Design And Implementation Of A Computerized Voting System With Fingerprint Authentication

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Abstract
One of the perennial problems facing the conduct of Nigerian elections in recent time is how to tackle the menace of ballot box snatching, electoral fraud, ballot paper destruction and thuggery in the existing voting system in the country in spite of the introduction of a bimodal voter accreditation system. This is paper was borne out of the necessity to develop a computerized voting system with fingerprint authentication that would enable voter to vote using computers instead of ballot papers. This paper is an ex-post facto research that is utilized observational method, wherein content analysis was used as a method of data analysis. Nevertheless, Structured Systems Analysis and Design Methodology (SSADM) and Object-Oriented Analysis and Design Methodology (OOADM) was adopted as the model for the new system. The project implementation was done using Visual Basic.NET. XML. Database was used to design the database while the code was written in Visual Basic Studio and Notepad++. The paper proposed that the computerized voting system would be fast, accurate and more secured in registering voters and capturing their respective fingerprints, registering candidates, verifying voters, recording votes as well as managing election results. Thus, the system was expected to achieve optimal result. Similarly, it is equally expected that successfully verified voters are allowed to vote while those whose fingerprints do not match are not allowed to vote. More so, cases of ballot box snatching, ballot paper destruction, multiple voting, double counting, miscalculation, omission, and mutilation are not expected to be obtainable in the system; as it is expected to reduces the incidence of thuggery, manipulation of election results, and other forms of electoral fraud.
Keywords: *Computerized Voting, Fingerprint Authentication, Electoral Fraud, Voters Accreditation*

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I. Introduction

Nascent democracy like Nigeria has faced lots of challenges that have inhibited the effective conduct of free and credible election since the return of the fourth republic [1]. Previous elections conducted in Nigeria before 2015 were characterized by electoral malpractices and such, has prompted diverse scholars and practitioners to advocate for a gradual transition from the manual voting system to a more innovative system that would guarantee the integrity of electoral process in bid to ensure the continued sustenance of Nigerian democracy [2]. Between 2007 and 2011, a series of accusations and counter-accusations were exchanged by the Electoral Management Body (EMB) in Nigeria regarding the organization of peaceful and credible elections. The elections during this period were often marred by irregularities such as ballot box snatching, vote miscalculations, falsification of votes, multiple voting, and political violence [3, 4]. Consequently, since 2015, there has been increasing pressure from scholars and Nigerians alike for the Independent National Electoral Commission (INEC) to transit to electronic-elections (E-elections) utilizing an E-voting system [5]. The burning desire to ensure the credibility of Nigerian election through an e-voting led to the repeal of the Electoral Act No. 6, 2010 and the subsequent signing of 2022 Electoral Amendment Bill into law on February 25th, 2022 by the Buhari led administration [6]. However, before this amendment, [2] observed that before this amendment were made, INEC had in 2007 instituted the Direct Data Capture Machine (DDCM) which gave birth to Electronic Voters Register (EVR) and the Smart Card Readers that have been in use in contemporary election in Nigeria. Nevertheless, it is pertinent to note that the above mechanism were only instituted to curb electoral irregularities, issues revolving around over-voting, death of electoral candidates, technological adoption in electoral process such as the use of Bimodal Voter Registration System (BVAS) for accreditation voters, electronic transmission of electoral result and so on [2,6]. In spite of the benefits inherent in the innovation introduced by INEC, the process of the conduct of the Nigerian election has not changed much. Thus, bagging the questions on the purported irregularities witnessed in the 2023 presidential election in Nigeria.

Thereof, it is against the above backdrop on the challenges facing the existing voting system in Nigeria that this study seeks to design and implement computerized voting system with fingerprint authentication in bid

to eliminate issues of multiple voting while automating the process of collation, analyzing and publishing of election result.

II.   Related Works

Studies have shown that around the global, there are basically four voting technologies/computer system that could be used in election across the world [7]. These technologies include optical scanning, paper marking, mechanical lever systems, and Direct Recording Electronic (DRE) voting system hardware [7, 8, 9]. According to [9], paper making system also known as manual voting is the prevailing election method that involves the casting and hand-counting of votes. This is method of voting is mainly found in developing countries. However, due to the increasing criticism levelled against this system, many scholars, practitioners as well as countries have supplanted this traditional method with computerized voting system. The emergent of other voting technologies such as mechanical lever system, optimal scan and DREs was as a result of the evolution of computerized voting system [9]. The Mechanical Lever System was a popular voting method where voters select their candidates by moving a lever. Votes are casted by pulling the lever, updating a mechanical counter [7]. According to [8], this technology emerged in the United States during the 1930s and is no longer manufactured on a significant scale. The sole record of the vote is confined within the machine. Some of the advantage of this system is that it guarantees faster counter of votes as well as its durability while its challenges include its expensive maintenance and absence of a paper trail for auditability. Conversely, according to [8, 9], the optical scan method is recognized as a secure approach for tallying votes, involving the annotation of a ballot with multiple choices which is then processed through a scanning machine. This system allows voters to review, confirm, or reject their vote, and can detect over and accidental under-voting. [8] and [9] affirmed that Direct Recording Electronic Systems (DRE) are touch screen voting systems that implement all voting steps, from registration to counting. Voters use a PIN or smart card to enter their information, and the DRE displays their choices on a screen. More so, DRE has the capacity of recording votes directly in a computer's memory. It is not surprising why DREs remains one of the best electronic voting technologies. It is important to highlight the existence of the Direct Recording Electronic System-Voter Verified Paper Audit Trail (DRE-VVPAT), which can print out votes verified by voters. Unlike DRE voting, which lacks independent result verification, a "voter verifiable audit trail" (VVAT), such as a paper receipt, enables comparison with electronic results without compromising voter secrecy. DRE systems often encounter challenges including potential tampering, privacy concerns, and legal ambiguity regarding result discrepancies. In bid to surmount this obstacle, [9] opined for a multiple cross-checking machines and a hybrid system with a standalone vote-marking machine and optical scanner in order to balancing speed and security.

Enthroning Electronic Voting System in Nigeria

President Muhammadu Buhari's approval of the Electoral Act Amendment Bill in 2022 opened avenues for Nigeria's Electoral Management Body (EMB), the Independent National Electoral Commission (INEC), to harness digital technology for the complete automation of the electoral management system [10]. Since the introduction of the e-voting system in Nigeria, INEC has successfully implemented the Bimodal Voter Accreditation System (BVAS) during the recently concluded 2023 election. It is worth noting that as early as 2007, INEC established the Direct Data Capture Machine (DDCM), which led to the creation of the Electronic Voters Register (EVR) and the adoption of Smart Card Readers for contemporary elections in Nigeria. Following the just concluded 2023, the issue on the use of BVAS as well as the transmission of electoral results have remained a subject of debate and criticism amongst diverse scholars and practitioner. According to [10], Wardchat, an indigenous Nigerian company, has developed a digital social network app to connect voters across various wards, districts, and states, supporting electoral arrangements in 774 local government areas, 82,000 wards, 176,000 polling units, and 36 states. Wardchart is equipped with distinctive and user-friendly features that facilitate seamless engagement, enabling voters to effortlessly share content and knowledge. This innovative application is believed to be core in enhancing voter participation and engagement in electoral process in Nigeria [10].

In a nutshell, it pertinent to note that existing voting system in Nigeria is partly computerized such that computer systems with fingerprint capturing machines are used to register voters while bimodal voter accreditation systems are used to verify registered voters just before receiving ballot papers at the polling units. Since ballot papers are used for actual voting, cases of ballot box snatching, ballot paper destruction, thuggery, manipulation of election results, and other forms of electoral fraud are obtainable. The existing system has not been able to address these challenges.

Voting Systems Vulnerability and Security Requirements

Diverse scholars have suggested some of the security threat to computerized voting system to include denial of service (Dos), virus infestation and malicious software and spoofing attacks on the system [10,11]. Emphasizing on the impediment of the aforementioned factors on democratic process, it is imperative to point

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out that Dos attack can prevent citizens from gaining access to electoral web, thereby assisting in perpetuating electoral fraud. Similarly, malicious software such as Malware has the tendencies of damaging computer system by manifesting itself in the form of viruses, worms and Trojan horse. Spoofing attack is another security impediment to electronic voting [11, 12]. In this attack, an individual tries to obstruct communication between a client and a server. In other words, it tends to mislead voters that they are at the real voting websites, thereby exploiting electorates' votes in order to tamper it in favor a particular candidate. Consequently, to surmount the above security concerns inherent in computerized voting system, [13] opined that countries in contemporary time, are increasingly operating within functional and constitutional requirement in bid to ensure that democratic electoral principles are enthroned.In terms of technological solutions, this means there are security criteria that must be met by the operational setting where voting occurs. Essential criteria for any voting system comprise authentication, uniqueness, privacy, reliability, verifiability, and accuracy [13]. Supplementary requirements that offer advantages encompass convenience, transparency, scalability, and cost-effectiveness.

III. Methodology

This paper integrated both the Structured Systems Analysis and Design Methodology (SSADM) and the Object-Oriented Analysis and Design Methodology (OOADM). OOADM provides a structured approach for examining and building applications, systems, or enterprises utilizing object-oriented programming. It integrates visual representation at every stage of software development to enhance communication among stakeholders and enhance the quality of the end product. Conversely, SSADM employs a system-centric approach to analyze and design information systems, primarily utilizing logical data modeling, data flow modeling, and entity event modeling. The project was implemented using Visual Basic.NET and XML, with database design conducted using a database, and coding completed in Visual Basic Studio and Notepad++.

The use case diagram entails the proposed computerized fingerprint-based voting system. The system is made up of five classes of entities namely: Voter, Candidate, Admin, Election, and Vote. The system allows every user to register and login. The voter can enroll (with fingerprint), verify thumbprint, vote, and view election result. The candidate can register, login, apply to become a candidate and view election result. The admin can register, login, review candidate, create election, and view election result.

IV. System Design and Result

The main implementation tool of the proposed system is Visual Basic .NET. In addition, graphics tools such as Corel Draw and image editors such as PAINT were used to design elements used in the interface of the application. Notepad++ was used to implement the database of the system.
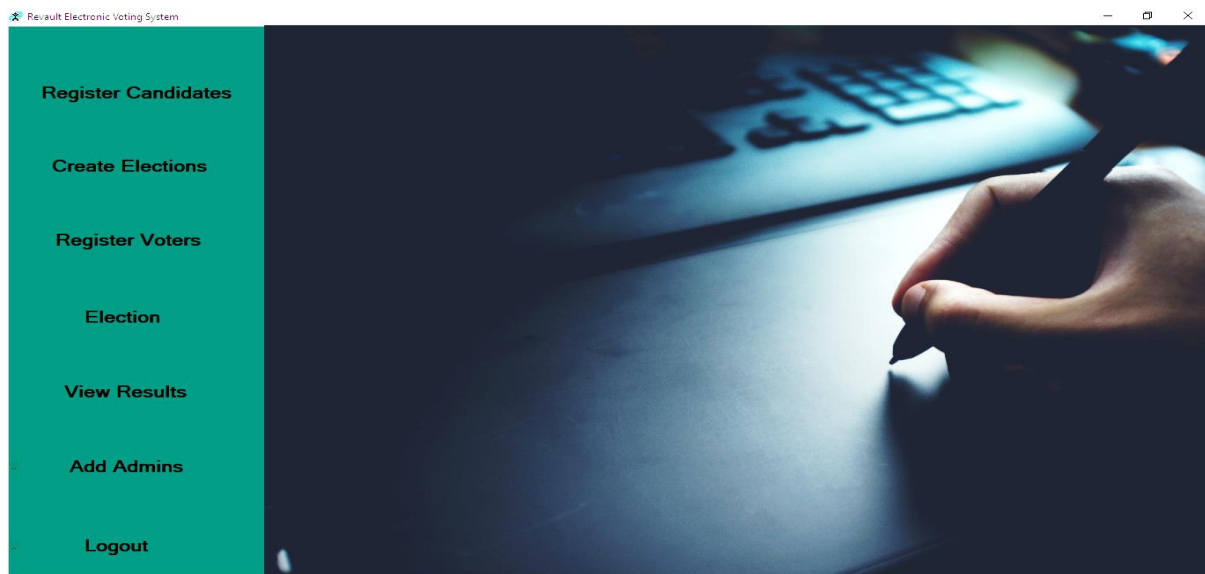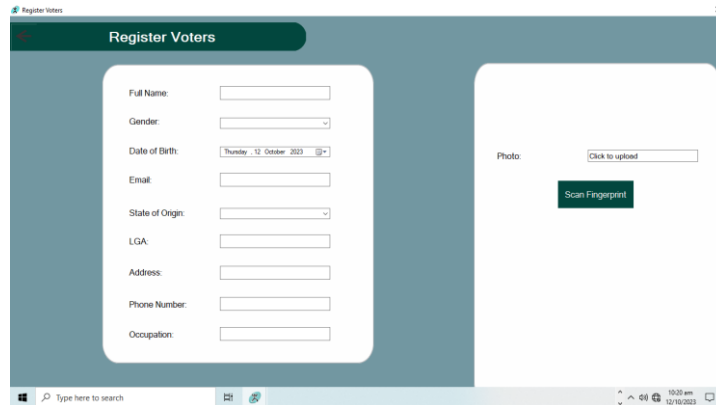

Figure 23: User Interface Implementation

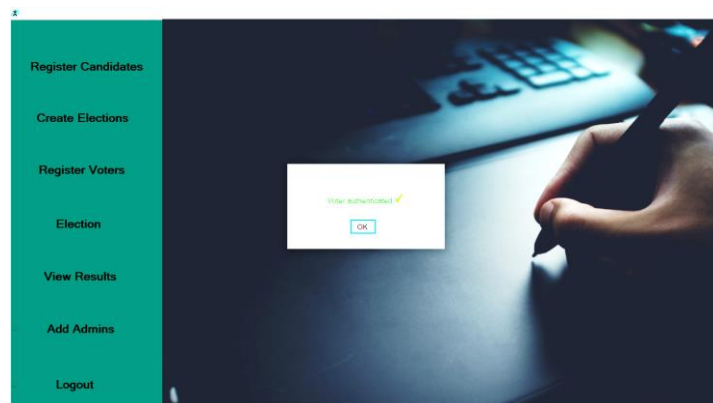**Figure 24: Voter Registration Implementation**

Figure 27: Success Message
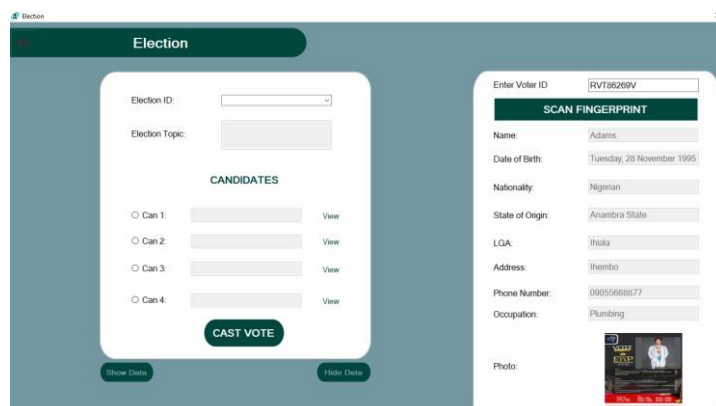
Figure 29: Voter Profile

Figure 30: Election Result

V.   Discussion And Conclusion

At the end of the software development exercise, the following achievements were recorded:
- The researchers designed and implemented a computerized electronic voting system that uses fingerprint authentication. Basically, the system allows a voter to enter biodata and scan fingerprint; verify fingerprint, vote for any of the registered candidates, and view election result.

- The fingerprint-based computerized voting system was verified and found to be consistent with the predefined system specifications. It was also validated to be sure it satisfies user expectations. The verification and validation exercise proved that the developed system is of high quality and that it works as expected.
- The performance of the system was equally evaluated and it was found that the system performs optimally. The response time of the system is quite reasonable.
- The process of developing the system exposed the researcher to Visual Basic programming language, XML databases, and vast knowledge on electioneering in Nigeria. The exercise has also sparked the researcher's interest in political participation and in electronic governance.

In conclusion, the researchers successfully designed and implemented a computerized voting system that uses fingerprint authentication. The system contains a database of candidates, voters and voting records and enables candidates to register. The system also provides secure access to all the records in the system. The system replaces paper ballots with an electronic interface which enables a voter to register electronically and submit his/her fingerprint to the system, select a preferred candidate, and vote for the candidate upon successful fingerprint verification, from the comfort of his/her home or from a designated center. The system eliminates cases of ballot box snatching, miscalculation, multiple voting, and delay in election result publication. Given the results of the system testing and system performance evaluation exercises, the system can be adjudged to be of high quality and high performance.

VI. Recommendations

This paper presents the following recommendations. Firstly, it proposed that the country's electoral body, student union governments, unions, and other institutions adopt the suggested fingerprint-based computerized voting system, as it offers greater efficiency compared to the current BVAS-based electronic voting system, which still relies on ballot papers and is susceptible to issues like ballot box snatching, multiple voting, calculation errors, and delays. Secondly, to ensure the smooth operation of the proposed system, users must ensure adequate power supply and Internet connectivity when required. Thirdly, it sort for the adoption of security protocols like antivirus programs, intrusion detection and prevention systems, as well as firewalls, which will be geared towards protecting the system from hackers and unauthorized entry. Lastly, as institutions are transiting to a new system; it is exigent that they must educate users on its importance as well as organize literacy programs to ensure both computer literate and illiterate individuals can utilize the system effectively.

Furthermore, the paper suggests that future research should explore cloud-based voting systems that eliminate the need for installation. It also emphasizes the importance of synchronizing the country's database to prevent illegal immigrants from exploiting the system.

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