Design and Development of Biometric based Electronic Voting System

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Abstract - In this research, a system that makes use of fingerprint and RFID technology is the main focus of this project. An RFID tag is given to each user, serving as their voter ID. The finger print scanning sensor included inside the gadget compares the user's print to one that has already been noted. The two finger prints are compared during voting, and a buzzer sounds to inform voters if they don't match. You can choose your preferred voting method using the keypad show the relevant information about the user for every key. Because each person's fingerprints are unique, it is consequently impossible to vote unlawfully. Voting is only completed when there is a match between the fingerprint and the recorded value. A "Secure Electronic Voting System" initiative aims to satisfy the urgent need for a reliable and impenetrable voting infrastructure in modern democracies. Through the use of trustworthy electronic voting technology, the openness, precision, and security problems can be minimized. Our research aims to increase public confidence in voting systems and promote a more robust and transparent democratic society by utilizing cutting-edge technologies.

1. INTRODUCTION

Now a day's election process plays a very important role in Indian government. Election is a process to select a perfect candidate who will lead our nation. In democracy people choose their leader by giving their valuable vote. The Electronic voting system can be operated with the application of controllers, computers, and computerized voting tools in order to enhance the process of casting ballots during an election. As one of the most important behaviors in the electoral process, voting methods have progressed in parallel with the development of the electoral system, from initially simple methods (such as standing in line to vote in public, and hand raising) to the implementation of ballot boxes (or similar devices), which serve to protect the privacy of voting citizens.

The "Biometric Based Electronic Voting System" is a project that aims to transform the electoral process by utilizing RFID, biometric, and Raspberry Pi 4 capabilities to guarantee a safe and effective voting process. A fingerprint sensor, an RFID tag and reader module, a keypad for voting, an auditory feedback buzzer, and a steady power source to guarantee continuous operation are all integrated into this system. The Raspberry Pi 4, the system's central component, runs the Raspberry Pi OS and makes use of specialized libraries for RFID reading and fingerprint sensing, which makes it easier for software and hardware to integrate and communicate with one another.

Voter biometric data is collected by the fingerprint sensor during voter authentication, which is the first step in the process. The voter's identity is then verified by cross-referencing this data with an already-existing database, guaranteeing that only voters who have registered to vote may do so. Each voter must present their individual RFID card, which is scanned and validated against the system's records, in order to add an extra degree of security. The RFID tag and reader module are used. The voting process's integrity is guaranteed by this dual-factor authentication mechanism, which also drastically lowers the possibility of fraudulent activity.

After a successful authentication process, the voter uses the keypad to select their options as they move on to the voting phase. The keypad offers a simple interface for casting votes, and the system design guarantees that the voting process is accessible and user-friendly. In order to improve the user experience by giving distinct auditory cues, a buzzer is integrated to provide instantaneous feedback on the status of actions, such as successful authentication and vote submission.

The Raspberry Pi OS, which offers a stable operating environment and the software libraries required for the fingerprint sensor and RFID reader module, is in charge of integrating these parts. These libraries make it easier to collect and process data

accurately, guaranteeing that every vote is securely and accurately recorded. A dependable power source powers the entire system, guaranteeing steady and consistent operation during the voting period.

2. LITERATURE SURVEY

[1] RFID and Fingerprint Recognition based Electronic Voting System for Real Time Application

Author name: Ashok Nalluri, B. Bhanu Teja, A.Balakrishna

The study investigates complex voting systems that combine fingerprint and RFID technology. An RFID tag is used to provide a voter's ID to each user. A fingerprint scanning sensor built into the hardware compares the user's fingerprint to one they've previously stored. Both fingerprints are compared during voting, and if any differences are found, a warning buzzer will sound. Voters express their preferences using a keypad, and each selection is accompanied by an LCD that shows pertinent data. Because each person's fingerprint is distinct, the system makes sure that voting illegally cannot occur. As a result, the electoral process is guaranteed to be secure and legitimate because voting can only begin if the fingerprints match.

[2] RFID Based Electronic Voting Machine Using OTP and Bio-Metric Verification

Author name: Ravuri Chandrika, K. Gowtham, S. Bhavya

Voting is a fundamental component of India's democratic system, as it allows citizens to choose their representatives. Illegal activities, however, pose a threat to the integrity of this process and could result in the election of unfit leaders. In order to combat these malpractices, the government has put in place a number of measures, the most important of which being voting process verification. A three-step procedure has been developed to deal with fraudulent voting. At first, every person's personal information is kept in a database, and they are each given an RFID card with their information on it. When someone is a member of the physically challenged population, they go through an extra OTP verification process after their RFID tag authentication. This multi-step verification procedure is intended to guard against election manipulation and avoid duplicate voting, ensuring the integrity and openness of India's electoral process.

[3] Fingerprint biometric voting machine using internet of things

Author name: Zakiah Mohd Yusoff, Yusradini Yusnoor, Arni Munira Markom, Siti Ami nah Nordin, Nurlaila Ismail

The holding of free and fair elections, in which voters choose their representatives, is a pillar of democracy. It is emphasized how important it is to have free, fair, and private elections. Voting used to entail stamping paper, inserting it into a ballot box, and then manually tallying the results—a laborious and error-prone process. This study suggests a comprehensive system to prevent election fraud and expedite the voting process in order to address these issues. The project is controlled by an Arduino Uno, and user verification is ensured by fingerprint authentication, which makes use of the distinctiveness of each person's fingerprint. Programming is done via the Arduino IDE, which makes it possible to show the ballot card and store the results on the cloud. Voters who are registered to vote only may Voting is allowed for registered voters only, and the system is designed to identify and notify users of any fraudulent activity. The goal of this project is to uphold democratic values by protecting citizens' right to vote and guaranteeing fair elections.

[4] ONLINE VOTING SYSTEM USING FINGERPRINT SENSOR, FAC RECOGNITION AND QRCODE SCANNER

Author name: MS. SHUBHANGI D. DHANE, PROF. S. B. RATHOD

The limitations and vulnerabilities of India's current voting systems, such as electronic voting machines (EVMs) and secret ballot paper, raise worries about security and safety. These problems are made worse by instances of fraudulent voting by ineligible voters, which calls for a renewed emphasis on voter identification. Online voting is still new in India, despite advances in voting technology worldwide. This project suggests a novel identification method for online voting systems in order to address these problems. To improve security and integrity, the proposed system combines fingerprint scanners, QR codes, and facial recognition technology for voters. Three modules comprise the voting process: Super Admin, Admin, and User. Each user must enroll under the Super Admin's supervision. By utilizing multi-tiered authentication and cutting-edge identification technologies process, the goal of this project is to reduce fraudulent voting and increase

the legitimacy of online voting in India. Transparency and accountability are further improved by the efficient administration and supervision of the voting process, which is ensured by the separation of roles and duties among various modules.

[5] ELECTRONIC VOTING MACHINE USING RFID AND FIN GERPRINT

Author name: Ajaykumar K H, Akash R B, Dhanunjay J T

To improve security and stop voting-related misconduct, this project suggests a voting mechanism that combines RFID technology and fingerprint identification. The principal aim is to enhance the credibility of voting processes by employing fingerprint verification and RFID authentication. Voter names and fingerprints are stored in a database as one of the system's key features, and RFID tags are used to match user data. Following RFID verification, the user's fingerprint is authenticated by the system to confirm the vote's legitimacy. The system also looks for instances of multiple voting and shows the results on an LCD screen. The system produces a "Already voted" notification in the event of malpractice, such as attempted multiple voting. Programming is done for the system. employing the Arduino IDE, and an LCD interface to enable the ballot card to be displayed. Notably, voter integrity and confidentiality are preserved by the system, which only notifies administrators in the event of malpractice. The electoral process is legitimate because only authorized voters are allowed to cast their votes.

3. METHODOLOGY

The Raspberry Pi 4 is selected for its versatility and strong processing power. The Raspberry Pi is interfaced with the fingerprint sensor, which is the main method of voter identification, through GPIO (General-Purpose Input/Output) pins. The fingerprint sensor library is used by the Raspberry Pi to process the biometric data that is captured by the sensor. To add even more security, an RFID tag and reader module are incorporated into the system at the same time. To ensure dual-factor authentication, each voter is given a distinct RFID card that is used are voter-Id, the RFID module needs to read. Through a serial interface, the RFID module connects to the Raspberry Pi and uses the RFID reader module library to process and validate data.

The Raspberry Pi OS is a flexible and stable operating system that supports many libraries required for the project. The RFID reader module library manages the reading and authentication of RFID tags, the fingerprint sensor library is used to collect, store, and validate fingerprint data. To handle these exchanges, unique scripts are created, guaranteeing smooth data processing and movement.

When the voter approaches the voting voting station, the authentication starts. Prior to the voter's biometric data being sent to the Raspberry Pi for verification against a pre-registered database, the voter is asked to show their RFID card. The voter is then asked to place their finger for verification, if RFID is confirmed. After the card is scanned by the RFID reader and the fingerprint is confirmed, the data is confirmed once more. Voters are only permitted to move on to the voting phase after completing dual-factor authentication successfully.

The voter is sent to the voting phase after their authentication is successful. The voter can use the keypad to choose their favorite candidates from the list of options. Every vote will be precisely registered and kept in a safe database on the Raspberry Pi. The buzzer confirms that the vote was cast successfully by providing instant feedback. and wait times are reduced thanks to the voting process' streamlining, which makes it rapid and effective.

The votes cast and all biometric and RFID data are safely kept in the Raspberry Pi database. To safeguard the data and make sure that unauthorized people cannot access it, encryption techniques are used.

4. HARDWARE COMPONENTS

Raspberry Pi:

The Raspberry Pi 4, a versatile single-board computer responsible for coordinating the operations of all connected components. It runs the Raspberry Pi OS and hosts the necessary software libraries for interfacing with the fingerprint sensor, RFID reader, keypad, and buzzer. The Raspberry Pi 4 processes biometric data from the fingerprint sensor, reads and verifies RFID tags, manages user input from the keypad, and controls the buzzer for auditory feedback. It acts as the central hub, ensuring smooth communication and integration between all hardware elements.

Fingerprint sensor:

The fingerprint sensor is directly connected to the Raspberry Pi 4 and is used for biometric authentication of voters. When a voter places their

finger on the sensor, it captures the biometric data and sends it to the Raspberry Pi for verification against a pre-registered database. This ensures that only authorized individuals can proceed to vote, thereby enhancing the security of the voting process.

RFID module (EM-18):
The RFID tag/reader module is another critical component connected to the Raspberry Pi. It serves as a secondary layer of authentication, where each voter is provided with a unique RFID card. The voter must present this card to the RFID reader, which then sends the tag information to the Raspberry Pi for validation. This dual-factor authentication (fingerprint and RFID) significantly reduces the likelihood of unauthorized voting and ensures the integrity of the voter verification process.

RFID cards:
RFID (Radio Frequency Identification) cards are a kind of wireless communication technology that use radio waves to identify and follow a person or an object. These cards are made up of an antenna that allows them to interact with RFID readers and a microchip that has a unique identifier embedded in it. Because RFID technology can identify a person quickly, contactlessly, and reliably, it is highly valued and used in many different applications, such as electronic payment systems, inventory management, and access control. The microchip, which houses a distinct serial number or other important data, is the main part of an RFID card. An antenna that is attached to this microchip makes it easier to communicate with an RFID reader.

Buzzer:
The audible alert component, a passive buzzer, plays a vital role in Raspberry Pi software, generating local notifications or alarms in response to sensor readings or system events. Through its integration with the software via a GPIO pin, users can directly control the buzzer's operations, enhancing the system's responsiveness and adaptability. This feature enables timely alerts of critical information, significantly enhancing the Raspberry Pi's utility in real-time notification and alarm applications, making it an indispensable component in various projects.

TTL module:
Transistors are a type of digital logic circuitry that are used in TTL (Transistor-Transistor Logic) modules to handle data and perform logical operations. These modules, which are well-known for their quickness, dependability, and simplicity of interface with microcontrollers and other digital devices, are essential parts of digital systems and electronics. Typically, two voltage ranges—a low level (0) and a high level (1)—define TTL logic levels. A voltage near 0V denotes a logic low in most TTL systems, and a voltage near 5V denotes a logic high (1).

5. BLOCK DIAGRAM

The architecture of a biometric-based electronic voting system with a Raspberry Pi 4 serving as the central controller is depicted in the block diagram. Key components of the system are integrated, such as an RFID tag/reader module, a keypad, a buzzer, a power supply, and a fingerprint sensor. The Raspberry Pi and all of its peripherals receive the electrical power they require from the power supply. Voters' biometric information is captured by the fingerprint sensor for identity verification, and their RFID cards are scanned by the RFID reader for additional voter authentication and to avoid duplicate voting. Voters can choose their candidates using the keypad, and the Raspberry Pi will process and record their selections. When an action is completed, such as a successful verification, an incorrect input, or a vote confirmation, the buzzer sounds. The required software is run on the RFID module and fingerprint sensor, as well as controls communication between all parts to guarantee safe, precise, and effective voting procedures.

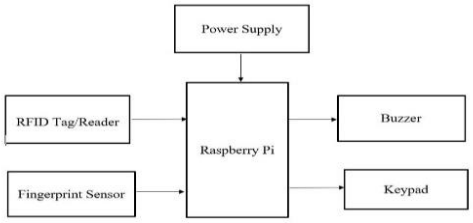

Figure 1. Block Diagram

6. CIRCUIT DIAGRAM

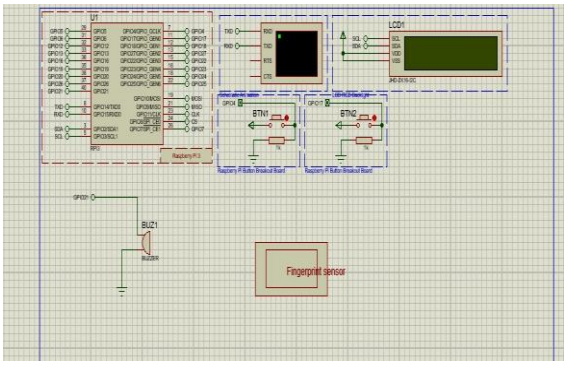

Figure 2. Circuit Diagram

7. FLOW CHART

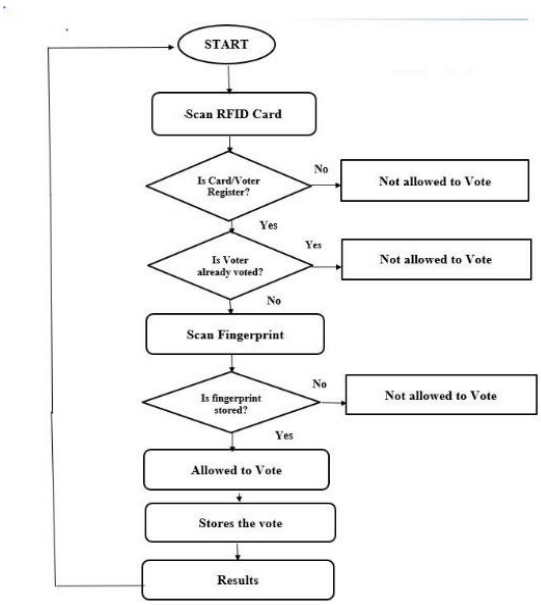

Figure 3. Flow chart

8. RESULTS AND OUTCOMES

All connected peripherals were successfully initialized by the Raspberry Pi 4 running Raspberry Pi OS. Using the appropriate libraries, the fingerprint sensor and RFID reader were correctly identified and configured. According to the initialization logs, there were no startup errors and every component was working. This dependable initialization procedure made sure the system was prepared for the voting and authentication tasks that followed. Using the RFID library, the RFID reader module reliably read and recognized every registered RFID tag. Throughout testing, the system successfully verified legitimate tags and compared them to the Raspberry Pi's voter database that was pre-loaded. Tests were also conducted with invalid RFID tags, and the system correctly activated the buzzer to signal an authentication failure. There were no cases of improper tag recognition or compromised RFID authentication thanks to a reliable process. discrepancies, guaranteeing precise and safe voter identification. The fingerprint sensor processed and recorded fingerprint data with accuracy by using the fingerprint library. The system was able to successfully match fingerprints that were registered with templates that were kept in the database. The buzzer gave clear feedback when an authentication attempt failed using an unregistered fingerprint. The fingerprint authentication method proved to be highly dependable and secure, successfully thwarting unwanted access. On an attached screen, voters who had verified their identity were shown a clear selection of voting options. Voters used the keypad to select options in an easy-to-use voting process. Before the vote was recorded, the system asked for confirmation to make sure it was accurate. The integrity and confidentiality of the voting data were guaranteed by the safe storage of each vote in the Raspberry Pi's database. The system managed scenarios with ease, showcasing its effectiveness and usability. The buzzer was triggered by the system to indicate that voting was finished after a successful vote submission. After that, the system was reset, erasing session data and getting ready for the following voter. This feature of the reset function was consistently dependable, guaranteeing that every new voter started the process from scratch. During the testing phase, the system's security and readiness were successfully preserved by the reset mechanism.

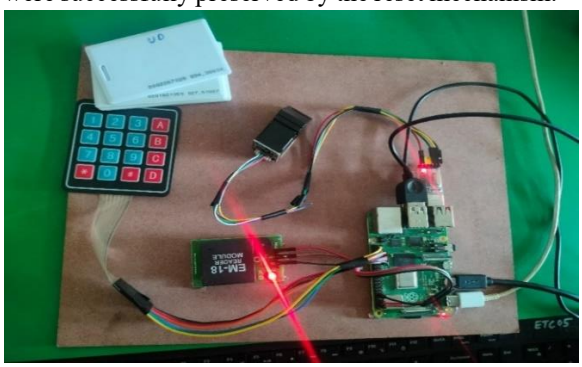

Figure 4. Hardware Result

Figure 5. Actual Product

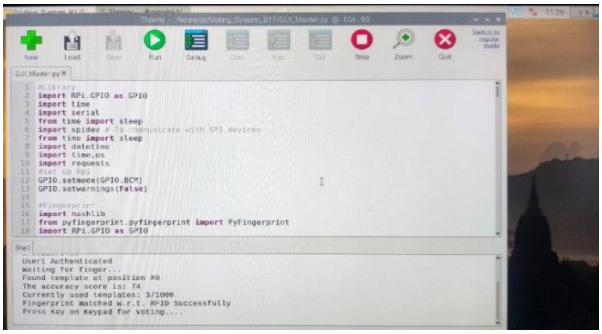

Figure 6. Software Result

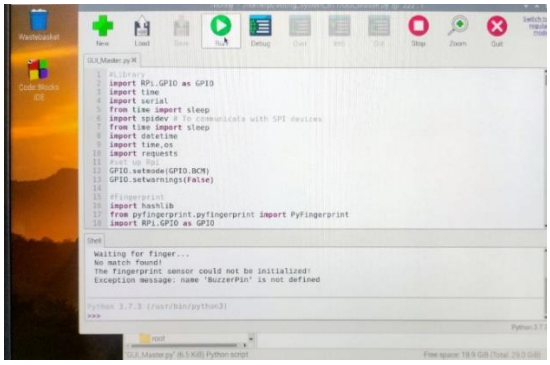

Figure 3: Fingerprint not found

9. CONCLUSION

Using a Raspberry Pi 4, fingerprint sensor, RFID tag and reader, buzzer, power supply, and keypad, the "Biometric-based Electronic Voting System" was developed and tested. The results show that the system is functional, secure, and reliable. A thorough testing process validated the system's reliable multi-factor authentication via fingerprint and RFID verification, safe vote recording, and smooth component communication enabled by Raspberry Pi OS and pertinent libraries. In order to ensure vote integrity and confidentiality, the system offered precise voter identification, user-friendly voting procedures, and safe data storage. With further testing and user feedback, this promising solution can be put into practice and provide a safe, effective, and easy-to-use electronic voting system that can improve democratic processes all over the world.

10. FUTURE SCOPE

In the upcoming years, the voting process integrity and transparency can be guaranteed by enhancing the system with cutting-edge security features like blockchain technology and end-to-end encryption. Furthermore, user-friendly interface development and the integration of assistive technologies, such as voice recognition for visually impaired voters, can be employed to enhance accessibility. The system can be expanded to accommodate more voters and polling places during larger elections, and it has strong failover procedures to ensure uninterrupted operation. Additionally, remote voting might be made possible by safe web portals that use biometric authentication to prevent fraud and guarantee that only qualified voters cast ballots. By integrating with current voter registration systems, the authentication procedure can be streamlined and voter data can be kept accurate and up to date. Additionally, adding analytics and feedback features can yield insightful data and enable ongoing system enhancements based on voting trends and user experiences. The creation of mobile applications could improve accessibility and convenience even further by enabling voters to safely register and cast ballots using smartphones. Finally, gaining widespread acceptance and standardizing practices will depend heavily on working with election authorities and making sure that regulatory standards are followed. By investigating these potential upgrades, the system can develop into a highly safe, effective, and inclusive solution for contemporary election procedures, encouraging increased confidence and engagement with democratic processes.

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