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Electronic Voting Machine Using Fingerprint Sensor and Arduino UNO

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***Abstract*—**Secure, transparent, and efficient voting systems are critical for maintaining democratic integrity. Traditional electronic voting machines often rely on physical identification methods that are vulnerable to impersonation and fraudulent activities. This paper presents the design and implementation of an electronic voting machine that integrates a fingerprint sensor with an Arduino Uno microcontroller to enhance security and eliminate duplicate voting.

I. INTRODUCTION

The process of conducting free and fair elections is fundamental to the democratic framework of any nation. Traditional paper ballot systems, although still used in many regions, suffer from several drawbacks including ballot stuffing, lengthy counting procedures, and high operational costs. To overcome these issues, Electronic Voting Machines (EVMs) have been adopted in many countries. These machines improve the speed and accuracy of vote counting; however, they are not entirely immune to security threats such as tampering, duplication of voter identities, and unauthorized access.

One of the most critical challenges in conventional voting systems, whether paper-based or electronic, is the authentication of voters. Most EVMs rely on manual verification or voter identification cards, which can be forged, stolen, or misused. Such vulnerabilities may compromise the credibility of the entire election process. To address these concerns, researchers and governments have increasingly explored biometric authentication as a

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means to strengthen the security and transparency of elections.

Biometric authentication refers to the use of unique physiological or behavioral characteristics, such as fingerprints, iris patterns, or facial features, to verify an individual's identity. Among these methods, fingerprint recognition stands out due to its high reliability, ease of acquisition, low cost, and widespread acceptance. Every individual possesses a unique fingerprint pattern that remains stable throughout life, making it a suitable and robust choice for voter authentication. Integrating fingerprint verification with an electronic voting system can significantly reduce electoral fraud, prevent multiple voting attempts, and ensure that only legitimate voters participate in the process.

In this work, we propose an electronic voting machine that incorporates a fingerprint sensor with an Arduino Uno microcontroller. The Arduino Uno is selected for its affordability, simplicity, and compatibility with a wide range of hardware modules, making it ideal for prototyping and small-scale implementation. The system is designed to first authenticate the voter using fingerprint matching; once validated, the voter is granted access to cast a vote. The recorded votes are securely stored and can be retrieved for counting and verification, ensuring both accuracy and reliability.

The motivation behind this system lies in developing a low-cost, tamper-resistant, and user-friendly voting machine that can be deployed in small- to medium-scale elections, such as institutional voting, community decision-making, or local governance. Furthermore, the integration of biometric technology in voting systems enhances voter confidence, reduces the dependency on manual supervision, and minimizes the risk of fraudulent practices.

The remainder of this paper is structured as follows: Section II presents a review of related research on biometric voting systems and Arduino-based implementations. Section III explains the system design, including both hardware and software components. Section IV discusses the results of the prototype testing and evaluates its performance. Finally, Section V concludes the paper and outlines potential future enhancements such as database integration, cloud-based vote storage, and large-scale deployment.

The credibility of an election depends not only on the fairness of the process but also on the reliability of the technology used to conduct it. While Electronic Voting Machines (EVMs) have reduced the dependency on manual counting and minimized human error, they are still vulnerable to manipulation, unauthorized access, and voter impersonation. In many cases, voter identity is verified manually using identification cards or voter lists, which can be forged, misplaced, or duplicated, leading to fraudulent practices. These challenges highlight the urgent need for more advanced and secure voting technologies.

Biometric authentication, particularly fingerprint recognition, has become one of the most reliable methods of identity verification in recent years. Fingerprint-based systems are already being used in areas such as banking, attendance management, and access control due to their uniqueness, stability, and ease of use. Unlike traditional methods of authentication, fingerprints cannot be easily duplicated or shared, making them ideal for secure voting applications. Integrating biometric verification with electronic voting ensures that each voter can cast a single vote, thereby enhancing transparency and accountability in elections.

Several researchers have proposed and implemented biometric voting systems using microcontrollers, but many of these solutions face challenges such as high implementation cost, complex hardware requirements, and lack of scalability. In this context, the Arduino Uno microcontroller offers an attractive platform due to its affordability, ease of programming, compatibility with biometric modules, and widespread support from the open-source community. It enables the design of cost-effective prototypes that can be easily scaled or modified for institutional, community, and local elections.

The proposed system integrates a fingerprint sensor with an Arduino Uno to authenticate voters before granting access to cast a ballot. Once verified, the voter can select their candidate, and the vote is securely recorded in memory, preventing duplicate voting. The system is designed to be simple, reliable, and tamper-resistant,

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making it suitable for real-time deployment in environments where both cost and security are critical considerations.

The main contributions of this work are as follows:

1. Development of a prototype electronic voting machine that integrates biometric fingerprint verification with Arduino Uno for enhanced voter authentication.
2. Demonstration of a secure, tamper-resistant system that prevents duplicate voting and ensures accurate vote recording.
3. Evaluation of the system's performance in terms of authentication accuracy, response time, and reliability.
4. Presentation of a cost-effective solution suitable for small- to medium-scale elections.

By addressing the limitations of traditional EVMs and incorporating biometric authentication, this system contributes toward building a more secure and trustworthy voting framework.

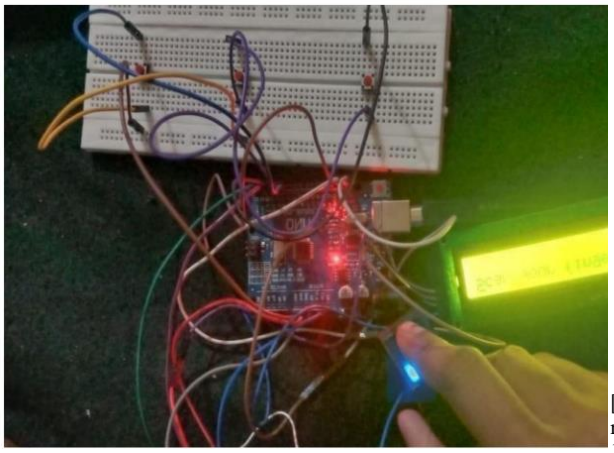

Fig.1.Output

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