

Design and Implementation of Electronic Ballotting System; A case study of Nigeria

Steve A. Adeshina, Lukman E. Ismaila , Kaltume U. Ibrahim and Adegboyega Ojo

Abstract—Elections have been found to be a panacea for good governance. Governments become accountable when voters are allowed to choose who represent them. Traditional manual based ballotting system have been shown to be susceptible to elections malpractices. This is apart from the huge financial and other costs associated with manual ballotting. This work addresses the above issues by designing and implementing an Android tablet based Electronic ballotting System. An android-based application has been developed using android programming kit. An electronic ballot paper was simulated using a Graphical user interface (GUI) on a touchscreen device to eliminate the use of keyboard and mouse to avoid complications for voters. At the conclusion of polling, results are displayed. An electronic based Voter Verified Audit Trail (VVAT) was implemented to ensure recount is possible where necessary. Results of tests shows that usability of the system is high while accuracy have been shown to be better and more cost effective than a manual ballotting system.

Index Terms—Polling Unit; Electoral Management Ballot Paper; Voter Verified Paper Audit (VVPAT); Electronic Ballotting



1 INTRODUCTION

An election is a formal decision making process by which a population chooses an individual to hold public offices. Elections have been the usual mechanism by which modern representative democracy has operated since the 17th century. Elections may fill offices in the legislature, sometimes in the executive and judiciary, and for regional and local government. This process is also used in many other private and business organizations, from clubs to voluntary associations and corporations.

The universal use of elections as a tool for selecting representatives in modern democracies is in contrast with the practice in the democratic archetype, ancient Athens. As the Elections were considered an oligarchic institution and most political offices were filled using sortation, also known as allotment, by which office holders were chosen by lot [1]

Electoral reform describes the process of introducing fair electoral systems where they are not in place, or improving the fairness or effectiveness of existing systems. Psephology is the study of results and other statistics relating to elections (especially with a view to predicting future results) [2]

This work is intended to help developing nations conduct free and fair elections by implementing an electronic ballotting system. This is an Android application which will replicate the ballot paper to the intended voter. The uniqueness in this work is the fact that it strives to replicate the ballot paper as much as possible. This is to the intent that illiterate users who vote by looking at symbols of political parties can still perform their franchise. It also implements an electronic based an electronic Voter Verified Paper (Electronic) audit. This makes recount possible in the event of a dispute. The objective of this work is as follows: The objectives of this thesis are as follows:

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- To develop an android/tablet electronic ballotting system.
- To design a user (technical) customizable Ballotting system.
- To design Graphical User Interface using Android APK
- To Display the result and prepare the result

in a mode that is ready for electronic transmission

- To determine how the present system can be improved upon.
- To implement electronic Voter Verified Paper Audit Trail (VVPAT).

2 RELATED WORK

Election is a key component in democracy because that is how most of the leaders are elected. G.O. Ofori-Dwumfuo *et al.*[3] carried out research to device an electronic voting system. Paying good attention to system security, their work is intended to avoid the use of ballot papers, punched cards and other mechanical voting system. Voting is the process of casting ballots to select desired candidates for a position therefore they have to be transparent, secure and fair which are requirements for a successful election process [4]. Conducting free and fair elections is a major problem in most developing countries [7], they experience issues like ballot box snatching, coercion and violence because of insufficient security measures put in place. These fraudulent occurrences can easily weaken the confidence of the voter and support of the democratic system [6]. In Nigeria today we use the open ballot system where voters go through the election process life cycle in stages which are: accreditation process, voting, counting and result announcement. The accreditation process is done using a card reader to verify that the voter was registered, then a ballot paper is presented to the voter which he takes to the voting booth to vote. The voters thumb prints against desired candidate, then the ballot paper is folded in two and dropped in the appropriate box in the presence of the officials, party agents, other voters and security personnel [5]. Because of the high illiteracy rate in the country this system can bring about high number of invalid votes, because of the thumb printing method. It can be difficult for some to fit their thumbprint in the space provided without encroaching into another party's space or they could even vote outside the space provided totally, which will invalidate the vote also the process of folding the ballot paper before the ink dries which can smudge into another space. In the 2015 presidential general elections 844,519 out of the 29,432,083 cd votes were considered invalid [8]. The Independent National Electoral Commission (INEC) is the body that regulates elections in Nigeria, they are constantly looking for ways to make the elections and voting process a success.

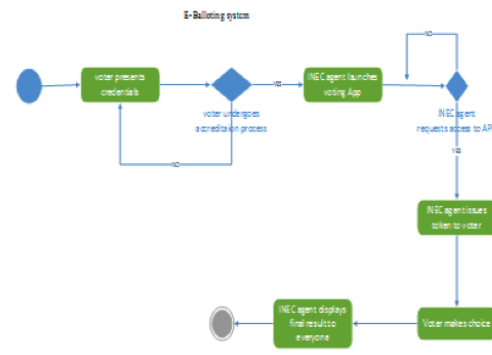


Fig. 1. Systems' Process diagram

During the 2015 election, voters had to be accredited first then later went back for voting which was quite tiring as there was limited automobile movement. Several problems were also faced which included manual counting error and multiple voting. E-voting is aimed at improving the outcomes of challenges by addressing the challenges faced using the traditional method [15]. M. Volkamer *et al.*[20] propose a vote casting device that does not store votes but only prints a summary of the selection voters made at device. His work is similar to what we are trying to achieve with the E-balloting system but we are well focused on use of a simple android application to do this. We also agree with the claim made by H. Gllpunar [21] on the impact of ballot paper design on voter choice.

3 METHODOLOGY

3.1 Requirement Analysis

A this stage of the work, some observation and necessary interview on how elections are generally carried out in Nigeria and also to give an understanding of how a system like this is supposed to work a diverse environment like Nigeria. A closer look at past cases of election process mismanagement gave clear idea on potential threats to the proposed system. A typical ballot paper was obtained from INEC website.

3.2 System Diagrams/Designs

The design implemented various diagram in other to capture the dynamic behavior of the systems under various situations.

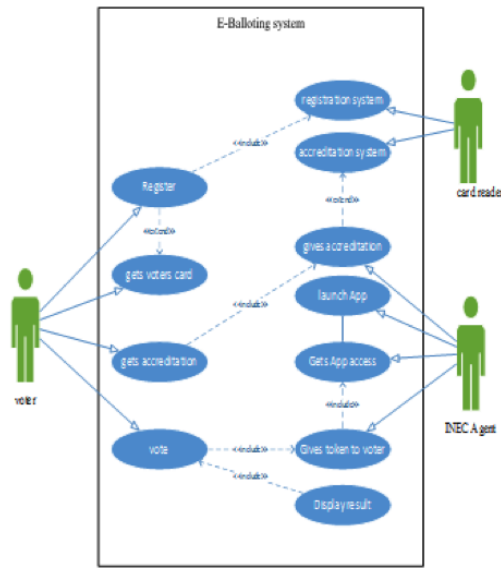


Fig. 2. Use case diagram

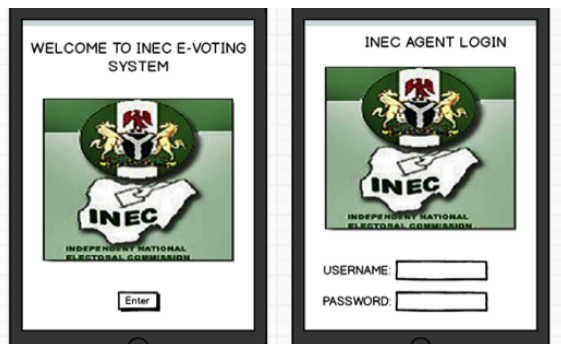


Fig. 3. User login page

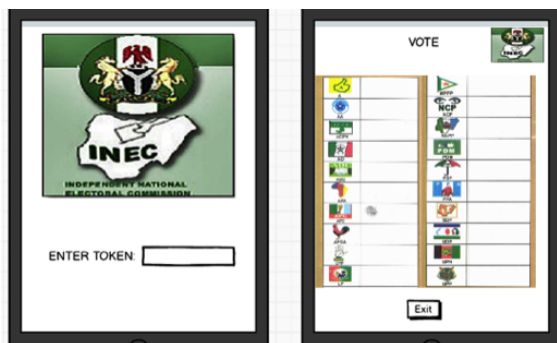


Fig. 4. Token and Ballot page

4 SYSTEM DESIGNS AND IMPLEMENTATION

The design of the proposed android E-Balloting application: the figure.1 and 2 above shows the layout view of the proposed android application.

4.1 Android Application

We used android Studio Android Development Toolkit (ADT) for the application development. The design procedure is as follow. Algorithm For Android application Development (E-Ballot Paper)

- Setup Android studio
- Create new project
- Test run to see if project was created successfully else repeat step 2
- In the project directory go to res folder and select layout.xml file
- Design the user interface with the xml file and assign id to interface components
- Initialize variable for xml components using the relative id in the MainActivity.java file
- Test run to adjust error and repeat step 6 if needed
- Run the app on a virtual device or a real device
- Generate Android application package (APK) file for the android application.
- Generate Android application package (APK) file for the android application

4.2 E-Voting Process

The various user interfaces provided to users for data input that will be used by the system or application in processing output result.

4.3 Output Screens

The user interfaces where processed user inputs are show in form of response or feedbacks.

4.4 System Cost Benefit Analysis

Currently there are about 119,973 polling units in the country to cater for about 73.528 million registered voters. According to Vanguard, it was said that it would cost INEC about N9billion to print ballot papers for the elections, N6billion to a foreign firm for the presidential and gubernatorial and N3billion for the national assembly and house of assembly. From the speculations of the cost of printing ballot papers, it means such costs will be incurred every four years for new elections as compared to a one-time purchase cost of the android devices.

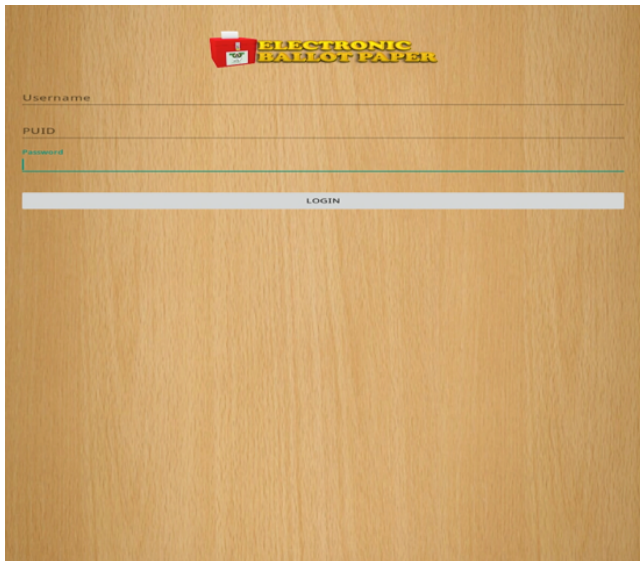


Fig. 5. Implementer Login Screen on an Android Tablet

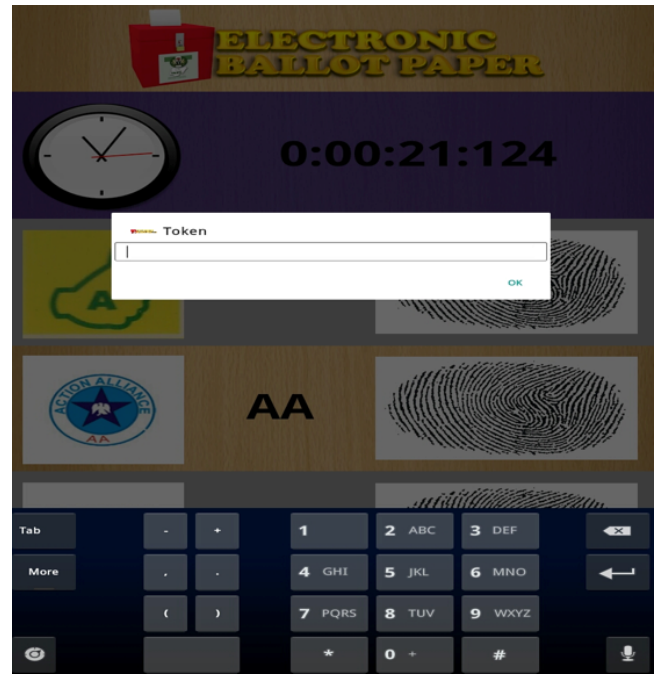


Fig. 7. A request for token after a voter confirm his/her choice and before anyone else can vote

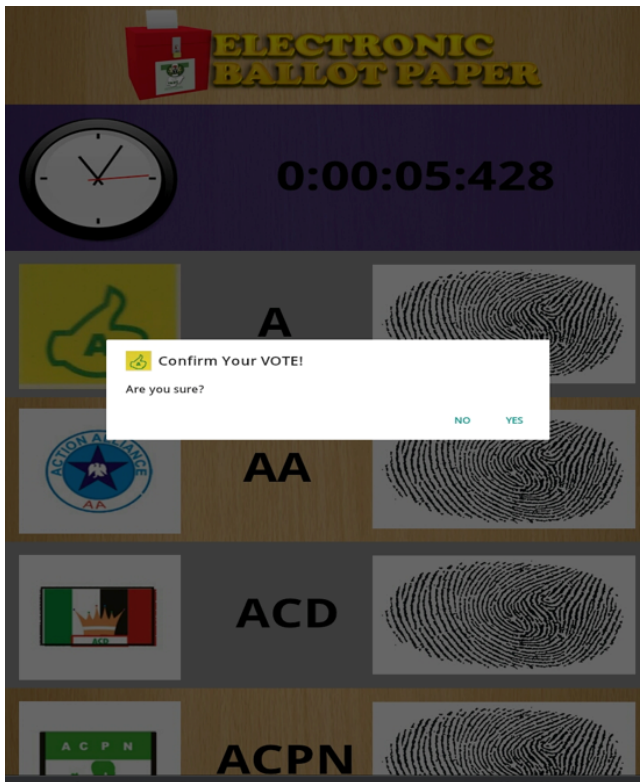


Fig. 6. Dialogue to confirm Vote selection

During the last elections every polling unit had at about 4 adhoc staff.

As compared to the purchase of the device which is a one time cost of say N10,000 per device which will sum up to N1,199,730,000. This could even come out cheaper if the electoral body goes to the manufacturers direct instead of buying off

the market. The only recurring cost will be training of staff which with the application less hands will be needed and also security personnel. System Security The E-Balloting System has a security system designed to help issues that may arise during voting process. The agent will be informed of all hot keys in the application.

4.5 System Evaluation Important features of system Security

GPS: The system is equipped with a Global Positioning System(GPS) feature which assist in retrieving the location where votes are carried out and confirms that the location is within the valid area that correspond with the voting point identification.

Timer: This timer is design to run as stop watch from the voting commence to when it officially closed.

Status: System status can be valid or invalid. An agent can deliberately make the system invalid in case of hijack at the polling point by entering the next token in reverse order when requested by the app.



Fig. 8. Selection display to voter after confirmation.

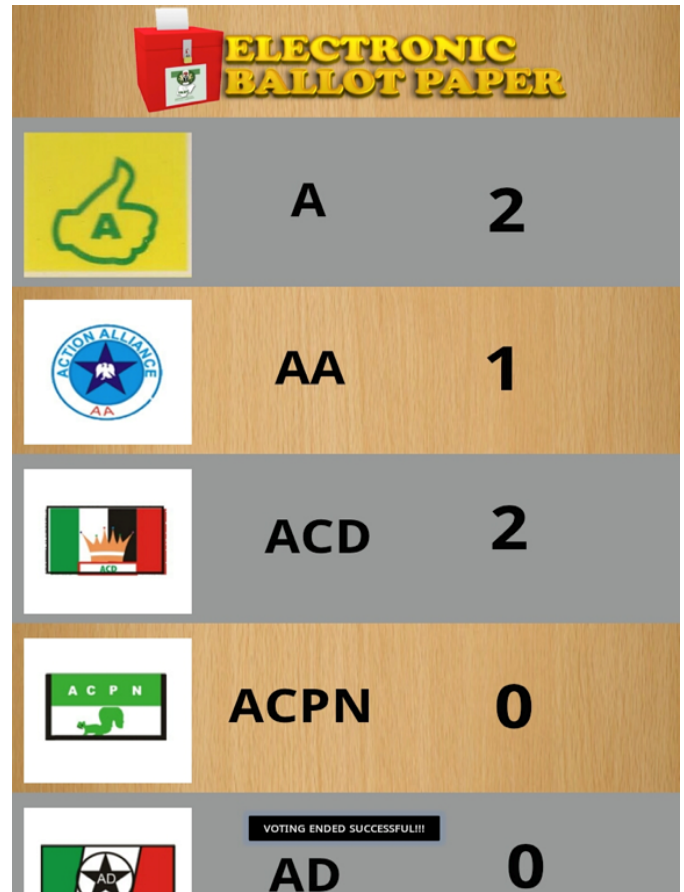


Fig. 9. Result display of individual party vote count and Total Vote count at a polling point.

5 SYSTEM EVALUATION AND EFFECTIVENESS ANALYSIS

5.1 Android E-Balloting application

The tables below show the form format for android application usability test.

Alpha Testing: Android studio kit was used to debug the program to check for any bugs. Additionally a test was run to confirm that the program was bug free. It was given to a software developer to check and it also came back okay. Recovery Testing: The system was tested to see if it can easily recover if it stops unexpectedly and if it will clear up previous votes or not. It was tested by not entering anything when a dialog box comes up that either username or password needs to be entered, ok was just clicked and the application exits. When it was logged into again, voting continued and at the end it totals the previous votes before the exit and the ones after the re-login. Security Testing: this is to verify that the security setting put in place incase of any malpractice is working properly. This is done by entering the token in reverse order which still allows voting to continue but when the voting process is over you can confirm by viewing the event log which says invalid. That way they know

E-balloting Feedback Form		
	YES	NO
1 Simplicity		
2 Turnaround Time		
5 Accuracy		

TABLE 1
E-balloting Feedback Form

there was a malpractice and the polling unit will be cancelled. Performance Testing: this test was done to check the overall performance of the application. The application was tested using 15 over 50 years old of both literate and illiterate, 15 highly illiterate and 15 literate from ages 18 50 to carry out test on user friendliness, timeliness and accuracy. These users are of different educational and social standing as they are the ones to use it eventually. This test was done to see if the objectives of this project were met and how effectively.

User	Easy to Use	Timliness	Accuracy
Above-50			
User1	Y	Y	Y
User2	Y	Y	Y
User3	Y	N	Y
User4	Y	Y	Y
User5	Y	N	Y
User6	Y	Y	Y
User7	N	N	Y
User8	Y	Y	Y
User9	Y	Y	Y
User10	Y	Y	Y
User11	Y	Y	Y
User12	N	N	Y
User13	N	N	Y
User14	Y	Y	Y
User15	Y	Y	Y
Highly Illiterate			
User1	Y	Y	Y
User2	Y	Y	Y
User3	N	Y	Y
User4	N	Y	Y
User5	Y	N	Y
User6	Y	Y	Y
User7	N	Y	Y
User8	N	Y	Y
User9	Y	Y	Y
User10	Y	N	Y
User11	Y	Y	Y
User12	Y	Y	Y
User13	Y	Y	Y
User14	Y	Y	Y
User15	N	Y	Y
Literate			
User1	Y	Y	Y
User2	Y	N	Y
User3	Y	Y	Y
User4	Y	Y	Y
User5	Y	Y	Y
User6	Y	Y	Y
User7	Y	Y	Y
User8	Y	Y	Y
User9	Y	Y	Y
User10	Y	Y	Y
User11	Y	N	Y
User12	Y	Y	Y
User13	Y	Y	Y
User14	Y	Y	Y
User15	Y	Y	Y

TABLE 2
E-Balloting system result details

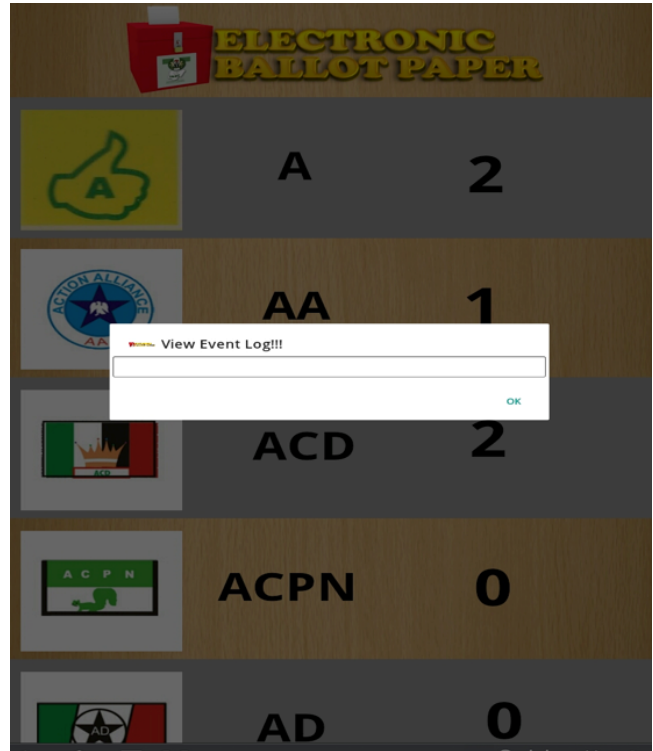


Fig. 10. Event Log for Security Purpose.

6 DISCUSSION AND CONCLUSIONS

The e-voting system encompasses several aspects. These include electronic registration and authentication, electronic voting or balloting and results transmission, tabulation and display. In one of our recent works we discussed Results transmission [18]. The electronic balloting system strives to reproduce a ballot paper on an Android tablet. The essence is to make the system user friendly to the extent that individuals who are not literate and who would ordinarily find it difficult to use a Kiosk based Electronic Voting System will be able to use our device.

Unfortunately, countries where trust level is high may need to apply minimal technology to achieve transparency in Elections whereas other developing countries where the trust level is low often require complex systems to achieve the same objective of free and fair elections. This is the objective that this work strived to achieve.

As discussed earlier, the tests conducted revealed that the system performed better than a typical manual ballot paper based elections system.

An electronic voter verified audit trail (VVAT) was also implemented, the essence of this is to fulfill the requirement of recount where necessary.



Fig. 11. Event log showing an invalid voting process.

This system can provide a bridge between an authentication system (like the Smart Card Reader as was done in Nigeria) and a Results transmission system to provide a seamless Electronic Voting System.

The designed system will be very useful in countries with large difficult terrain, remote areas and a less than average literate population as obtainable in developing countries of the world.

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