International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 21 No. 4 (2025)

ijerst.editor@gmail.com

editor@ijerst.com

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Vol. 21, No. 4, 2025

Research Paper

ADVANCED SECURITY-DRIVEN ELECTRONIC VOTING MACHINE ARCHITECTURE USING XILINX FPGA FOR ROBUST ELECTORAL INTEGRITY

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ABSTRACT:

By utilizing FPGA technology from Xilinx, the research offers a safe and advanced method for electronic voting that guarantees data integrity, secrecy, and transparency. By leveraging sophisticated cryptographic algorithms and secure communication protocols, the system seeks to tackle the issues related to conventional voting systems, including fraud, vote manipulation, and voter impersonation. At its heart, the concept is an FPGA-based voting system that uses encryption methods to safeguard vote data and guarantee the exact recording of each vote. By utilizing biometric or smart card verification, the system guarantees voter authentication and safeguards against unwanted access. In addition, it ensures the secrecy of votes by using methods such as homomorphic encryption, which prevents the disclosure of voter identities during vote processing. The system's adaptability and scalability are enhanced by the utilization of Xilinx tools in the creation of bespoke hardware. The design has features that enable authorities to monitor and audit the system in real-time, ensuring its integrity throughout the voting process. The system's reliability and speed in processing a large number of votes are guaranteed by the usage of FPGA. With these qualities included, the suggested system provides a complete and unchangeable answer to the problem of modern elections; it increases faith in the voting process and safeguards voters' privacy and security.

Keywords: FPGA, votetampering, EVm, Xilinx, LFSR, OTP, shipt register.

Received: 08-10-2025 Accepted: 23-11-2025 Published: 02-12-2025

I. INTRODUCTION

The introduction of a digital platform for casting votes, known as electronic voting machines (EVMs) [1], has completely transformed the way elections are conducted. But, these systems' susceptibility to many types of manipulation, hacking, and illegal access makes their security and integrity a major worry. To overcome these obstacles [2], Xilinx has introduced a security-based electronic voting machine that uses state-of-the-art FPGA technology and strong cryptographic protocols to build a voting system that is both tamper-resistant and extremely safe. In an effort to boost voter confidence and reduce the dangers associated with conventional voting methods, this initiative aims to provide a trustworthy and open voting process [3].

A key component of this safe voting system is the use of FPGA (Field Programmable Gate Array) technology, particularly using Xilinx tools [4]. For fast execution of authentication protocols and encryption algorithms, specialized hardware circuits built using FPGAs which offer a great degree of speed and flexibility are necessary. Secure voting requires a hardware-based solution that can handle sophisticated cryptographic processes [5] Xilinx's Vivado and ISE design tools make this possible. The system can validate and process votes in real-time using FPGA, guaranteeing speed and accuracy—two crucial factors in election settings [6].

This electronic voting system's foundation is security. The system safeguards votes during

transmission and storage by utilizing encryption methods like Advanced Encryption Standard (AES) and Rivest-Shamir-Adleman (RSA), which prohibit any unwanted changes. Votes can be tallied without exposing the voter's identity or the substance of their vote because homomorphic encryption ensures vote secrecy [7]. The security of the system may be further enhanced and only authorized persons can take part in the election process by integrating biometric identification technologies like fingerprint or face recognition to confirm the voter's identity [8].

Voting process accountability and openness are also addressed by the suggested approach. The system may produce an immutable record of all transactions using hardware based on field-programmable gate arrays (FPGAs) [9], allowing one to track every vote from casting to counting. There will be less opportunity for election fraud or manipulation thanks to this feature, which allows election officials to check the system's integrity whenever they choose. Voter confidence in the election process is further enhanced by the system's ability to monitor voting activities in real-time, allowing for the rapid detection and mitigation of any suspicious conduct [10].

The goal of the "Security Based Electronic Voting Machine Using Xilinx Tool" is to develop an electronic voting system that is more safe, efficient, and transparent than current ones [11, 12]. This system provides an unprecedented combination of speed and security by combining field-programmable gat array (FPGA) technology with strong cryptography algorithms [13]. The suggested electronic voting system guarantees the most trustworthy and safe elections by including features like real-time monitoring [14], voter authentication, and secure vote transfer. An important step forward in the development of voting technology, this system has the potential to significantly impact how democracies function in the years to come [15].

II. SURVEY OF RESEARCH

[1] The article "A Secure Electronic Voting System Based on FPGA and Blockchain Technology" was written by B. Zhang, Y. Zhang, and L. Zhang in 2019.

Using field-programmable gate arrays (FPGAs) for real-time vote processing and blockchain technology for data integrity, this article presents a safe voting system. It stresses the significance of decentralized ledger systems in conjunction with hardware-based security for an electoral process that cannot be tampered with.

[2] A. Gupta and R. Agarwal's "Design and Implementation of an FPGA-based Voting System for Secure Elections" (2017).

The authors provide a voting system that uses field-programmable gate arrays (FPGAs) and cryptographic approaches to guarantee the security of votes. The system employs encryption methods such as AES and RSA for safe transmission and makes use of Xilinx FPGA devices for efficient vote processing.

[3] The work by M. Patel, V. Desai, and R. Shah titled "Electronic Voting System Using Xilinx FPGA" was published in 2020.

In order to create a secure and quick electronic voting system, this study investigates the possibility of using Xilinx FPGA. In this article, we'll go over how we used Xilinx tools to simplify hardware and encryption module development, as well as how we implemented secure protocols like RSA.

[4] Article cited as "A Secure and Scalable Electronic Voting Scheme Based on FPGA" in 2018 by S. Liu and H. Liu.

In this study, we offer an FPGA-based system for electronic voting that combines scalability with security. A system that can manage large-scale elections while keeping votes secure and private is designed by the authors using Xilinx FPGA.

[5] J. C. Lee and T. H. Kim's "FPGA Implementation of a Secure Voting System" (2016).

An FPGA-based secure voting system is the primary emphasis of this effort. Secure vote collecting and transmission is achieved by the authors using Xilinx's Vivado suite to develop an FPGA-based architecture. This architecture employs cryptographic algorithms and hardware-level security features.

[6] "A Secure Electronic Voting Scheme for E-Government Applications" (S. Kumar and S. K. Sharma, 2015).

Using encryption and field-programmable gate array (FPGA) technology, this paper suggests a safe electronic voting system for e-government purposes. The authors use field-programmable gate arrays (FPGAs) from Xilinx to improve processing speed,

vote authentication, and data integrity control.

[7] By M. S. Chen and K. H. Lee (2018), "Design of an Electronic Voting System with Secure Authentication Using FPGA" was published.

This study delves into the design of a safe voting machine that utilizes FPGA technology. The authors specifically address the issue of voter authentication using biometric technologies. A quick and secure hardware architecture is implemented using the Xilinx FPGA to provide both voter identity verification and vote secrecy.

III. PROPOSED SYSTEM

To prevent voting system manipulation, electronic voting machines serve an essential role in democratic societies. Electronic voting machines are crucial for a number of reasons, including the protection of voters' personal information, the reliability of election results, and the elimination of the need for paper ballots. Our work takes into account a voting procedure with three contestants: party0, party1, and party2. The registers seg0, seg1, and seg2 hold the votes of party0, party1, and party2, respectively. To enable the voting process, one uses Venable, and to enable the complete election process, one uses clk. Each contestant's voting can be activated with the 2-bit input known as Vswitch. To vote for party0, set vswitch to 00; to vote for party1, set vswitch to 01; and to vote for party2, set vswitch to 10. When the venable is not in the high condition to begin the voting process or if a voter attempts to vote for any contender, the signal "invalid" is activated. Doubt will retain the total votes of all candidates. The development and verification of one-time passwords (OTPs) from the voter's mobile device prior to granting access to the voting process can be a security measure. An One-Time Password (OTP) may be generated using a pseudo-random binary sequence generator (PRBS) to produce a 6-bit random integer. Therefore, a democratic society may benefit from a digital electronic voting system that is safe, secure, and honest.

A Linear Feedback Shift Register (LFSR) is used to create the one-time password (OTP) for the aforementioned uses. You can see the 8-bit pattern generator in Figure 1, which may produce the pattern X^7+X^5 +X^4+X^3+1. The need for low power consumption circuits is growing in tandem with the rate of technological advancement. As a result, the circuit is often anticipated to have a smaller footprint, faster reaction time, and lower power consumption. The power consumption of flip-flops with active clocks in register designs is too high to provide high throughput, hence pulsed latches are recommended as a replacement for flip-flops.

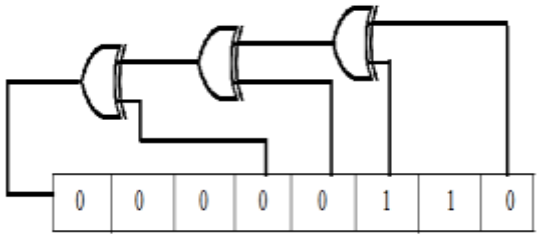

Fig.1. 8-bit LFSR circuit

There are several approaches described in the literature that may be used to lower the device's power consumption. Reducing the amount of transitions is one way to optimize power consumption. Swapping bits and applying clock to half of the circuit reduces transitions. Another method used for optimizing power consumption is clock gating. The device's power consumption is minimized by the use of numerous optimization techniques; nonetheless, these methods do nothing to reduce the reaction time and area. strategies for maximizing speed and decreasing space are also utilized, similar to power optimization strategies. To make the shift register faster, we employ the tried-and-true approach of converting the architecture from serial to parallel and using pipelining methods. Additionally, the performance is increased in the transposed serial architecture when the output value is calculated just by using the past feedback value. One way to save overhead is to convert lengthy LFSR sequences to many short LFSR sequences in series. When it comes to critical route delay, none of the methods utilized to decrease power, area, or speed are efficient.

IV. WORKING METHODOLOGY

Building a bespoke hardware architecture with Xilinx FPGA tools like Vivado and ISE is the first step in the process methodology of the Security-Based Electronic Voting Machine Using Xilinx Tool. The versatility, speed, and efficiency with which Xilinx FPGAs manage parallel processing jobs are the deciding factors in their selection. Encryption,

voter authentication, and real-time vote processing are some of the security measures that the system contains. Secure vote transmission, storage, and retrieval are ensured by implementing cryptographic methods like AES or RSA in the FPGA-based design, which prevents unwanted access or manipulation. Fast vote processing is also made possible by the FPGA, which is essential for accurate results in time-sensitive elections.

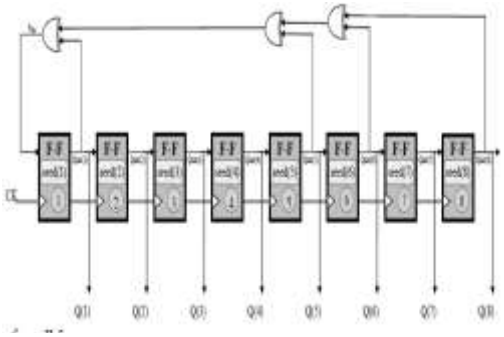

Fig.2. Proposed model.

Voter verification and casting ballots constitute the second phase of the approach. Biometric technologies, like fingerprint or face recognition, or secure identification methods, such smart cards, are used to verify voters. Once they've verified their identity, voters may use a user-friendly interface to cast their ballots. Before storing or transmitting any vote, the system encrypts it using a strong encryption process to guarantee secrecy. To ensure the privacy and security of the votes, the system employs homomorphic encryption to encrypt them as they are processed. The FPGA effectively handles the encryption and decryption duties in real-time, guaranteeing a quick and safe procedure.

Lastly, for accountability and transparency, the system includes audit trails, safe vote storage, and secure vote counting. Votes are safely kept in the FPGA's memory or an external storage system, and audit trails that cannot be tampered with are created utilizing secure logging or blockchain technology. The results are presented after decrypting and tallying the encrypted votes, which occurs after the voting session finishes. In order to identify and address any questionable behavior or possible security breaches, the FPGA-based system incorporates real-time monitoring. The use of Xilinx FPGA technology in an all-encompassing method makes electronic voting safe, transparent, and efficient while also lowering the possibility of manipulation and fraud.

V. RESULTS EXPLANATION

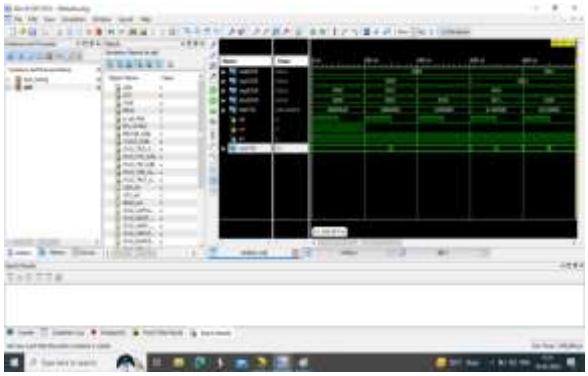

Fig.3. Simulation Result

This clock signal is utilized to initiate the election process in the simulated electronic voting system. When it comes to voting, Venable is a pro. To choose which candidates to vote for, we utilize the "V" switch.This is where the contestant-specific outputs (seg0, seg1, seg2, and total votes Dout) are derived from.

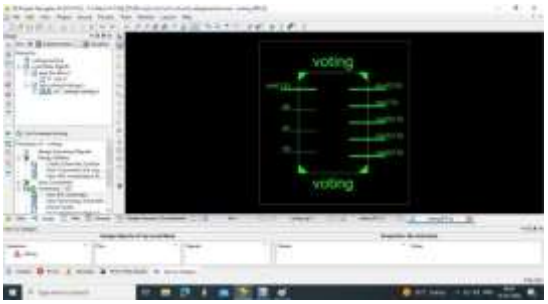

Fig.4. Block Diagram

With the inputs of a clock reset, a V switch, and an enable signal, the electronic voting machine may produce the outputs shown in Figure 4 (seg0, seg1, seg2, and Dout).

Fig.5. RTL Schematics

As shown in Figure 5, we may construct the internal circuits for the electronic voting machine using the RTL schematic.

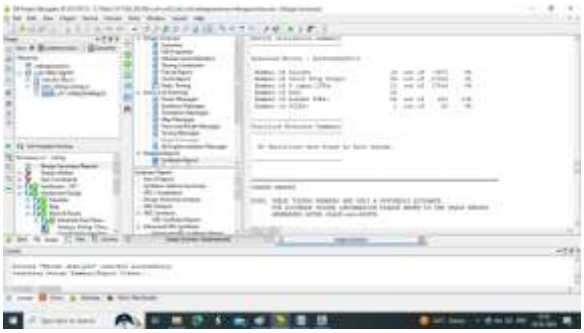

Fig.6. Area Report

Here is the area report of the electronic voting system that we need to deploy (Fig. 6).

Fig.7. Power Report

Fig.7: The Voting Machine's Power Report This will provide the circuit's power consumption.

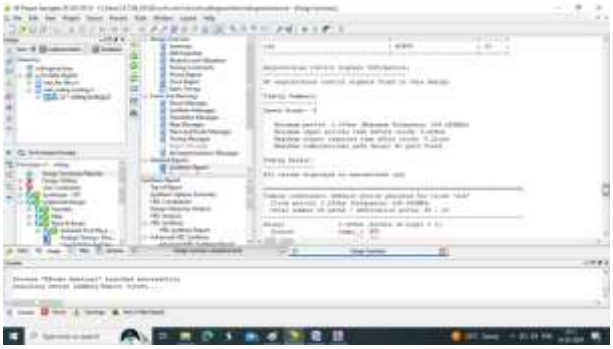

Fig.8. Output results.

VI. CONCLUSION

In conclusion, the Security-Based Electronic Voting Machine Using Xilinx Tool offers a robust, secure, and efficient solution for modern electoral processes by integrating FPGA technology with advanced cryptographic protocols. By utilizing Xilinx FPGAs, the system ensures fast processing, secure vote transmission, and real-time data validation, making it highly resistant to tampering, fraud, and unauthorized access. Features such as voter authentication, vote encryption, and secure storage provide a high level of privacy and data integrity, while the use of audit trails ensures transparency and accountability throughout the election process. Overall, this system represents a significant advancement in electronic voting technology, providing a trustworthy and scalable solution for secure elections.

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