heard or unexpected message is displayed on the screen during virus infection](image)

Majority of the respondents are of the opinion that virus infections do not make sound or display unexpected message on the computer screen while a few of the respondents of the opposite. This implies that virus infections show other symptoms other than sound and unexpected messages. Figure 14 shows the response on whether anti-virus terminate virus to an extent.
In the total of 55 respondents, most of the respondents are of the view that any time they run an updated antivirus software on their system it terminate the virus to an extent while few respondents does not share this view. This implies that updated anti-virus software is one of the major remedy to virus infection on computer system.

Hypothesis testing
In order to test the hypothesis stated, the expected frequency is calculated based on the responses of the most relevant questions from the questionnaire and these were compared with the observed frequency using a chi square test with a degree of freedom at 5% level of significance [13].

Decision rule
Reject the null hypothesis \( H_0 \) if chi-square calculated is greater than the table value. Otherwise, the attribute hypothesis \( H_1 \) alternative is accepted.

Hypothesis one
\( H_0 \): System does not get infected with virus through the use of flash drive.
\( H_1 \): System gets infected with virus through the use of flash drive.

Since the calculated chi-square is greater than the table value, we therefore reject the null hypothesis \( (H_0) \) and accept the alternative hypothesis \( (H_1) \) which states that a system gets infected with virus through the use of flash drives.

Hypothesis Two
\( H_0 \): Virus does not corrupt the operating system
\( H_1 \): Virus corrupts the operating system

Since the calculated chi-square is greater than the table value, we therefore reject the null hypothesis \( (H_0) \) and accept the alternative hypothesis \( (H_1) \) which states that Virus corrupt the operating system.

4.1 Research findings
Following the statistical analysis that was employed, and the responses obtained from questionnaire, it was observed that some of the effect of virus in a computer system includes difficulty in system booting, hardware components fail to function, loss of data and corruption of the operating system. The common kind of virus that affects computers systems are; boot sector, worms, Trojan horse and file infections virus. Furthermore, based on the research findings so far it is discovered that system can be affected with virus through downloading from the internet café, using of flash drive or external memory. However, despite the problems faced by the respondents, they are of the opinion that the presence of antivirus on a system may reduce the extent of damage and the effects of virus possible attack.

5. DISCUSSION

This study is an eye opener to many people who have little or no knowledge about virus and antivirus. The research will correct various misconceptions and provide basic ideas in understanding the subject. This research work has made us to understand that;

i. Viruses are not bugs, dirt, dust, or corrupted programs
ii. Viruses may attack more than one component at a time
iii. Computer viruses problems are not mystical; it is purely the work of somebody somewhere, a code developed by a computer professional.

Some viruses may be powerful than a particular antivirus due to the following reasons:

i. If the antivirus is weak, it has to be upgraded since some virus writers might have weaken the strength of the existing codes of the antivirus by writing more powerful codes that supersede that version of the antivirus
ii. Some antivirus only work for a particular system type and a particular operating system
iii. Some antiviruses are virus specific; they can only identify a particular virus and not all viruses
iv. Biological viruses operate on human beings and the medium of spreading is human body, but computer viruses operates on computer systems and the media for spreading it are flash drive, external hard-disks, shared networks, internet files and e-mails, all aimed at destruction.

v. The effects of virus attack on the host computer ranges from loss of information to the destruction of files, folders, hard disk, operating system blocks and start-up programs.
vi. The presence of anti-virus on a system may reduce the extent of damage and the effects of virus possible attack.
6. CONCLUSION

There is certainty that the future will witness the development of more sophisticated codes for viruses. These viruses may be difficult to detect and if detected, could prove stubborn to erase or remove from the computer system. This will no longer be seen as malicious act but as significant impact on the future of computing, knowing well that viruses are legitimate software. It becomes an intellectual challenge to become a virus and antivirus developer. This may in one way or the other limit the growth of information technology due to fear of loss of capital to the users. Many people may prefer to give up the fate they had on computer system. In order to help people stand the test of time, the researcher has considered this research study as a way of exposing viruses and its characteristics to the wider world. Implementing the recommendation obtained in this study will go a long way to prepare both the computer experts and users for the future war against viruses, which may defile even the use of weapons such as antivirus. Implementing antivirus software might be expensive considering compatibility of some antivirus to the existing hardware and operating system, but the benefits outweigh its cost. Information as a great tool for management decision must be well secured. The following are recommendations: computer user is encouraged to report every virus attack they encounter to computer specialists so as to make materials available for upgrading the existing antivirus and writing new ones; it was carefully observed in the course of this research work, that when users delete a virus from a component, they tend to forget that the virus might have infected one or two other components other than the one seen, thus giving room for the virus to bounce back which (to the user) is caused by inefficiency of the antivirus, but certainly not. The user only needs to make sure that all drives and diskettes are properly scanned at any suspicion.

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Enforcing Dilution of Precision in Global Positioning System (GPS)

O.J. Unogwu
Research Scholar, Department of IT
Sikkim Manipal University
Accra, Ghana
Omega.unogwu.2014@ieee.org
+234 706 786 3838, +233 543 844 062

K.H. Kamal
Head, Department of IT
Sikkim Manipal University
Accra, Ghana
kamalhiran@gmail.com
+233 574 974 212

ABSTRACT

This paper considers the robustness of space-based systems with specific example of GPS to faults in providing accurate positional data. Recent advances in navigation technologies enabled the infusion of information technology into physical processes. One of the keys to obtaining high-accuracy position and time keeping with GPS is the use of redundant atomic clocks onboard GPS satellites and in the GPS control segment. Time is the cornerstone of GPS technology because distances are measured at the speed of light. Atomic clocks provide the means for estimating satellite orbits and satellite clock correction parameters. Therefore, in order to achieve a high degree of accuracy, error source of GPS signal broadly categorized into three classes of 1) Receiver noise errors, 2) Orbital and Clock errors and 3) Propagation errors are to be well contained to achieve a high degree of precision. Generating GPS applications for extracting and enforcing dilution of precision made positioning accuracy feasible using the understanding of Geometric Dilution of Precision (GDOP) deals with both navigation position as well as error in time estimation; Vertical Dilution of Precision (VDOP) for the quality of the calculated vertical position as well as the Time Dilution of Precision (TDOP) for the mean error of the current time estimation using the GPS constellation. All DOP measurements are packaged into the $GPGSA$ sentence every few seconds. Using ParseGPGSA method extracts DOP values and reports them through HDOPReceived, VDOPReceived and PDOPReceived. The result shows that adopting suitable programming language like VB.Net infrastructure produces a highly accurate precision fix in radio signal transmission between satellites in space and terrestrial receivers.

Keywords: Global Positioning System (GPS); Geometric Dilution of Precision (GDOP); Positional Dilution of Precision (PDOP); Horizontal Dilution of Precision (HDOP); Vertical Dilution of Precision (VDOP) and Time Dilution of Precision (TDOP).

I. INTRODUCTION

Global Positioning System [2] is a satellite-based navigation system providing precise three-dimensional position, navigation, and time information to suitably equipped users. It is made up of three segments namely; the ground control stations, 24+ satellites in earth orbit and receiver units on the earth surface. The initial intention was to use this system mainly for navigation purposes of the US military. Due to the tremendous accuracy potential of this system, and the latest improvements in receiver technology, there is a growing community which utilizes the GPS for a variety of civilian applications [6].

Fig 1: Constellation of GPS Satellites over Earth
The Global Positioning System (GPS) is a constellation of 24 active (and a number of spare) earth-orbiting satellite navigation system with associated tasks in a wide variety of applications operated by the United States Government through the US Air Force. GPS provides worldwide twenty four hours a day positioning in three dimensions and time services. Primarily designed for land, maritime and aviation navigation services, GPS applications [5] have evolved into services. Primarily designed for land, maritime and aviation through the US Air Force. GPS provides worldwide twenty two frequencies operated by the United States Government active (and a number of spare) earth-orbiting satellite L1 and L2 at 1575.42MHz and 1227.60MHz respectively. Signals are transmitted from GPS satellites at two frequencies vehicular tracking as well as emergency services dispatching. geographic information system geo-referencing, automatic vehicular tracking as well as emergency services dispatching.

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Trimble wrote: “in order to compute a receiver’s solution (location and time), the receiver algorithm selects four satellites from all of the satellites in the receiver’s view. In mathematical terms, the user’s receiver solves a system of equations with four equations and four unknowns; the four equations represent the four satellites selected by the receiver to compute a solution and the four unknowns represent the latitude, longitude, altitude, and time”. With an aggressive period of research, empirical or mathematical and simple models were generated to mitigate the effects of the errors in GPS positioning. The following equation represents a good example of such models where the algorithm is used to model GPS error solutions with emphasis on the Ionosphere, Troposphere and measurements of the carrier phases on L1/L2 frequencies.

\[ \begin{align*} 
\delta_1 \lambda_1 &= R + c \left( \delta tu - \delta ts \right) + T - Ip1 + M\Omega1 + N1\lambda1 + \epsilon\Omega1 \ldots \quad (1) \\
\delta_2 \lambda_2 &= R + c \left( \delta tu - \delta ts \right) + T - Ip2 + M\Omega2 + N2\lambda2 + \epsilon\Omega2 \quad (2) 
\end{align*} \]

Where,
- \( \delta_1 \lambda_1 \) = Carrier phase measured on L1 frequency (C/A or P(Y) parts)
- \( \delta_2 \lambda_2 \) = Carrier phase measured on L2 frequency
- \( R \) = Geometric range from satellite s to user u
- \( \delta tu \) = User/receiver clock error
- \( \delta ts \) = Satellite clock error
- \( T \) = Tropospheric Delay
- \( Ip1, Ip2 \) = Ionospheric delay in measurement on L1/2
- \( M\Omega1, M\Omega2 \) = Multipath delay in carrier phase measurement on L1/2
- \( N1, N1\lambda1 \) = Carrier phase ambiguity or bias
- \( \lambda1, \lambda2 \) = Carrier wavelength
- \( \epsilon\Omega1, \epsilon\Omega1 \) = Other delay/errors in carrier phase measurement on L1/2

In computing Dilution of Precision, the unit vector from the receiver to satellite is given by the equation.

\[ f = \left( \frac{p}{S_1}, \frac{p - q}{S_2}, \frac{p - r}{S_3}, \frac{q - r}{S_4} \right) \]

Where,

\[ S_i = \sqrt{(p - q)^2 + (q - r)^2 + (p - r)^2} \]

and, the variables \( p, q, r \) represent the GPS receiver’s position and \( q_i, r_i \) and \( q_i \) represent the position of satellite \( i \). A matrix “A” for a set of satellites is given as:

\[ A = \begin{bmatrix} 
q_1 & r_1 & \cdots & 1 \\
q_2 & r_2 & \cdots & 1 \\
q_3 & r_3 & \cdots & 1 \\
\vdots & \vdots & \ddots & \vdots \\
q_n & r_n & \cdots & 1 
\end{bmatrix} \]

Satellites are constantly in motion, which is good because it prevents the existence of “blind spots” in the world with little or no satellite visibility. Just like finding stars in the sky, satellite locations are described as the combination of an azimuth and an elevation [7]. As mentioned above, azimuth measures a direction around the horizon. Elevation measures a degree value up from the horizon between 0° and 90°, where 0° represents the horizon and 90° represents “zenith”, directly overhead.

GPS programming guidelines follows a set of collections of rules that, with all the parameters made available, eliminates positioning errors [9]. In programming, to access GPS information to a high degree of reliability, information of the following attributes of the satellite needs to be present.

- Latitude
- Longitude
- Altitude
- Time Stamp
- Travel Direction
- Altitude Uncertainty
- Speed Uncertainty

With these, GPS positions can be retrieved and its status can be obtained.
In each row of A, the first three elements are the components of a unit vector from the GPS receiver to the designated satellite. Supposing the elements in the fourth column denotes the speed of light \( c \) then the time dilution factor \( \sigma_t \) always equals 1. However, if the elements here is -1 then the \( \sigma_t \) can effectively be calculated. The matrix \( Q \) is formulated as:

\[
Q = (\mathbf{A}^T \mathbf{A})^{-1}
\]

In accordance with the Principles of Satellite Positioning document, where the weighting matrix \( M \) is set to the identity matrix.

In \( Q \) the elements are denoted as:

\[
Q = \begin{bmatrix}
\sigma_{E}^2 & \sigma_{E} \sigma_{N} & \sigma_{E} \sigma_{U} \\
\sigma_{E} \sigma_{N} & \sigma_{N}^2 & \sigma_{N} \sigma_{U} \\
\sigma_{E} \sigma_{U} & \sigma_{N} \sigma_{U} & \sigma_{U}^2
\end{bmatrix}
\]

(7)

And, PDOP, TDOP and GDOP are denoted by:

\[
\text{PDOP} = \sqrt{\sigma_E^2 + \sigma_N^2 + \sigma_U^2}
\]

(8)

\[
\text{TDOP} = \sigma_T
\]

(9)

\[
\text{GDOP} = \sqrt{\text{PDOP}^2 + \text{TDOP}^2}
\]

(10)

This agrees with the principles of Satellite Positioning. Consequently, the Horizontal Dilution of Precision designated as:

\[
\text{HDOP} = \sqrt{\sigma_E^2 + \sigma_N^2}
\]

(11)

and the Vertical Dilution of Precision:

\[
\text{VDOP} = \sqrt{\sigma_U^2}
\]

(12)

are both reliant on the coordinate system used.

2. METHODOLOGY

Solving GPS precision problems is done by using more sophisticated GPS receivers which use real-time correction data such as WAAS (for North America) and EGNOS (for Europe). Yet, these problems cause relatively small inaccuracies when compared with Geometric Dilution of Precision [4], which can cause a receiver to be inaccurate by more than a football field. Fortunately, Geometric DOP is the easiest to manage with the right programming techniques. The idea of Geometric DOP is to state how errors in the measurement will affect the final state estimation. Knowing the location of satellites is important when determining how precise readings are and how stable a GPS fix is.

Computationally, this can be defined [9] as:

\[
\text{GDO}P = \frac{\Delta \text{(Output Location)}}{\Delta \text{(Measured Data)}}
\]

(13)

Conceptually, errors on a measurement resulting in the term changing can be imagined. Ideally little changes in the measured data should not significantly result in large changes in output location as such a result would imply the solution is very sensitive to errors.

In this work construction of VB.Net application takes the distance between satellite in orbit and a receiver at any point on the earth’s surface, the satellite’s azimuth and elevation angles and acceleration, as well as each satellite’s precise location in space as attributes. Controlling GDO\( P \) [17] is the key to writing accurate GPS applications. This is informed by the understanding of the ratio of position error to the range error of each satellite.

3. DESIGN

This novel research design is to add to modern precision standards involving identification of the various components of the error sources, with particular emphasis on the atmospheric segments - ionosphere and troposphere. This, it is hoped has added to push advances in GPS technology precision to new levels.

![Fig 3: Magnitude/percentage distribution of all GPS Errors](image.png)

Enforcing DOP by using of VB.Net [besides other programming languages as java and C#] would address GPS errors that are inherent by the effects of the atmosphere. It utilizes the distance, elevation, orbits and acceleration of the satellites from the receiver’s position on the surface of the earth. Considering a scenario with lines joining four satellite positions and receivers form a tetrahedron, the smaller the volume of the tetrahedron, the worse Geometric Dilution of Precision, likewise, the better the Geometric Dilution of Precision when there is a larger Dilution of Precision values.
DOP values range between 1 to >20 with rating decreasing in quality from IDEAL to POOR starting from 1. A high DOP does not produce an accurate position; though it could still be good. However, the position is probably closer to being right with a low DOP.

There are a number of ways to improve accuracy:
- Use DGPS to reduce the errors in the inputs.
- Improve DOP by using more satellites.
- Take your measurements when the satellites are spread out over the sky.
- Average the GPS position readings over time.

Implementation of the methodology was carried out having in mind the need to construct appropriate codes that will extract and enforce maximum DOP values. DOP can be expressed as a number of separate measurements; HDOP, VDOP, PDOP, and TDOP representing Horizontal, Vertical, Positional (3D), and Time Dilution of Precision respectively. Mathematically, they follow from the positions of the usable satellites. Signal receivers allow the displays of sky plots of these positions in addition to the DOP values. All DOP measurements are packaged into the $GPGSA$ sentence every few seconds. By generating programming codes to enforce Dilution of Precision, as earlier stated, the thrust of the code project is hinged on the use of VB.Net. Also, a method called ParseGPGSA is added which extracts all DOP values and reports them via three events: HDOPReceived, VDOPReceived PDOPReceived.

**Satellite**
The system architecture starts from the satellite in space sending positional data through the earth’s atmosphere which gets distorted by the ionosphere and troposphere amongst others, resulting to positional fix errors.

**Satellite Dish**
The satellite dish receives the distorted data packets and sends it to the VB.NET/C# workstation where inconsistencies are eliminated and retransmitted back to the satellite, Field receiving stations and communications towers.
Communication Towers
The communications tower forms an important segment of the transmission system as it serves as validation point for both distorted and corrected GPS position fix data to the satellite in space and the GPS field receivers on the ground.

GPS Receivers
This is the primary reason for the system. These are equipment fitted to hand held devices, auto motives, aircrafts, stationary structures and many others for the purpose of obtaining accurate positional fixes as well as other relevant data for specialized functions.

4. THE ALGORITHMS

Problem: Find and Extract GPS Dilution of Precision

Step 1: Start

Step 2: Public Class HighPrecision Test

Step 3: Private WithEvents As New NmeaInterpreter where NMEA = National Maritime Electronics Association

-Private Maximum DOP Allowed As Integer = 6 (on the event to interpreting all components of Dilution of Precision: GDOP, TDOP, PDOP, HDOP, VDOP and Time)

Step 4: Public Sub Test ()
Parse satellite Information (HDOP is 0.9)

Step 5: With ParseGPGSA DOP values are extracted and reported via three events – HDOPReceived, VDOPReceived, and PDOPReceived.

Step 6: MyInterpreter.Parse("$GPRMC, 060000,A,0533.000,N,&_00013.000,E,022.4,084.4,01071 4.4.433,W*6A"

Step 7: MyInterpreter.Parse("$GPGSA,A,3,28,26,,1.8,0.8,1.6*14"

Step 8: $GPRMC (Recommended Minimum sentence) contains nearly every component GPS applications require – latitude, longitude, speed, bearing, satellite-driven time, fix status and magnetic variations.

Step 9: End sub

Step 10: Private Sub OnHDOPReceived(ByVal value As Double)
- Handles MyInterpreter.HDOPReceived
- CurrentHDOP = value

Step 11: End Sub

Step 12: Private Sub OnPositionReceived(ByVal latitude As String, ByVal longitude As String) Handles MyInterpreter.PositionReceived
‘Is the HDOP at least six?

Step 13: If CurrentHDOP <= MaximumDOPAllowed then
‘Yes. Display the current position
Debug.WriteLine("You are here: “&latitude &”,
"& longitude)

Step 14: Else
‘No. Discard this positional measurement
- Debug. WriteLine("The received location is not precise enough to use").

Step 15: End If

Step 16: End Sub

Step 17: End Class

5. PERFORMANCE EVALUATION

Implementing dilution of precision was executed using GNSS online Planning and Planning software tools from Trimble to analyse Dilution of Precision.
Fig 8: GNSS (GPS) Planning software to enforce DOP

The planning interface was used to set the satellite almanac where visible satellites are selected based on visibility at Latitude 5° 33' 0" N and Longitude 0° 13' 0" E) at 10 days intervals starting from the 1st, 10th, 20th and 30th in the month of July, 2014.

Fig 9: Satellite availability selection
The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 5°33′0″N and Longitude 0°13′0″E) starting from 0600 hours to 1800 hours for the 1st of July, 2014, computed from broadcast satellite ephemeris set at 13° elevation mask angle.
### TABLE IX. DOP VALUES FOR 10TH OF JULY 2014

<table>
<thead>
<tr>
<th>Time (Hr)</th>
<th>GDOP (Units)</th>
<th>TDOP</th>
<th>PDOP</th>
<th>HDOP</th>
<th>VDOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00</td>
<td>2.97</td>
<td>1.49</td>
<td>2.57</td>
<td>1.23</td>
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</tr>
<tr>
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<td>0.84</td>
<td>1.69</td>
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<td>1.46</td>
</tr>
<tr>
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<td>1.88</td>
<td>0.96</td>
<td>1.62</td>
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<td>2.35</td>
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<td>2.16</td>
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<td>2.34</td>
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<tr>
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<td>0.89</td>
<td>1.69</td>
<td>0.87</td>
<td>1.46</td>
</tr>
<tr>
<td>12:00</td>
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<td>3.4</td>
<td>0.84</td>
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<tr>
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<td>1.17</td>
<td>2.25</td>
<td>0.89</td>
<td>2.07</td>
</tr>
</tbody>
</table>

The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 5° 33' 0" N and Longitude 0° 13' 0" E) Starting from 0600 hours to 1800 hours for the 20th of July, 2014, computed from broadcast satellite ephemeris set at 13° elevation mask angle.

**Fig 11:** Dilution of Precision Plots from broadcast satellite ephemerides for 10th July, 2014
### TABLE X. DOP VALUES FOR 20TH OF JULY 2014

<table>
<thead>
<tr>
<th>Time (Hr)</th>
<th>GDOP (Units)</th>
<th>TDOP (Units)</th>
<th>PDOP (Units)</th>
<th>HDOP (Units)</th>
<th>VDOP (Units)</th>
</tr>
</thead>
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<td>1.76</td>
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<td>1.26</td>
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</tr>
<tr>
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<td>0.79</td>
<td>1.76</td>
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<td>1.96</td>
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</tbody>
</table>

The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 5° 33’ N and Longitude 0° 13’ E) Starting from 0600 hours to 1800 hours for the 20th of July, 2014, computed from broadcast satellite ephemeris set at 130 elevation mask angle.

**Fig 12: Dilution of Precision Plots from broadcast Satellite ephemeris for 20th July, 2014**
TABLE XI: DOP VALUES FOR 30TH OF JULY 2014

<table>
<thead>
<tr>
<th>Time (HR)</th>
<th>GDOP (Units)</th>
<th>TDOP</th>
<th>PDOP</th>
<th>HDOP</th>
<th>VDOP</th>
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<td>1.12</td>
<td>2.09</td>
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<tr>
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<td>2.36</td>
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<td>2.08</td>
<td>0.77</td>
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<td>1.99</td>
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<td>1.76</td>
</tr>
</tbody>
</table>

The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 5° 33′ 0″ N and Longitude 0° 13′ 0″ E) Starting from 0600 hours to 1800 hours for the 30th of July, 2014, computed from broadcast satellite ephemeris set at 13° elevation mask angle.

![Dilution of Precision Plots from broadcast satellite ephemerides for 30th July, 2014](image-url)
6. CONCLUSION

GPS satellite signal have several ways of being distorted. Some are corrected by the Department of Defense and others can be corrected in your GPS receiver using real-time ground station correction signals. The only precision problem which is left to be controlled is Dilution of Precision (GDOP, TDOP, PDOP, HDOP and VDOP). Being an indicator that show how well GPS satellite constellation is organized, controlling DOP using applications as VB.NET greatly enhances the effect of the atmospheric error sources of GPS signals and is the key to writing commercial-grade GPS applications.

A small mathematical formula can be applied also to determine the maximum allowable DOP for a particular application. The maximum allowable error should be the greatest possible value which minimizes accuracy problems while maximizing operational conditions. Hence, the smaller the DOP the more accurate positioning fix gets. Relatively, the more the number of evenly spread satellites, the better the impact on good DOP.

Time is another factor which helps developers. Advances in GPS receiver technology are pushing precision to new levels. While precision can be questionable with any consumer GPS device, there will soon be a time when precision to a centimeter is possible and that is what VB.Net is poised to achieve.

Acknowledgment

The authors would like to thank the proprietors of GNSS Planning software (Trimble) as well as Analytic Graphics incorporated for magnanimously making their Systems Tool Kit accessible for use in this work. We would like to thank the management who constantly inspired to involve in research work and special thanks to Dr. Tahir Yakubu for cordial cooperation and motivation in our work. We would also like to thank for the valuable information they provided us and our family members for their love and care.
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Comparative Study of Media Usage In News Consumption: A qualitative Approach

I. G. Saleeman, A. M. Budiman & M. K. Ahmad
School of Multi-Media Technology and Communication, College of Arts and Sciences, Universiti Utara Malaysia, Kedah.
E-mails: rugmaak@yahoo.com, adrian@uum.edu.my, khairie@uum.edu.my
Phone No:+60146274133

ABSTRACT
Empirical studies have explored the relationship between news gratifications sought and news gratifications obtained in the online media and in the conventional media. Previous studies have rarely compared between the extent to which news gratifications sought are obtained in the conventional media and the extent to which the news gratifications are sought and obtained in the online media. Through a qualitative approach, this study employs a uses and gratifications approach to compare how news gratifications are sought and obtained in both the online and conventional media. In-depth interviews were conducted with 14 members of the National Youth Service Corps (NYSC) in Nigeria between January and April, 2014. Qualitative analysis was done on Nvivo 10 software for a thorough and transparent analysis. Investigation reveals why news gratifications are less sought but more obtained in the conventional media and why news gratifications are more sought but less obtained in the online media.

Keywords: News, Gratifications, Motivations, Gratifications Sought (GS), Gratifications Obtained (GO), Online Media, & Conventional Media.

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION
Media behaviour has followed the changing pattern of human society brought about by development and evolution of technology. At the onset of the 21st century, a technological phenomenon described variously as new media, digital media or information communications technologies (ICTs) began to change the media landscape dramatically. Although changes have been occurring on the media landscape since the last forty years and even farther [1], the last one decade has seen dramatic and revolutionary changes brought about by the phenomenon of new media [2]. Broadly defined as new information and communication technologies (ICTs) or as computer-based artistic activities [3], internet, mobile phone and multimedia have commonly featured in the lists of what constitute new media in majority of media studies [4, 5, 3, 6, 7].

In some communication studies, the tendency has been to substitute ‘new media’ for ‘online media’ or ‘digital media’ [8, 9]. The old conventional mass communication platforms, particularly television, radio and newspaper had remained the major news habitat for centuries. They remained so even up to the onset of the 21st century. This is because as at 1999, the computer/internet was still being likened to the telephone, prompting such assertion that even if every household were to have a personal computer with a modem, internet would never develop a character of mass communication[10].

But from the year 2000 to 2010, it became evident that a new information age that would challenge the existing concept and thus extend the conventional boundary of mass communication had evolved. Within the last decade, findings from many media studies have indicated that the new media, particularly the internet and the mobile phone have become major news consumption outlet for both the adults and the young in the society [11, 9]. In fact, as at 2003, news was coming second from top in the list of online activities in 12 core European countries with 70 per cent reading news relating to business and world affairs [9]. The traditional mass media seem to have come to terms with this reality as most of them have moved their platforms into these new media in the name of media convergence or 360-degree.[12]

With smartphones performing many functions ranging from programming a Digital Video Recorder (DVR) to surfing the internet and posting a status update to a social network which by 2010 was boasting of 500 million profiles [13], the fears of some newspaper and television executives about the future survival of their traditional news platforms can be contextually understood. This is where the issue now lies at the global discourse of online news consumption. That the new media have become major outlets of news is no more a debate.
The debate is what tolls has the movement to online news had on the old news platforms. The theoretical factions are between those scholars who opine that the new media have displaced the old platforms as news consumption outlets [14, 15, 16, 17, 18] and the other camp comprising of those who believe that the relationship is supplementary and complementary as the old news platforms are still surviving in the news circle [19, 20, 21]. Even as at 2011, the debate was still raging. The lack of clear pattern on the relationship between the old and new media as news sources was what prompt [19] to recommend that in the study of news consumption, there is need for a shift away from the traditional theoretical and methodological approaches which often treat media features and social practices separately. For instance, uses and gratifications approach to the study of news consumption in both the old and the new media can serve as a better theoretical approach in the effort to get a clearer pattern of the relationship between the old and new media as news outlets because media ‘users goals and interests have more concern to them than the media attributes’ [22, p. 55].

Media scholars have responded to this challenge by exploring the uses and gratifications of news in the old and new media. [23] explored the motivations for using social media for news among university students and found information seeking, socialising and status seeking to be the motivations of the social media users for sharing news. In their own study of why people use the websites for political information [16] identified guidance, entertainment/social utility, convenience and information (seeking) as motives. While examining how college students get hooked to news, [24] found internet to be one of the media that surveillance gratification is positively correlated with. In their own study, [25] found YouTube users to seek leisure and entertainment gratifications when they watch comedy news video while they seek information gratification in traditional news video.

Empirical studies have also explored how old, conventional media are used for news. Information seeking/surveillance and Para-social gratifications have frequently been associated with conventional television news. In his study of media involvement and local news effects, [26] found local news to be primarily linked to information seeking and Para-social gratifications. Similarly, in [27], Taiwanese news consumers found TV news to be a good source of surveillance gratifications. In some other studies, local TV news provides a mixture of information and entertainment gratifications to viewers. This is because its news reports on such core issues as politics; crime and disasters are often mixed with ‘human and local interest stories and newscaster appeal to provide light-hearted respite from hard news’ [26, p20]. In their own study, [24] found television news to positively relate to only escapism gratifications. News in the printed Newspaper is commonly associated with cognitive needs of the readers [27, 28] while [29] found information seeking and entertainment gratifications to predict the use of radio for news. The conclusion is that news gratifications, relative to the media, are not mutually inclusive.

They seem to differ only in degrees. Gratifications sought (GS) by media consumers and gratifications they eventually obtained (GO) are mutually exclusive. This is because there is absolute discrepancy between GS and GO [30]. In other words, the needs of media consumers when they visit the media are not always met [31]. Early researchers had sought to know whether at a point in the media usage, GS and GO can become equivalent with GS being obtained having known over a period of media usage how to receive such gratifications [32]. But, as [33] quickly pointed out, ‘while such equivalence may be established over the long run, initially the motivations which lead an individual to expose himself to a particular medium or type of content may not always match the gratifications derived from this exposure’ (p. 6) Previous studies have found both the online and conventional media to give varying degree of satisfaction to news seekers 34, 31, 35.

2. STATEMENT OF THE PROBLEM

Previous studies have explored the extent to which news gratifications sought in the online media and in the conventional media are obtained in the two media categories. [33] investigated how gratifications sought (GS) from television news are obtained from network evening news programs and found each GS correlated in varying degree with its corresponding GO. Similarly, in his examination of the role of gratifications sought (GS) and gratifications obtained (GO) in predicting dependency on network evening news programs and 60 Minutes, [35] found GS to be most strongly correlated to corresponding GO. On the other hand, [34] found news in the internet to provide satisfaction to the news consumers. A comparison between the extent to which news gratifications sought are obtained in the conventional media and the extent to which the news gratifications sought are obtained in the online media is rare in previous studies.

The attempt by [34] to compare news satisfaction in the internet and traditional media from the dimension of niche breathe when internet was just beginning to provide alternative to traditional media as a source of news could still have left an empirical vacuum on the issue of the relative strength of online and conventional media as news outlets. This is because the traditional media have since resisted the force from the online to make them irrelevant in news consumption as relatively more recent studies have found the traditional and online media playing complementary role in news consumption.(see (Boczkowski and [19, 20, 21]. Further, since [19] recommended a shift in the methodological approach to the study of media usage for news consumption, there appears to be no fundamental shift from the dominance of quantitative method. This study attempts to fill this methodological vacuum through the use of qualitative approach to understand how the online and conventional media are used for news gratifications.

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From the theoretical gap identified above, we sought to answer these research questions:

**RQ1** To what extent are the news gratifications sought in the conventional media obtained?

**RQ2** To what extent are the news gratifications sought in the online media obtained?

**RQ3** Why are news gratifications more sought and more obtained in either the online or conventional media than in the other?

3. **METHOD**

In-depth interviews were conducted with fourteen members of the National Youth Service Corps (N.Y.S.C) in Nigeria to gather data on how they use news to gratify their needs. NYSC is a one-year national service mandatory on any fresh university or polytechnic graduate who is not above thirty years of age. With hindsight of the observation that the university undergraduates have become relevant to the study of news consumption [24], we purposively selected from the NYSC members with the assumption that their relative maturity and experience would make them more suited to a qualitative study which requires descriptive response. The study used a thematic qualitative data analysis technique. Data were transcribed and analysed on the QSR NVIVO 10 software. Themes relevant to the three research questions were identified from the coded data and interpreted.

### Table 1.1: Informants’ demographic profiles

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4. **RESULTS**

![Figure 5.13: Model of NGO and its sub themes]
RQ1 To what extent are news gratifications sought in the conventional media obtained?

Few informants use conventional media to seek news. However, there is a stronger expression of news gratifications being obtained by those who use conventional media mostly for news. Informant 5 seeks news primarily for personal interactive purpose, that is, human interest news that creates empathy and draws out emotions and feelings for others. The informant uses more of his transistor radio than any other medium

I do listen to radio and the reason behind that is as a result of the incessant epileptic power supply; so I do go for radio because 24/7 even if there is no electricity very easy you can get battery and insert. I do use radio a lot because apart from that power supply, the real news I really want to hear or that I need most comes from my local environment because when I listen to my transistor radio it will give me the news that primarily has to do with my local surrounding. I do incorporate the internet which sometimes I use simultaneously with radio because radio has to do with my listening skill while the other one has to do with my reading skill. I do read and listen to radio sometimes but most importantly I do listen to radio

and to a large extent, he obtains this gratifications he seeks from the news:

I said earlier that my primary objective wherever I browse any of these media, the first thing that I look up to is any news that affects human; so the moment I read that news I picture that scenario and apply it to my life; if anything happens for instance, may be certain hazards, I study how that thing happen. Though I cannot protect myself but I will like to take caution on how to go about; sometimes what to say, where to say it and how to say it especially in the public, all this I learn from news because it must have affected somebody.

To a large extent, the need of informant 9 to confirm from the news media happenings reported to him by non mediated sources I is met: ‘to a large extent I obtain what I seek. For instance the insecurity in the north east, you hear a lot of things happening there from people and you confirm them from in the media.’ The informant also uses more of conventional medium to gratify this news need

I use mostly radio and television. Most of the time on television, I spend like from 9-10. I go on NTA news; sometimes I go on CNN, but I love to go on NTA. And I am a sports fan. It was when there is no light like early in the morning that I use to use radio and late hours; so I will go on BBC Hausa service.

Informant 1 seems to articulate better this issue of news gratifications sought being obtained when he reasons that from the news, ‘you get the normal information definitely; information that directs me on what I need to know; sometimes you don’t get what you want; but generally it is

O.K., better than not being informed.’ Although informant 1 uses both online and conventional media for news, his news needs appear more gratified in the conventional media. He says

if you are sourcing online you might not actually get the complete information. But when you are trying to get the major information on the highlights, then you can actually wait for the conventional media. So the online give me a tip of what has happened which I would pursue further in the newspapers.

Informant 8, whose primary purpose of seeking news is to acquire knowledge, ‘mostly used Radio Nigeria and sometimes online because I keep a sort of Facebook account which keeps me updated.’ In order to justify his claim that he obtains his news gratifications of learning through news, he recounts an experience:

There was a time when I read Vanguard newspaper online; so before I don’t like to travel to other state; so when I read that news I had a story of one person who travelled and on his travel he learnt a lot of other languages and these languages he learnt helped him a lot because that’s what he used to get job because he was employed as an interpreter in an organization and that encourage me to be travelling around the countri

RQ2 To what extent are news gratifications sought in the online media obtained?

Contrastingly, majority of our informants seek news in the online media, mostly through their mobile phones. Among the specific online media used for news, news websites are the dominant sources. However, unlike those who use the conventional media primarily to seek news, most of the online users who claim to have obtained the news gratifications they seek could not justify their claim. For example, informant 7 seeks news primarily to know about happenings around her environment. Although the informant casually remarks that ‘on the average I mostly get what I went out to seek from the news’, the countenance on her face and the tone in her voice seem to suggest more of disappointment with the news which she had alluded to while recounting an experience of her media visit for news: ‘there was an instance when Mandela died and I was trying to find out what happened to him and I couldn’t get much needed information.’

It is informants 10 and informant 9 who directly state the relative disadvantage of online media in providing news satisfaction. Informant 10 comes out of online news most of the times with her cognitive news needs ungratified because ‘most of the time these online media don’t give you most details about that information. So in most cases you come out of the news not well informed.’ Whenever informant 9 also accesses news online, he only imagines the details surrounding the news because details are not just there:
but for online media not much of satisfaction because duration of time they give to news is not enough. They just give you highlights and all that; they don’t give me the information as I want it. I will just imagine how it happens.

Instead of imagining how the details will be, informant 1 would rather pursue the details in the conventional media:

if you are sourcing online you might not actually get the complete information. But when you are trying to get the major information on the highlights, then you can actually wait for the conventional media. So the

RQ3 Why are news gratifications more sought and more obtained in either the online or conventional media than in the other?

1.4.1 Relative Advantages of Online Media

Figure 1.2: Model of online channels used for news
Majority of those who go online for news use the news websites, followed by Facebook. Blogs and YouTube were the least sourced online for news. One of our informants accesses news through the What Sapp: ‘I use Facebook, what Sapp and twitter.’ Informant 14 reads newspaper ‘mostly online’ which is the same with informant 10 who, most of the time reads ‘soft copy (of newspaper online.’ Informant 11 just goes to ‘websites of news,’ particularly those of Vanguard and Sun newspapers. Informant 6 also uses ‘Vanguard website’ while Informant 4 uses, majorly, ‘Facebook and websites of radio stations.’ Informant 7 goes to ‘news websites.’ But why do these informants prefer to seek news in the online media?

Informant 12 is always online for news ‘because they keep updating me of current issue (which is why) I don’t want to use Facebook because sometimes when news are like out of date, I don’t want to see that something has happened an hour ago; I want to see them as they are happening.’ The updates of news in the online media give informant 1 quick overview of the news he would pursue further in the conventional media: ‘online is actually faster because it gives me update; it keeps me updated of events happening suddenly which I would pursue further in the newspapers.’

Besides, online media quickly help to fill news vacuum where the conventional media cannot be accessed due to unavailability, linguistic barrier or poor signals. Away from her ethnic home, Informant 13 cannot access news in the conventional television media as she used to at home because of the language barrier and poor signals. So she had to abandon her urge for television news and concentrate on online news:

They don’t have many TV stations; they have just three; I think they have AIT, DITV, NTA and most of the times the stations are not clear. (Yet) I have more urge for news now that I am here because of the crisis situation (in the country...I (now) concentrate more on online.

Online media also reduce the risk of total news black-out in remote areas where the conventional media cannot be accessed. In her ethnic home, informant 7 feels cut off from the world. So, she could get access to news only through the online media: ‘where I am at home is very remote; it’s like you are cut off from the world with no information; so I had to be constantly online.’

Informant 3 points to the holistic nature of the online media as a relative advantage since she can ‘still get news from those (conventional) channels on internet because I subscribe to their services online.’ It’s the ease of use that constitutes the relative advantage of online media to informant 14 as he prefers ‘to get news online because it’s easy for me to get unlike conventional and I use only search engine. I just type whatever I want.’
1.4.2 Relative Advantage of Conventional Media

Figure 1.6 Model of TV media used for news
A couple of the informants prefer the conventional media for news. For the television channel, most of the respondents use the NTA for their news offline, followed by CNN. Channels TV, AIT and LTV are used equally.

If news gratifications are less obtained in the online media because the online media do not provide details, it could be inferred that news gratifications will be more obtained in the conventional media because of their advantage of detailed news. This inference is corroborated by informant 1 who says:

"if you are sourcing online you might not actually get the complete information. But when you are trying to get the major information on the highlights, then you can actually wait for the conventional media happened sometimes through dramatic conversation newspaper gives you the narrative story of what has actually happened; so the online give me a tip of what has happened which I would pursue further in the newspapers"

Similarly, informant 9 spends about the same time sourcing news from both the online and the conventional media. But his news gratifications are more obtained in the conventional media:

"to a large extent I obtain what I seek. For instance the insecurity in the north east, you hear a lot of things happening there from people and you confirm them in the media. But for online media not much of satisfaction because duration of time they give to news is not enough. They just give you highlights and all that; they don’t give me the information as I want it. I will just imagine how it happens."

The conclusion that news gratifications are more obtained in the conventional media is strengthened by informant 13 who reasons that to a large extent, she obtains news gratifications in her ethnic home where she used more of conventional media than in the ethnic setting she has migrated to where she has to concentrate on online media because the conventional media were relatively not available to her:

"There (in Lagos) it’s not all the time that I used my online (phone) to get news; I listened to radio, TV and newspapers to get news though I still use a bit of online but here in the north I concentrate more on online. (So) Its better over there than here because it’s only once in a while that I get newspaper to read here; the one I get is even in my office"

The conventional media could also present advantage of proximity which helps to localize news. Informant 5 is passionate about getting news on his transistor radio because ‘apart from that power supply, the real news I really want to hear or that I need most comes from my local environment because when I listen to my transistor radio it will give me the news that primarily has to do with my local surrounding.’ Informant 6 seems to get a sort of companionship from the newspaper since he ‘hardly read (s) newspaper except when I am travelling.’
5. CONCLUSION

Findings show that news gratifications are sought more in the online media and less in the conventional media. The most relative advantage of the online media as news sources is the quick update which they give which makes them faster news sources. The most relative disadvantages of the conventional media are ownership interference and erratic signals.

The extent to which what is sought in the news is obtained seems to depend on the amount of information in the news. This point can be inferred from the observation of informant 10 that 'most of the time (the) online media don’t give you most details about that information. So in most cases you come out of the news not well informed.' Informant 9 also makes similar inference when he notes that 'for online media, not much of satisfaction because duration of time they give to news is not enough. They just give you highlights and all that; they don’t give me the information as I want it. I will just imagine how it happens.'

But is it just about the media type or about how much time spent on the news? Majority of our informants access news from the websites of conventional media. The dominant use of news websites for news could indicate that for one reason or the other, the respondents prefer the conventional news media but, as indicated in their response on the use of mobile phone to access news, they need the news of those conventional media on-the-go. So, they get exposed to details without accessing the details. In other words, their being exposed to the news detail in the news websites must have enhanced their chances of obtaining gratifications from the news. Impliedly, detail or completeness of news is the crucial factor in obtaining gratifications sought from the news and not essentially the media type in the broad categories of online and conventional media.

Therefore, the extent to which news gratifications sought are obtained depends on a complementary role of the media which must supply details to news and that of the news consumers who must be ready to access the news details. Besides, findings indicate that both the online and conventional media have relative advantages over each other in news consumption. As such, each of them plays a given role in the news gratifications process. The online media are especially good for their speed of delivering news while the conventional media are especially desirable for details. This complementary role of the online media being more suited seeking news gratifications while conventional media ensure news satisfaction is well articulated for by informant 1.
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The Impact of E-Learning to Enhance Quality of Education: The Case of Adama Science and Technology University

T. Ketema & M. Nirmala PhD
Department of Computing
School of Engineering
Adama Science and Technology University
Adama, Ethiopia
E-Mail: tesfalidet.ketema@gmail.com, nirmala.mungamuru@gmail.com

ABSTRACT

E-learning is the use of Internet technologies as well the pedagogical approach of advancing the scalability of knowledge and performance. Due to the fastest growth of Information Communication Technology, the impact of E-learning for the contribution of quality education become vital, leading to a great paradigm shift for Ethiopian higher educational institution in general and Adama Science and Technology University in particular. This study examines the impact of e-learning to enhance quality of education through implementing it as a blended learning approach for boosting the learning teaching process within the academic settings. This study also confirms that the application of e-learning in ASTU extensively facilitates e-learning as a tangible asset to build up the students’ intention and perception to technology as well as fostering the quality of education via assisting them to improve their learning knowledge and skills by accessing their particular courses’ materials online 24/7. By using the secondary data a source of information to conduct the analysis, the study verified that, the application of e-learning trainings for Instructors and delivering their own courses on the e-learning platform have contributed a lot for positively influencing both stakeholders achieving the prospective successes and significant effects on improving the momentum of providing greater access to the students, enhance an institution’s reputation and enrich the teaching and learning experiences.

Keywords: ASTU, e-learning, e-learning Portal, Quality of Education, MOODLE

1. INTRODUCTION

The increasing influence of globalization and the emerging information society, set new requirements for all areas of social life, including to higher education. E-learning [1] became an important instrument in the new Higher Educational Environment in the digital age which creates student-centered learning and educational practice, offering new more flexible learning methods. In the advancements of the 21st century, integrating the learning-teaching practices to the latest information and communication technologies would be indisputable to achieve high results in learning and educational process. Ngaia, Poonb, & Chana [2] stated that E-learning system supports external collaborative activity (i.e. domestic students can consult with foreign students) rather than internal collaborative activity (i.e. two domestic students consult each other in physical space), which makes it an effective web-based technology. E-learning system is a capable system for educational systems, especially for interactive activities which is increasing among students all over the world for improving their knowledge [3].

The ASTU’s e-learning center is established with the goal of enabling departments in all schools of the University to apply e-learning in their teaching and learning process primarily in their regular programs and later proceeding to expand it to extension programs. Being the pioneer of e-Learning in Ethiopia, initiated on October 15, 2009, ASTU’s e-learning center still maintain its e-learning technology leadership in the nation by accomplishing a lot in terms of e-learning promotion, training and implementation in ASTU. The center so far has exerted its tireless efforts to promote e-Learning on various occasions to create wide range awareness about e-Learning in the minds of various stakeholders both in ASTU and outside. Demonstrations during meeting sessions, ASTU’s Research Park inauguration ceremony, BPR workshop, during city day programs in Hawassa, Adama, Bahirdar, and presentations in national conferences in Addis Ababa University, Bahir Dar University, UK and USA are some to quote. Regarding training, the center has been providing e-learning training to ASTU’s communities, pool attendants and especially to the instructors. Outside ASTU, e-learning center delivered e-learning training to Hawassa University instructors. The center even moved onto providing training to Sudanese University professors and U.K Professors. [4]
2. PROBLEM STATEMENT

According to the survey of this study, a deep investigation and observation has taken place on the entire trends of the center’s activities and finally come up with the following major revealed challenges.

2.1 Problems related to ICT Pools and Class Delivery

Limitation of ICT Pools is to provide the e-learning training to students across all the departments of each school due to students-class ratio assumes that five ICT centralized Pools with nearly 80 PCs for about 17,000 students. Even among these PCs, some of them are completely out of order, have no internet connection, frequent failure of operating system as well as some demanding application software like flash player, adobe player, internet downloader etc. The pools also are not well organized with multimedia kits, frequent power interruption since there no UPS batteries or a standby generator, appropriate Lab assistants; for example the lab attendants have no ICT background in their qualification and poor lab usage scheduling.

2.2 Problems Related to Instructors

Absence of rules, regulations and policies regarding the Intellectual property rights of lecturers related to e-learning in the University, to implement it as a learning teaching strategy in the curriculum. Lack of motivation and awareness about e-learning approaches and even some of them come up with resistance due to expectations of compensation and incentives by considering preparing of their course materials and implementing of the learning-teaching processes as an additional tasks.

2.3 Problems Related to Students

Majority of students come from rural side of the country, have lack of interest and frustration to work on the platform particularly during at start up sessions due to lack of basic computer skills and experience to e-learning technology.

2.4 Problems Related to the Digital learning environment

Since the university focuses on Science and Technology courses, the old legacy of the MOODLE’s version has not yet supported the new features of its succession updates, lack of on job training for the e-learning experts which are also few in number for adopting further authoring tools to suit the demand of engineering course matters as well as the e-learning center has no audio-video studios to record and edit lectures and finally uploads them as additional course materials on the platform. It has neither Content Development Center nor High Quality e-lecture Halls. Lastly the center has no facility to conduct a video conferencing to other universities in and out of the country.

3. METHODOLOGY

This research paper is the first in kind, for the e-learning center of the university and one of the author is an e-learning expert here for past two years. Secondary source of information is gathered from the center’s quarterly reports, thorough investigation, and observation, various consecutive meetings with the lecturers, senior management bodies, some expatriates, ICT directorate, ICT Team Leaders, Lab Technicians, Lab attendants, attending meetings, experience sharing programs with others local universities and even students during the authors demonstrations, classes and providing trainings for instructors during training sessions.
In addition the former archived documents are revised from the portal’s feed backing forwarded to Instructors and students.

4. FINDINGS AND DISCUSSIONS

Being the founder in e-learning integration as a blended learning approach and implementation in Ethiopia in October 15, 2009, ASTU’s e-Learning /e-Teaching was primarily established under the School of Pedagogy and Vocational Teacher Education and taking the lead of expanding its services with the aim of enabling departments across all the schools of ASTU applying e-Learning as a new learning-teaching approach in the regular and as well as later on proceeding to the extension programs. After the unit has been re-established in July 2012, it then officially became a center and has been made to be directly accountable to the Vice President for Academics of Adama Science and Technology University.

Even though the unit then after called the center has provided unstructured and random training for local instructors specifically to their respective courses for more than 3 years, all the attempts were not centrally administrated, supervised and supported by the senior bodies of the university. And for that reason, evaluating the old trend of its succession training delivery and other relevant activities, the recent staff members of center has deeply discussed the detail of the former e-Learning training trends and its legacy approaches to a new strategic approach which demands a timely reporting schemes and close relation with the university’s senior offices in regarding to the development growth of the center’s services various dimensions.

Therefore, since the old legacy of providing e-learning training has been theory dominated, the new upcoming e-Learning training packages and approaches put more inclination to provide practical sessions than theoretical contents in order to enable the instructors or trainees to internalize the realm of the e-learning technology as well as to successfully implement their respective courses on the e-learning portal. In other words, the training will build a balance between theory and practice where theory will consume 20% of the total training effort, sample practical session consumes 30% and real course session consumes the remaining 50% respectively. [5]

4.1 Contents of the Theoretical Framework of the Training Package

(i) An Overview of e-Learning (Introduction and e-Learning for Quality Education)
(ii) E-Learning in ASTU, Cooperative Learning and,
(iii) Active Learning, Continuous Assessment

This session of the training is expected to consume 20% of the total training time and is expected to be delivered in Conference Hall considering all trainees in one syndicate.

4.2 Practical Exercise on e-learning Platform

With the view to practically implement the courses on ASTU e-Learning Platform the practical session of the training will be delivered in two parts as explained below:

(i) Sample Practical Demonstration /Training course Room

This part of the training is so vital for trainees to more understand the role of their students on their course room and get the gist of students activities so that later in the implementation stage it will be easy to coach students and motivate them to freely be receptive to e-Learning. The sample practical demonstration exercise will be held on e-Learning Training course room developed including all the templates:

- Learning Materials (Training PPTs)
- Additional Materials (Videos, eBooks, websites, leaflets, schedule……)
- Learning Activities (Forum, Assignment, Online trial quiz and online quiz (to be treated as quiz, mind and online final examinations)

The templates in this course room will be a model for the real course practical implementation where the trainees will exactly develop their own courses duplicating the templates.

(ii) Real Course Development /Practical Sessions on Trainee’s Own Course Room

This part of the training is concerned with developing the trainees’ own courses on ASTU’s e-learning portal where they will be enabled to upload their course materials, create and administer additional activities on the portal.

The content development stages for the implementation of the practical sessions of training package is shown in the figure 2.
5. **RESEARCH IMPLICATIONS**

Regarding the new strategy of providing trainees for local instructors, the following results become chronicled as a promising momentum for the center’s future perspective regarding providing trainings for the rest of professionals in all departments. The center delivered 1st round e-learning training to 20 instructors coming from 5 schools in ASTU main campus in February, 2014. Sixteen courses were delivered to a total number of 940 students across 16 departments via e-Learning portal. As a result of these 23 forums, 10 online trial quizzes, 7 online quizzes and 3 online final examinations were given to students. Keeping the momentum, the center provided the 2nd round training to 15 instructors in August 2014.

This training was designed with the main goal of creating access to e-Learning by all departments in the 5 schools in ASTU main campus and the aforementioned instructors have already uploaded their course materials on ASTU’s e-learning portal and have thought their students in a blended learning approach. Even though the second round training was successfully provided to those 15 instructors and 827 of their students across 15 departments, the recent transformation of the university as a National Science and Technology University which is going to be accountable to the Ministry of Science and Technology of Ethiopia merges a new organizational structure as well as a curriculum revision disregarding the consideration of the e-learning strategy which was going to be implemented on the upcoming second semester of the university’s academic year of 2014/15.

Therefore, the implementation of the second round training would become engaged to be suspending for a semester and expected to be applied in the coming new academic calendar of the university considering the new structure of the university and its full focus on science and technology courses across all departments of each school. Finally, the ASTU’s e-learning-teaching center has been expected to be relatively in a better position than other governmental universities in Ethiopia pertaining to delivering and implementing with a total of 72 courses recently available on the portal serving about 5356 users registered out of which 108 are instructors,3461 are students and the rest are guests. So far the center has totally given 32 online trial examinations, 20 online mid examinations, 15 online final examinations, 57 forums and 15 assignments. The recent trend of conducting trainings and way of e-learning processes is shown on the picture below and the processing cycle depicts how is used in ASTU within each point of the education process and powerfully coordinates the learning teaching processes.
Considering the above trends of the overall activities of the e-learning center, the findings draws a conclusion regarding the potential impact of e-learning to significantly affect ASTU’s learning teaching standards. Identifying the actual impact that e-learning programs have had on students, teachers and schools is, however, difficult. Because of the newness and diversity of the programs and the complexity of factors affecting outcome, measuring e-learning’s impact is an emerging science. Nevertheless, some direct and indirect outcomes can be discerned. They are presented below by e-learning’s impacts on students and teachers.

5.1 The impact of e-learning on student achievement:

It is complex and mediated by a range of other factors affecting achievement. It is clear, however, that:

i.) Their effectiveness is closely related to how the technology is used as an educational tool. Students learn best with e-learning when interactively engaged in the content. Using technology can motivate students, particularly under-achieving students, to learn.

ii.) Teachers report that tutorials in subjects such as engineering and science significantly improve student performance. The Mavis type tutorial and the word processing software play a significant role in order to improve the students writing skills.

iii.) Providing technology on its own has little impact on achievement. Substantial effort must be put into infrastructure, teacher training, curriculum development, assessment reform, and formative evaluation.

5.2 The effect of e-learning on teachers and teaching parallels that of students.

It includes:

i.) The pedagogy often shifts from a teacher - centered classroom environment to a more learner - centered environment, allowing more effective use of technologies.

ii.) Teachers report that they gain confidence, self-esteem and renewed motivation in e-learning environments.

iii.) There are significant barriers to teachers in developing countries that need to be overcome including their lack of ICT skills and ICT-related pedagogical skills.

6. BARNETT’S FRAMEWORK REGARDING QUALITY IN HIGHER EDUCATION

One of the contemporary thinkers of higher education and total quality management, Ronald Barnett (1992) says “Quality in higher education demands the establishment of an institutional culture, not so much a matter of total quality management but rather one of total quality care, in which each professional is seized of his or her responsibilities and takes care over all his or her own professional efforts”[7]. According to him, quality should be seen as a process of critical dialogue within an institution, where course teams accept ownership and facilitate student engagement towards learning and development, and there is a self-critical culture of continuous care for the students’ quality course experience.

Barnett suggested that there are four core activities that take care of quality in higher education: (1) teaching and learning; (2) student assessment; (3) staff development and experience that is central to quality higher education. The ideas of Barnett are depicted below in the figure. Beyond this, the activities within ‘auxiliary belt’ are important but have less direct bearing on the quality of student experiences [8].
Studies on effective integration of technology in education show the opportunities e-learning provides to help increase student engagement, motivation, and attendance—key requirements for learning. The potential for e-Learning to improve performance on core subjects and foster the development of radical skills in mature and emerging economies depends on the schools ability to model student-centered, highly personalized learning environments. [9].

The ASTU’s e-Learning center has designed Strategic Plan of giving 206 courses via e-Learning portal for the coming 5 years starting from 2015 academic calendar of the university marked the commencement of implementation of the strategy by training instructors across 5 schools in ASTU. This future plan is highly expected to alleviate the aforementioned challenges of e-learning practices in the university in collaboration with a Korean upcoming project which ASTU has already signed the agreement with the Korea International Cooperation Agency (KOICA).
Since KOICA has been established for an Official Development Assistance (ODA) to enhance the effectiveness of South Korea's grant aid programs for developing countries by implementing the government's grant aid and technical cooperation programs, ASTU’s e-learning center would be one of the beneficiaries from the project to fulfill its demanding effort to expand the e-learning practices to enhance quality of education through a blending learning styles. And with this regard, the center will continue to train instructors in every semester and the trained instructors will be made to implement e-Learning afterwards. The project entitled, “The Project for Educational Quality Improvement of Adama Science and Technology University through ICT Integration PMC service.” Regarding the scope of Educational environment and Quality Improvement of Adama Science and Technology University the project has two goals:

7.1 The apportionment of the project

It also has focused on three special divisions which encompasses the following:

i.) Providing the Project Management Consultancy (PMC) on the following areas:
  ✓ Teaching and Learning Design and Skill Transfer
  ✓ e-Learning Contents Production and Library Material(e-book) Development
  ✓ ICT Infrastructure Building Consultation
  ✓ System Design and Development Consultation
  ✓ Project and Result Management

ii.) Providing System Development Services including the following potential areas as follows:
  ✓ MOODLE (Modular Object Oriented Dynamic Learning Environment) based e-Learning System Development Support
  ✓ Basic Management System Upgrade and Additional Development
  ✓ Electronic Library Data Interational Solution Development

iii.) Providing Equipment Supplies for the following two special areas.
  ✓ ICT Infrastructure Equipment Set up and Manage Training
  ✓ Teaching Equipment Set up and Manage Training

7.2 Expectation from KOICA

In order to enhance quality of education through e-learning in the near future binds the following solutions one by one.

i.) Solution for a challenge of e-Studio Building

Goal: A High quality contents produce through 1e-Learning producing environment (Contents Production Room for one person) and holds the following equipment’s like: Live Switcher - Real-time Field Recording Device, Authoring SW, HD Camera, Line Audio Mixer, Tablet Monitor, PGM Monitor, Chroma-key Screen, Instructor PC, etc…

ii.) Solution for a challenge of Up-to-date Classroom Building

Goal: Holding conference with other University and Country through Video Conference System and Various e-Learning Contents production environment (Equip mobile contents production environment through Any cast).

Part 1: Classroom
  ✓ Electronic Lectern system, Lecturer PC, PGM monitor, HD camera, Sound system, LCD projector, Electric screen and Microphone,

Part 2: Control Room
  ✓ Live switcher, Audio mixer, C/R monitor speaker and record VCR

iii.) Solution for a challenge of e-Learning Contents Draw up and Development

Goal: Implementation of four steps on e-Learning Contents Development and Management Ability Reinforcement.

Step 1: Flagship Open Course Ware OCW (7 Types) for e-Learning System managing ability reinforcement through strategic, core OCW development

Step 2: High Quality Contents (49 Types) to improve education environment through high quality e-Learning Contents production by Authoring Tool.

Step 3: Additional Material for Blended Learning (147 Types) to improve Blended Learning Teaching through digitalized teaching material

Step 4: e-Learning Contents Production and Training Support includes: e-Learning Contents production, managing and Up-to-date learner-focused teaching method (Blended Learning, Flipped Learning etc.) ability reinforcement.

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CONCLUSION

The findings of this research paper summarizes the significance of the application of e-learning as a supporting technology tool has already become granted and emphasized for the right implementation upon the next five consecutive years anticipating the attainment of quality education in the learning environment of ASTU. And as a result of this ASTU will become the first university in the country using high quality educational contents to deliver online courses to students for their academic performance and achievements in the Science and Technology fields. Lastly the study does not mention about the details of the courses’ which are already uploaded on the e-learning portal, annual budget issues, comparative discussion about the students achievements, the performance report about the instructors up on implementing their courses and the implementation of the five year strategic plan of the KOICA project and other information which would be kindly granted for the next researcher.

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Authors’ Brief

Mr. Tesfalidet Ketema is an E-Learning Expert in Adama Science and Technology University (ASTU); and IT instructor in other local universities. He is a PG Scholar in Software Engineering in M.Sc. Program in ASTU 2015; He has obtained his Bachelor of Science degree in Management Information System in 2011 from Adama Science and Technology University, Ethiopia. He has contributed his significant research works regarding Educational Technology areas within and outside. Moreover, he is a multidisciplinary person on various professions like: he is a Theologian and a Movie Actor in Ethiopian Amharic Movies. He belongs to several professional bodies and can be reached through the following contacts: Mob: +251 937 847 797

Dr. Nirmala is working as an Assistant professor, Department of Computing, Adama Science and Technology University, Ethiopia. Her main research interests include Software Testing and Quality Assurance, Big Data, ICT in Education, and Distributed Databases in specific. She is a dedicated and astute academician with over 15 years of experience in the field of teaching various streams of students in India and abroad. A through professional with a proactive attitude, capable of thinking in and out of the box, optimistic, goal oriented and receptive to multi-ethnic, multi-cultural environment. She is a researcher and has published 18 papers in indexed national and international journals. She is a life member of CSI, IETE, ISTE and an editorial board member of many reputed journals.
Prediction of Software Maintenance Effort of Object Oriented Metrics Based Commercial Systems

V.K. Yadav
Department of Computer Science and Engineering
S.L.S.E.T.
Kichha Uttarakhand, India
vinodrockcsit@gmail.com
Phone: +919451611568

S. Kumar & M. Mittal
Research Scholar, Department of Computer Science
Gurukula Kangri University
Haridwar, Uttarakhand, India
satendra04cs41@gmail.com
mittal.mohit02@gmail.com
Phones: +918923683462, +918394832967

ABSTRACT

The software systems really advanced and seize with problems on their maintenance. The software maintenance work is presently one in every one of the foremost tough, time-consuming, expensive and costly tasks in the software development life cycle. It’s invariably been a vital issue for software project developers. Therefore, it is worthwhile to develop an object oriented system with easy maintenance at design phases. This analysis concentrates the development of a method based on the data mining techniques as K-means and Hierarchical clustering are implemented in MATLAB package on two commercial systems are UIMS (User Interface Management System) and QUES (Quality Evaluation System). The maintenance effort is measured by the number of lines changed (addition or a deletion) per class which are already pre defined classes of UIMS and QUES. It is ascertained that the algorithms will be able to decide the cluster with Easy, Medium, and High conditions of maintainable classes of similarity based on object oriented metrics. This paper is most beneficial for the software maker and maintainers to take the necessary steps at design level to design of maintainable object oriented software.

Keywords: Software Metrics; Clustering; K-mean clustering algorithm; Hierarchical clustering

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1. INTRODUCTION

Software maintainability is going to be a seamless challenge for several years to come back. Software maintenance is in view a very necessary and typical or complex section in software life cycle usually constituting 50-70 proportion of total effort allocated to a software system [1]-[2]. The most of researches are working on these prediction approaches [3] but the still need for improvement is always there. The software maintainability is an important aspect to correct errors, enhance features and port to new platforms. In recent years, data mining technology and its ability to deal with huge amounts of data has been considered a suitable solution in assisting software maintenance [4]-[7]. It is accept as true that predicting the maintenance at the design level can facilitate to software designers and maintainers to change the architecture of the software system for higher Performance that will lead to the general reduction of maintenance costs [8].

Keeping this view in mind, the data mining technique of clustering based approach for designing maintainable object oriented systems using the K-means and Hierarchical clustering algorithms are proposed.

2. RELATED WORK

Many papers have shown that clustering is a technique that is used for general application likes pattern recognition, spatial data analysis, image processing and the WWW. It is also used for analyzing the architecture of the software system for better performance and maintenance [3], [5], [9], [14]. Data mining and uncovering hidden patterns have been proposed as a means to support the evolution and assessment of the maintainability of industrial scale software system [10]-[11].
The fault prediction model should be adequate to produce reliable product in accessible time frame and budget, meeting the customer’s necessitates. However, numerous faults in the prediction model using clustering algorithms are already available in the literature however still there is need to develop a strong model [12]-[13]. There are many studies for evaluating a system’s maintainability and controlling the hassle needed to hold out maintenance activities [14]-[17]. An approach for the evaluation of dynamic clustering was presented in [15], [18], and [19].

The scope of this resolution was evaluating the usefulness of providing dynamic dependencies as input to software clustering algorithms. Various techniques for maintainability consistent with ISO/IEO-9126 have been proposed [20]. Maintainability is characterized by the analyzability, changeability, testability, maintainability compliance. The clustering information extracted from Java source code aiming at capturing program structures and achieving better program understanding methodology have been presented [18].

The value of this work that differentiates it from what presented above, is that here we have a tendency to don’t cluster raw software measurement data. Instead, we provide the software designers and maintainers to change the design of the software system for higher performance that leads the general reduction of maintenance by using centroids based clustering method K-means and overlapping based hierarchical clustering are used in this paper.

3. CLUSTERING

Cluster analysis is the process of discovering groups of objects in such a way that data points in same clusters have high intra-class similarity and data points in different clusters have terribly low inter-class similarity. Clustering is a data mining technique to groups datasets primarily based on distance or similarity. Clustering is particularly helpful in issues for unsupervised learning, automatic classification, and typological analysis and clustering is additionally where there is very little previous information available about the data, and software makers must have to take decision of logical and physical storage possibility on these data. These restrictions build this methodology applicable for the investigation of a logical or natural association between two or more things among the data points to make an evaluation concerning their structure[3]. Clustering creation is often performed in a number of ways as follows:

- Partitioning Methods
- Hierarchical Methods
- Density-Based Methods
- Grid-based Methods
- Model-Based Methods

In these methods K-means is one the most popular partitioning clustering algorithms in which each cluster is manipulated by the centroids of the data points (objects) in the cluster. Its main problems are that it is sensitive to noise and to the initial partitioning. As many possible initial partition lead to many different results, the final clustering is influenced by the initial partition.

4. K-MEANS CLUSTERING APPROACHES

The K-means algorithm is centroids based partitioning technique. Here K stands for the number of partitions or clusters. To perform the K-means algorithm we have to take any arbitrary objects as the initial centroids of the first K objects as initial centroids. In this paper we use the euclidean distance between point’s r and c in p-dimensional space. The well known metric is euclidean distance, defined as in equation (1):

\[ d(r,c) = \sqrt{(x_{r1}-x_{c1})^2+(x_{r2}-x_{c2})^2+\ldots+(x_{rp}-x_{cp})^2} \]  

Where

\[ r = (x_{r1}, x_{r2}, \ldots, x_{rp}) \quad \text{and} \quad c = (x_{c1}, x_{c2}, \ldots, x_{cp}) \]

It uses square error function (terminating condition) to give aggregate dissimilarity of clusters that is defined as follows in equation (2):

\[ E = \sum_{i=1}^{k} \sum_{p \in c_i} \left| p - m_i \right|^2 \]  

\[ E = \text{Summations of the square error in data sets.} \]

\[ p = \text{Points in space representing a given object.} \]

\[ m_i = \text{Mean of cluster } c_i. \]

![Figure 1: K-means and no. of literatures](image-url)
Several of the have been proposed in the literature, many authors have tried to exploit the features of K-means. An interesting paper on K-means clustering has been proposed in [21]. According to above figure 1 shows thirteen papers of algorithm’s sensitivity to initial conditions: the number of partitions, the initial centroids. The efficiency of the algorithm show by twelve papers. The convergence of algorithm to local optimum rather than a global optimum show by five papers. Three papers show that the K-means is sensitive to outliers and noise. Three papers show the definition of “mean” limits the application only to numerical variables.

5. K-MEANS ALGORITHM FOR SIMULINK

This section presents the K-means clustering algorithm applying it to evaluate a maintenance effort involved on classes within UIMS and QUES object oriented system models. The algorithm used in simulation (in MATLAB) is given below:

Step 1: Initialization
1.1 Input the number of classes with their attributes.
1.2 Take any random objects as the initial centroids.
1.3 Input number of K cluster.

Step 2: Classification
2.1 Compute the distance using most popular distance measure is city block distance or Manhattan between classes and randomly choose objects.
2.2 Objects are including to the group related to this centroids.

Step 3: Centroids Calculation
3.1 For each group generated in the previous step, its centroids are recalculated.

Step 4: Come together or towards the same point’s condition
4.1 Stopping when reaching a given number of iterations.
4.2 Stopping when there is no exchange of objects among groups.

Step 5: If the step 4 is not satisfied then steps 2 to step 4 must be repeated.

Step 6: Produce the group of classes in a given K cluster.

Step 7: Finally, produce the cluster whose maintenance effort are Easy, Medium and High.

6. HIERARCHICAL CLUSTERING APPROACHES

Hierarchical cluster is an agglomerate cluster methodology. As its name suggests, the thought of this methodology is to make a hierarchy of clusters. This method is usually continuing till there's one giant cluster containing all the first information points. Ranked cluster leads to a "tree", showing the link of all of the first points. Hierarchical cluster rule is of 2 types: agglomerate ranked cluster rule dissentious ranked cluster rule each this rule aren’t the same as one another. The agglomerate ranked cluster works by grouping the information on the idea of the closed distance live of all the pairwise distance between the info purposes. There are several on the market strategies that distance to contemplate once the teams are fashioned, a number of them are: single linkage, complete linkage, average linkage, Centroids distance, ward's methodology - total of square geometry distance is reduced.

This way we tend to proceed grouping the info till one cluster is made. Currently on the idea of dendogram graph we will calculate what percentage numbers of clusters ought to be really gift.

7. ALGORITHMIC STEPS FOR AGGLOMERATIVE HIERARCHICAL CLUSTERING

Let X = \{x_1, x_2, x_3, \ldots \ldots x_n\} be the set of data points.

Step 1: In the first step we have to calculate the distance between every a mated couple of objects within the data set by using pdist function in MATLAB.

Step 2: In the second step, we bring together of object by using linkage function that is in much closed to each other. The linkage function uses the distance calculation that is formed by pdist function in step 1 to determine the closeness of objects. The objects are bringing together into binary clusters; the previously formed clusters are grouped into of wide range clusters until a hierarchical tree is formed.

Step 3: In the last step, calculate where to cut the hierarchical tree into object’s clusters. We use the cluster function of MATLAB to merge the furthest part of the hierarchical tree, and allocate every object below each cut to a single cluster.

8. PROPOSED WORK AND SELECTED OBJECT ORIENTED METRICS

In this paper the k-means clustering data mining techniques are implemented on UIMS class's data and QUES class's data. The UIMS and QUES are used in this inspection, which have been presented in [22]. The UIMS contains 39 classes with 11 object oriented metrics and QUES contains 71 classes with 11 object oriented metrics. It observed that the data mining algorithms are able to decide the maintainers to take the necessary action at design level. The description of proposed work and selected object oriented metrics for UIMS and QUES are given in figure 2 and table 1 respectively.
Step 1: Take the system design’s data of UIMS and QUES.

Step 2: In the second, we use the data mining clustering programme of K-means and Hierarchical on the Step1 in the MATLAB.

Step 3: Having apply clustering programmed we get the group of three clusters. The silhouettes plots and dendogram are used to show the classes belong to which clusters.

Step 4: It is observed that in the fourth step, we obtained the maintenance libraries that will be able to decide the cluster with Easy, Medium, and High conditions of maintainable classes of similarity based on object oriented metrics.
Table 1: Selected Object Oriented Metrics for UIMS and QUES

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Metrics</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DIT</td>
<td>It provides for each class a measure of the inheritance levels from the objects hierarchy top.</td>
</tr>
<tr>
<td>2</td>
<td>NOC</td>
<td>It measures the number of the immediate descendants of the class.</td>
</tr>
<tr>
<td>3</td>
<td>MPC</td>
<td>It is a count to measure the complexity of message passing among classes.</td>
</tr>
<tr>
<td>4</td>
<td>RFC</td>
<td>It is count to the set of all methods that can potentially be invoked in response to all methods accessible within the class hierarchy.</td>
</tr>
<tr>
<td>5</td>
<td>LOCM</td>
<td>It measures if a class of the system has all its methods working together in order to achieve a single, well defined purpose.</td>
</tr>
<tr>
<td>6</td>
<td>DAC</td>
<td>It counts to measure the coupling complexity caused by ADTs.</td>
</tr>
<tr>
<td>7</td>
<td>WMC</td>
<td>It measures the overall complexity of class. It is a sum of all complexities of its methods.</td>
</tr>
<tr>
<td>8</td>
<td>NOM</td>
<td>It counts the number of local methods in a pre-defined class.</td>
</tr>
<tr>
<td>9</td>
<td>SIZE1</td>
<td>It counts the number of semicolon in pr-defined class.</td>
</tr>
<tr>
<td>10</td>
<td>SIZE2</td>
<td>It measures number of attributes and number of methods in class.</td>
</tr>
<tr>
<td>11</td>
<td>Change</td>
<td>The maintenance effect is measured by the number of lines changed per class.</td>
</tr>
</tbody>
</table>

9. EXPERIMENTAL RESULTS

An experimental test carried, the well known UIMS with 39 classes and 11 different attributes and QUES with 71 classes and 11 different attributes have been taken to measure the performances of these difference classes. We can make a silhouette plot and dendogram using the cluster indices output from K-means and Hierarchical clustering to get an associate plan of how independent the resulting clusters.

The silhouette plot shows how similar each point in one cluster is to points in the other clusters. This measure ranges from +1, showing points that are very away from the nearest clusters, through 0, showing points that are not decidedly in one cluster or another, to -1, showing points that may be assigned to the wrong cluster. The silhouette plot in figure 3 of QUES, we can see that most points in the second and third cluster have a silhouette value, less than 0.6. However, the first cluster contains some points with low silhouette values, and few points with negative values in second and third cluster, indicating that those two clusters are not well separated. Similarly form figure 4 of UIMS, we can see that most points in first, second and third clusters have silhouette value, less than 0.6.

Figure 3: Silhouette Plots of QUES using K means
The “idx3” in figure 5 and figure 6 of the test results on MATLAB using k-means for the QUES and UIMS. The figure 5 shows that forty four classes are included in cluster1, eleven classes are include in cluster2 and rests of sixteen classes are include in cluster3. According to these results cluster1 has the largest classes as compare to cluster2 and cluster3. This Cluster1 has the largest population of similarity based classes. Therefore it is easier to understand and maintain them. This cluster3 can be considers as “Easy” maintenance effort cluster.
The above figure shows that six classes are included in cluster1, thirty two classes are included in cluster2 and rest of one class is included in cluster3. According to these results cluster2 has the largest classes as compare to cluster1 and cluster1. This Cluster2 has the largest population of similarity based classes. Therefore it is easier to understand and maintain them. This cluster2 can be considered as “Easy” maintenance effort cluster.

The hierarchical, binary cluster tree created by the linkage function is most easily understood when viewed graphically. Statistics Toolbox includes the dendogram function that plots this hierarchical tree information as a graph, as in the figure 7 and figure 8. In the figure 7, the numbers along the horizontal axis represent the indices of the objects in the original data set. The links between objects are represented as upside-down U-shaped lines. The height of the U indicates the distance between the objects. For example, the link representing the cluster containing objects 4 and 9 has a height of 0. The link representing the cluster that group’s object 26 together with objects 4 and 9 has a height of 1. The height represents the distance linkage computes between objects. Similarly, we can conclude the information about grouping of objects in figure 8.

![Figure 7: Dendrogram of QUES using Hierarchical Clustering](image1)

![Figure 8: Dendrogram of UIMS using Hierarchical Clustering](image2)

![Figure 9: Classes in 3-Clusters of QUES using Hierarchical Clustering](image3)
The “idx3" in figure 9 and figure 10 of the test results on MATLAB using hierarchical clustering for the QUES and UIMS. The figure 9 shows that nine classes are included in cluster1, sixty classes are include in cluster2 and rests of one class is include in cluster3. According to these results cluster2 has the largest classes as compare to cluster1 and cluster3. This Cluster1 has the largest population of similarity based classes. Therefore it is easier to understand and maintain them. This cluster2 can be considers as “Easy” maintenance effort cluster. Similarly, we can conclude the information about classes of each cluster in figure 10.

The final experiential results of QUES and UIMS in MATLAB are represented in table 2. According to this we can observed the following results on k-means and hierarchical clustering are given below:

1. At times, there is an interpretive advantage to non-hierarchical clusters. For example, assume that if the data are divided into three clusters, units A and B will be in the same cluster. It may often make sense that if the data are divided into say two clusters, A and B will be in different clusters. This result is impossible with a hierarchical method.
2. K-means algorithms are used for large data set while hierarchical algorithms for small data set.
3. Hierarchical algorithms give better result when random dataset are used while k-means provide better result in case of ideal dataset.
4. As the number of records increase the performance of hierarchical algorithm goes decreasing and time for execution increased.
5. As the value of k becomes greater, the accuracy of hierarchical clustering becomes better while k-means have less quality (accuracy). We can see on table 2 the easy maintenance effort of k means algorithm is 82.05 on the other hand the easy maintenance effort of hierarchical clustering algorithm is 84.50. Thus according to this Hierarchical algorithm shows more quality as compared to k-mean algorithm.
6. There is one dependent variable as Change and ten independent variables as DIT, NOC, SIZE1, etc. are used to implement the data mining techniques on QUES and UIMS. The dependent variable “change” is a measure of maintenance effort. It is ascertained that the table 2 shows to decide the clusters with Easy, Medium, and High conditions. It provides the help to the software designers and maintainers to take the proper action at design level. It can also be used by software designers to modify the design of difficult to keep up classes at design level of software.

11. CONCLUSION AND FUTURE SCOPE

The main objective of this paper to development of a methodology based on the K-means and Hierarchical clustering data mining techniques have been implemented on UIMS and QUES class’s data with set of selected metrics. This work is small step toward the design of maintainable object oriented software system. There is a future scope for more similar studies may be carried out with large data set of industrial object oriented system. It is planned, in future, to compare this methodology with other data mining clustering technique in terms of performance, noise and outliers and complexity, to increase the significant level of k clusters in K-means. This paper presents the identification of maintainable classes at the design phase of software development.

Thus, overall, it is concluded that it helps to the software designers and maintainers to take the appropriate action at design level. More similar studies must be carried out with large data type of set. It is planned, in future, to compare this methodology with other data mining clustering technique in terms of performance, noise and outliers and complexity, to increase the significant level of k clusters in K-means.

REFERENCES


Transmission Range, Density & Speed based Performance Analysis of Ad Hoc Networks

D. Kumar & S.C. Gupta
Department of Electrical Engineering,
Indian Institute of Technology (BHU)
Varanasi, India
dkumar.rs.eee@iitbhu.ac.in, scgupta.eee@iitbhu.ac.in

ABSTRACT

Mobile Ad Hoc Network (MANET) is a self-configured, infrastructure less network of mobile nodes which are free to move independently. It is deployed in areas where infrastructural setup like base stations, routers is not available e.g. emergency scenarios like war, earthquake etc. To send packets, routing protocols are required. To minimize the battery usage, many factors are considered like transmission power, routing protocol, node speed etc. These parameters have some effect on the use of battery power. In this paper, we have studied the effect of varying transmission range, node density and speed on three routing protocols namely OLSR, DSR and ZRP representing the three groups in which MANETs have been classified namely proactive, reactive and hybrid routing protocols respectively. The performance metrics considered were end to end delay and packet delivery ratio. There was an obvious impact on these metrics on variation of transmission range.

Keywords: - MANET, Random Waypoint Mobility Model, OLSR, DSR, ZRP, end to end delay, packet delivery ratio, transmission range, transmission power, node density, node speed.

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1. INTRODUCTION

Transmission power is an important parameter for Mobile Ad Hoc Network (MANET) [1] because each node has limited battery power and it is not easy to replace/recharge the battery. Hence, it is important to efficiently utilize the battery power to ensure longer network lifetime. If the transmission power is kept high, then although all the packets will be delivered but battery power consumption will be high. If it is kept less, then although power consumption will be low but the packets may not be able to reach destination. In order to maximize battery life, an optimum value of transmission power is to be chosen.

This study focuses on variation in transmission range. Along with that, node density and node speed is also varied, so as to have an estimate of performance in denser and dynamic networks. The studies done on transmission power are discussed below. Rahman Et.al [2] presented a study for the performance of OLSR and DYMO routing protocols under varying data rate, node velocity and transmission range with variation of 512, 768, 1024, 1280, 1536 Bytes/sec for data rate, 1, 5, 10, 15 meters/sec for node velocity and 150, 200, 250, 300, 350 meters for transmission range. The metrics considered were Packet Delivery Fraction, Average end-to-end delay of data packets and Normalized Routing Load. The protocols were simulated and compared with NS-2 under Gauss Markov mobility model.

The authors concluded that along with other parameters, transmission range has significant effect on the metrics. The effect of transmission range on ODMRP- On-Demand Multicast Routing Protocol for multicast communication was studied by Venkatalakshmi Et.al [3]. GloMoSim was used for the simulation purpose. Metrics considered were packet delivery ratio, collision and throughput. Variation was done for transmission range and mobility range. It was observed that, though increase in the transmission range enhances connectivity but it also increases the probability of collisions. Hence the effective bandwidth of individual nodes is reduced. A study for the performance of probability-based routing protocols under different transmission ranges for AODV protocol was done by Yassein Et.al [4]. NS2 was used for simulating the scenario. Packet delivery ratio, end to end delay and routing overhead were the considered metrics. Along with different probabilities (Fixed, adjusted and smart), transmission range was varied as 100, 150, 200, 250, 300m. The authors concluded that, when the transmission range and probability was increased, the performance of algorithm was improved.
Nagpal Et.al [5] designed a simulator in Matlab to study the impact of variable transmission range on power saving. In this work, minimum hop routing (MHR) and minimum total power routing (MTPR) was evaluated using Dijkstra's shortest path algorithm. The performance metrics considered were: percentage power saving and average power consumption. Variation in transmission range was done by using Received Signal Strength Indicator (RSSI) and variation in node density was done for 30, 35, 40, 45, 50 nodes. The authors concluded that power saving of MTPR is always higher than MHR.

A novel study on the effect of variation in transmission power on AODV protocol was made by Das Et.al [6]. The metrics evaluated were packet delivery fraction, routing load, average energy consumption per node and hop count. Along with variation in transmission power: 10, 15, 20 dBm, variation in number of sources: 10, 15, 25 was also considered. The author marks variations in performance and concluded that performance of the network is best for a specific transmission power (i.e. 15dBm) along with specific number of sources (15 sources).

Grover Et.al [8] studied the impact of variation in transmission range and scalability on ZRP protocol. The scenario was simulated on NS2. The performance metrics chosen were: Packet Delivery Fraction/Ratio (PDF/PDR), Routing Load, End-to-End Delay, Dropped Packets, Throughput, Energy Consumption, MAC Load and Overhead. NS2 was deployed for simulation. Transmission range was chosen as 100, 150, 200, 250, 300, 350, 400, 450, 500 and 550 meters. This range was derived from the transmission power. The authors observed that the multi hop routing protocols perform good only at particular levels of transmission ranges/powers.

In the past the researchers have performed analysis of routing protocols as a function of transmission range. In this paper, we have considered node density and node speed as a function along with the transmission range. Hence we are able to provide a broader analysis for these variations, taken together into account. Organization of the rest of paper is as below. Factors affecting the performance are given in section II. In section III, routing protocols considered, are briefly reviewed followed by a brief discussion of the mobility model in section IV. Simulation setup is given in section V. Finally results are discussed in section VI.

2. FACTORS AFFECTING PERFORMANCE

The performance of routing protocols depends on various factors including:
1. Node Density: When it is low, it leads to low reachability and when it is high it does not add extra advantage, so an optimum value should be chosen.
2. Node Movement: The performance degrades when speed is high due to increase in number of link failures. When kept low, it may not be useful in applications like VANET, Underwater network etc.
3. Mobility Model: There is a variation in performance according to the mobility model chosen.
4. Transmission Range: When it is high, the nodes have high reachability but consume more battery power. When it is low, nodes have lower number of reachable paths and that is not desired.

There are other factors also but the above discussed four factors are prevalent.

3. ROUTING PROTOCOLS

A routing protocol defines the way, mobile nodes communicate with each other disseminating information that enables them to select routes between any two nodes. They have been classified into three groups:
1. Proactive protocol: The route information is obtained a priori and stored in a table for future lookup. E.g. OLSR [10].
2. Reactive protocol: The route information is calculated when and wherever required hence favoring an on demand route formation. E.g. DSR [11].
3. Hybrid protocol: It combines the advantages of proactive and reactive routing. The route is initially established with some proactive protocol and then to serve the demands from additionally activated nodes are responded with reactive flooding. E.g. ZRP [12].

In this study, optimized link state routing (OLSR), dynamic source routing (DSR) and zone routing protocol (ZRP) has been simulated. We briefly describe the functioning of these protocols.
3.1 OLSR (Optimized Link State Routing) [10]
It is a table driven proactive routing protocol, described in RFC3626. It utilizes the link state in an optimized manner to extract information regarding topology. The change in topology causes flooding of information to all nodes. In order to reduce this overhead, Multi point relays (MPR) are used. Being a table-driven protocol, information is updated and maintained in a variety of tables. The data in these tables is based on received control traffic, and control traffic is generated based on information retrieved from these tables. The route calculation itself is also driven by the tables.

OLSR defines four types of control messages:

a. HELLO: It is transmitted periodically to all neighbors. This is done to find updates about the link status and host’s neighbor.

b. TC: Topology Control message is sent periodically by a node to a subset of its neighbors. It is used to broadcast information about one’s own neighbors.

c. MID: Multiple Interface Declaration message is transmitted to inform other nodes that the host can have multiple OLSR interface. It lists all IP addresses used by a node.

d. HNA: Host and Network Association message is transmitted to give information regarding external routing. It contains important information regarding the network and the net mask address.

3.2 DSR (Dynamic Source Routing) [11]
It is a simple and efficient reactive routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Here, the network is completely self-organizing and self-configuring, requiring no existing network infrastructure or administration. It follows two mechanisms namely Route maintenance and Route discovery. Route Discovery: It is the mechanism by which a source node S which wants to send a data packet to destination D, requests for and obtains a route to D. It happens only when route to D is unknown to S.

Route Maintenance: It is the mechanism by which source node S is able to detect if there is a topology change, which results in route breakage to destination. When unavailability of a route is shown, the source S can either attempt to use any other route to D which is known by S or can revoke route discovery again to find a new route.

3.3 ZRP (Zone Routing Protocol) [12]
It is a hierarchical and hybrid protocol, hence it takes advantage of both reactive and proactive routing. It works on the principle that, nodes and its local neighborhood are separate from the global topology of entire network. Transmission power of the nodes is adjusted to control the number of nodes in the routing zone i.e. by lowering the power; number of nodes within direct reach is reduced. The routes found by ZRP are loop free routes.

ZRP utilizes two components:

1. At local level, IntrA-zone Routing Protocol (IARP) for Proactive routing component.
2. At global level, IntEr-zone Routing Protocol (IERP) for reactive routing component.

4. MOBILITY MODEL
For the simulations, Random Waypoint Mobility Model [13] is used. It was proposed by Johnson and Maltz. It is a popular model for simulations, because of its wider availability and simplicity. According to this model, a node stays at one location or point for a certain period (pause time). The value of pause time lies between \( P_{\text{min}} \) and \( P_{\text{max}} \). This pause time is induced whenever the node changes either speed or direction. After the pause time is over, the node starts travelling randomly with the speed of the node lying between \( V_{\text{min}} \) and \( V_{\text{max}} \), which can be changed according to the use. The process repeats, until the destination is reached.

5. SIMULATION SETUP
To study the effect of variation in Node transmission range, density and speed, Qualnet simulator was used. The routing protocols under consideration were OLSR (proactive), DSR (reactive) and ZRP (hybrid). For placement of the nodes random waypoint mobility model was utilized and the nodes were confined to an area of 1000 x 1000 sq. m area. Constant bit rate (CBR) links were used between the randomly chosen source destination pair. For the above discussed variations three scenarios are considered viz. transmission range scenario, node density scenario and node speed scenario.

a. Node Density Scenario: It is the number of nodes in the network. It was modeled by varying the number of nodes in the fixed area. It was varied from 25 to 100 in steps of 25 i.e. 25, 50, 75 and 100.

b. Transmission Range Scenario: It is the average maximum distance up to which a node can send data packets. It was modeled by varying the range of transmission. The transmission range was varied between 50 m to 500 m in steps of 100 i.e. 50, 150, 250, 350 and 450 m.

c. Node Speed Scenario: It is the speed of a node in the network. It was modeled by varying the speed of the nodes in the fixed area. It was varied from 0 m/s to 20 m/s in steps of 4 i.e. 0, 4, 8, 12, 16 and 20 m/s.

The simulations parameters are given in table 1.

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Table 1: Simulation parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrain/ Simulation Area</td>
<td>1000m x 1000m</td>
</tr>
<tr>
<td>Data transfer rate</td>
<td>2 MBPS</td>
</tr>
<tr>
<td>Node Density (m)</td>
<td>25, 50, 75, 100</td>
</tr>
<tr>
<td>Transmission Range</td>
<td>50, 150, 250, 350, 450, 500</td>
</tr>
<tr>
<td>Node Speed (m/s)</td>
<td>0, 4, 8, 12, 16, 20</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Random Waypoint</td>
</tr>
<tr>
<td>Channel Frequency</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>Packet size</td>
<td>512 Bytes</td>
</tr>
<tr>
<td>Data Transmission Speed</td>
<td>4 Packets/Second</td>
</tr>
<tr>
<td>Routing Protocol</td>
<td>OLSR, DSR and ZRP</td>
</tr>
</tbody>
</table>

The performance metrics considered are end to end delay and packet delivery ratio.

a. End to end delay: It is the average amount of time that is taken by a packet to reach final destination from source. It is the sum of delays at links. The delay at a link is the sum of the following components (if, retransmission is not considered).

- Processing delay: It is the time from the arrival of a packet until it is assigned to a queue of an output link for transmission.
- Queueing delay: It is the time the packet is in a queue before transmission starts.
- Transmission delay: It is the time between the transmission of the first bit and last bit of the packet.
- Propagation delay: It is the time for signals to traverse the link.

Average delay = Σ (tr - ts)/Pr, where ts is the packet send time and tr is the packet receive time.

b. Packet delivery ratio (PDR): It is the ratio of number of packets delivered to destination, to the number of packets sent at source. The source follows CBR (Constant bit rate) traffic. It depicts the rate of loss of packets in the network.

\[
PDR = \frac{\text{Data packets delivered}}{\text{Data packets sent}}
\]

6. RESULTS & DISCUSSIONS

6.1 End to End Delay

Figure 1 to Figure 4 shows the end to end delay for OLSR, DSR and ZRP with figure 1 showing delay for 25 nodes, figure 2 for 50 nodes, figure 3 for 75 nodes and figure 4 for 100 nodes. The speed of 0, 4, 8, 12, 16 and 20 m/s is shown as a, b, c, d, e and f respectively. It was observed that delay is decreasing with increase in speed and transmission range. We get the minimum values for DSR and maximum values for ZRP in all the cases. OLSR being a proactive protocol, stores route information in routing table. The amount of stored information increases with increase in transmission range as more nodes tend to be reachable.

This results increased delay as compared to reactive protocol. DSR being a reactive protocol performs better than OLSR and ZRP. When we increase the node density then delay is decreased because more number of nodes brings more of them together, when confined to an area.
6.2 Packet Delivery Ratio
Figure 5 to Figure 8 shows the packet delivery ratio for OLSR, DSR and ZRP with figure 5 showing delay for 25 nodes, figure 6 for 50 nodes, figure 7 for 75 nodes and figure 8 for 100 nodes. The speed of 0, 4, 8, 12, 16 and 20 m/s is shown as a, b, c, d, e and f respectively. In all the cases DSR outperforms OLSR and ZRP. The reason is the reactive nature of DSR. With increase in transmission range the packet delivery ratio increases. When the speed of node is less than or equal to 8 m/s the packet delivery ratio decreases and when the speed is greater than 8 m/s, it increases. This phenomenon is valid, only if transmission range is less than 150 m. When the range is greater than 150m, the behavior reverts i.e. if the speed of node is less than or equal to 8 m/s the packet delivery ratio increases and when the speed is greater than 8 m/s, it decreases.
7. CONCLUSION

In this paper, we have studied the effect of variation in transmission range along with a variation in node speed and node density. End to end delay and packet delivery ratio was obtained to assess the performance of routing protocols viz. OLSR, DSR and ZRP. We observed that DSR was the better performing protocol, followed by OLSR and ZRP. In the future work more protocols and parameters will be considered.

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Energy Efficient Homogeneous Wireless Sensor Network Using Self-Organizing Map (SOM) Neural Networks

M. Mittal & K. Kumar
Department of Computer Science
Gurukul Kangri University
Haridwar, India
mittal.mohit02@gmail.com, kumar_krishana@yahoo.com
Phones: +918394832967 & +919319777952

ABSTRACT

Today, Wireless Sensor Network (WSN) is becoming an interesting research area for wireless communication in very harsh or hostile environment. In WSN, limited battery power is considered as the main constraint; due to which the network lifetime is very low. To overcome this problem, many types of improvement have been carried out in both hardware and software levels. But still, there is a much more need to improve. Data clustering or classification using artificial neural networks (ANN), an emerging area of artificial intelligence is a step forward to enhance the network’s lifetime by means of optimizing some of its parameters like power battery backup, data traffic, end-to-end delay. Now-a-days, ANN has become one of the most popular techniques for solving real time optimization problems. In this paper, Kohonen’s Self-Organization Map (SOM) neural network algorithm has been efficiently used for data clustering; that learns to classify data without any supervision i.e. in unsupervised learning mode. We have analyzed and reduced the real data to make the network less bulky, communication gets faster as due to lager volume of data is get reduced, and end-to-end delay and power consumption of communication network also gets lowered.

Keywords - Wireless sensor network (WSN); artificial neural network (ANN); self-organizing map (SOM); energy efficiency.

1. INTRODUCTION

Wireless Sensor Network was developed for various real time applications such as battlefield surveillance, industrial process monitoring and control, health monitoring, animal tracking, environment and habitat monitoring, home automation etc. It consists of large number of distributed homogeneous tiny sensor nodes to cooperatively monitor physical or environmental conditions such as humidity, temperature, sound, pressure, pollution etc; their implementation became possible due to recent developments in micro-electro-mechanical systems (MEMS) and state of the art communication electronics [2]. These environmental parameters are sensed by these tiny nodes in the form of sensed data and forwarded to base station (BS). The base stations are also acts as gateway, which allows the user to access the collected data through an infrastructure network, such as internet [3].

There are many limitations battery life, bandwidth, end-to-end delay, data traffic, latency etc which restricts the communication. Among these limitations battery life is one of the major constraints because these sensor networks are mostly deployed in very harsh or hostile environment to which it is very difficult to change their batteries. So, to overcome this critical issue, we have to work on routing techniques to prolong the overall network lifetime.

The data processing consumes large amount battery power of the sensor nodes. Artificial neural network works efficiently on this problem. Self Organizing Map neural network create clusters of data given to the input. Clustering helps in reducing the large amount of data. So, by this clustering technique the network lifetime is improved.

There are some technical requirements of a WSN applied to environmental monitoring include:

- Autonomy: batteries must be able to power the nodes during the whole network lifetime. As the radio transceiver accounts for most of the power consumption in a node, the network has to reduce data traffic as much as possible, as well as the number of hops required to send a message.
- Robustness: In this kind of application, human maintenance is usually difficult because of the hardness of the terrain. Therefore it is important to design robust software and hardware that can be adapted to any incident.
- Flexibility: the network must be able to add, move or remove nodes to meet the applications requirements. The network must automatically detect the changes, organizing the communication in consequence.
2. ARTIFICIAL NEURAL NETWORK

The human brain, which possesses an extraordinary ability to learn, memorize and generalize, is a dense network of over 10 billion neurons, each connected on average to about 10,000 other neurons which is called synapses. Each neuron receives signals through synapses, which control the effects of the signals on the neuron. These synaptic connections play an important role in the behavior of the brain. These findings have inspired modeling of biological neural systems by means of NNs [15]. From the human brain, the computer scientist’s creates artificial neural network which is used to solve real time problems. Learning is the process in which the weights of a NN are updated in order to discover patterns or features in the input data. Learning methods are generally classified into the two types: i) supervised learning and ii) unsupervised learning. In supervised learning, a teacher presents an input pattern and the corresponding target output. Network weights are adapted in such a way that the error is minimized. The objective of unsupervised learning is to discover patterns in the input data with no help from a teacher [14].

2.1 Self Organizing Map Neural Network

Kohonen Self-Organizing Maps (or just Self-Organizing Maps, or SOMs), are a type of neural network. They were developed in 1982 by Tuevo Kohonen, a professor emeritus of the Academy of Finland. Self-Organizing Maps are aptly named. “Self-Organizing” is because no supervision is required. SOMs learn by their own unsupervised competitive learning. “Maps” is because they attempt to map their weights to conform to the given input data. The nodes in a SOM network attempt to become like the inputs presented to them. In this sense, this is how they learn. They can also be called “Feature Maps”, as in Self-Organizing Feature Maps. Retaining principle ‘features’ of the input data is a fundamental principle of SOMs, and one of the things that makes them so valuable. Specifically, the topological relationships between input data are preserved when mapped to a SOM network [7].

2.2 Architecture

Each node in the SOM is mapped to neuron in the neural network. The architecture of SOM is shown in the “Fig.1”. The neighborhood of the radii R=2, 1 and 0 are shown in the “Fig.2” for a rectangular grid and in “Fig. 3” for hexagonal grid. In each illustration, the winning unit is indicated by the symbol “#” and the other units are denoted by “*”. Note that each unit has eight nearest neighbors in the rectangular grid, but only six in the hexagonal grid. Winning units that are close to the edge of the grid will have some neighborhoods that have fewer units than that shown in the respective figure [8].
2.3 Algorithm
Step 0. Initialize weights $w_{ij}$ (possible choices are discussed below). Set topological neighboring parameters.
Step 1. While stopping condition is false, do step 2 to 8.
Step 2. For each input vector $x$, do Steps 3 to 5.
Step 3. For each $j$, compute: $D(j) = \sum (w_{ij} - x_i)^2$
Step 4. Find index $J$ such that $D(J)$ is a minimum.
Step 5. For all units $j$ within a specified neighborhood of $J$, and for all $i$: $W_{ij}(\text{new}) = w_{ij}(\text{old}) + \alpha [x_i - w_{ij}(\text{old})]$.
Step 6. Update learning rate.
Step 7. Reduce radius of topological neighborhood at specified times.
Step 8. Usually the stopping criterion is a fixed number of iterations or till radius becomes zero or the weight matrix reduces to a very negligible value.

3. RESULT ANALYSIS
The simulation is done in MATLAB and Viscovery SOMine5. Humidity data values are taken as parameter for analysis. We are considering as 15 sensor nodes as input in SOM neural network. This data contain 100 values by each sensor nodes. Some of the input values are shown in TABLE I. We have created 4 clusters in the output layer. In Figure 4, Different clusters are shown cluster 1, cluster 2, cluster 3 and cluster 4 (simulation after 20 iterations). Figure 4. Represents clusters after 100 iterations. Correlation between sensor nodes is shown in TABLE II. PCA values and eigen values are shown in TABLE III.

Table 1: Sensors Input Values

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Figure 4. Clustering after 20 iterations
Figure 5. Clustering after 100 iterations
Figure 6 a. Cluster 1 (c1) consists 4 sensor nodes (sensor node_3, sensor node_11, sensor node_4, sensor node_12).

Figure 6 b. Cluster 2 (c2) consists 1 sensor node (sensor node_9)

Figure 6 c. Cluster 3 (c3) consists 5 sensor nodes (sensor node_1, sensor node_4, sensor node_12, sensor node_3 and sensor node_11).

Figure 6 d. Cluster 4 (c4) consists 2 sensor node (sensor node_2, sensor node_14)
Table 2: Correlation Matrix Of Sensor Nodes.

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<th>S_3</th>
<th>S_4</th>
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Table 3: Calculation Of Pca Value And Eigenvalue

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Eigenvalue 5.4504 | 2.4302 | 2.1859 | 1.7282 | 1.2806 | 0.9222 | 0.5447 | 0.4009 | 0.0347 | 0.0203 | 0.0018 |

% variance 36.34 | 16.2 | 14.57 | 11.52 | 8.54 | 6.15 | 3.63 | 2.67 | 0.23 | 0.14 | 0.01 |

Cumulative % variance 36.34 | 52.54 | 67.11 | 78.63 | 87.17 | 93.32 | 96.95 | 99.62 | 99.85 | 99.99 | 100 |
4. CONCLUSION

In this paper, Kohonen’s Self-Organization Map neural network is implemented & clustered using MATLAB and Viscovery SOMine5. Simulation is done using clustering. In simulation, we have processed 1500 values and send it to base station. In this process a lot of power is wasted. To overcome this problem, we reduced these values by doing clustering and choosing the best suitable cluster. Therefore only selected clustered values are able to process and send it to base station.

Ultimately we reduce the data traffic by which we minimize bandwidth usage and enhance the battery power. In this way, communication gets faster due to lager volume of data is get reduced. Hence end-to-end delay and power consumption of communication network gets lowered. Finally we can get an energy efficient wireless network.

REFERENCES


Enforcing Dilution of Precision in Global Positioning System (GPS)

J.O. Unogwu, K.H. Kamal, A.O. Jarikre & J.S. Prince
Department of Information Technology
Sikkim Manipal University
Accra, Ghana
omega.unogwu.2014@ieee.org, kamalhiran@gmail.com, jarikre.amos.2014@ieee.org, josackey3@gmail.com
+234 706 786 3838; +233 543 844 062; +233 574 974 212; +233266086080; +233204226740

ABSTRACT

This paper considers the robustness of space-based systems with specific example of GPS to faults in providing accurate positional data. Recent advances in navigation technologies enabled the infusion of information technology into physical processes. One of the keys to obtaining high-accuracy position and time keeping with GPS is the use of redundant atomic clocks onboard GPS satellites and in the GPS control segment. Time is the cornerstone of GPS technology because distances are measured at the speed of light. Atomic clocks provide the means for estimating satellite orbits and satellite clock correction parameters. These quantities are estimated on the ground by the control segment. GPS devices analyze positions over time to calculate speed and bearing because greater precision require greater satellite visibility. Therefore, in order to achieve a high degree of accuracy, Error source of GPS signal broadly categorized into three classes of 1) Receiver noise errors, 2) Orbital and Clock errors and 3) Propagation errors are to be well contained to achieve a high degree of precision. Generating GPS applications for extracting and enforcing dilution of precision made positioning accuracy feasible using the understanding of Geometric Dilution of Precision (GDOP) which deals with both navigation position as well as error in time estimation; Positional Dilution of Precision (PDOP) which manages spatial geometric quality value of the navigated GPS solution; Horizontal Dilution of Precision (HDOP) for the quality of the calculated horizontal position; Vertical Dilution of Precision (VDOP) for the quality of the calculated vertical position as well as the Time Dilution of Precision (TDOP) for the mean error of the current time estimation using the GPS constellation. All DOP measurements are packaged into the $GPGSA$ sentence every few seconds. Using ParseGPGSA method extracts DOP values and reports them through HDOPReceived, VDOPReceived and PDOPReceived. The result shows that adopting suitable programming language like VB.Net infrastructure produces a highly accurate precision fix in radio signal transmission between satellites in space and terrestrial receivers.

Keywords- Global Positioning System (GPS); Geometric Dilution of Precision (GDOP); Positional Dilution of Precision (PDOP); Horizontal Dilution of Precision (HDOP); Vertical Dilution of Precision (VDOP) and Time Dilution of Precision (TDOP).

1. INTRODUCTION

Wireless Sensor Network was developed for various real time Global Positioning System [2] is a satellite-based navigation system providing precise three-dimensional position, navigation, and time information to suitably equipped users. It is made up of three segments namely; the ground control stations, 24+ satellites in earth orbit and receiver units on the earth surface. The initial intention was to use this system mainly for navigation purposes of the US military. Due to the tremendous accuracy potential of this system, and the latest improvements in receiver technology, there is a growing community which utilizes the GPS for a variety of civilian applications [6]. The Global Positioning System (GPS) is a constellation of 24 active (and a number of spare) earth-orbiting satellite navigation system with associated tasks in a wide variety of applications operated by the United States Government through the US Air Force.

Fig 1: Constellation of GPS Satellites over Earth
GPS provides worldwide twenty four hours a day positioning in three dimensions and time services. Primarily designed for land, maritime and aviation navigation services, GPS applications [5] have evolved into other areas including space navigation, surveying, mapping, geographic information system geo-referencing, automatic vehicular tracking as well as emergency services dispatching. Signals are transmitted from GPS satellites at two frequencies L1 and L2 at 1575.42MHz and 1227.60MHz respectively.

Trimble wrote: “in order to compute a receiver’s solution (location and time), the receiver algorithm selects four satellites from all of the satellites in the receiver’s view. In mathematical terms, the user’s receiver solves a system of equations with four equations and four unknowns; the four equations represent the four satellites selected by the receiver to compute a solution and the four unknowns represent the latitude, longitude, altitude, and time”.

With an aggressive period of research, empirical or mathematical and simple models were generated to mitigate the effects of the errors in GPS positioning.

The following equation represents a good example of such models where the algorithm is used to model GPS error solutions with emphasis on the Ionosphere, Troposphere and measurements of the carrier phases on L1/L2 frequencies.

\[ \begin{align*} \phi_1 \lambda_1 &= R + c \left( \delta t_u - \delta t_s \right) + T - I_{p1} + M\phi_1 + N_1 + \epsilon\phi_1 \ldots \quad (1) \\ \phi_2 \lambda_2 &= R + c \left( \delta t_u - \delta t_s \right) + T - I_{p2} + M\phi_2 + N_2 + \epsilon\phi_2 \ldots \quad (2) \end{align*} \]

Where,
- \( \phi_1, \lambda_1 \): Carrier phase measured on L1 frequency (C/A or P(Y) parts)
- \( \phi_2, \lambda_2 \): Carrier phase measured on L2 frequency
- \( R \): Geometric range from satellite s to user u
- \( \delta t_u \): User/receiver clock error
- \( \delta t_s \): Satellite clock error
- \( T \): Tropospheric Delay
- \( I_{p1}, I_{p2} \): Ionospheric delay in measurement on L1/2
- \( M\phi_1, M\phi_2 \): Multipath delay in carrier phase measurement on L1/2
- \( N_1, N_2 \): Carrier phase ambiguity or bias
- \( \lambda_1, \lambda_2 \): Carrier wavelength
- \( \epsilon\phi_1, \epsilon\phi_2 \): Other delay/errors in carrier phase measurement on L1/2

In computing Dilution of Precision, the unit vector from the receiver to satellite is given by the equation.

\[ \mathbf{i} = \left( \frac{p_1 - p}{z_1}, \frac{q_1 - q}{z_1}, \frac{r_1 - r}{z_1} \right) \]  

Where,
- \( p_1, q_1, r_1 \): Position of satellite 1
- \( p, q, r \): Position of receiver

A matrix “A” for a set of satellites is given as:

\[ A = \begin{pmatrix} a_1 & b_1 & c_1 & d_1 \\ a_2 & b_2 & c_2 & d_2 \\ \vdots & \vdots & \vdots & \vdots \\ a_n & b_n & c_n & d_n \end{pmatrix} \]
In each row of A, the first three elements are the components of a unit vector from the GPS receiver to the designated satellite. Supposing the elements in the fourth column denotes the speed of light \( c \) then the time dilution factor \( \frac{s}{c} \) always equals 1. However, if the elements here is -1 then the \( \sigma_t \) can effectively be calculated. The matrix \( B \) is formulated

\[
B = (X^T X)^{-1}
\]

In accordance with the Principles of Satellite Positioning document, where the weighting matrix “\( M \)” is set to the identity matrix.

In \( B \) the elements are denoted as:

\[
B = \begin{bmatrix}
\sigma_u^2 & \sigma_{ud} & \sigma_{ue} & \sigma_{uf} \\
\sigma_{ud} & \sigma_d^2 & \sigma_{de} & \sigma_{df} \\
\sigma_{ue} & \sigma_{de} & \sigma_e^2 & \sigma_{ef} \\
\sigma_{uf} & \sigma_{df} & \sigma_{ef} & \sigma_f^2
\end{bmatrix}
\]

and, TDOP, PDOP and GDOP are denoted by:

\[
TDOP = \sqrt{\sigma_t^2}
\]

\[
PDOP = \sqrt{\sigma_a^2 + \sigma_d^2 + \sigma_e^2}
\]

and

\[
GDOP = \sqrt{TDOP^2 + PDOP^2}
\]

This agrees with the principles of Satellite Positioning. Consequently, the Horizontal Dilution of Precision designated as:

\[
HDOP = \sqrt{\sigma_a^2 + \sigma_d^2}
\]

and the Vertical Dilution of Precision:

\[
VDOP = \sqrt{\sigma_e^2 + \sigma_f^2}
\]

are both reliant on the coordinate system used.

2. METHODOLOGY

Solving GPS precision problems is done by using more sophisticated GPS receivers which use real-time correction data such as WAAS (for North America) and EGNOS (for Europe). Yet, these problems cause relatively small inaccuracies when compared with Geometric Dilution of Precision [4], which can cause a receiver to be inaccurate by more than a football field. Fortunately, Geometric DOP is the easiest to manage with the right programming techniques. The idea of Geometric DOP is to state how errors in the measurement will affect the final state estimation. Knowing the location of satellites is important when determining how precise readings are and how stable a GPS fix is. Computationally, this can be defined [9] as:

\[
GDOP = \frac{\Delta(\text{Output Location})}{\Delta(\text{Measured Data})}
\]

Conceptually, errors on a measurement resulting in the short-term changing can be imagined. Ideally little changes in the measured data should not significantly result in large changes in output location as such a result would imply the solution is very sensitive to errors. In this work construction of VB.Net application takes the distance between satellite in orbit and a receiver at any point on the earth’s surface, the satellite’s azimuth and elevation angles and acceleration, as well as each satellite’s precise location in space as attributes. Controlling GDOP [17] is the key to writing accurate GPS applications. This is informed by the understanding of the ratio of position error to the range error of each satellite.

3. DESIGN

This novel research design is to add to modern precision standards involving identification of the various components of the error sources, with particular emphasis on the atmospheric segments - ionosphere and troposphere. This, it is hoped has added to push advances in GPS technology precision to new levels.
Enforcing DOP by using of VB.Net [besides other programming languages as java and C#] would address GPS errors that are inherent by the effects of the atmosphere. It utilizes the distance, elevation, orbits and acceleration of the satellites from the receiver’s position on the surface of the earth. Considering a scenario with lines joining four satellite positions and receivers form a tetrahedron, the smaller the volume of the tetrahedron, the worse Geometric Dilution of Precision, likewise, the better the Geometric Dilution of Precision when there is a larger Dilution of Precision values.

Fig 3: Magnitude/percentage distribution of all GPS Errors

DOP values range between 1 to >20 with rating decreasing in quality from IDEAL to POOR starting from 1. A high DOP does not produce an accurate position; though it could still be good. However, the position is probably closer to being right with a low DOP.

The followings are a number of ways to improve accuracy:
- Use Differential Global Positioning System (DGPS) to reduce the errors in the inputs. This requires that a GPS receiver, designated as the base station, is set up on a precisely established location. This receiver calculates its position based on satellite signals and compares this location to the known location. The difference is applied to the GPS data recorded by a roving GPS receiver and yields a more accurate positioning from about 15 meters to 10 meters.
- Improve DOP by using more satellites.
- Take your measurements when the satellites are spread out over the sky.
- Average the GPS position readings over time.

Fig 4: Illustration of bad and good DOP
Fig 5: Step for Dilution of Precision in GPS
Enforcing maximum DOP values is the easiest part of the whole programming process because enforcing precision is a matter of ignoring positional measurements above the maximum allowable DOP amount.

The system architecture starts from the satellite in space sending positional data through the earth’s atmosphere which gets distorted by the ionosphere and troposphere amongst others, resulting to positional fix errors.

**Ground Control Segment**
The ground control segment receives the distorted data packets where inconsistencies are eliminated and retransmitted back to the satellite, field receiving stations and transmitter towers in real to near-real time.

### Fig 6: Process logic for Programming GPS Solutions

Implementation of the methodology was carried out having in mind the need to construct appropriate codes that will extract and enforce maximum DOP values. DOP can be expressed as a number of separate measurements; HDOP, VDOP, PDOP, and TDOP representing Horizontal, Vertical, Positional (3D), and Time Dilution of Precision respectively. Mathematically, they follow from the positions of the usable satellites. Signal receivers allow the displays of sky plots of these positions in addition to the DOP values. All DOP measurements are packaged into the SGPGSA (GPS DOP and Active Satellites) sentence every few seconds. The GPGSA is made up of GPS fix data comprising of time, latitude, longitude, fix quality, number of satellites, HDOP, altitude and geoidal height (mean sea level) above WGS84. A method called ParseGPGSA is added which extracts all DOP values and reports them via three events: HDOPReceived, VDOPReceived and PDOPReceived.

### Fig 7: System Implementation

**Transmission Towers**
The transmitter towers serves as validation point or base station/control point for both distorted and corrected GPS position fix data to the satellite in space and GPS rover receivers.

**GPS Receivers**
This is the primary reason for the system. These are equipment fitted to hand held devices, auto motives, aircrafts, stationary structures and many others for the purpose of obtaining accurate positional fixes as well as other relevant data for specialized functions.
Fig 8: Flowchart for DOP Enforcement
4. PERFORMANCE EVALUATION

Implementing dilution of precision was executed using GNSS online Planning and Planning software tools from Trimble to analyse Dilution of Precision.

Fig 9: GNSS (GPS) Planning software to enforce DOP

The planning interface was used to set the satellite almanac where visible satellites are selected based on visibility at Latitude 5° 33’ 0″ N and Longitude 0° 13’ 0″ E) at 10 days intervals starting from the 1st, 10th, 20th and 30th in the month of July, 2014.

![Fig 9: GNSS (GPS) Planning software to enforce DOP](image)

Fig 10: Satellite availability selection

The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 5° 33’ 0″ N and Longitude 0° 13’ 0″ E) Starting from 0600 hours to 1800 hours for the 1st of July, 2014, computed from broadcast satellite ephemeris set at 13° elevation mask angle.

### TABLE XII. DOP VALUES FOR 1ST OF JULY 2014

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<th>PDOP (Units)</th>
<th>HDOP (Units)</th>
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TABLE XIII. DOP VALUES FOR 10TH OF JULY 2014

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The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 50 33/ 0/ N and Longitude 00 13/ 0/ E) Starting from 0600 hours to 1800 hours for the 20th of July, 2014, computed from broadcast satellite ephemeris set at 130 elevation mask angle.

TABLE XIV. DOP VALUES FOR 20TH OF JULY 2014

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<td>17:30</td>
<td>2.33</td>
<td>1.08</td>
<td>2.07</td>
<td>0.89</td>
<td>1.87</td>
</tr>
<tr>
<td>18:00</td>
<td>2.21</td>
<td>1.02</td>
<td>1.96</td>
<td>0.97</td>
<td>1.7</td>
</tr>
</tbody>
</table>

The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 50 33/ 0/ N and Longitude 00 13/ 0/ E) Starting from 0600 hours to 1800 hours for the 20th of July, 2014, computed from broadcast satellite ephemeris set at 130 elevation mask angle.
The table gives the output of GDOP, TDOP, PDOP, HDOP and VDOP values of Accra, Ghana (Latitude 5° 33' 0" N and Longitude 0° 13' 0" E) starting from 0600 hours to 1800 hours for the 30th of July, 2014, computed from broadcast satellite ephemeris set at 13° elevation mask angle.

![Dilution of Precision Plots from broadcast satellite ephemerides for 30th July, 2014](image)

**TABLE XV. DOP VALUES FOR 30TH OF JULY 2014**

<table>
<thead>
<tr>
<th>Time (HR)</th>
<th>GDOP (Units)</th>
<th>TDOP</th>
<th>PDOP</th>
<th>HDOP</th>
<th>VDOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00</td>
<td>2.37</td>
<td>1.12</td>
<td>2.09</td>
<td>0.98</td>
<td>1.85</td>
</tr>
<tr>
<td>6:30</td>
<td>1.95</td>
<td>0.8</td>
<td>1.78</td>
<td>0.73</td>
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</tr>
<tr>
<td>7:00</td>
<td>3.25</td>
<td>1.42</td>
<td>2.92</td>
<td>0.91</td>
<td>2.78</td>
</tr>
<tr>
<td>7:30</td>
<td>2.58</td>
<td>1.04</td>
<td>2.36</td>
<td>0.77</td>
<td>2.23</td>
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<td>8:00</td>
<td>2.32</td>
<td>1.01</td>
<td>2.08</td>
<td>0.77</td>
<td>1.94</td>
</tr>
<tr>
<td>8:30</td>
<td>2.03</td>
<td>0.9</td>
<td>1.82</td>
<td>0.78</td>
<td>1.64</td>
</tr>
<tr>
<td>9:00</td>
<td>2.18</td>
<td>1.03</td>
<td>1.92</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>9:30</td>
<td>1.71</td>
<td>0.76</td>
<td>1.53</td>
<td>0.82</td>
<td>1.29</td>
</tr>
<tr>
<td>10:00</td>
<td>1.9</td>
<td>0.89</td>
<td>1.68</td>
<td>0.85</td>
<td>1.45</td>
</tr>
<tr>
<td>10:30</td>
<td>2.04</td>
<td>0.96</td>
<td>1.8</td>
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</tr>
<tr>
<td>11:00</td>
<td>2.18</td>
<td>0.99</td>
<td>1.94</td>
<td>0.82</td>
<td>1.76</td>
</tr>
<tr>
<td>11:30</td>
<td>2.38</td>
<td>0.99</td>
<td>2.17</td>
<td>0.75</td>
<td>2.03</td>
</tr>
<tr>
<td>12:00</td>
<td>3.1</td>
<td>1.26</td>
<td>2.84</td>
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</tr>
<tr>
<td>12:30</td>
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<td>0.85</td>
<td>2.52</td>
</tr>
<tr>
<td>13:00</td>
<td>3.15</td>
<td>1.16</td>
<td>2.93</td>
<td>1.01</td>
<td>2.75</td>
</tr>
<tr>
<td>13:30</td>
<td>2.96</td>
<td>1.19</td>
<td>2.71</td>
<td>0.99</td>
<td>2.52</td>
</tr>
<tr>
<td>14:00</td>
<td>2.92</td>
<td>1.21</td>
<td>2.66</td>
<td>0.95</td>
<td>2.48</td>
</tr>
<tr>
<td>14:30</td>
<td>3.37</td>
<td>1.45</td>
<td>3.44</td>
<td>1.03</td>
<td>3.28</td>
</tr>
<tr>
<td>15:00</td>
<td>6.68</td>
<td>2.69</td>
<td>6.12</td>
<td>1.38</td>
<td>5.96</td>
</tr>
<tr>
<td>15:30</td>
<td>4.2</td>
<td>1.69</td>
<td>3.84</td>
<td>0.87</td>
<td>3.74</td>
</tr>
<tr>
<td>16:00</td>
<td>4.29</td>
<td>1.91</td>
<td>3.84</td>
<td>1.04</td>
<td>3.7</td>
</tr>
<tr>
<td>16:30</td>
<td>2.76</td>
<td>1.26</td>
<td>2.46</td>
<td>0.91</td>
<td>2.28</td>
</tr>
<tr>
<td>17:00</td>
<td>2.18</td>
<td>1.01</td>
<td>1.94</td>
<td>0.89</td>
<td>1.72</td>
</tr>
<tr>
<td>17:30</td>
<td>2.22</td>
<td>1.03</td>
<td>1.96</td>
<td>0.98</td>
<td>1.7</td>
</tr>
<tr>
<td>18:00</td>
<td>2.24</td>
<td>1.05</td>
<td>1.99</td>
<td>0.92</td>
<td>1.76</td>
</tr>
</tbody>
</table>

![Visibility of GPS satellites over Accra from 0600hrs to 1800hrs](image)
5. CONCLUSION

GPS satellite signal have several ways of being distorted. Some are corrected by the Department of Defense and others can be corrected in your GPS receiver using real-time ground station correction signals. The only precision problem which is left to be controlled is Dilution of Precision (GDOP, TDOP, PDOP, HDOP and VDOP). Being an indicator that show how well GPS satellite constellation is organized, controlling DOP using applications as VB.NET greatly enhances accuracy by mitigating the effect of the atmospheric error sources of GPS signals and is the key to writing commercial-grade GPS applications. A small mathematical formula can be applied also to determine the maximum allowable DOP for a particular application. The maximum allowable error should be the greatest possible value which minimizes accuracy problems while maximizing operational conditions. Hence, the smaller the DOP the more accurate positioning fix gets. Relatively, the more the number of evenly spread satellites, the better the impact on good DOP.

Time is another factor which helps developers. Advances in GPS receiver technology are pushing precision to new levels. While precision can be questionable with any consumer GPS device, there will soon be a time when precision to a centimeter is possible and that is what VB.Net is poised to achieve.

Acknowledgment

The authors would like to thank the proprietors of GNSS Planning software (Trimble) as well as Analytic Graphics incorporated for magnanimously making their Systems Tool Kit accessible for use in this work. We would like to thank the management who constantly inspired to involve in research work and special thanks to Dr. Tahir Yakubu for cordial cooperation and motivation in our work. We would also like to thank for the valuable information they provided us and our family members for their love and care.
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Cluster Head Selection in Mobile Ad-hoc Network (MANET) Using ART1 Neural Network

S. Gangwar, K. Kumar & M. Mittal
1Department of Computer Application, V. B. S. Purvanchal University, Jaunpur, India
2&3Department of Computer Science, Gurukul Kangri University, Haridwar, India
gangwar.sanjeev@gmail.com; kumar.krishana@yahoo.com; mittal.mohit02@gmail.com

ABSTRACT

Mobile ad-hoc network or simply MANET is one of the better choices for communication in various fields like military, environment, tracking etc. due to its cost effectiveness. Limited battery power is a major challenge in MANET for many applications. Hence, to handle this problem, we more often work on routing technique like DSR, AODV, DSDV, OLTP. Therefore it consumes less power during data transfer from mobile nodes to the respective base stations. In today’s research artificial neural network has become one of the most promising real time problems solving technique which is being used widely in many real time applications. It is also best suited for the cluster head selection in MANET. In this paper, ART1, an unsupervised learning technique of artificial neural network has been implemented to select the cluster head in routing. Simulation result shows that 58% network lifetime enhancement is achieved.

Keywords- MANET, cluster head, ART1 neural network, unsupervised learning.

African Journal of Computing & ICT Reference Format:

1. INTRODUCTION

Basically mobile ad hoc network (MANET) [18-20] is the combination of different network nodes which are able to communicate among themselves. These mobile ad hoc networks are without any predefined infrastructure, multi-hop, dynamic networks established by a collection of mobile nodes. Wireless nodes can communicate independently at it own in such networks without any fixed infrastructure or centralized administration. MANET nodes can receive their network packets from their respective neighbors. Nodes during their movement these nodes change their topologies time to time. This type of communication in MANET is helpful for large scale infrastructure. These nodes usually establish their connections and share information along with the access of many specified resources.

Generally, there is no centralized network and it only consists of mobile nodes on which the entire network depends. Each node use limited battery power consumption and it forwards the data into the form of packets from source location to destination. MANET typically uses distributed system environment and a fixed infrastructure. As we know mobile nodes consist of radio range by which they communicate. In case if one station can communicate with other station but it doesn’t in their range they can communicate via their intermediate nodes. Some of the important characteristics of MANET are:

1.1. Distributed Operation:
Every mobile node has individual functionality. They are communicate as per own various configurationally setups. Every node must communicate with each other for information transmission. Each node may act as a relay for implementation of specific functions such as routing and security.

1.2. Multi-hop Routing
When a node tries to send information among other nodes which are out of its connectivity area, then packet must be forwarded via one or more existing intermediate nodes.

1.3. Autonomous
Every mobile node is an individual entity, which acts as host as well as router.

1.4. Dynamic Topology
The network topology may change randomly in MANET. Some of nodes are free to move throughout specified network having different speeds.

1.5. Neighbour Discovery
The neighbouring node is discovered by transmitting and receiving hello packets.

1.6. Data Routing
Data packets can be routed from one source node to other destination node using a specific path.
1.7. Resource Constraints
Limited bandwidth is available for communication between intermediate mobile nodes.

1.8. Diversity in Nodes as well as Protocols
Various nodes are available like ipods, palm handheld computers, PCs, smart tablets, smart sensors. Nodes can use different protocols such as IrDA, Zigbee, 802.11, GSM or TCP/IP etc.

1.9. Light-Weight Mobile Nodes
The nodes configuration is mobile with less CPU capability, low power storage and small memory size.

2. PROBLEM DESCRIPTION
As we know that MANET is an infrastructure-less system, mobile nodes communicate with each other with the help of radio signals. One-to-one communication happens throughout the network at a particular time span. If a node wants to send its data to other node which is placed outside its coverage area then multi-hop routing is strictly needed. In that case, intermediated nodes act as routers having data forwarding properties to make communication complete and possible. During the movements of nodes energy is a very important issue and it should be handled carefully. Therefore, our main objective from the existing scenario is to make system energy efficient. To overcome this problem, we need to work over clustering of various nodes available in a MANET. Clustering means grouping of various nodes. Presently, clustering mechanisms are being used for MANET in various areas, such as building automation and home networks, and ubiquitous applications. Clustering strongly influences communication overhead, latency, congestion, inter-cluster and intra-cluster formation.

In MANET, clustering of various available nodes is done based on residual energy. So many clusters can be created using residual energy concept. Out of these formed clusters we choose one node. This one selected node is called cluster head (CH) node (fig 1).

These cluster head nodes are responsible to communicate over the network. The non-cluster head nodes selected the cluster head node using cluster head id by sending a confirmation packet to get in a particular cluster’s vicinity. Then at a particular round, a node in a particular cluster sends its data to cluster head node. These cluster head nodes afterward forwards these collected information to the base station (BS). Then again cluster head is selection is done for another round. It goes on till nodes are shut down their battery life more than minimum nodes required for the communication in the network. This is the brief overview of clustering process and transmission of data packets from nodes to base station. Also this is one of the energy saving procedure for a MANET.

Now we need to modify the existing system for making the system more energy efficient. We have used adaptive resonance theory (ART1) neural networks to find the cluster head. ART1 is an unsupervised learning clustering algorithm which can be used for where competition among nodes or any other type of entities happens. This works well for solving the real time problems [1]. We have implemented this ART1 technique over the cluster head part in MANET. Here, clustering is done over various parameters of MANET and ART1. As a result of it has performance is achieved at a greater extent and at a greater rate.

![Figure 1: Basic Scenario of Cluster Formation](image-url)
3. REALTED WORK

Amis et al. have discussed about the clustering in wireless ad hoc network. They have proposed a d-clustering heuristic technique which is modified of 1-hop clusters as traditionally generated. Under this election of cluster head is done an even network configuration change. Krishan Kumar et al. have proposed routing protocol to control power based on coverage using neural network. The main objective is to maximizing the network lifetime. In this paper, the cluster head selection procedure has been modified using adaptive learning in neural network. There are many clustering schemes available. But there is need to modify them according to the problem. As energy efficiency is one of the main constraints in MANET. Other is the heterogeneity in the network. These two major problems is to solve as much as possible. A practical approach is needed to analyze the existing routing protocols and modify using artificial neural network to get a better network communication and energy efficient.

Ratish Agarwal et al. have surveyed on several clustering algorithms. After survey completed, it is observed that a cluster-based MANET consists many issues such as the control overhead of cluster, cluster structure stability, the energy consumption of mobile nodes, load distribution in clusters, and the fairness of serving as cluster heads for a mobile node [15].

4. BASIC CLUSTERING CONCEPT

Clustering in MANETs can be considered as the virtual partitioning of dynamic nodes in the flat structure or distributed network structure into several clusters [22]. Clusters of the nodes in the flat structure or distributed network structure are made with respect to their closeness to each other. Such nodes are considered neighbors when all neighboring nodes are located within their transmission range and set up a bidirectional link between them. Typical algorithms for clustering in the flat structure or distributed network structure are known as one-hop clustering and multi-hop (d-hop) clustering algorithms [22].

In the one-hop clustering, every member node is at most 1-hop distance away from a central node that is called the cluster head. Thus, all member nodes remain at most two hops distance away from each other within a cluster category. On the contrary, in multi-hop clustering [22,23], the management of neighboring nodes to the cluster head is performed by allowing the nodes to be presented at most d-hop distance away from each other to form a cluster. A typical wireless MANET structure consists of flat and hierarchical structures as shown in Figure 2(a,b).

The small circle in the figure represents the nodes in MANET. The lines joining the circles denote connectivity among the nodes. Every node is identified with an ID number (i.e., 1–10) along with a number within parenthesis. The numbers in the parenthesis are the weights of the nodes. These weights are measured with respect to various node parameters and apply the selection of cluster heads. Every node in the flat structure shares equal responsibility to act as a router to route the packets to every other node. However, to achieve better routing efficiency, this structure requires an amount of message flooding. Occasionally, such message flooding has the merit of reducing overhead of the MAC layer. On the other hand, nodes in the hierarchical structure are assigned with different functionalities while acting as a cluster head, gateway, or a cluster member as shown in Figure 1(b).

The cluster head in the hierarchical structure plays an important role in inter-cluster and intra-cluster communication. Thus, the cluster head works as the local coordinator for its member nodes and manages the cluster members. A gateway node is a node that connects the bridge between the inter-cluster and intra-cluster communication. On the other hand, a gateway works as the common or distributed access point for two cluster heads. Both of the distributed gateways provide the path for inter-cluster communication. The ordinary nodes of the cluster are the immediate neighbours of the cluster heads. They have the capability of serving as either a head or a gateway whenever selected to do so.

Figure 2: Flat Structure & Hierarchical Structure of Cluster formation [21]
5. ART1 NEURAL NETWORKS

Adaptive resonance theory (ART), an unsupervised learning neural network method, was given by Carpenter A Grossberg in 1987 [17]. It was divided in two categories, first one i.e. ART1 for the binary pattern and the second one ART2 for the continuous values. ART1 consists of basically two layers, an input layer and an output layer. ART1 receives only binary input vectors. It expands if new input has not been categorized with the existing neuron. It maintains two matrices one is bottom-up matrix and other is top-down matrix. ART1 main forms clusters as an output depend on given input. The clusters size is fixed and depends on vigilance parameter ($\rho$). A vigilance parameter describes the tolerance of matching process.

5.1 Training Algorithm

A discussion of the choice of parameter values and initial eights follows the training algorithm [1]. The used notations follows:

- $n$ - number of components in the input vector.
- $m$ - maximum number of clusters that can be formed.
- $b_{ij}$ - bottom-up weights (from F1(b) unit Xi to F2 unit Yj).
- $t_{ji}$ - top-down weights (from F2 unit Yj to F1 unit Xi).
- $\rho$ - vigilance parameter.
- $s$ - binary input vector (an n-tuple).
- $x$ - activation vector for F1 (b) layer (binary).
- $||x||$ - norm of vector $x$ (defined as the sum of the components $x_i$).

The training algorithm an ART1 net is presented next. A discussion of the role of the parameters and an appropriate choice of initial weights follows.

Step0. Initialize parameters:

$L > 1$, 
$0 < \rho \leq 1$. 

Initialize weights:

$0 < b_{ij} (0) < \frac{L}{L-1} + n$,
$t_{ji} (0) = 1$. 

Step1. While stopping condition is false, do
Steps 2-13.

Step2. For each training input, do steps 3-12.

Step3. Set activation of all F2 units to zero.

Step4. Compute the norm of $s$:

$||s|| = \Sigma \ s_i$. 

Step5. Send input signal from F1 (a) to the F1 (b) layer: $x_i = s_i$.

Step6. For each F2 node that is not inhibited:

If $y \neq -1$, then

$y_j = \Sigma b_{ij} * x_i$. 

Step7. While reset is true, do step 8-11.

Step8. Find J such that $y_j \geq y$ for all nodes j. 

If $y_j = -1$, then all nodes are inhibited and this pattern cannot be clustered.

Step9. Recompute activation x of F1 (b):

$x_i = s_i * y_j$. 

Step10. Compute the norm of vector $x$:

$||x|| = \Sigma x_i$. 

Step11. Test for reset:

If $||x|| / ||s|| < \rho$, then $y = -1$ (inhibited node J) (and continue executing Step 7 again)

If $||x|| / ||s|| \geq \rho$, 

Then proceed to Step 12.

Step12. Update the weights for node $j$ (fast learning):

$b_{ij} (new) = L * x_i / L-1 + \frac{||x||}{||s||} * t_{ji} (new) = x_i$. 

Step13. Test for stopping condition.
Figure 3: Basic Architecture of ART1

Figure 4: Flowchart of ART1 Neural Network
5.2 Actual Parameters

- **n**: number of components in the input vector.
- **m**: maximum number of clusters that can be formed.
- **b**: bottom-up weights (from F1(b) unit \( X_i \) to F2 unit \( Y_j \)).
  
  Used to store different clusters values.

  Permissible range is given by
  
  \[ 0 < b_{ij} (0) < \frac{L}{L - 1 + n} \]

  Sample value \( \frac{1}{1 + n} \).

- **tji**: top-down weights (from F2 unit \( Y_j \) to F1 unit \( X_i \)).
- **p**: vigilance parameter. (For deciding the learning node).
- **s**: binary input vector (an n-tuple). Input array to store different input values.
  Output array to decide the learning node.

\[ \| x \| \text{ - norm of vector } x, \text{ defined as the sum of the components } x_i. \]

Initialize parameters:

- \( L = 50 \)
- \( p = 0.5 \)

Initialize weights:

- \( b_{ij} (0) = 0.2 \)
- \( t_{ji} (0) = 1 \)

6. RESULT ANALYSIS

Cluster head selection in MANET depends on residual energy which is left to each mobile node. The location-based algorithm decides the cluster using location information and residual energy power. This algorithm affects the problem of determining the lifetime of nodes in advance. Thus, if the nodes are managed in a distributed manner or flat structure without the cluster, the clustering performance is heavily affected by overheads. If the nodes are at the stage of critical energy then it cannot be the part of cluster head selection.

Therefore ART1 neural network is used for selection of cluster head in MANET routing protocol and it is found that it is suitable for it. ART1 algorithm helps in cluster formations based on residual energy of mobile nodes. Cluster head selection is done on the basis of high energy residual cluster formed in ART1. Here we may have more than one cluster formed after setting up of the appropriate parameters of ART1. First of all the nodes are converted in binary patterns on the basis of their id (Table-1).

### Table 1: Binary Vectors for Input Patterns

<table>
<thead>
<tr>
<th>Node Number</th>
<th>Vector Pattern</th>
<th>Input Number</th>
<th>Vector Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node-1</td>
<td>(0.0,0.0,0.1)</td>
<td>Node-11</td>
<td>(0.0,1.0,1.1)</td>
</tr>
<tr>
<td>Node-2</td>
<td>(0.0,0.1,0.0)</td>
<td>Node-12</td>
<td>(0.0,1.1,0.0)</td>
</tr>
<tr>
<td>Node-3</td>
<td>(0.0,0.1,1.0)</td>
<td>Node-13</td>
<td>(0.0,1.1,1.0)</td>
</tr>
<tr>
<td>Node-4</td>
<td>(0.0,1.0,0.0)</td>
<td>Node-14</td>
<td>(0.0,1.1,1.0)</td>
</tr>
<tr>
<td>Node-5</td>
<td>(0.0,1.0,1.0)</td>
<td>Node-15</td>
<td>(0.0,1.1,1.1)</td>
</tr>
<tr>
<td>Node-6</td>
<td>(0.0,1.1,0.0)</td>
<td>Node-16</td>
<td>(0.1,0.0,0.0)</td>
</tr>
<tr>
<td>Node-7</td>
<td>(0.0,1.1,1.0)</td>
<td>Node-17</td>
<td>(0.1,0.0,0.1)</td>
</tr>
<tr>
<td>Node-8</td>
<td>(0.0,1.0,0.0)</td>
<td>Node-18</td>
<td>(0.1,0.1,0.0)</td>
</tr>
<tr>
<td>Node-9</td>
<td>(0.0,1.0,0.1)</td>
<td>Node-19</td>
<td>(0.1,0.0,1.0)</td>
</tr>
<tr>
<td>Node-10</td>
<td>(0.0,1.1,0.0)</td>
<td>Node-20</td>
<td>(0.1,1.0,1.0)</td>
</tr>
</tbody>
</table>

Among these clusters one winner will be of the highest energy. This clustered node with highest energy can be the part of cluster head in routing for next round of data transmission. Rest of ART1 neural network clusters elements act as intermediate mobile nodes. Simulation result of total energy consumption has been shown in table-2 & table-3.

Comparison of results of energy and payload is represented in figure 5. Consequently it is observed that cluster node consumes more energy/power (Tx and Rx) when we increase payload data.

### Table 2: Cluster Head Formed after Clustering By ART1 Neural Network

<table>
<thead>
<tr>
<th>Sector/class</th>
<th>Input classification in different sectors</th>
<th>Vector Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,8,26,27,29,30,35,41</td>
<td>(0.0,0.0,0.1)</td>
</tr>
<tr>
<td>2</td>
<td>14,21,4,5,34,43,31,40</td>
<td>(0.0,0.1,0.0)</td>
</tr>
<tr>
<td>3</td>
<td>3,6,12,17,19,23,25,28,37</td>
<td>(0.0,0.1,1.0)</td>
</tr>
<tr>
<td>4</td>
<td>7,9,11,15,16,22,32,33,42</td>
<td>(0.0,1.0,0.0)</td>
</tr>
<tr>
<td>5</td>
<td>1,24,10,13,18,39,20,44,38,45</td>
<td>(0.0,1.0,1.0)</td>
</tr>
</tbody>
</table>

7. CONCLUSION

We can say that MANET is the choice for cheap communication now-a-days. However this has few limitations which make it less preferable. One of the major challenges is battery life of MANET. During communication process whole system consume battery lives of mobile nodes. To reduce this power consumption; we have worked on routing techniques which lower the power consumption at a greater extent. We have implemented ART1 neural network over the cluster head selection as a part of the routing technique which selects the cluster head depending on residual energy of the mobile node after the completion of every data transmission. After simulating the results in table-3 and figure-5 we found that ART1 algorithm or simply ART1 has optimized the problem of cluster head selection and consequently optimized residual energy. And the network lifetime is increased up to 58% as compared to traditional routing techniques.
Table 3: Total Energy Analysis with Vigilance Parameter

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Energy Tx</th>
<th>Energy Tx ($\rho = 0.9$)</th>
<th>Energy Tx ($\rho = 0.6$)</th>
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<td>0.5891</td>
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</table>

Fig 5: Comparison of Residual Energy with Different Vigilance Parameters

**ACKNOWLEDGEMENT**

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Modified Page Ranking System

L.N. Onyejegbu & O.D. Egbe
Department of Computer Science
University of Port Harcourt
Port Harcourt, River State, Nigeria
E-mail: neka2k@yahoo.com; oladavideegbe@gmail.com.
Phone: +2348036748634, +2347036106989

ABSTRACT

The need to find information more efficiently on the World Wide Web has become the concern of researchers and developers over decades, and the most efficient way to get the best from the web is when the page ranking system can conveniently rank millions of pages in the shortest time possible. To achieve that the web is looked at, as a directed graph called webgraph with pages on the web corresponding to the nodes or vertices of a directed graph and the hyperlinks between pages represented as edges or arcs. In this graph, each node is a web page and each edge is directed, representing a link from one page to another using the HTML hyperlink notation. The page rank algorithm is what determines the quality of information retrieved to the user. In this paper, we developed an efficient rank algorithm that can retrieve quality information that meet the information need of the user, and the fuzzy c-means clustering was used to accelerate the processing time of the page rank algorithm while retrieving information. Object oriented methodology was adopted for the analysis and the implementation was done using Java programming language.

Keywords: Page rank, clustering, fuzzy c-means, webgraph, and crawler.

1. INTRODUCTION

The World-Wide Web has spawned a sharing and dissemination of information on an unprecedented scale. The existence of an abundance of dynamic and heterogeneous information on the Web has offered many new opportunities for users to advance their knowledge discovery. As the amount of information on the Web has increased substantially in the past decade, it is difficult for users to find information through a simple sequential inspection of web pages or recall previously accessed URLs. Consequently, the service from a ranking system becomes indispensable for users to navigate around the Web in an effective and more precise manner. But if the search engine is not designed properly with the ability to rank pages that are relevant to a particular search topic, the whole exercise becomes unfruitful and one end up wasting precious time chasing down useless URLs.

Search Engines essentially act as filters for the wealth of information available on the Internet. They allow users to quickly and easily find information that is of genuine interest or value to them, without the need to wade through numerous irrelevant web pages. There is a lot of filtering to do in 2004 the number of pages in Google’s index exceeded the number of people of the planet, reaching the staggering figure of over 8 billion, and in 2013 Google says that the web now has 30 trillion unique individual pages. That up an astonishing 30 times in five years: Google reported in 2008 that the web had just one trillion pages. Google says that it stores information about those 30 trillion pages in the Google Index, which is now at 100 million gigabytes. That’s about a thousand terabytes, and you’d need over three million 32GB USB thumb drives to store all that data [1]. Since the Web is a huge repository of information that has been growing exponentially over the years. This rapid growing nature of the web has led to the invention of various techniques for managing the vast amount of content available online in order to realize its potential as a useful information resource [8].

With that much content out there, the Internet would be essentially unworkable without an efficient page ranking system, with Internet users drowning in sea of irrelevant information and shrill marketing messages. For a page ranking system to satisfy the need of user’s trying to retrieve information, web mining techniques have to be employed by the search engines to extract relevant documents from the web database documents and provide the necessary and required information to the users. The search engines become very successful and popular if they use efficient ranking mechanisms.
Page ranking algorithms are used by the search engines to present the search results by considering the relevance, importance and content score and web mining techniques to order them according to the user interest. Some ranking algorithms depend only on the link structure of the documents i.e. their popularity scores (web structure mining), whereas others look for the actual content in the documents (web content mining). In this study we will analysed few algorithms which uses link structure or web structure mining and few algorithms which uses web content mining for calculating the page rank value of webpages and proposed one algorithm which uses both web structure mining as well as web content mining for calculating the page rank value of webpages using the webgraph with the application fuzzy C-Means clustering to facilitate accelerated retrieval of the ranked information. This gives better and efficient results as compare to other and overcome some limitations of web structure mining based algorithms.

2. REVIEW OF RELATED WORK

The World Wide Web is the collection of information resources on the Internet that are using the Hypertext Transfer Protocol. It is a repository of many interlinked hypertext documents, accessed via the Internet. Web may contain text, images, video and other multimedia data. In order to analyse such data, some techniques called web mining techniques are used by various web applications. Web mining is the application of data mining techniques to discover patterns from the Web, it is the extraction of interesting and potentially useful patterns and implicit information from artefacts or activity related to the World Wide Web. [9].

There are three different knowledge discovery domains in web mining: Web Content Mining, Web Usage and Web Structure Mining. Most page ranking algorithms are mostly based on web structure mining they exploit only the link structure of the webpages in ranking.

2.1 Web Content Mining
Web Content Mining is the process of extracting useful information from the contents of Web documents. Content data corresponds to the collection of facts a webpage was designed to convey to the users. Web content mining is related but is different from data mining and text mining. It is related to data mining because many web documents contains data and data mining techniques can be applied in web content mining [7]. It is related to text mining because much of the web content is text. Web data contents may involve the different types of data. These are: Text, Image, Audio, Video, Metadata and Hyperlinks.

2.2 Web Usage Mining
Web usage mining is the application of data mining techniques to discover usage patterns from Web data in order to understand and better serve the needs of Web based applications. It involves the mining of web logs to discover access patterns of the pages accessed by the user [10].


2.3 Web structure mining
It is the process of retrieving the information from World Wide Web into more structured forms and indexing the information to retrieve it quickly [6]. Web structure mining, is a tool used to identify the relationship between Web pages linked by information or direct link connection. The goal of Web structure mining is to generate structural summary about the Web site and Web page. Technically, Web content mining mainly focuses on the structure of inner-document, while Web structure mining tries to discover the link structure of the hyperlinks at the inter-document level. Based on the topology of the hyperlinks, Web structure mining will categorize the Web pages and generate the information, such as the similarity and relationship between different Web sites.

Web structure mining can also have another direction -- discovering the structure of Web document itself. This type of structure mining can be used to reveal the structure (schema) of Web pages, this would be good for navigation purpose and make it possible to compare/integrate Web page schemes. This type of structure mining will facilitate introducing database techniques for accessing information in Web pages by providing a reference schema. [4].

2.4 Comparative Study of Page Ranking Systems
There are several algorithms proposed based on link analysis, these are algorithms that exploit the hyperlinks nature of the web in page ranking. The most important algorithms are PageRank, HITS (Hyper-link Induced Topic Search) and Weighted PageRank which is a content based algorithm, they are comparatively discussed below.

2.4.1 PageRank Algorithm
Page Rank algorithm is the most commonly used algorithm for ranking the various pages. Working of the Page Rank algorithm depends upon link structure of the web pages. The Page Rank algorithm is based on the concepts that if a page contains important links towards it then the links of this page towards the other page are also to be considered as important pages. The Page Rank considers the back link in deciding the rank score. If the addition of all the ranks of the back links is large then the page is provided a large rank. A simplified version of PageRank is given by:

\[
PR(b) = \frac{1}{m} \sum_{a \in N(b)} \frac{PR(a)}{L(a)}
\]

Where the PageRank value for a web page b is dependent on the PageRank values for each web page v out of the set M (this set contains all pages linking to web page b), divided by the number L(a) of links from page a. [5].
In a nutshell the assumption in Page and Brin's theory is that the most important pages on the Internet are the pages with the most links leading to them. PageRank thinks of links as votes, where a page linking to another page is casting a vote. This makes sense, because people do tend to link to relevant content, and pages with more links to them are usually better resources than pages that nobody links. PageRank doesn't stop there. It also looks at the importance of the page that contains the link. Pages with higher PageRank have more weight in "voting" with their links than pages with lower PageRank. It also looks at the number of links on the page casting the vote. Pages with more links have less weight.

This also makes a certain amount of sense. Pages that are important are probably better authorities in leading web surfers to better sources, and pages that have more links are likely to be less discriminating on where they're linking. The main advantage of the Google’s PageRank measure is that it is independent of the query posed by user, this means that it can be pre computed and then used to optimize the layout of the inverted index structure accordingly. However, computing the Page-Rank requires implementing an iterative process on a massive graph corresponding to billions of Web pages and hyperlinks. The main disadvantage of this algorithm is that it favours older pages, because a new page, even a very good one, will not have many links unless it is part of an existing web site.

2.4.2 HITS Algorithm

HITS (Hyperlink-Induced Topic Search HITS, also known as hubs and authorities) is a link analysis algorithm that rates Web pages, developed by Jon Kleinberg. It was a precursor to PageRank, it ranks the web page by processing in links and out links of the web pages. In this algorithm a web page is named as authority if the web page is pointed by many hyperlinks and a web page is named as HUB if the page point to various hyperlinks. An Illustration of HUB and authority are shown in figure1.

HITS is technically, a link based algorithm. In HITS algorithm, ranking of the web page is decided by analysing their textual contents against a given query. After collection of the web pages, the HITS algorithm concentrates on the websites and future work include to calculate the rank score by utilizing more than one level of reference page list and increasing the number of human user to classify the web pages (Kleinberg, 1998).

To begin the ranking $v_p.author(p) = 1$ and $v_p.hub(p) = 1$ two types of updates are considered Authority Update Rule and Hub Update Rule. In order to calculate the hub and authority scores of each node, repeated iterations of the Authority Update Rule and the Hub Update Rule are applied. A k-step application of the Hub-Authority algorithm entails applying for k times first the Authority Update Rule and then the Hub Update Rule.

For authority update $v_p.author(p)$ is updated to be the summation

$$author(p) = \sum_{i \epsilon N} \text{hub}(i) \quad \text{2.2}$$

Where n is the total number of pages connected to p and i is a page connected to p. That is, the Authority score of a page is the sum of all the Hub scores of pages that point to it.

For, hub update $v_p.hub(p)$ is the summation:

$$hub(p) = \sum_{i \epsilon N} \text{author}(i) \quad \text{2.3}$$

Where n is the total number of pages p connects to and i is a page which p connects to. Thus a page's Hub score is the sum of the Authority scores of all its linking page. HITS, like Page and Brin's PageRank, is an iterative algorithm based on the linkage of the documents on the web. However it does have some major differences:

It is query dependent, that is, the (Hubs and Authority) scores resulting from the link analysis are influenced by the search terms. As a corollary, it is executed at query time, not at indexing time, with the associated hit on performance that accompanies query-time processing. It is not commonly used by search engines. (Though a similar algorithm was said to be used by Teoma, which was acquired by Ask Jeeves/Ask.com).

It computes two scores per document, hub and authority, as opposed to a single score. It is processed on a small subset of relevant documents (a focused subgraph or base set), not all documents as was the case with PageRank.

The HITS algorithm has some obvious limitation which are discussed below: HITS is a purely link-based algorithm. It is used to rank pages that are retrieved from the Web, based on their textual contents to a given query. Once these pages have been assembled, the HITS algorithm ignores textual content and focuses itself on the structure of the Web only.
HITS algorithm has some problems which are which are discussed here like, high rank value is given to some popular website that is not highly relevant to the given query. And drift of the topic occurs when the hub has multiple topics as equivalent weights are given to all of the out-links of a hub page.

2.4.3 Weighted PageRank (WPR)
Weighted PageRank Algorithm is proposed by Wenpu Xing and Ali Ghorbani. Weighted page rank algorithm (WPR) is the modification of the original page rank algorithm. WPR decides the rank score based on the popularity of the pages by taking into consideration the importance of both the in-links and out-links of the pages. This algorithm provides high value of rank to the more popular pages and does not equally divide the rank of a page among its’ out-link pages. Every out-link page is given a rank value based on its popularity. Popularity of a page is decided by observing its number of in-links and out-links. Simulation of WPR is done using the Website of Saint Thomas University and simulation results show that WPR algorithm finds larger number of relevant pages compared to standard page rank algorithm [2].

The more popular webpages are, the more linkages that other webpages tend to have to them or are linked to by them. It extended PageRank algorithm, this algorithm assigns a larger rank values to the more important pages rather than dividing the rank value of a page evenly among its outgoing linked pages. Each outgoing link gets a value proportional to its importance i.e. each out-link page gets a value proportional to its popularity (its number of in-links and out-links). The popularity from the number of in-links and out-links is recorded as \( P_{in}^{(u,v)} \) and \( P_{out}^{(u,v)} \) respectively.

\[
W_{in}^{(u,v)} = \frac{I_u}{\sum_{v=1}^{n} I_v}
\]

\[
W_{out}^{(u,v)} = \frac{O_u}{\sum_{v=1}^{n} O_v}
\]

Where
- \( I_u \) and \( I_p \) represent the number of in-links of page \( u \) and page \( p \), respectively. \( R(v) \) denotes the reference page list of page \( v \).
- \( P_{in}^{(u,v)} \) is the weight of link \((v,u)\) calculated based on the number of in-links of page \( u \) and the number of in-links of all reference pages of page \( v \).
- \( P_{out}^{(u,v)} \) is the weight of link \((v,u)\) calculated based on the number of out-links of page \( u \) and the number of out-links of all reference pages of page \( v \).

The weighted page rank algorithm has some advantages and limitation which are discussed below: The Quality of pages returned by this algorithm is high as compared to PageRank algorithm. And it is more efficient than PageRank because the rank value of a page is divided among its out-link pages according to importance of that page.

As this algorithm considers only the link structure of the pages on the web not the content of the page, it returns less relevant pages to the user query.

3. DISADVANTAGES OF THE EXISTING SYSTEM

1. The algorithm relies mainly on the in-links of a page for ranking, without putting into consideration the out-links, content and usage of a webpage.
2. It takes a lot of time to calculate page rank for large URLs.
3. The algorithm of the existing system is link analysis based, which is prone to retrieve junk which results in false positive ranking.
4. A page irrelevant to the query still receives a high priority because of its many in-links.

3.1 The Proposed System
The proposed new system combines the features of PageRank algorithm with an improved algorithm that attached weight to pages to determine the most relevant pages, weight of web page is calculated on the basis of input and outgoing links and on the basis of weight, the importance of page is decided. The proposed algorithm is called content-link weighted page rank algorithm it is a hybrid page ranking algorithm that is aimed at overcoming the limitation inherent in the original page rank and weighted rank algorithm. It employ Web structure mining as well as Web Content mining technique to enable the users get the required relevant documents easily on the top few pages.

To make the rank algorithm scalable, to enable it handle large hyperlinks of webpages, fuzzy logic c-means clustering was applied to it since it can find a structure in a collection of unlabelled data by not matching the query exactly it improves the efficiency, effectiveness and speed of ranked pages retrieval.
3.2 Content-Link Weighted Pagerank Algorithm for the Proposed System

This algorithm exploits the hybrid approach for calculating page rank value as it uses both web structure mining as well as web content mining. In this algorithm the importance and relevance of the webpages is calculated by taking into account weight of in links, weight of out links and number of visit to the link by users and by taking new parameter content weight of the web pages with respect to the query terms. 

Consider equation \( \text{PR}_{\text{in}}(v) = \frac{\text{PR}(u) \cdot W_c(v)}{\sum_{v \in V} \text{PR}(u) \cdot W_c(v)} \) \hspace{1cm} (3.1)

And equation \( \text{PR}_{\text{out}}(u) = \frac{\text{PR}(v) \cdot W_c(u)}{\sum_{v \in V} \text{PR}(v) \cdot W_c(u)} \) \hspace{1cm} (3.2)

Where

- \( \text{PR}(u) \) and \( \text{PR}(v) \) are ranking of the Webpages \( u \) and \( v \) respectively.
- \( d \) is the dampening factor.
- \( V_v \) is the number of visits of link which points from \( v \) to \( u \).
- \( \text{TL}(v) \) is the total number of visits of all links present on \( v \).
- \( B(u) \) is the pages which points to webpage \( u \).
- \( W_c(v) \) is the weight of in links of connecting page \( v \) and \( u \).
- \( W_o(u) \) is the weight of out links of connecting page \( v \) and \( u \).
- \( W_c \) is content weight of the web pages with respect to the query terms.

Step 1: Take the link structure of the retrieved webpages from the crawler.
Step 2: Obtain the web graph from the link structure of the retrieved webpages.
Step 3: Give initial page rank value to the all webpages as one.
Step 4: Using equation number (3.1) and (3.2), calculate the weights of in links and out links and also calculate total no. of visits of all links by using client side script.
Step 5: Calculate the Content weight from the equation (3.5).
Step 6: Apply the proposed algorithm as in following equation

\[
\text{PR}(u) = (1-d) + d \cdot \sum_{v \in V} \frac{W_c(v) \cdot \text{PR}(v)}{\text{TL}(v)}
\]

\hspace{1cm} (3.3)

Step 7: Iteratively repeat process until ranks of all Webpages are stable i.e. same in two consecutive iteration. This algorithm reduce the problem of theme drift which is present on every link structure based algorithms as it uses the new parameter content weight from web content mining. \( W_c \) parameter takes user’s query in to account and because of this the results retrieved are efficient and relevant as per user’s query.
3.3 Application of fuzzy logic C- means clustering

Fuzzy logic c-means clustering is used to accelerate the retrieval of ranked pages.

Step 1: Initially enter a key word to search.

Step 2: Apply the Content-link Weighted Rank Algorithm and calculate the rank.

Step 3: Input: Page P, Inlink and Outlink Weights of all back links of P, Query Q, d (damping factor)

Step 4: Output: Rank score

Step 5: Relevance calculation:
(a) Find all meaningful word string of Q (say N)
(b) Find whether the N strings are occurring in P or not? Z = Sum of frequencies of all N strings.
(c) S = Set of the maximum possible strings occurring in P.
(d) X = Sum of frequencies of strings in S.
(e) Content Weight (CW) = X/Z ...... (3.5)
(f) C = No. of query terms in P
(g) D = No. of all query terms of Q While ignoring stop words
(h) Probability Weight (P/W) = C/D

Step 6: If the Keyword has already calculate the rank by using the Content-link Weighted Page Rank in such case it simple use fuzzy algorithm formula to calculate cluster value.

The Cluster value is

\[ K = \frac{1}{n} \] .......................... (3.7)

Where n is the number of data points
Based on the cluster value then that page will be looked for in that cluster and display on the screen.

Step 7: Apply FCM algorithm to cluster the scattered data. FCM is based on minimization of the objective function below.

\[ F(u) = \sum_{i=1}^{n} \sum_{j=1}^{c} u_{ij}^m \| x_i - v_j \|^2 \] .......................... (3.8)

Let \( X = \{ x_1, x_2, x_3, ..., x_n \} \) be the set of data points and \( V = \{ v_1, v_2, v_3, ..., v_c \} \) be the set of centres. \( \| x_i - v_j \| \) is the Euclidean distance between \( i \) data and \( j \)th cluster center

Initialize the Initial membership matrix \( U = [u_{ij}] \) which is \( U(0) \)

\( (l \| = \text{number of members}, j \| = \text{number of clusters}) \)

Membership matrix, \( U \), shows how much a document belongs to a cluster

Step 8: At k-step calculate centroids for each cluster using the equation below, the centres vectors \( V(k) = [v_j] \) with \( U(k) \) if \( k \neq 0 \). (If \( k=0 \), initial centroids location by random)

K is the iteration step. The membership values are calculated w.r.t the new centres. Belongingness of the document to the cluster is calculated using Euclidian distance between the centre and the data point.

\[ v_j = \frac{1}{\sum_{i=1}^{n} u_{ij}^m} \sum_{i=1}^{n} u_{ij}^m x_i \] .......................... (3.9)

Step 9: Calculate the degree of membership \( u_{ij} \) is the degree of membership of \( x_i \) in the cluster

\[ u_{ij} = \frac{1}{\sum_{j=1}^{c} \| x_i - v_j \|^2} \] .......................... (3.10)

Step 10: If \( \| U(k+1) - U(k) \| < \varepsilon \) where, \( \varepsilon < 1 \) is the termination criterion. The usual choice of \( \varepsilon \) is 0.001 then STOP otherwise, return to step 2
4. RESULT ANALYSIS

The existing system took 3 hours to rank and retrieve result for 300Kb URLs. And as the number of hyperlinks increases the processing time increases exponentially, that is a considerable amount of time. But the modified page ranking system took just milliseconds to compute ranking for URLs and retrieve results.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Number of URL Retrieved</th>
<th>Time taken in Milliseconds for the algorithm to calculate and retrieve rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>59</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>75</td>
</tr>
</tbody>
</table>

The time taken to retrieve results largely depend on the amount of system’s resources available to process data like the CPU, RAM and disk space, this results may vary from time to time and from one system to the other.

The results above has proven that developing a page ranking system without a facility to speed up the rank algorithm processing time for large web links will make searching activity very boring even for large domain network, when it comes to the web where Google says that the web now has 30 trillion unique individual pages by 2013, ranking of pages will take hours to deliver query result to the user. Ranking algorithm no matter how efficient, is mostly designed to calculate the page rank that is why to facilitate fast retrieval of the calculated rank value, and enable the system maintain scalability fuzzy c-means clustering is used. In this the time taken to process the Web Pages is so small. As the number of web links is increased, the time is not increased. So, this helps to improve the processing time of the Web links.
4.1 Implementation details
The system is implemented with an improved algorithm that takes into consideration both the in-links and the out-links of pages, and in addition it considers the page usage (number of visit to a page) and the content of a page to deliver quality query result.

5. CONCLUSION
Page-Rank computation time depends on the URL link structure and also the algorithm used for the computation, even though the page rank algorithm is highly efficient without the fuzzy c-means that retrieve the cluster that contain the required rank value calculated by the rank algorithm, information retrieval becomes time consuming. Fuzzy c-means clustering success in clustering the web documents to yield the best result in classification and fast retrieval is a milestone in this research work.

REFERENCES
Estimation of Missing Video Frame Block Using Bi-Directional Temporal Approach for Low Motion Sequences

A.D. Shelotkar
Department of Electronics Engineering, Sant Gadge Baba Amravati University, Amravati, Maharashtra, India
anishelotkar@gmail.com

P.V. Ingole
G. H. Raisoni College of Engineering and Management, Anjanagaon Bari Road, Badnera-Amravati, Maharashtra, India
prashant.ingole@raisoni.net

ABSTRACT

With improvements in network technology, demand for video streaming application is on the rise. In video streaming applications, the quality of service is usually not guaranteed to reduce delay. The side effect of this approach is that there may be loss of a packet during video transmission which may corrupt block of data or even an entire video frame. There are many techniques proposed to recover loss of macroblocks in video frame, our bi-directional temporal; block estimation approach guarantees it at minimal complexity. For each pixel in the lost frame, the proposed algorithm estimates missing block using reconstructed frame and the next frame. We also extend the proposed algorithm for second order prediction to improve the performance. Upon macroblock recovery, an averaging filter or median filter is applied to reconstructed block as a deblocking filter. In case of scene change, we estimate missing block based on next frame and neglect previous reconstructed frame. Experiments are carried with different YUV streams and compressed domain AVI videos. The experimental results show improvements in PSNR as well as visual quality.

Keywords: Error concealment, Data Prediction, Deblocking filter

1. INTRODUCTION

With improvements in wired and wireless networks, more and more users are demanding video services, including video streaming and video conferencing over the Internet. However, the Internet does not provide guaranteed quality of service (QoS). Traffic congestion usually result in the loss of data packets. In wireless networks, packet loss happens frequently due to multipath fading, shadowing and noise disturbance of wireless channels. Video transmission uses compressed video streams for transmission so that video data can be transmitted even with poor network bandwidth situations. A loss of packet over transmission in compressed stream introduces severe distortion because the compression algorithms use temporal and spatial estimation methods to improve compression efficiency. Therefore a single distorted block within a frame may lead to errors not only in present frame but also propagate error over several frames.

Many error resilience and decoder error concealment techniques have been proposed to control amount of error in reconstructed frame [1]-[8]. A simple error resilience strategy is to use feedback channels and request for retransmission whenever there is error. This is the most robust technique and the recovered data would always be correct. However, it involves halting decoding process till error block of data is received again. This is an inefficient approach in terms of delay involved in process. Another way to avoid errors is to embed error checks in encoded video bit streams and transmit over the channels. This method though avoids retransmission of video, it affects compression efficiency of the encoder and thus increased usage of network bandwidth. Hence, a set of post processing algorithms on the decoder side are proposed for error concealment. The advantage with decoder error concealment is that it does not require any change in encoding or decoding process.
It simply appends a post processing block which recovers erroneous data. Hence, there is no increase in bit rate or delay. Fig.1 shows block diagram for post processing of video sequence to recover loss of macroblocks. Therefore these techniques can be used in real time video applications like video-voice over internet and streaming applications [3]. Temporal error concealment technique uses temporal neighbors to estimate erroneous block of data. It utilizes previous frame and/or next frame to conceal errors in current frame. Most of the temporal error concealment methods assume that only a few macroblocks (MB) or slices in a video frame are lost. Typically, temporal reconstruction process recovers lost data with the help of motion field interpolation (MFI) [3].

However, using just one of the frame may not be sufficient in case of scene change during video sequence. In case of scene change, Mean Absolute Difference (MAD) between two frames is very large and hence the temporal estimation methods fail. Therefore in this paper, we propose an approach based on temporal error concealment using averaging and Gaussian filters with the scene change into consideration. The algorithm selects macroblocks from reconstructed frames and next frame. The estimation of missing block of data is done based on selected macroblocks, and then smoothing filters are used to avoid blocking artifacts in reconstructed block of data. This method usually produces a relatively high Peak Signal-to-Noise Ratio (PSNR) value.

\[
SSD_{\text{in}} = \sum_{i} \sum_{j} (I_{\text{in+1}}(i,j) - I_{\text{in}}(i,j))^2 \tag{1}
\]

Where, \(I_{\text{in}}(i,j)\) is current frame and \(I_{\text{in+1}}(i,j)\) is next frame. We apply adaptive threshold for detecting scene change based on SSD [10]. The threshold use is,

\[
T_{\text{th}} = \frac{\sum SSD_{\text{in}}}{N} \tag{2}
\]

Where

\(N\) is the size of SSD vector window use for calculation.

If the block loss happen in the frame which is not a key frame (frame after scene change) but having second frame after key frame then we use the first order bidirectional prediction as,

\[
IB_{\text{in}}(i,j) = \frac{IB_{\text{in-1}}(i,j) + IB_{\text{in+1}}(i,j)}{2} \tag{3}
\]

Where

\(IB_{\text{in}}\) represent lost block and \(n\) is frame index. If the loss happens in the frame which has two frame before and after then we extend our algorithm as weighted quadratic predication,

\[
IB_{\text{in}}(i,j) = \frac{k_1 * IB_{\text{in-1}}(i,j) + k_2 * IB_{\text{in-2}}(i,j) + k_3 * IB_{\text{in+1}}(i,j) + k_4 * IB_{\text{in+2}}(i,j)}{4} \tag{4}
\]

Where

\(k_1\) and \(k_2\) are coefficient of quadratic model. We chose coefficients such that \(k_2 > k_1\) and \(k_2 + k_3 = 1\).

If block loss happen in the decoding of residual frame (we do not consider the loss of side information of previous and next frame, which contain the motion vector information) of compressed video. We replace the damaged block with the content of the previous frame at the motion compensated location.

\[
IB_{\text{in}}(i,j) = \frac{IB_{\text{in-1}}(i,j) + u \cdot (u \cdot v - v) + IB_{\text{in+1}}(i,j) - v \cdot (u \cdot v - u)}{2} \tag{5}
\]

Where

\(u\) and \(v\) are the horizontal and vertical motion vector at loss block location calculated from the motion vector of previous and next frame motion vectors.
\[ u(t,f) = \frac{MVX_{x-1}(t,f) + MVX_{x+1}(t,f)}{2} \]  \hspace{1cm} \text{(6)}

\[ v(t,f) = \frac{MVY_{y-1}(t,f) + MVY_{y+1}(t,f)}{2} \]  \hspace{1cm} \text{(7)}

Where

MVX and MVY are horizontal and vertical motion vector fields inside information of compressed video.

Another approach to recover the block of data is to use spatial information instead of temporal. In this method, it is assumed that the blocks surrounding the missing block of data are reconstructed perfectly. However, it may not be always necessary that the spatial reconstructed data be correct always.

Therefore, to we propose a technique which uses previous reconstructed frame and the next frame to estimate the data. Fig 2 explains proposed first order prediction algorithm.

\[ H_{avg} = \begin{bmatrix} 1 & 1 & 1 \\ 9 & 9 & 9 \\ 1 & 1 & 1 \\ 9 & 9 & 9 \end{bmatrix} \]  \hspace{1cm} \text{(9)}

\[ H_{gauss} = \begin{bmatrix} 0.1096 & 0.1118 & 0.1096 \\ 0.1118 & 0.1141 & 0.1118 \\ 0.1096 & 0.1118 & 0.1096 \end{bmatrix} \]  \hspace{1cm} \text{(11)}

\[ a^2 = 5 \]  \hspace{1cm} \text{(12)}

\[ H_{gauss} = \frac{1}{(2 \times \pi \times a^2)} \times e^{-\frac{(x^2+y^2)}{2a^2}} \]  \hspace{1cm} \text{(10)}

\[ 3x3 \text{ Gaussian Filter} \]

Fig. 2 Proposed Block Recovery Algorithm.

Upon recovering the missing block, we use further improve estimation based on averaging and Gaussian filter to avoid blocking artifacts in reconstructed block.

We simply convolve reconstructed block with filter under consideration and obtain the final result.

\[ Y = X \ast H \]  \hspace{1cm} \text{(8)}

Where X is reconstructed block with averaging across two frames as depicted in Fig.2, H is filter to avoid blocking artifacts and Y is reconstructed block of data and ‘\( \ast \)’ indicates 2 dimensional convolution operation. Filter H can take either \( H_{avg} \) or \( H_{gauss} \) values as mentioned below.

The stepwise algorithm is as follows:
1. Decoded video sequence is used as an input to the algorithm.
2. Detect the video scene change using proposed algorithm.
3. Determine the block to be recovered in a given frame.
4. Estimate block using previous reconstructed frame and next frame either based of first order or quadratic prediction.
5. Apply smoothing filter to remove any blocking artifacts which may occur in the recovered frame.
6. Recovered data is smoothened by applying image smoothing filter.
7. Experiments are compared with averaging and Gaussian smoothing filter functions as mentioned.
8. Compute PSNR of smoothened frame.
3. **Experimental Results**

This section describes experimental results for the proposed algorithm. The following assumptions are made while conducting experiments, video sequences used for RAW video error concealment are of QCIF resolution at 30fps, YUV format and AVI, MP4 videos for compressed video error concealment. Fig 4 shows the original frame at top left, corrupted frame at top right, recovered frame at bottom left and the filtered frame at bottom right for ‘akiyo’ sequence. Similarly Fig 5 shows results for ‘forman’ sequence. Fig. 6 and Fig. 7 shows frame number vs PSNR graph for foreman and akiyo video sequence.

![Fig. 4 Results for ‘Akiyo’ Sequence.](image1)

![Fig. 5 Results for ‘Forman’ Sequence.](image2)

![Fig. 6 Frame Vs PSNR for ‘Foreman’ Sequence.](image3)

![Fig. 7 Frame vs PSNR for ‘Akiyo’ Sequence.](image4)

To show the comparative study we have used the algorithm given in [11], as it is conceptually similar to the proposed algorithm. Fig. 8 shows the concealment results for one frame using reference and proposed algorithm. Fig. 9 shows the PSNR comparison respectively.
4. CONCLUSION

In this paper, we propose a bi-directional temporal error concealment algorithm. The proposed method exploits the information from previous frame and next frame to estimate pixel and avoids blocking artifacts by smoothing filter function. We have applied the method on RAW and compressed video sequence and it clearly indicates that the method give comparative results as compare to existing methods in terms of PSNR and visual quality. Moreover, the method is also efficient in stopping error propagation. Future work includes to use spatial and temporal information adaptively to reconstruct lost pixel information.

Fig. 8 Results for Compressed Sequence (Bottom right is proposed and bottom left is as per algorithm in [11]).

Fig.9 Comparison between algorithm given in [11] and proposed algorithm.
REFERENCES


A User-Friendly Query Interface Based on Best Position Algorithm for Distributed Databases

C. Ugwu & M. Abuh
Department of Computer Science
University Of Port-Harcourt
Port-Harcourt, Nigeria.
chidebereugwu@yahoo.com, abuhnature@yahoo.com;

ABSTRACT

The need for a user friendly query interface that helps non expert database users that use database effectively in a distributed environment was identified as a gap to be filled. However, existing systems are still unable to provide a user friendly platform for querying databases without the need to type codes, and an obvious implication of these, is the reduced exploitation of the ability of database systems especially in a distributed environment, by non technical users. This paper adopts an object oriented methodology and presents an approach that overcomes some of these flaws by using the Best Position Algorithm (BPA), which is an efficient algorithm for the problem of answering top-k queries over sorted lists in a distributed database. Implementation of the system was done using Java Programming language and Microsoft SQL Server 2005 as the back-end and driven by JDBC API. The results were commonly needed queries fetched from a database and presented to the user just at the click of a mouse. Furthermore, the automatically generated query statement executed is presented to the user so as to educate and help build competence. These implies that users can now run queries and perform tasks on a database even in a case of complete ignorance of the underlying query technicalities with few or no manually written query, rather just at the click of a mouse button.

Keywords: User-Friendly Query Interface (UQI), Natural Language Interface to Databases, Best Position Algorithm (BPA).

1. INTRODUCTION

Natural Language Query Interface to Database (NLIDB) systems has made it easy to manipulate database systems without the need for the user to use formal query languages (Gabriel et al, 2013, Davis, 2014), such as SQL. Database query languages can be difficult to non-expert users and learning these formal queries takes a lot of time. Query interfaces are meant to support users in formulating a precise query against a database described by a specific data model. Queries are specified by means of special purpose query languages, where a query language is a set of formally defined operators allowing requests to be expressed to a database. (Kacprzyk, and Zadrozny, 2001). By executing a query, the user expects that the produced results extracted from the stored data are coherent with the intended meaning of the request. The most widely used database query languages have been programming languages which require knowledge about language syntax, technical background, and information of both the system application domain and its interaction mechanisms. Such languages do not help to understand the meaning of data, nor do they provide any guidance in satisfying the user’s needs. In general, they do not fulfill the requirements of user friendliness and ease of use (Oussama, 2001, Hallet, 2006).

But lately, there is an overwhelming need for non-expert users to query relational databases in their natural language using linguistic variables and terms instead of working with the values of the attributes. As a result, intelligent databases and interfaces have emerged, which provides expanded and more flexible options for manipulating queries.

2. RELATED LITERATURE

Our work has been inspired by a number of works available in the literature related to intelligent aspects of database systems. The field of intelligent database and information systems has achieved remarkable growth in the last few decades. Researches in the area of intelligent query processing interface in a distributed database, has started to increase the efficiency of retrieving and exchanging information between database applications and users, and thus have made the exploration of databases much more embraced. Benharzallah, et al., (2001), proposed an efficient query processing approach for semantic interoperable information systems, they also proposed a generic multi agent architecture that supports the approach.
The approach consists in the exploitation of intelligent agents for query reformulation and the use of a new technology for the semantic representation. The algorithm is self-adapted to the changes of the environment, offers a wide aptitude and solves the various data conflicts in a dynamic way; it also reformulates the query using the schema mediation method for the discovered systems and the context mediation for the other systems. Neelu, et al. (2009), proposed an intelligent layer for database which is responsible for manipulating flexible queries. Initially, the flexible queries from users in their natural language are submitted to intelligent layer and this layer converts the amorphous query into a structured SQL query. The shaped query is executed and the results are presented to the user. Afterwards, on the basis of results, feedback and the acceptance or rejection of the results are requested from the user. It enables the design of a knowledge based self learning system based the values obtained from user, which will aid the selection of appropriate SQL query, when a same flexible query is issued in the future. The experimental results demonstrate the effectiveness of the proposed intelligent database system.

Khayut, et al.(2014), proposed the data, information and knowledge based technology of Smart/Intelligent User Interface (IUI) design, which interacts with users and systems in natural and other languages, utilizing the principles of Situational Control and Fuzzy Logic theories, Artificial Intelligence, Linguistics, Knowledge Base technologies and others. The proposed technology of IUI design was defined by multi-agents of (a) Situational Control of data, information and knowledge, (b) modeling of Fuzzy Logic Inference, (c) Generalization, Representation and Explanation of knowledge, (d) Planning and Decision-making, (e) Dialog Control, (f) Reasoning and Systems Thinking, (g) Fuzzy Control of organizational unit in real-time, fuzzy conditions, heterogeneous domains, and (g) multi-lingual communication under uncertainty and in Fuzzy Environment.

In (Ndueso et al, 2014) An Intelligent layer for Database was designed which is responsible for manipulating flexible queries. Initially, the flexible queries from users in their natural language are submitted to intelligent layer and this layer converts the amorphous query into a structured SQL query. The shaped query is executed and the results are presented to the user. Afterwards, on the basis of results, feedback and the acceptance or rejection of the results are requested from the user. It enables the design of a knowledge based self learning system based the values obtained from user, which will aid the selection of appropriate SQL query, when a same flexible query is issued in the future. However, this requires users to formulate natural language queries in an organized manner, so as to enable the intelligent layer recognize, read the query, and parse. Another problem is the time taken to match the natural language queries to appropriate SQL commands, as well as the time taken to formulate such queries(Ben et al, 2014 and Ben et al, 2013).

Another problem is the requirement of using additional knowledge to extract meaningful information, the input can have many choices and it is not easy to choose the correct choice among target representations (one-to-many mappings), the complexity of mapping in NL sentences if you change a single word, the entire structure can be changed, which is called the quantifier scoping problem. Words such as “the,” “each,” or “what” can have several meanings in different situations production rules for the possibly introduced queries. Also there is another of the identification of tables required to build. (Nittaya K. and Kittisak K., 2012).

All these works have been major breakthroughs, but this has also created another complex problem as to how the natural language queries should be formulated so as to be parsed by the compiler as well as the right structure of such queries. This work eliminates such flaws by not allowing the user go through the task of thinking of how to ask questions or queries, but automatically generates the query for the user just by the click of the mouse. In this work, we solved some of these problems by designing a framework where users can access different databases in a server and run queries just by clicking the mouse. JDBC API assists in fetching all the tables and columns in a particular database server and displays the results to the user for selection. We are focused at building a bridge between database query technologies and non expert users in a distributed environment. The idea is to have a query interface that enables the users to access heterogeneous data sources by means of an intelligent agent (JDBC API) without having to write many queries using the best position algorithm. The query interface supports the users in the task of formulating precise and accurate query without an idea of the complexities and technicalities required to manually write such codes.

3. MATERIALS AND METHODS

In this paper, we adopted the object oriented model in developing the User Friendly Interface. The programming languages used was MS SQL Server 2005 and Java because of their robustness interoperability. The database connectivity and manipulations were driven by an intelligent tool called JDBC API. JDBC is a Java-based data access technology (Java Standard Edition platform) from Oracle Corporation, and we followed the best position algorithm (BPA) for top-K queries) (Akbarinia, 2007). In the existing system architectures, the system will check if user question has SQL built in functions by using semantic dictionary data if there exists, it will get corresponding function name to determine which function category it belongs to in the system, it covers some categories such as mathematical and statistics functions (Count, Sum, Max, Min, Avg, Mean, etc ). It searches for some words in user question and they are mapped into the semantic dictionary with corresponding word in lexical dictionary for example how many in semantic dictionary will be converted into count in lexical dictionary, as it already has predefined data in semantic and lexical dictionaries.
Though this system enables the querying process to be more user friendly, and eases the whole querying process, it does not completely eliminate the issues experienced by users in querying, rather it creates its own problem of knowing the format and structure of questions fed into the system for it to be recognized as tokens. It likewise follows a strict set of rules for querying, even though in natural language.

3.1 Model of the System

Our querying model includes four main modules: Database, Intelligent/Flexible Query Components, the Flexible Query Language Processor, and the Login/Dialog Component. Figure 1 depicts the conceptual model of the system and inter-relations of its main components.

As the user makes use of the system, he is first greeted by the Login/Dialog component which is responsible for the authentication of the user who is expected to have provided the correct credentials, and then the Flexible Query Language Processor then takes over after the authentication and connects to the remote servers in the network as well as clients hosting the database and retrieves the data structures and information on the host system, then passes on to the Intelligent/Flexible Query Component which contains two major subcomponents namely; Basic and Tables. The Basic along with its attributes, Domains, and Associations is responsible for connecting to Server as well as picking out all the databases on the server for selection as well as the tables in such databases, and then the Table subcomponent then selects the rows and columns on the tables presented by the Basic and presents to the user for querying.

In our proposed system architecture, we identify four main components of the system and their interactions with the Local Transaction Management System (LTMS) and Local Database Management System respectively. Our User-Friendly Query Interface operates at the application layer of the OSI model, the software is introduced to provide the interface with remote sites. The User Interface manager module is responsible for the translation of queries into global form if necessary, determines the location of the data referenced in the queries, and passes control to the Local Transaction Management system (LTMS) if the transaction is local only or to the Global Transaction Analyzer if the transaction needs access to remotely located data as determined by the JDBC API. This Module is also responsible for gathering all user results generated during transaction execution and presenting the results to the user and this actions are also executed by the JDBC API. Transaction Plan Generator (TPG) is the module responsible for generating an execution graph for optimizing the performance of the arriving transactions. The Global Transaction Execution Monitor is the module responsible for receiving the plan generated by the TPG and responsible for the initiation, execution, and integrity control (synchronization, reliability) of the transaction plan.

Figure 1: Model of the Proposed System
4. IMPLEMENTATION

To verify the efficiency of the proposed system, we conducted a simulation test of systems running MS server 2005, created sample databases, tables and data on each of the host, and deployed the proposed system for the network. For the wide area network, our university’s intranet was used. Laptops were used as nodes with each laptop signifying a host server. Because of the financial implications, we opted to telnet instead of more secured protocols like the secured shell (SSH). We were able to interface each of the databases on the host network servers, select available databases, and automatically select the tables present in the database, and could query the columns of data present in the tables one by one, and all at once as deemed fit all without writing manual queries, but just at the click of the mouse.
4.1 The flexible Query Interface Module.
Figure 4 shows Flexible Query Interface module. The FQI provides the user with the server name of all the servers in the system. From the list of server provided by the system the user can now select the required server. The server status will indicate connected immediately the user is connected to the server. All the created databases in the server will appear for the user to select the required database. From the FQI there is a button that list out the entire tables that are found in database. The user is required to select from the list of tables and FQI still gives the user an alternative to create tables when the desired table is not available. The user then executes query if the desired query is already written and there is also an alternative for the user to write his/her own query.

4.2 The Flexible Query Interface with the Query Result
Figure 5 shows the flexible query interface (FQI) with the query result. After successfully executing a query for queries that are often executed, you can save such query as a script file with the save script button for further execution. The execute query from script button allows you to execute queries that are saved on script file. After every successful execution of queries (e.g THE SELECT STATEMENTS) the result are displayed on the Result Set Table but for other queries like the DDL or DML, a message dialog box displays the success/error message.

4.3 Experimentations and Results

<table>
<thead>
<tr>
<th>Account No</th>
<th>Cust ID</th>
<th>Account Type</th>
<th>Branch</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>04225402</td>
<td>CST1</td>
<td>Corporate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00138644</td>
<td>CST2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00134520</td>
<td>CST3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00139101</td>
<td>CST4</td>
<td>Head Office</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00138846</td>
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<td>Current</td>
<td>NA</td>
<td>30000</td>
</tr>
</tbody>
</table>

5. DISCUSSION OF RESULTS
In table 1 the Result Set for the query (select*from accounts) was displayed by just clicking a button. The columns that were displayed include the account number, customer identity, account type, branch and balance. In table 2 the Result Set for the query (select*from ComputeProfit) was displayed by just clicking a button. The columns that were displayed include the account number, account type, profit and DateUpdated.

6. CONCLUSION
A user friendly interface for a distributed database for an efficient and flexible database query processing model has been developed. The model represents the first step towards the support of more diverse and richer set of queries and presents the techniques for flexible query processing. We also described the algorithms of query processing unstructured system to obtain high quality answers while minimizing the communication cost.
REFERENCES