The Design and Development of Real-Time E-Voting System in Nigeria with Emphasis on Security and Result Veracity

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The Design and Development of Real-Time E-Voting System in Nigeria with Emphasis on Security and Result Veracity

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Abstract — Elections are believed to be the key pillars of democracy and voting is one of the electoral processes that ensure the sustenance of democracy in any civil society. In this paper, we developed an electronic voting system, which will eliminate rigging and manipulation of results to its barest minimum, this problem is mostly associated with the manual system of voting. The implementation of electronic voting system in Nigeria will boost the integrity of INEC and the result they produce. The programs used to develop this system are PHP, MySQL, Java Query, CSS and HTML. These packages make the Graphic Interface User friendly enough for even those with little or no computer knowledge.

Index Terms — Biometric Security, E-Voting, Voting System, Database Security, Result Veracity, Real-Time System

I. INTRODUCTION

Elections are understood to be the key mainstay of democracy all over the globe and voting is one of the electoral routes that ensure the sustenance of democratic system in any civilization. Voting is the process that allows the general public or the people to choose their leaders and articulate views on how they will be governed. The veracity of democratic system is primary to the veracity of election itself consequently the election system must be satisfactorily secured to survive a range of fraudulent behaviours and must be sufficiently translucent and comprehensible that voters and candidates can accept the outcome of an election. Unsurprisingly, history is littered with examples of elections being manoeuvred in order to change their outcome.

Many parts of Nigeria have experienced setbacks, which have led to the destruction of both lives and property, simply because the rule of the game was not adhered to, and so political violence, unhealthy politicking have been the order of the day. People usually wanting to impose themselves on the voters, so they use all sorts of means to get into office. And this has continued to cause a lot of harm and has made the citizens poorer in spite of the abundance of natural and human resources in the country.

On May 29, 2009 Nigeria celebrated a decade of democracy. Many Nigerians said it was not worth celebrating, because our electoral system is a flawed exercise. Our political and electioneering process is branded with so many irregularities, ranging from ballot box snatching, stuffing of ballot boxes, political killings, using of political thugs to harass opposing candidates and finally weak Electoral Act. This mainly, is due to the fact that electoral processes in Nigeria are done manually and the result of such manual electoral process inevitably produces questionable electoral results.

Elections in most developed nations of the world with enviable democratic platforms has over the years been conducted electronically and in these countries little or no setbacks follow the results of such elections as they are seen to be free, fair and credible. The Nigeria's Independent National Electoral Commission (INEC) has since indicated its interest in using the electronic voting system for future elections. This decision has been as a result of series of accusations leveled on the electoral body by some political parties, for aiding a particular set of political party especially in the 2007 and 2011 general elections to rig those elections.

If the Nations Electoral Commission is determined to conduct a credible poll in the future elections, then electronic voting should be seen as a veritable option to achieve its aim. Electronic voting (also Known as biometric voting) has been effectively implemented in

some countries in Africa with Mozambique taking the lead. As the most reliable solution to electoral fraud and malpractice, Nigeria has been Africans largest needs to follow suit in order to overcome the problems of mass thumb printing of ballot papers by an individual, ballot stuffing, snatching of ballot boxes, impersonation of voters, errors due to manual collation of results and multiple registration. Since equity and fairness are symbols of a good democracy, if a real-time e-voting system is implemented "everybody will be happy at the end of the day as the citizens will see that the elections are transparent" and ill-motivated politicians will be helpless at certain level to rig elections, hence programs and policies that are people-oriented will be put in place.

An Automated Direct Recording Electronic Voting System (ADREVOS) was proposed as an improved electronic voting system for conducting efficient and credible elections in Nigeria that consolidates security as well prevent electoral fraud [1]. In another paper, a computer-based e-voting system (Automated Voting Machine-AVM) for future election in Nigeria. The system imitates the automated teller machines (ATMs) used by financial institutions for financial transactions [2].

The rest part of the paper is organized as follows: section II explained some related works; section III covered materials and method; section IV deals with results, while section V discussed about the conclusions and recommendations before the references of the research.

II.   BASIC CONCEPT AND RELATED WORKS

Nigeria is a federation of 36 states with a federal capital territory and it has 774 local governments, about 8,800 registration areas, 111,119 polling units, senatorial districts, federal constituencies, and the state constituencies. The general observation is that conducting elections that are free, fair, peaceful and credible in a country such as Nigeria given its size, large population, terrain, and ethno-religious diversity is a difficult assignment even under normal circumstances [3]. A TreeMap based visualization technique was proposed to monitor in real-time the distributed balloting and voting processes. It was proved that TreeMap algorithms can be configured and deployed on the central server to monitor effectively the voting transactions in real-time and hence enable transparency [4]. In another research, the security issues associated with remote internet voting analyzed. In particular, the research examines the feasibility of running national elections over the Internet. The focus of this research was on the limitations of the current deployed infrastructure in terms of the security of the hosts and the Internet itself. It concludes that without appropriate security measures, internet based elections can be a major challenge [5]. An E-voting prototype called improved DynaVote e-Vote protocol was designed to protect the counter from anomalies associated with counting impersonated votes (multiple votes) in the

same election. This was achieved by introducing biometric fingerprint and pseudo voter identities (PVID) encryption for each voter during voter registration via online or data mining of population data containing fingerprint biometrics. Furthermore, fingerprint reader and RSA public key cryptography is used in PVID to eliminate counting impersonated votes. The performance results showed that improved DynaVote e-Vote protocol is more reliable, eligible, and accurate, and protects voter privacy against other e-Vote protocols [6].

One of the most important government services like elections became a severe pressure on people involved in that process, according to many constraints that must be applied to the beneficiaries of this service and which are divided into two parts, *candidates* and *voters*. Voting is an efficient method for the public to show their opinion about a given topic or issue [7, 8]. The traditional election is normally held under the supervision of the government officials to assure the right application of the rules during the election process and to ensure that only eligible voters are permitted to join the election process avoiding any kind of forgery and the attempts of multi-voting. In addition, the process of human supervision over the election process requires a lot of efforts and money in order to achieve the desired level of privacy, security and trust. Moreover, when the election is done, another problem appears which is vote checking and counting. This type of election is considered as a time consuming process and its accuracy is always distrusted. The whole world is moving on toward the trend of e-voting. E-voting systems are expected to be the solution for the weakness in traditional voting systems. The use of computer networks and modern state of the art cryptography technique to build e-voting systems is expected to produce a voting system which confirms that only people with the right to vote are able to cast a vote, emphasizing that every vote cast is counted only once. An ideal e-voting system should allow the voting process to be available on a public communication channel such as the internet, which will encourage more voters to cast their vote remotely and increase voter participation. With the help of the internet, voting can be done on workdays. Even citizens abroad can cast their vote. E-voting must deliver a very high degree of security such as privacy and Integrity.

A reviewed was made of some of the problems and challenges of organizing and conducting an Election using the traditional Open Ballot System (OBS) with case study INEC, Kaduna. And after the review of the manual system and electronic voting technologies, the project focused on the question "Is the internet voting sufficient for our voting processes" and the work concluded that it is relatively impossible to develop an e-voting system that will satisfy all INEC specification of an e-voting system. Then, developed an e-voting system that is web based and also advised that before the implementation of the system, the entire system should be reviewed by INEC to ensure that it meets with

certain standard of the INEC specification of an e-voting system. The work also identified and recommended that every citizen should be issued a citizen/national identification with which he/she can be uniquely identified, which will help in voters authentication. The research concluded that there is no doubt that a comprehensive electronic voting system will enhance the standard of elections in the state and the country at large, and that the veracity of all the people involved in the process determines the integrity of the system and the whole process and despite the potential advantages offered by e-voting, care should be taken as it may become a source of subversion rather than improving the current system [9].

Also another review was made of some of the problems associated with electronic voting system and proposed an architecture that attempts to minimize its drawbacks while taken into consideration the social aspect of the populace and technical constraints in achieving a real e-voting system in Nigeria [10]. The architecture puts more emphasis on usability and data security while taking into consideration the highly decentralized nature of voting polls as well as the real time response of voters, the work also stated that the results of the web-based application implementation shows the great accuracy of the architecture in achieving successful election. However due to constraints associated to electronic voting system, the project recommends that INEC should review the standards of IT infrastructure in the country and develop more secure software before embarking on e-voting. The research places more emphasis on thorough review on the implementation of e-voting so as to address issues associated with its implementation in Nigeria. Recommendations were made on how to instantly update the election results visibly on the e-voting system [11, 12]. This will help to avoid manipulations of results by any individual or party, as this will increase transparency and integrity. A proposal was made on a new e-exams system that uses data encryption in order to protect the questions sent to the e-Examination centre through the internet or intranet and a biometric fingerprint authentication to screen the stakeholders [13].

III. MATERIALS AND METHOD

The design and implementation phase of this e-voting application development was concerned with the design of proposed system using unified modeling language (UML) and the translation of the design into the desired design specifications into source code. The primary goal of the implementation is to write the source code and also that conforms with the specifications. Basically in this research, PHP, MySQL, Java Query, CSS and HTML were used to design a user friendly interface (UFI) because they are the more appropriate and most preferable programming language used for designing web applications. The two major users in this project are

the *voters* and *administrator*. The designs UMLs are listed in Figures 1, 2 and 3 below.

The main modules in this real-time e-voting system are:

A. Registration process (voters card and print)
B. Ballot design module
C. Database Administrator module
D. Voting module
E. Real-Time Live Results module

A. Registration Module

This module is for the voter, where he/she must first register his/her details first into the registration form, fulfilling all the required specifications. The required fields are; First name (CHAR), Middle name (CHAR), Surname (CHAR), Sex (BOOLIAN), Date of birth (DATE), Phone numbers (INT), Local government (VARCHAR), State of origin (CHAR), Occupation (VARCHAR), Locale government to be registered (CHAR), User name (CHAR) Confirm username (CHAR), Email (VARCHAR), Address (CHAR) and Picture upload (jpg, gif, bitmap and maximum size of 5MB).

If the validations are valid then only the information get registered. Once the voter gets registered he/she is provided voters identity number (VIN) on the voters' card which would be printed out and be used in case of password loss.

B. Ballot Design Module

This feature is provided for the administrator, where ballot can be setup i.e. inserting candidate names into the ballot for respective categories (electoral position). The administrator can also update any candidates' profile or information by either editing or deleting information for respective categories of the election. After editing the setup the administrator can post the ballot for voting.

C. Database Administrator Module

Administrator has the privilege of viewing registered voters and editing their information, searching for a person (registered voter) by entering his name or VIN, can view the details of all voters who have registered. The administrator is also provided with the feature of viewing the information of voting i.e. numbers of voters, the all error log, view live results, though voters also have the privilege to view live results as the voting is taking place, which reduce the tendencies for rigging.

D. Voting Module

This module is for the voters, where votes are casted. After a voter has registered, a password is sent to the mail of each registered voter. During the voting, on the voting interface, voters are required to fill in their username and password correctly, which automatically takes them to the voting proper. And once a voter has cast his or her vote for all categories i.e. for Governor and Local council elections, a voter cannot go back on this page to cast a vote again.

E. Live Result Module

This module is developed for the voter, where he/she can view the results of the respective categories live immediately a vote is cast and this vote counts appears on top of the homepage of NSEC (Niger State Electoral Commission).
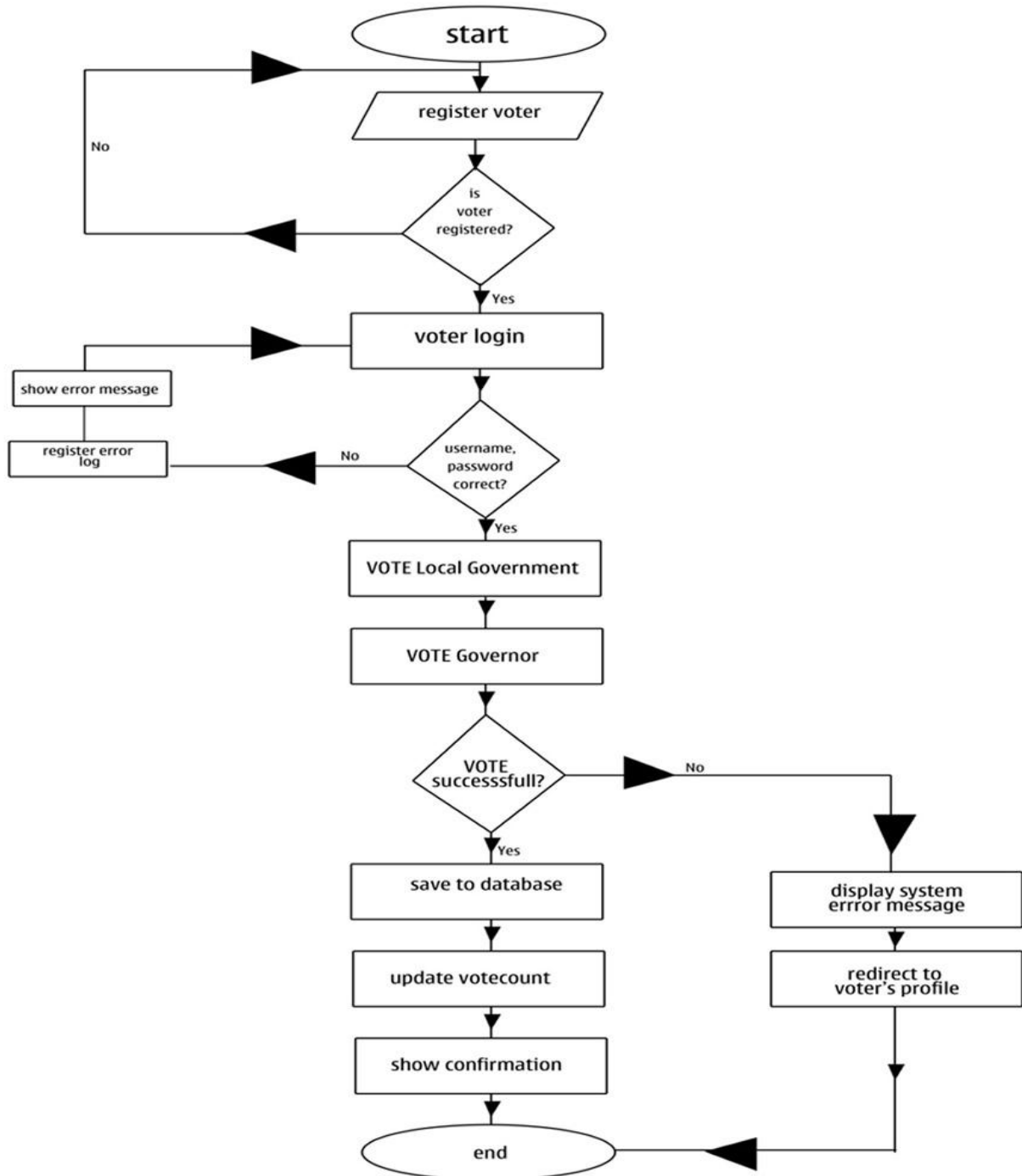
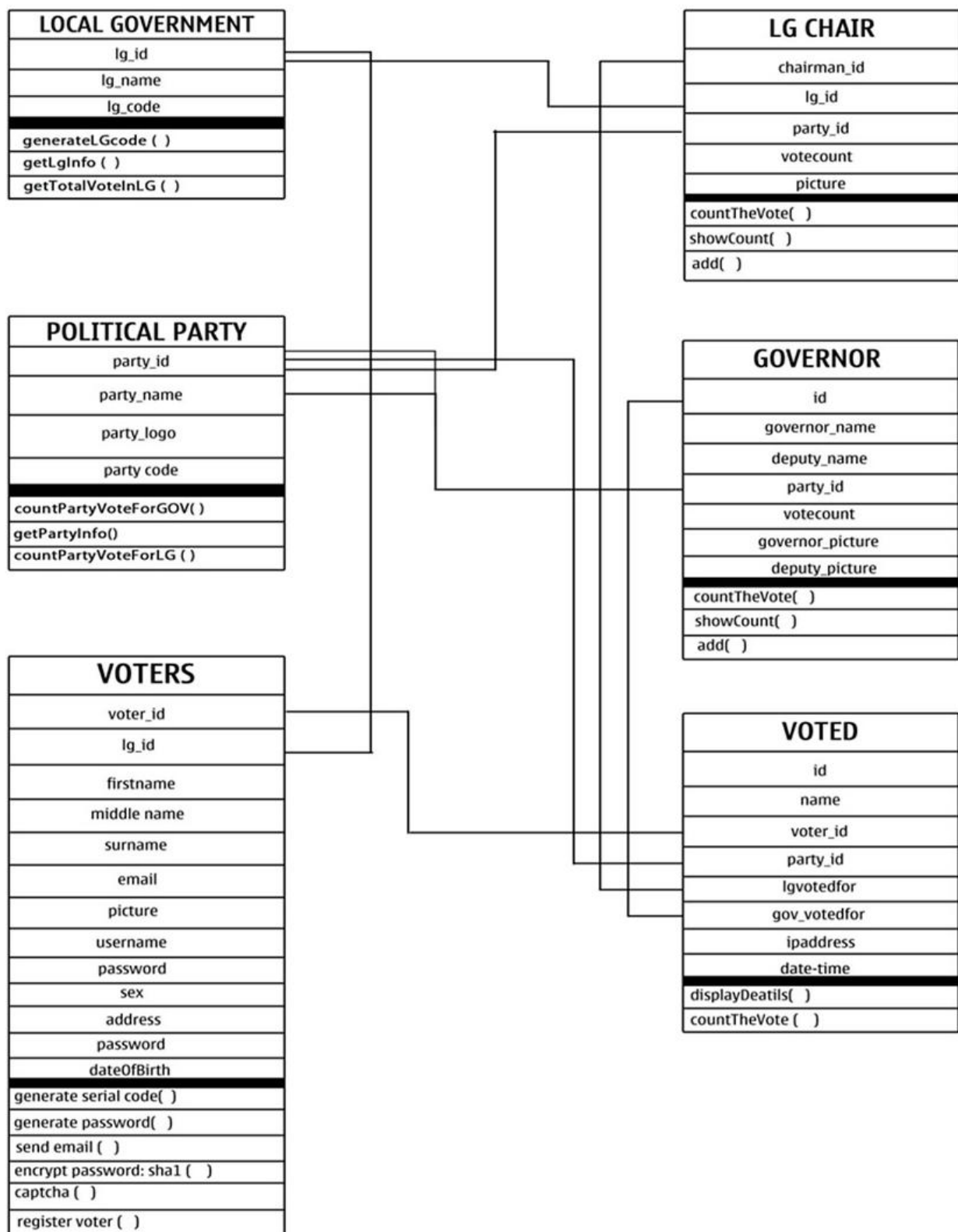

Figure 1: Secure E-Voting Flowchart

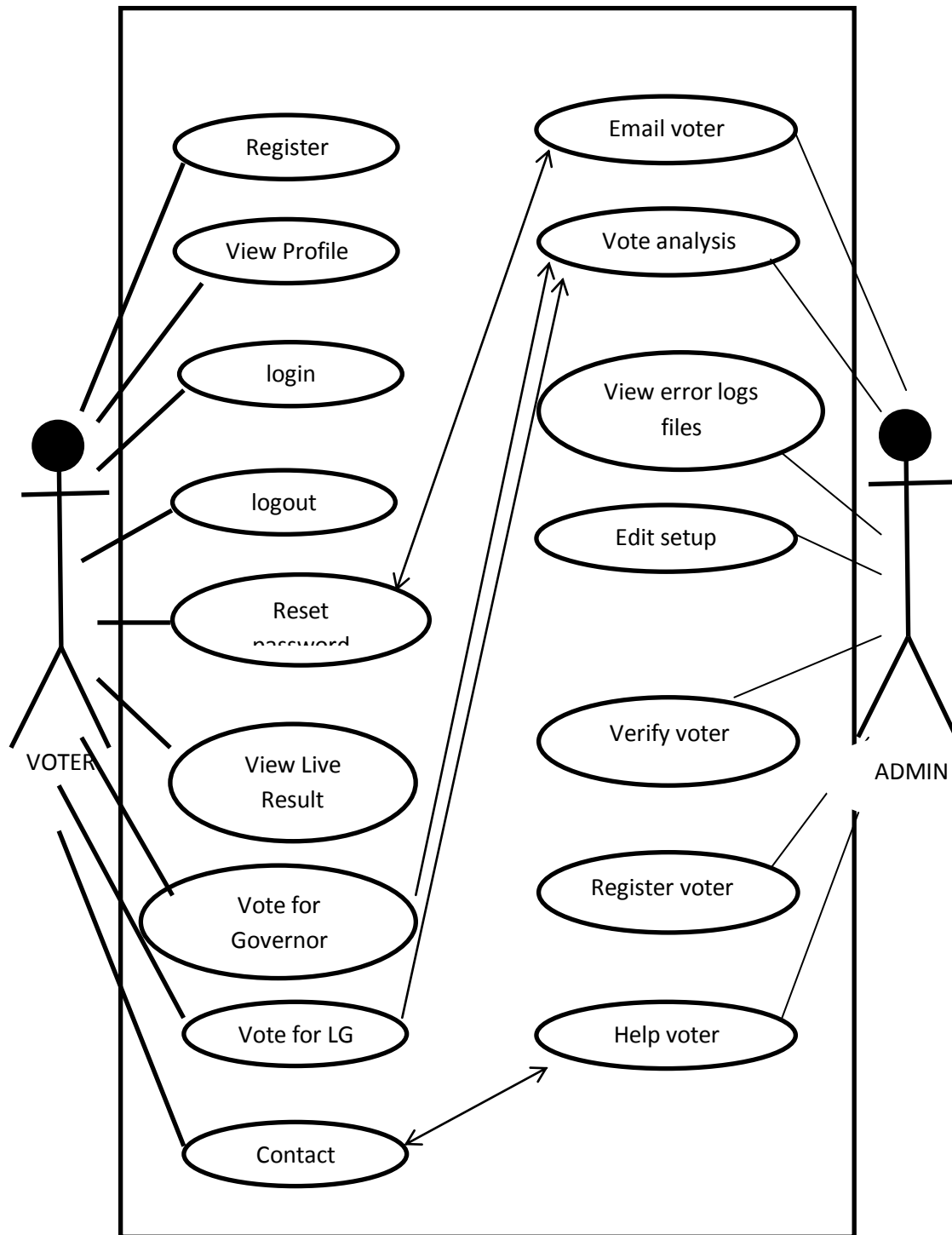Figure 2: Class Diagram of the proposed e-voting Registration System

e-VOTING APPLICATION

Figure 3: Use-Case Diagram Showing the Links between a Voter and an Administrator.

IV. RESULTS

System implementation and testing are two important phases without which the system cannot be released for use. Testing is vital to the success of this program. System testing ensures that all processes are according to specification. The logical and physical design is continuously examined to ensure that test data are verified for correctness and accuracy. During testing, two kinds of errors are likely to occur; they are Syntactic errors and Logistical errors. Syntactic errors occur when a program statement violates one or more rules of the language in which the program is written, these errors have to be corrected before the program is finally executed. The compilation of the program does not show any error if syntax errors are corrected. But when the program is run, and the desired output does not appear this is due to logical errors. These errors

occur due to incorrect handling of data, improper sequence of program statement, etc. These errors can be corrected by tracing the program, asking the program to display a number of message statements. Different modules would be tested individually and are made error free. The implementation and testing results of the proposed e-voting system are presented in the figures 4 - 11 below.
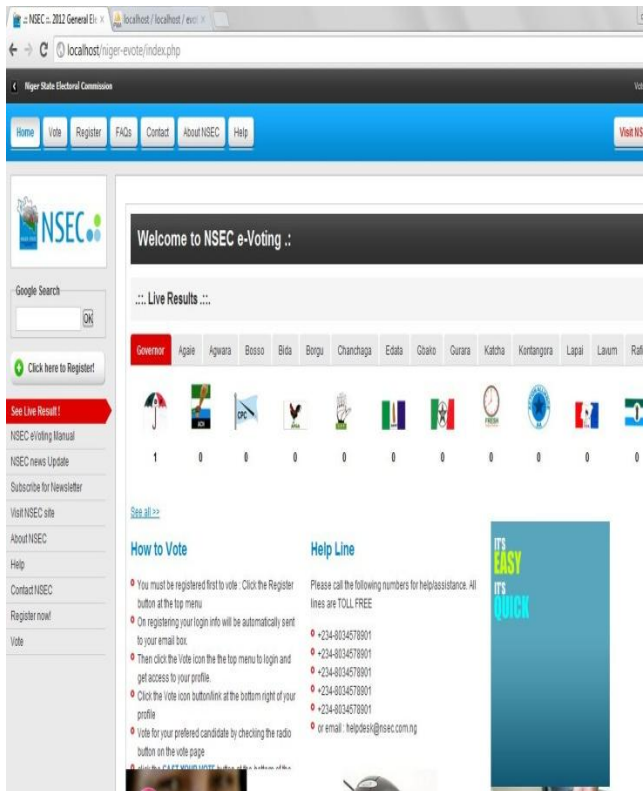
number of voters and the number of people that have voted for each categories in the election(view live results) and edit error logs.

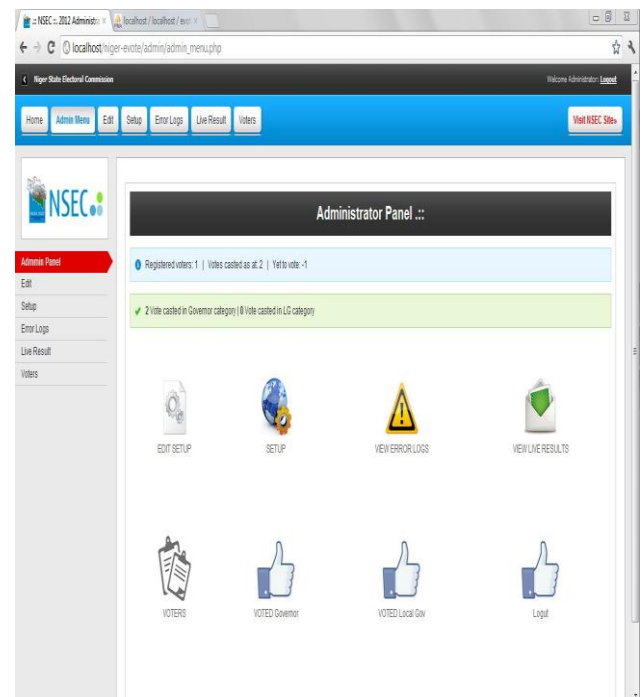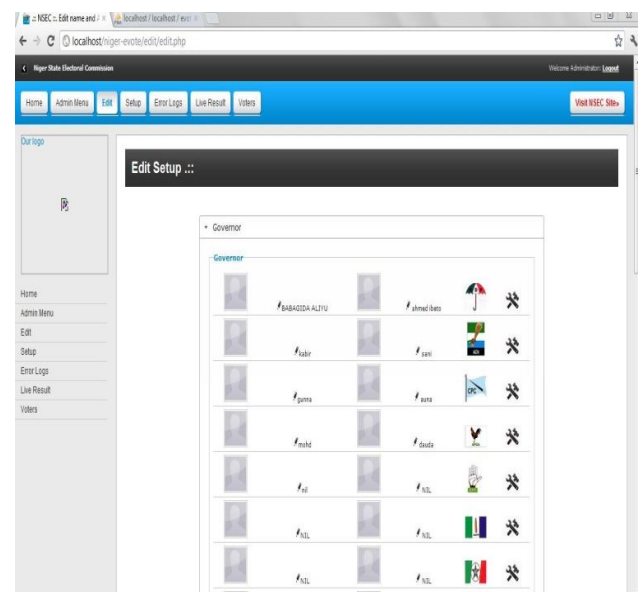Figure 6: Admin Panel

Figure 4: Home Page of the e-voting Interface (Users Interface).

Figure 7: *Candidate Registrations Page* showing list of Governorship Candidates and their Different Political Parties.

Figure 5: Administrator's Interface

Administrator panel here the admin can edit or setup the ballot for voting, the administrator can view the
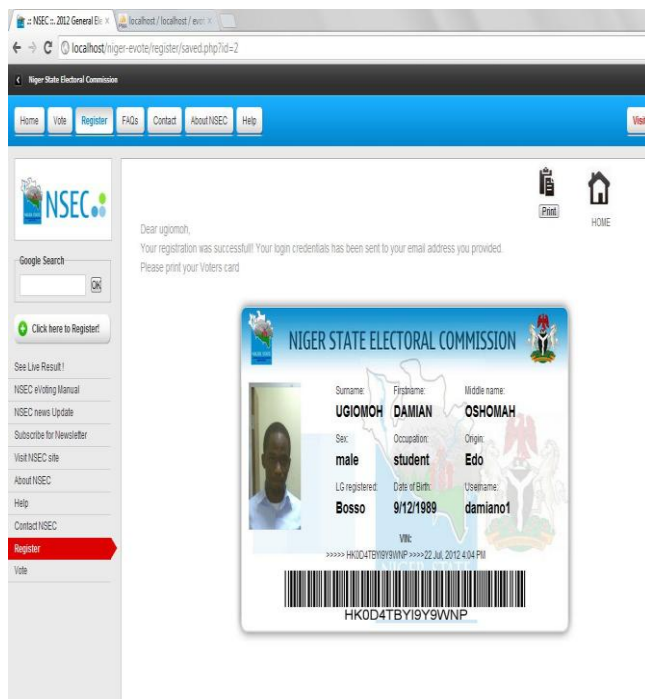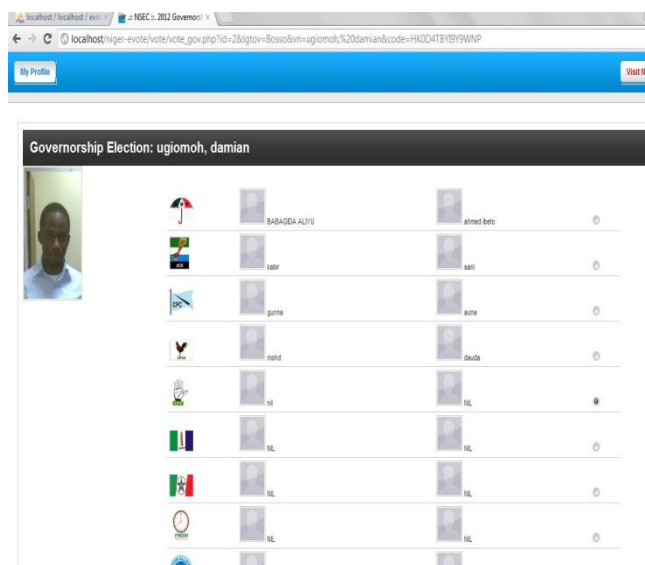
Figure 8: *Voter's Card* after registration.

Figure 9: Governorship election interface.

Live Result Page

When you through with casting your vote, you can click on "**see live result**" from the left corner of the page you notice with the increase in bar on each candidate from each party this is for the governorship election.
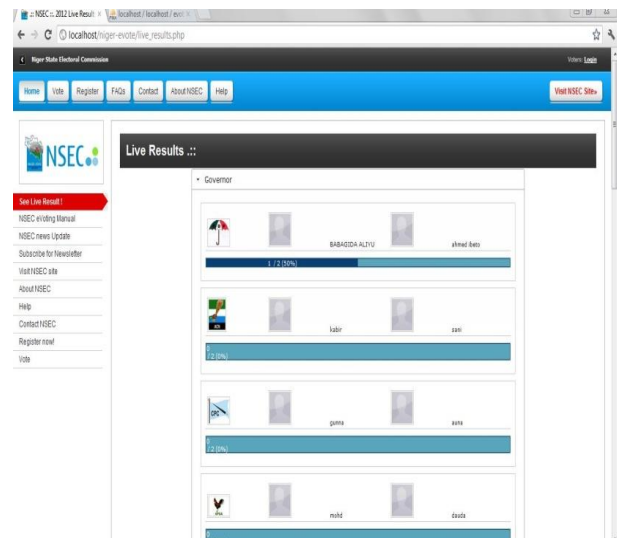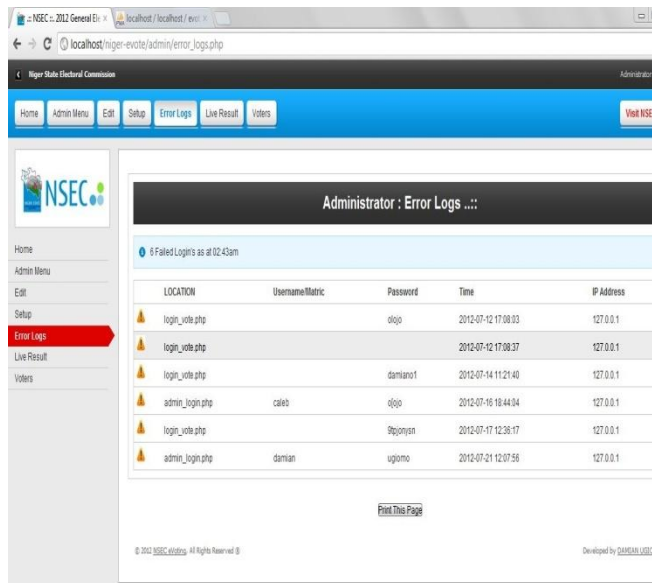

Figure 10: Real-Time Live Results

A.   Security Features Built-in in the System

1.   Error logs: Allows the administrator to see all login error events performed by user including their IP addresses which can be used to track down intruders or hacking attempt as shown in Figure 11 below.

2.   Password authentication: this is another good security features for checking all unauthorised attempts.

3.   Authentication of session and session timeout has been provided to prevent session hijacking.

4.   Password has been hashed (One way encryption) as shown in Figure 5.

5.   Voters IP addresses are recorded at every point in other to trace if an attack occurs.

6.   Site root files are authenticated to prevent cross-site scripting (XSS).

7.   Check bounds and validation has been incorporated to prevent SQLIA.

8.   System ensures that voter's password is 8 characters or more.

9.   System also ensures that the username entered by the voter during registration is 8 or more.

10.   On casting vote, the system encrypts the vote record till it enters the database.

11.   System does not at any time show voter's password in plaintext.

Figure 11: Error log page.

V.   CONCLUSIONS AND RECOMMENDATIONS

After much investigation and research carried out on the manual method of voting, it was observed that a lot of problems and inconsistencies that result from the manual voting method has led to serious manipulations and rigging of the process, which in turn causes conflicts and disagreement among the people. That is the reason why we proposed the adoption of electronic voting system which is more secured than the manual voting, so as to avoid future reoccurrence of disagreement amongst the people. Overwhelming evidence internationally, has shown that electronic voting system can guarantee a credible and reliable election, with results produced in real-time and without any possibility of interference with the election results. This research work has therefore come as a platform to propose an electronic voting system that will place our democracy on a path of success. In a whole, this research seeks to increase the efficiency of voting process and the image of the independent national electoral commission INEC.

In conclusion, this research has analyzed, designed and implemented how an electronic voting system would be of great benefit to Niger state and Nigeria as a whole which has been chosen as the case study for this research. However, this system must be carefully planned and implemented so that it can bring about a free and fair election. The hardware and software to be used for this system must be carefully engineered to avoid unnecessary breakdown. The human resources i.e. the poll workers who will be in charge of the system must be properly trained. Finally, the law should be amended to at least two years before the elections, so as to enable adequate public enlightenment for the people to be aware and be prepared for the process.

After a lot of research work carried out, which brought out the challenges with the manual method of voting, we are certain that the challenges which have been made known with the help of this research could be solved if electronic voting is adopted. Therefore, we recommend the followings: INEC should review the standards of ICT infrastructure in the country and develop more secure databases and networks before embarking on e-voting; there should be adoption of distributed encryption techniques for the purpose of secured data transmission; there should be use of biometric capturing devices, which will serve as a means of voter's authentication; there should be adequate and proper public enlightenment before the system is fully implemented. Finally, we also want to recommend that more research should be carried out on this area.

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