

# Enhanced Automated Biometric Web-Based Electronic Voting System for Nigeria

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**Abstract**—Nigeria's electoral system has been fraught with several challenges from the time of changing from manual accreditation/voting to electronic voters' accreditation/voting since March 2015. Prior to 2015, Nigeria has tried several voters' registration and voting system, not limited to the manual open-ballot option-A4 brought about by the then General Ibrahim Babangida Administration in 1990s or the secret ballot voting system introduced later by successive electoral commissions. Despite transiting from manual-based voters accreditation to electronic-based voters accreditation via the use of smart card reader (SCR) and Permanent Voter Card (PVC) in 2015 general elections introduced by then INEC Chairman Prof. Attahiri Jega, there are still issues relating to rigging, malfunctioning of the smart card readers, electoral violence, snatching of ballot papers, vote buying, falsification of poll results, disenfranchisement of eligible registered voters and so on. All these anomalies still cast aspersions on the integrity of elections conducted by INEC – the Nigeria's electoral umpire. This paper attempts to identify the problems associated with the Nigeria's current electronic accreditation using biometric smart card readers (SCRs) and Permanent voters' cards (PVCs) and subsequent manual (offline) voting. This paper introduced automated online/web-based voting system integrated with biometric authentication system to identify or accredit genuine registered voters. This new innovation will enable eligible voters to vote from anywhere irrespective of the electoral ward or polling unit they registered in. This new voting system will save cost, reduces ballot box snatching, vote buying and mass thumb printing; it will discourage bribery, corruption and electoral fraud amongst others. This innovation will give more chance for all registered voters to vote from any location using computers or devices connected to the internet. This can make the result of voting from several polling units to be collated simultaneously and in real-time and give authentic and accurate result devoid of bias and manipulation. This system was implemented using Java Server Pages (JSP), HTML with Tomcat web server for testing. This system worked fine according to system's specification and functionality.

**Keywords**—INEC, PVCs, SCRs, voters, verification, accreditation, registered voter, polling units, biometric, smart card reader, permanent voter cards, Nigeria, election, option A4, web-based, online.

## I. INTRODUCTION

E-voting is an automated and online or web-based voting system integrated with biometric authentication. This type of voting system will guarantee that the majority of the registered voters will cast their votes irrespective of their locations or where they registered at. It will also ensure that the outcome of the election is credible, free and fair and acceptable. Multiple election data can be collated simultaneously from several polling units in real-time. The Electoral Commission

can monitor the result from their head office with ease. This is not the case with the current electoral and voting system in Nigeria which is manual or offline. Though, there was improvement in Nigeria's election since March 2015, because of the introduction of voters' verification via biometric authentication of registered voters by the use of Smart Card Readers (SCRs) and Permanent Voters Cards (PVCs), there still remain many challenges confronting Nigeria's elections as witnessed in the 2015 general election.

One of the numerous challenges in the current Nigeria's electoral system is that registered voters must vote where they registered (in their wards). Many voters that registered in their states of origin but are residing outside their states of origin, who could not travel to their states of origin/wards during the 2015 general election were not allowed to vote. Even voters who reside in their states of origin but registered in their locality or villages but are resident in the state capital or other towns far way from where they registered did not vote in the 2015 general election. The reason is simple- they did not register there and cannot be allowed to cast their votes there.

On the voting day, there was general restriction of movement of vehicles and people; people and vehicles were not allowed to move freely from their residential areas or electoral wards to other locations within the state. This made it difficult for voters who registered some distance away from their residential areas to move/travel to polling units where they registered. This challenge made most of the eligible registered voters (who have their PVCs) to stay away from polling units and were thereby disenfranchised. This kind of challenge can be solved by introducing automated or online/web-based voting with biometric authentication so that people can vote from their home online (and only once), not twice, with internet-connected computer or device attached with a biometric scanner.

With the current electoral and voting system, many Nigeria citizens who are abroad cannot register and vote during elections in the country except they return to Nigeria, register in their wards and come home during general elections. This is very cumbersome, costly and unrealistic. Automated and online web-based voting system will eliminate all these inherent shortcomings with Nigeria's current voting system. Nigerians who are abroad can register online from there and vote as long as they are up to 18 years of age and have been registered also from online INEC's portal. With online voting coupled with biometric authentication/verification, registered voters can vote from where they are domiciled or residing

instead of travelling back to far locations or their states of origin en masse in order to participate in general election. Many people have died in road accidents just because they want to travel to their states of origin to go and participate in one election or the other. Some that could not travel could not participate in the election. This is bad. This is not the best way to go.

Table 1 buttressed the low turn-out of voters during the Nigeria’s general election in 2015. In that election less than 70% of registered voters in some states did not turn up to vote on the election day while in some states like Abia, Anambra, Borno, Edo, Kogi, Ogun and FCT recorded low turnout of between 33% to 39% of the registered voters participating on the voting on the election day.

to vote in their polling units. The highest turnout is in Rivers State which polled up to 71% while majority of other states polled less than 50%. This could be most likely to be voter’s apathy or inability of the voters to travel and vote in their polling units where they registered.

Also, there were evidences that the electronic voters’ verification system adopted by Nigeria in the 2015 Presidential, Gubernatorial and National Assembly (NASS) elections gave a lot of problems in several polling units across the country. Many registered voters could not get their PVCs authenticated by the smart card readers presented by INEC at the polling units in several states in the country. This is as a result of defective and unreliable smart card reader (SCR) machines deployed by Independent Electoral Commission (INEC) in several locations or technical incompetence of the deployed INEC staff. Some of the SCRs worked in some polling units while some failed to authenticate registered voters. This problem made some electoral officers or INEC staff on duty to resort to manual accreditation and authentication of voters. This gave room to a lot of fraud and manipulation.

Fig.2 depicts the rate of failures of Smart Card Reader (SCR) machines during the Nigeria’s 2015 general elections

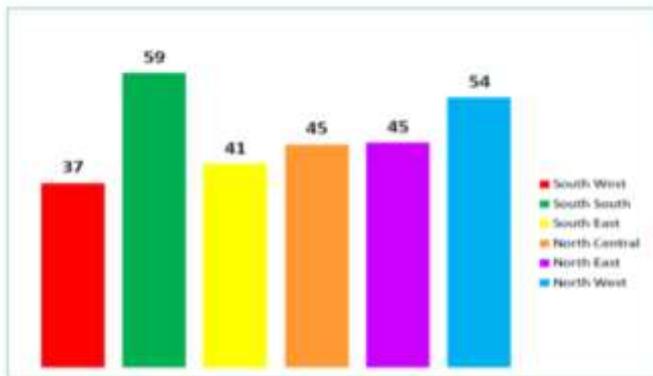


Fig. 1. Percentage of Voters’ Turnout per Geo-political Zone [1]

TABLE 1. Voters’ Turnout from March 28, 2015 Presidential and NASS Election in Nigeria [1]

S/N	Name of States	No of Registered Voters	No of Accredited Voters	% Voters' Turnout
1	Abia	1,349,154	442,538	33
2	Adamawa	1,518,123	709,993	47
3	Akwa Ibom	1,644,481	1,074,070	65
4	Anambra	1,963,427	774,430	39
5	Bauchi	2,053,484	1,094,069	53
6	Bayelsa	605,637	334,789	64
7	Benue	1,893,596	754,634	40
8	Borno	1,988,669	544,759	30
9	Cross River	1,144,288	500,577	44
10	Delta	2,044,372	1,350,914	66
11	Ebonyi	1,071,226	425,301	40
12	Edo	1,650,352	590,166	36
13	Ekiti	723,255	323,739	45
14	Enugu	1,581,563	616,117	45
15	Gombe	1,110,105	515,828	46
16	Imo	1,747,681	801,712	46
17	Jigawa	1,815,839	1,153,428	64
18	Kaduna	3,361,793	1,746,031	52
19	Kano	4,943,862	2,364,134	48
20	Katsina	2,842,741	1,378,646	56
21	Kebbi	1,457,763	792,817	54
22	Kogi	1,350,883	476,839	35
23	Kwara	1,181,032	489,360	41
24	Lagos	5,827,846	1,678,734	29
25	Nasarawa	1,222,054	582,959	48
26	Niger	1,995,679	633,607	47
27	Ogun	1,709,409	594,973	35
28	Ondo	1,501,549	618,040	41
29	Osun	1,378,113	683,168	50
30	Oyo	2,344,448	1,073,849	46
31	Plateau	1,977,211	1,076,833	54
32	Rivers	2,324,300	1,643,409	71
33	Sokoto	1,663,127	988,899	59
34	Taraba	1,374,307	638,378	46
35	Yobe	1,077,942	520,127	48
36	Zamfara	1,484,941	875,049	59
37	FCT	886,373	344,056	39
	<b>TOTAL</b>	<b>67,422,005</b>	<b>31,746,490</b>	

From the table 1, it can be deduced that out of 67,422,005 registered voters in March 2015 general elections, only 31,746,490 or 47.08% voted in the election. Majority of the voters who registered and obtained their PVC did not turn up

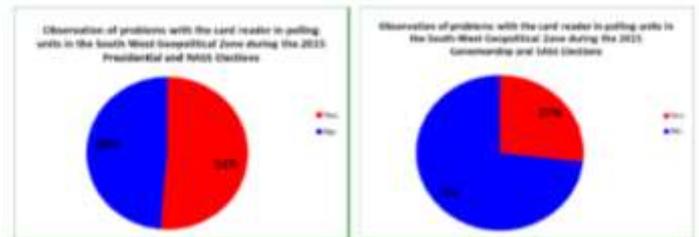


Fig. 2. Rate of Failure of Card Reader during the 2015 general elections [1]

### A. Research Questions

The following research questions need to be answered by the major stakeholders – The Nigerian citizens, the electoral commission (INEC) and the government to determine whether the current voting system is okay for Nigeria or whether it is due for modification or enhancement.

1. Can Nigerians cope with automated online/web-based voting system and accreditation?
2. Can smart card readers (SCRs) be 100% error free so as to authenticate or accredit all genuine PVC cards with INEC electronic register?
3. Can Nigerians abroad who are up to 18 years and above register online and participate in voting process come 2019 general election using web-based registration and voting system?
4. Can Nigeria combine or integrate both the current voter’s registration and voting system with the proposed automated online voters’ registration/web-based voting system so as to address the shortcomings of the current voting system?
5. Does INEC have the technical wherewithal or capability to handle web-based voters’ registration and web-based voting system integrated with biometric?
6. Does Nigeria has the facility and capability to embrace online or web-based voters’ registration and voting system

in 2019 general election or in future elections after the 2019 general election?

#### B. Related Works

There are dearths of research works on automated web-based e-voting system with biometric authentication for Nigeria. So this paper is an innovation and contribution to the enhancement of Nigeria's electoral process and system.

### II. ANALYSIS OF THE EXISTING VOTER'S ACCREDITATION AND VOTING SYSTEMS IN NIGERIA

In current situation we are having both electronic accreditation and manual voting systems. The Smart Card Reader (SCR) or Biometric system is used to electronically accredit each voter's Permanent Voter's Card (PVC) and thereafter the voter can cast his/her votes manually if he is successfully accredited. Because of this scenario all the qualified citizens (up to 18 years of age) must be apply for a PVC i.e. a biometric electric voter's card if he or she must be allowed vote during an election.

#### A. The Shortcomings of the Existing System

The shortcomings of this system are as follow:-

1. Before a qualified voter is allowed to vote his/her PVC must be accredited by the smart card reader (SCR) or he may not be allowed to vote; in some cases, a manual register is used to accredit voters who fall into this category but corrupt politicians and electoral agency staff have used this ploy to compromise/falsify the results of the electoral exercise.
2. This system gives rise to continuous voter's registration exercise and a lot of money is wasted to do this every time a general election is approaching.
3. Any voter that loses his/her PVC is not allowed to vote, even if his/her name is in the register.
4. If a qualified voter registers in Ward A in one state, he is not allowed to vote in another ward outside the state and ward where he registered few years ago; he must travel to the state and ward where he registered. This reason has disfranchised a lot of voters who must have relocated from where he registered or cannot embark on long travel to where he registered.

These are the main disadvantages of the existing system and to avoid these problems we are going to introduce a web based application called "e-voting or automated ballot vote" to take care of the highlighted problems in the existing system.

#### B. The Strengths of the Existing System

The strength of the existing system is its ability to incorporate biometric accreditation of voters (by the use of PVC in SCR). This feature helped INEC in 2015 general election and other by-elections to identify/accredit registered voters and prevented a lot of manipulations - double registration or multiple voting in the system.

### III. THE PROPOSED AUTOMATED WEB-BASED /ONLINE VOTING SYSTEM

Automated ballot voting or e-voting is an information management system that has been developed for automating

the process of election proceedings that take place between the people, and the government. This kind of electronic or e-voting is conducted real-time and online (web based) such that any registered voter can vote online from anywhere using any computer or device that is connected to the internet. Web-based voting can check multiple voting and at the same time use biometric voter's identification or verification just like the existing system. But the strength lies in its ability to allow a registered voter to vote from anywhere irrespective of where he or she registered. This system has the capability to enable Nigerians in Diaspora to participate in the election or voting. People can vote from any location without travelling to where they registered as long as there is an internet access there, and availability of a biometric scanner. The system does not require a registered voter to physically go to his/her polling unit in order to vote. The system requires a registered voter to only be authenticated or verified using his/her biometric identifies such as fingerprint or iris. The system makes sure that a registered voter is identified and he/she cannot vote twice.

The system needs consistent flow of information at different levels within the automated ballot vote, any interruption in the flow of major data can cause the final verdict to get stalled or pending. These kinds of situations should be holding our automated ballot vote system.

Data maintenance becomes a vital component with proper relation at all different stages. Any relational mismatch upon the actual information can change the actual meaning of the verdict, which is a great concern to the voters and to the Electoral Commission (INEC). The system also becomes false-proof for data attractions at any stage, because the overall control of information is kept in the hands of different administrations working at different levels. The subjective authority of data manipulation is handled with proper authentication, but all the recognized actions in the system can execute queries upon the system as per the substantial standardizations as they arise when the system is under the operational standards.

### IV. THE COMPONENTS OF THE PROPOSED SYSTEM

To provide flexibility to the users, the interfaces have been developed that are accessible through a web browser. The GUI'S at the top level have been categorized as:

1. *Administrative user interface*
2. *The operational or generic user interface*

The 'administrative user interface' concentrates on the consistent information that is practically, part of the organizational activities and which needs proper authentication for the data collection. These interfaces help the administrators with all the transactional states like Data insertion, Data deletion and Date updating along with the extensive data search capabilities.

The 'operational or generic user interface' helps the end users of the system in transactions through the existing data and required services. The operational user interface also helps the ordinary users in managing their own information in a customized manner as per the included flexibilities.

#### A. Number of Modules

After careful analysis the system has been identified to have the following modules:

1. Admin Module
2. User Module
3. Voter ID Application
4. Reports Module

##### 1. Admin Module:

This module tells all about an automated ballot vote department who are conducting elections in our country. By using this module Automated ballot vote can release election schedule which involves type of elections (National Assembly, Gubernatorial, Presidential) in addition with nomination starting date, ending date and also election starting date, ending date.

##### 2. User Module:

This module tells all about voters. By using this module any citizen who is 18 years and above can register his/her name to get electoral authentication, and also they can go for online or web based voting. This module consists of the following sub modules:

- a. *Voter Registration:* By using this functionality user can register to get authentication. After completion of registration user will get a unique voter ID.
- b. *Nomination:* By using this functionality a political leader can go for nomination by providing voter Id.
- c. *Online Voting:* By using this functionality users can use their electoral authentication by providing their voter Ids.
- d. *Reports:* By using this module user will go for different types of enquiries like voter enquiry result enquiry etc. This sub module consists following functionalities.

##### 3. Voter ID Application:

By using this module a user or voter will get authenticated by providing his/her details by using that authentication they can go for on line voting also. This sub module has the following functionalities:

- a. *Voter Enquiry:* By using this functionality a user can get all his/her personal details which are provided at the time of registration.
  - b. *Result Enquiry:* By using this functionality user can check the election result.
  - c. *Schedule Enquiry:* By using this functionality a user can check the election schedule.
4. *Voter List:* By using this functionality a user can check overall registered voters

#### V. SOFTWARE ENGINEERING METHODOLOGY

The methodology employed in the design and development of this e-voting system is the Object Oriented Analysis and Design (OOAD Standards). This document plays a vital role in the development life cycle (SDLC) as it describes the complete requirements of the system. It is meant for use by the developers and will be the basic during testing phase. Any changes made to the requirements in the future will have to go through formal change approval process.

OOAD MODEL was being chosen because all requirements were known beforehand and the objective of our

software development is the computerization/automation of an already existing manual working system.

The developer is responsible for:

- Developing the system, which meets the SRS and solving all the requirements of the system?
- Demonstrating the system and installing the system at client's location after the acceptance testing is successful.
- Submitting the required user manual describing the system interfaces to work on it and also the documents of the system.
- Conducting any user training that might be needed for using the system.
- Maintaining the system for a period of one year after installation.

#### A. Non-Functional Requirements

This section covers both the software requirements and hardware requirements for the system design and development.

*Software requirements:*

Operating System	: Windows
Technology	: Java/J2EE (JDBC, Servlets, JSP)
Web Technologies	: HTML, JavaScript, CSS
IDE	: MyEclipse
Web Server	: Tomcat
Database	: Oracle
Java Version	: J2SDK1.5, Tomcat 5.5, Oracle 9i
Hardware requirements:	

*Hardware requirements:*

CPU: Pentium based systems with a minimum of P4  
RAM: 256MB (minimum) and fingerprint scanner.

#### VI. SYSTEM DESIGN

This section covers the system design and development stages.

##### A. Input Design

Input design is a part of overall system design. The main objective during the input design is as given below:

- To produce a cost-effective method of input.
- To achieve the highest possible level of accuracy.
- To ensure that the input is acceptable and understood by the user.

*Input Stages:*

The main input stages can be listed as below:

- *Data recording*
- *Data transcription*
- *Data conversion*
- *Data verification*
- *Data control*
- *Data transmission*
- *Data validation*
- *Data correction*

*Input types:*

It is necessary to determine the various types of inputs.

Inputs can be categorized as follows:

- External inputs, which are prime inputs for the system.
- Internal inputs, which are user communications with the system
- Operational, which are computer department's communication to the system
- Interactive, which are inputs entered during a dialogue.

Input media:

At this stage choice has to be made about the input media. To conclude about the input media consideration has to be given to:

- Type of input
- Flexibility of format
- Speed
- Accuracy
- Verification methods
- Rejection rates
- Ease of correction
- Storage and handling requirements
- Security
- Easy to use
- Portability

Keeping in view the above description of the input types and input media, it can be said that most of the inputs are of the form of internal and interactive. As Input data is to be the directly keyed in by the user, the keyboard can be considered to be the most suitable input device.

### B. Output Design

Outputs from computer systems are required primarily to communicate the results of processing to users. They are also used to provide a permanent copy of the results for later consultation. The various types of outputs in general are:

- External Outputs whose destination is outside the organization.
- Internal Outputs whose destination is within organization and they are the User's main interface with the computer.
- Operational outputs whose use is purely within the computer department's Interface outputs, which involve the user in communicating directly with the system

Output definition:

The outputs should be defined in terms of the following points:

- Type of the output
- Content of the output
- Format of the output
- Location of the output
- Frequency of the output
- Volume of the output
- Sequence of the output

It is not always desirable to print or display data as it is held on a computer. It should be decided as which form of the output is the most suitable.

For Example:

- Will decimal points need to be inserted?

- Should leading zeros be suppressed?

Output media:

In the next stage it is to be decided that which medium is the most appropriate for the output. The main considerations when deciding about the output media are:

- The suitability for the device to the particular application.
- The need for a hard copy.
- The response time required.
- The location of the users
- The software and hardware available.

Keeping in view the above description the project is to have outputs mainly coming under the category of internal outputs. The main outputs desired according to the requirement specification are:

The outputs were needed to be generated as a hard copy and as well as queries to be viewed on the screen. Keeping in view these outputs, the format for the output is taken from the outputs, which are currently being obtained after manual processing. The standard printer is to be used as output media for hard copies.



Fig. 3. User Finger Print Enrolment



Fig. 4. Finger Print verification



Fig. 5. Users Registration



Fig. 6. Users ID verification

The user finger print enrolment, user finger print verification, user's registration and user's Id verification are shown in Figs. 3, 4, 5 and 6 respectively.

**C. Feature Extraction and Comparison of the system**

This includes scanning and processing and transfer of data to the hard disk. This is shown in Fig.7.

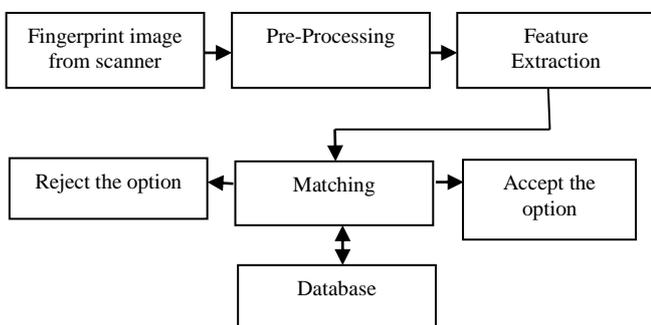


Fig. 7. Scanning and processing of the fingerprint image methodology

**D. Verification of Voters**

Fig.8 depicts the methodology used in the voters' verification process. A voter can vote from anywhere irrespective of where he/she registered but he or she must belong a particular constituency before he or she can vote for a candidate there. A registered voter in a ward in South West cannot cast his vote for a senatorial candidate in South East or North Central.

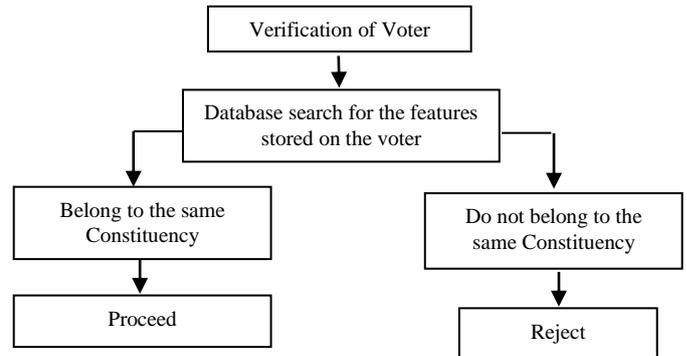


Fig. 8. Voter's verification methodology

**E. Processing and Counting of vote**

Fig.9 depicts the methodology used in the processing and counting votes cast. Here, the symbols of the political parties are displayed and an option is selected. If the option is invalid, the voting process is restarted, otherwise the vote count is incremented to validate that a valid vote is cast.

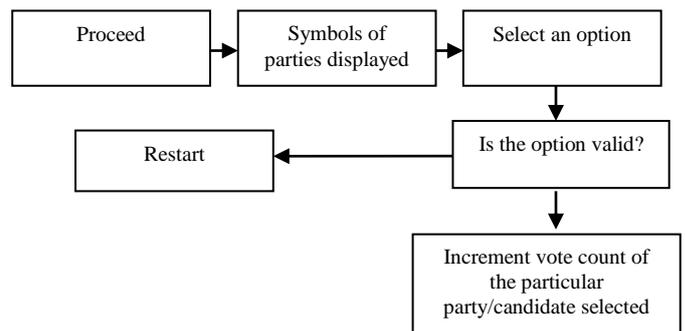


Fig. 9. Vote processing and counting methodology

**F. Detection/Rejection of Voter's reptition or Multiple Voting**

Fig.10 depicts the methodology used in the detection and rejection of multiple voting from a registered voter. This case is prone in Nigerian electoral system and must be detected to give room for free and fair election. Here a live scan of fingerprint of voters is used. If the voter is repeated the cast vote is rejected and the culprit is reported to the Police for prosecution. If there is no multiple or repeated vote, the vote is accepted as a valid vote.

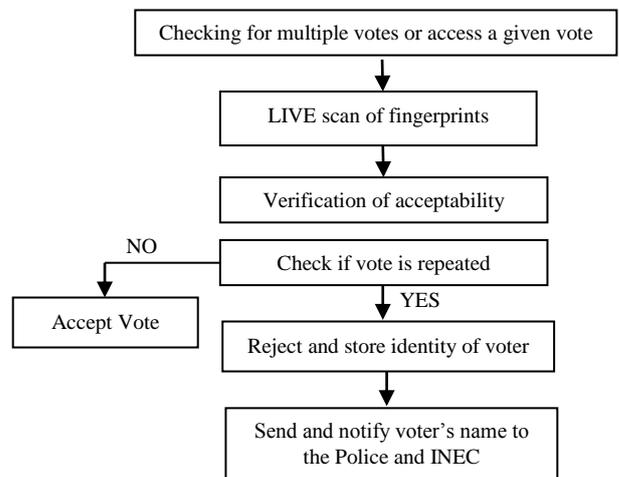


Fig. 10. Detection and rejection of repeated or multiple voting methodology

### G. Pseudocodes of the System

The algorithm or pseudocodes of the system (i.e. Administrative and User Modules are shown in this section).

#### Administrative Module:

- Step 1: Enter admin user name
- Step 2: Enter admin password
- Step 3: If (admin username and password=true)
  - Display a message box “You are logged in successfully”
- Else
  - Display a message box “Access denied Try again later”

#### User Module:

- Step 1: Enter your voter's id or serial number
- Step 2: If voter's id or serial number = true
- Step 3: Display a message box “You are eligible to vote”
- Step 4: Enter your fingerprint
  - Else if (fingerprint = true)
- Step 5: Display a message box “Your fingerprint is verified”
  - Else Display a message box “Your fingerprint does not match try again later”
- Step 6: Display the voter's profile
- Step 7: Display all registered polling constituency
- Step 8: Select only one polling constituency at a time
- Step 9: Display the type of election (Presidential, Gubernatorial, Senatorial, House Representative, State House of Assembly)
- Step 10: Select one at a time
- Step 11: Display all registered political parties
- Step 12: Select only one party at a time
- Step 13: Display the image or photo of the candidate for verification
- Step 14: Click to vote
- Step 15: Check for multiple votes or voting
- Step 16: If (vote count>1) then
  - Display message box “You have voted before”
  - Else “count the vote”
- Step 17: Display message box “Thanks for voting”
- Step 18: Stop the program

#### H. Voter's Registration Module

This module allows the voter to register online in order to participate in any election in the future.

The steps are highlighted below:

- Step 1: Begin
- Step 2: Enter the Voter's Id
- Step 3: Enter your first name
- Step 4: Enter your last name
- Step 5: Select your date of birth
- Step 6: Select your gender (Male or Female)
- Step 7: Enter your occupation
- Step 8: Select your state of origin (one out of the 36 States or FCT Abuja)
- Step 9: Select your constituency or zone
- Step 10: Enter your phone number or email address

Step 11: Capture fingerprint and photo

Step 12: End

## VII. CONCLUSIONS

This paper analysed the role of automated/online voting system with biometric technology in improving the credibility of the elections in Nigeria. The paper found that the deployment of Smart card readers (SCRs) and biometric technology in Permanent Voters Card (PVCs) in March 2015 general elections had rekindled the confidence of many Nigerian voters and that of development partners in INEC and Nigeria's elections. Reports from many accredited media organizations as well as international observers like Commonwealth, EU, AU, ECOWAS, NDI, IRI, International IDEA, IFES EOMs etc. attest to the fact that the elections were peaceful and credible. Although the technology experienced some glitches in its functionality, it largely accounted for the significant drop in the volume of election petitions filed by aggrieved candidates and political parties. This is because of the use of the device for organizing (authentication of PVCs and accreditation of voters) and counting votes (validation of the total votes cast by querying the machine). The paper also found that the governorship, NASS and SASS petitions filed at the tribunals in Abia, Akwa-Ibom, Delta, Ebonyi, Imo, Rivers, Taraba, among others, were due to the general failure or non-use of the SCRs for voters' accreditation and PVC authentication in these areas.

This paper equally observed that several millions of registered voters (more than 50%) who actually supposed to exercise their civic rights by voting did not do so because they were not able to travel to their local polling units where they registered and obtained their PVCs. This led to disfranchisement of several millions of registered voters in several Nigerian States especially in the South East. This kind of problem can be solved if there is an alternative voting system such as automated/online web-based voting system which can allow a registered voter to cast his/her vote irrespective of the location or polling unit where he/she is voting at. This technology will not allow impersonation and multiple voting because it uses biometric authentication and timestamping of voting confirmation to a database. It cannot allow a voter to vote twice. Despite the success of the existing biometric voters' verification using SCR and PVC, several underaged voters voted in the Northern parts of Nigeria thereby defeating the main objectives of using a biometric voter verification/authentication system. This is because the electoral staff used the so-called manual accreditation to perpetuate fraud.

## VIII. THE SECURITY OR AUTHENTICATION OF VOTERS

The proposed automated/online web-based voting system has a security feature that identifies or authenticates every registered voter to the database or INEC register once he/she logs in to vote. So there is no way an unregistered voter can vote or voter twice.

## IX. THE IMPLEMENTATION OF THE SYSTEM

The system has been implemented on a web-based online web server and can be replicated for Nigerian Electoral Commission, INEC.

## X. RECOMMENDATIONS

Arising from the foregoing, the paper recommends as follows:

1. INEC should maintain the usage of the smart card readers (SCRs) in all subsequent elections in Nigeria including the 2019 general elections. Despite the hiccups associated with the use of the machines (SCRs), it is very important that their usage be maintained in all subsequent elections. The 2015 general elections showed that technology has its merit and is the way to go in Nigeria's future elections.
2. Accreditation should be done simultaneously with voting. The reason for having accreditation first and later voting is to prevent voters who wish to vote at more than one polling unit on Election Day from doing so. The card reader makes it impossible to get accredited in two places (card reader only works with PVC specifically programmed for that unit). For this reason, there is no major reason to continue separating the two activities especially since the card reader has addressed this issue.
3. INEC should embark on full implementation of e-voting

(automated/online web-based voting with biometric authentication) and other technology-based approach in future elections administrations in Nigeria. To achieve this, however, the Commission should work with the NASS to get Section 52 of the Electoral Act 2010 amended. It is also important to test-run the e-voting (online web-based voting with biometric authentication) on smaller mid-season coming up in Nigeria such as Osun State before the main deployment in 2019 general elections. Only a phased implementation would give maximum impact.

4. This proposed technology (automated/online web-based voting with biometric authentication) should be run side by side with the normal voting system that was used in the 2015 general election; we mean the use of PVCs and smart card readers (SCRs)). By so doing millions of qualified and duly registered voters can vote from anywhere irrespective of the location/center where they registered at. Even some Nigerians in Diaspora (abroad) can participate, for the first, in Nigeria general elections using this proposed voting system if they can be registered by INEC.

## REFERENCES

- [1] Election Monitor, "2015 General Elections observation report". A Publication of Election Monitor.