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Enhanced Electronic Voting System (EEVS) in the Nigerian Electoral System

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Abstract
Every citizen of a democratic nation has a civic right to vote and be voted for. To exercise this franchise, an election is required. The quality of election conducted depends on the quality of voting process employed. The traditional methods of voting in an economy such as Nigeria have been characterized by various malpractices such that citizens do not have confidence in the integrity of the results obtained from the electoral system. To mitigate these integrity challenges, electronic voting (e-voting) machines (EVMs), employing different technologies and levels of authentication, such as passwords, fingerprints, voter identification number (VIN) and face recognition have been deployed in several economies over the years for polling-place and remote-place e-voting systems. Consequent upon the heightened insecurity arising from the insurgence of foreigners into the country, using only biometrics and passwords could amount to capturing non-citizens and under-aged citizens. This work therefore proposed an enhanced electronic voting system (EEVS), which incorporates a mechanism that captures the voter's national identification number (NIN) or bank verification number (BVN) to ensure that only eligible citizens of Nigeria are registered and accredited for the voting process. The results obtained showed that the proposed system has the ability to curb the menace of election malpractices. Integrating this system with the earlier biometric and password models will completely solve the menace of election malpractices, thereby assuring the integrity of future general elections in Nigeria.
Keywords: *Enhanced, Electronic, Voting system, Election, Malpractice, Quality, Voter's card, Bank verification number, National identification number*

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1. Introduction

Democracy is defined as the government of the people, by the people and for the people. This implies that every citizen of a democratic nation has a civic right to vote and be voted for. To exercise this franchise, an election is required. The quality of election conducted depends on the quality of voting process employed. Elections in Nigeria dates as far to the first republic, with the general election of 1959, conducted and superintended by the British colonial government to determine the parties that would govern the country after independence (Awa, 1960; Jim-Nwoko, 2019). The traditional methods of voting have either been by open ballot, where voters queue up for their preferred candidates or by secret ballot, in which voters choose candidates by casting votes, normally on paper for their preferred candidates.

These methods have both been employed in Nigeria. The existing Nigerian electoral system has been characterized by various malpractices such that citizens do not have confidence in the integrity of the results obtained from the system. Some of these integrity challenges include the possibility of voting by non-citizens and under-aged citizens, voter impersonation, multiple voting, ballot stuffing, snatching of ballot boxes and ballot papers, inaccurate counting of votes, result manipulation, and so on. The menace of these malpractices has lingered till now in Nigeria because of the vulnerable nature of the ballot voting system (Osinakachukwu and Jawan, 2011).

Sequel to this vulnerability, many democratic nations have migrated to and deployed electronic voting (e-voting) systems (EVSs) for both polling-place and remote-place elections (Buchsbaum, 2004; Kohno et al, 2004; Everett et al., 2008; Goldsmith and Ruthrauff, 2013; Jeberson et al., 2014; EISA, 2015; Freyer, 2017; Adewale et al, 2020; Achammal et al., 2021). According to Ekwealor (2018), electronic voting system was

deployed for the Kaduna State local government area elections in 2018. Several electronic voting machines (EVMs), including (Mercuri, 2002; Kadbe et al., 2013; Jeberson, et al., 2014; Narendra et al, 2015; Ranjan et al., 2015; Mikail et al., 2015; Anil et al., 2017; Alkali et al., 2019; SurendraRao et al., 2019; Priyadarshini et al., 2020; Malathy et al., 2020; Amrish et al., 2020; Achammal et al., 2021; Chakraborty et al., 2021; Jafar et al., 2021; Adewale et al., 2021), which employed different technologies and levels of authentication, such as passwords, fingerprints, voter identification number (VIN) and face recognition have been deployed over the years for polling-place and remote-place e-voting.

To curb the menace of election malpractices in the Nigerian electoral process, a radio frequency identification (RFID) based enhanced electronic voting system (EEVS) with additional verification process is hereby proposed. The system consists of hardware and software designs. The hardware uses an Arduino nano microcontroller, a radio frequency card or tag to store valid information of the voter, an RFID card reader to read the information stored in the card, a liquid crystal display unit to display the details captured by the system, a secured digital (SD) card to back up vital records and push buttons to enable voters select their parties of choice. The RFID reader and tag are used to identify voters and verify their identity to ensure that no false entry is made. C++ language was used to write the source codes (Okodugha and Okuboarre, 2021).

Consequent upon the heightened insecurity arising from the insurgence of foreigners into the country, using only biometrics and passwords could amount to capturing non-citizens as well as under-aged citizens. The proposed e-voting system therefore, incorporates a mechanism that captures the voter's national identification number (NIN) or bank verification number (BVN) to ensure that only citizens of Nigeria are registered and accredited for the voting process. That is, BVN or NIN was adopted in this work as an appropriate means of authenticating and verifying every legitimate voter so as to curb the inherent malpractices in the Nigerian national electoral process. Hence, the proposed EEVS will ensure a fast, free and fair (FFF) as well as a credible, confident and transparent (CCT) electoral process.

2. Materials and methods

The methodology comprised the hardware design and software design while the system implementation comprised the voter registration or enrolment process, the accreditation (or authentication and verification) process and the voting process.

2.1 Hardware design

The block diagram representation of the hardware circuitry of the proposed system is shown in Fig. 1. The microcontroller unit is a complete and breadboard-friendly Arduino Nano board based on the ATmega328 (Arduino Nano 3.x). It is powered via the Mini-B USB connection, 6-20V unregulated external power supply or 5V regulated external power supply. It is programmed with Arduino Integrated Development Environment (IDE) software. It has 16 MHz clock speed and 32kB of flash memory (Okodugha and Okuboarere, 2021).

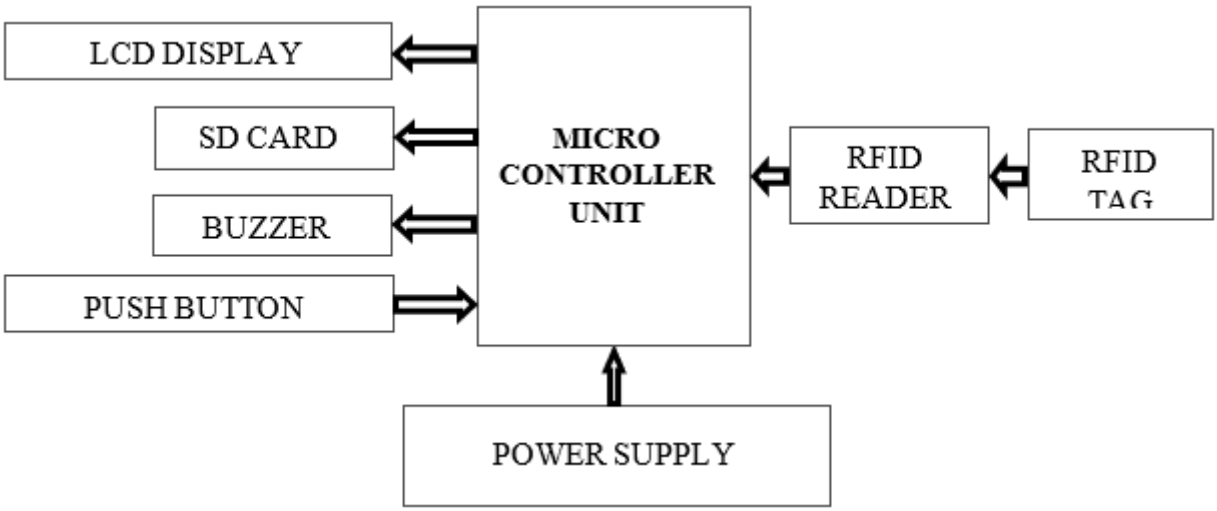


Fig. 1: Block diagram representation of the hardware circuitry.

The power supply unit used is a 9-volt, 1 ampere battery cell, which provides power to the hardware circuitry, though a 9-volt, 1 ampere power pack can also be used. It incorporates an

LM7805 voltage regulator that regulates the input voltage of 9V and gives an output voltage of 5V required by the microcontroller.

A 125 KHz, 64 bit, MCU ATmega 168 RFID reader and cards or tags with a range of 5cm to 8cm were used. The RFID reader is used to receive data from the RFID tags without any contact between the reader and the tags. The output of the RFID reader is serial and is connected to the receiver (RX) pin of the controller. The communication baud rate is 9600. The tags contain
antennas which are used to communicate and transmit data to the RFID card reader. The reader is a transceiver and can read and write to the RFID cards. It can detect registered and unregistered cards. Its internal memory can register up to 100 RFID cards (Okodugha and Okuboarere, 2021).

A 20x4 (20 by 4) liquid crystal display (LCD) screen was used as the output display unit of the system. The micro-SD card is used to save the data that comes from the RFID reader, which were read from the tags. It therefore adds mass storage and data logging enhancement to the designed system. The buzzer serves as an indicator for invalid votes or any error made at any point during the voting process. The push buttons are used to select parties of choice by voters during the voting process.

2.2 Software design

The software design was done using C++ language over the Arduino Integrated Development Environment (IDE). The IDE converts the C++ code (.cpp) to machine code (. hex) which the controller uses (Okodugha and Okuboarere, 2021).

2.3 The voter registration or enrolment process

Every valid voting card or tag has a unique identification (UID) number as well as the name and BVN or NIN of the voter, which are registered to a particular polling station and the information saved in the memory of the microcontroller of a particular enhanced e-voting machine (EEVM). The cards registered to a polling station are programmed to be used for accreditation. The voter is required to provide this card on the day of election to be eligible to vote. Table 1 shows the vital information of some of the voters that are contained in the voter's card, which were programmed into the microcontroller during the registration process. The bank verification and unique identification numbers used in this implementation were arbitrarily chosen.

Table 1: Voter's vital information.

S/N	Voter's Name	Voter's BVN	Card's UID Number
1	Akhere Okodugha	0224564125	153, 211, 149, 178
2	Dr. Dike	2289106746	90, 81, 229, 63
3	Alex O. Gift	2546725636	215, 234, 128, 99

The following political parties were arbitrarily chosen in the work: Progressive Democratic Party (PDP), Active Progressive Congress (APC), Youths Democratic Party (YDP) and Advanced Democratic Congress (ADC). The voter registration or enrolment process flowchart is given in Fig. 2.

2.4 The authentication and verification (or accreditation) process

A three-level verification process is adopted in this process. Particular EEVMs are customized or dedicated to particular polling stations. The Authentication process involves the verification of the voting cards that will be used for a particular voting process. At authentication, the voting card is held for about three seconds towards the reader unit. The system verifies the card's UID number, voter's name and BVN. These data must match those already stored in the microcontroller during registration.

As the RFID card reader senses the voter's vital information, it sends the data to the dedicated microcontroller. The microcontroller checks whether the received voter's UID belongs to the polling station (for example, Polling Unit 1) or not. If yes, the microcontroller checks if the voter has voted or not. If not, it makes the EEVM ready for voting. But if the card has already been used, the microcontroller will detect it and send a sound signal via the buzzer, indicating "card used previously" on the LCD display. If the card was registered to another polling station, the buzzer will also sound and "card rejected, Polling Unit 2", for example, indicated on the LCD display. All the data captured in this process are also recorded and backed up in the micro secure digital (SD) card. The authentication and verification (or accreditation) process flowchart is shown in Fig. 3.

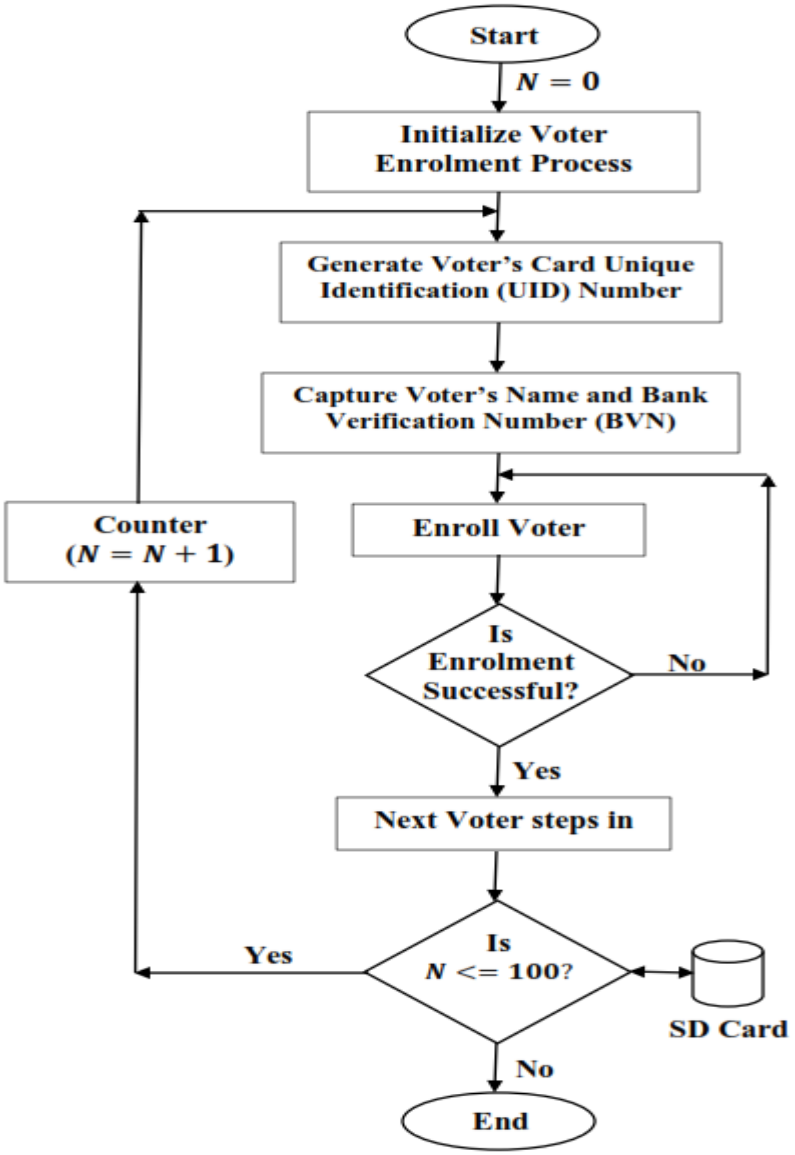


Fig. 2: Voter enrolment flowchart

2.5 The voting process

Once the accreditation exercise is concluded and the voter's card validated, the user is qualified to vote. The EEVM is made ready and grants access to the user to cast his/her vote. This process is repeated for every voter that is registered in this particular polling station. The voting process flowchart is shown in Fig. 4. At the end of the voting process, the Presiding Officer signs out by swiping the master card through the card reader.

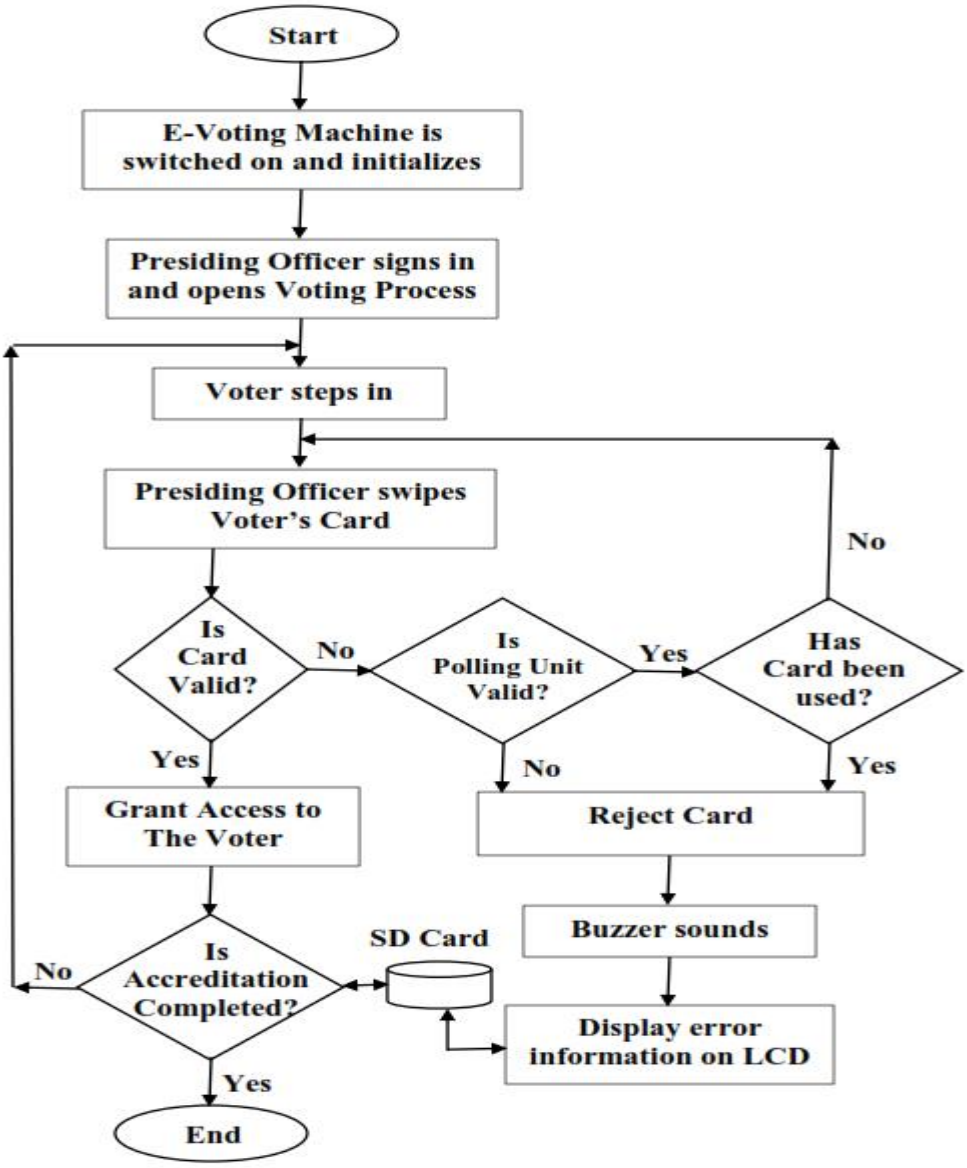


Fig. 3: Voter accreditation flowchart

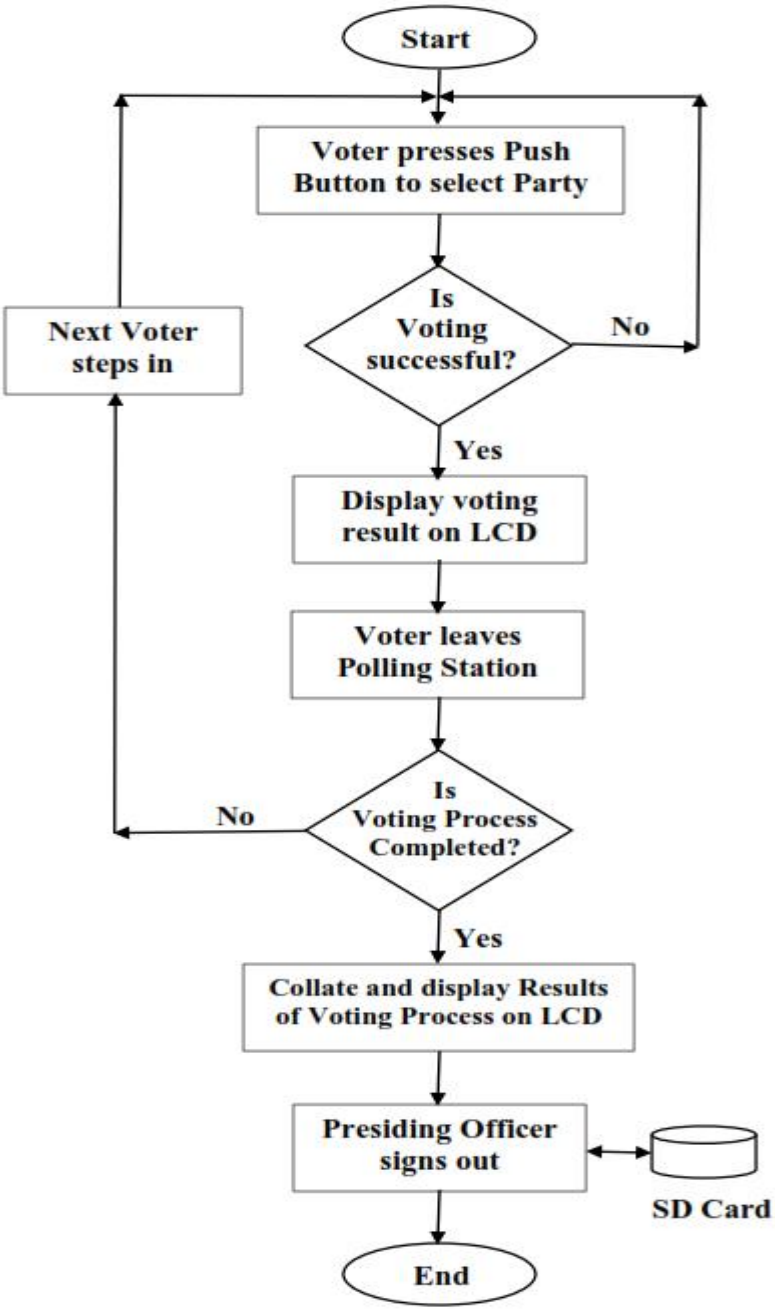


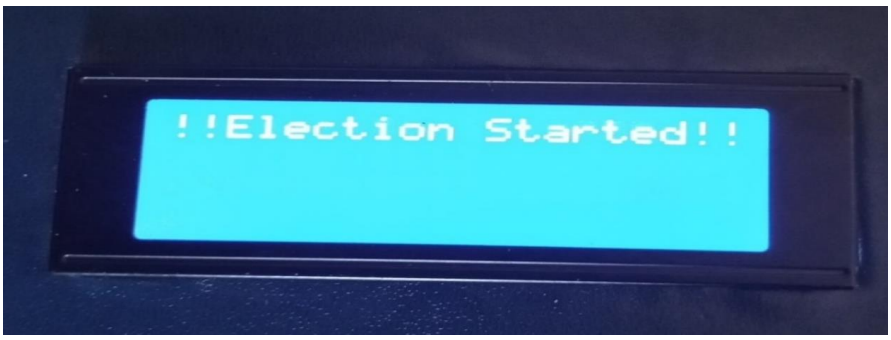
Fig. 4: Voting process flowchart

3. Results and discussion

The Presiding Officer kick starts the voting process by validating the EEVM or signing in with an RFID master card. This displays the status of the machine on the LCD with each contesting party having zero votes. At this stage, the machine is ready for voting to start. The displayed results are shown in Fig. 5. Fig. 5a is the status of the machine when switched on while Fig. 5b and 5c are the status after been validated. In the voter's card validation and voting implementation, the voting card is inserted into the RFID card reader. The status of the card as well as the name and bank verification number of the voter are displayed. If the card is valid, the machine grants access to the voter to vote by instructing the voter to select the party of interest. The status of the machine is displayed in Fig. 6a. Fig. 6b shows the status of the machine after the first voter has pressed the button corresponding to his/her party of choice. If the voting card has been used to vote previously in that same voting process, the machine rejects the card as shown in the display of Fig. 7. This is a case of multiple voting that culminates to election rigging or malpractice. When the voting process is concluded, the results are collated. The display for the collated results shows all the contesting parties with their total number of votes. This summary is

gotten as the Presiding Officer signs out by inserting the RFID master card into the card reader. This action brings the voting process to an end. The displays obtained are shown in Fig. 8. Fig. 9 shows the construction and packaging of the designed and implemented radio frequency identification based enhanced electronic voting machine (EEVM).

(a)



(b)

(c)

Fig. 5: Machine validation implementation

(a)

(b)

Fig. 6: Voter's card validation and voting implementation.

(a)

Fig. 7: Multiple voting validation implementation.

(a)

(b)

Fig. 8: Summary of results obtained at the end of the Voting Process.

Fig. 9: Construction and packaging of the enhanced electronic voting machine

4. Conclusion

An enhanced electronic voting system (EEVS) which incorporates a mechanism that captures the voter's national identification number (NIN) or bank verification number (BVN) to ensure that only eligible citizens of Nigeria are registered and accredited for the voting process has been successfully designed and implemented. The results obtained showed that the proposed system has the ability to curb the menace of election malpractices. The details of the entire voting process are backed up in the micro-SD card incorporated in the secure EEVM. The result summaries obtained from the various polling stations can then be transmitted through the appropriate media to a central data base from where the general results from the conducted election can be released. The information in the SD card is also transmitted to the appropriate authorities and kept for possible litigations arising from the general conduct of the election. Integrating this system with the earlier biometric and password models will completely solve the menace of election malpractices, thereby assuring the integrity of future general elections in Nigeria. Therefore, it is recommended that this device be deployed by the Independent National Electoral Commission (INEC) for general elections in Nigeria.

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