ABSTRACT

This Mini Project report documents the development of an Arduino-based electronic voting machine (EVM) aimed at enhancing the accuracy, security, and efficiency of the voting process. By utilizing an Arduino microcontroller, the EVM facilitates a smooth voting experience through a clear interface, with an LCD display that provides voter instructions and buttons for candidate selection. Each vote is recorded in real time to ensure accuracy and prevent duplicate entries. The system operates on a simple yet robust logic that manages voter interaction, secure vote storage, and results display. Designed as a prototype for small-scale use, this EVM presents a cost-effective, user-friendly solution that can be expanded for broader applications. By demonstrating effective data handling and intuitive design, the project underscores the potential for low-cost electronic systems in transforming traditional voting practices into more modern, accessible formats.

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LIST OF FIGURES

CHAPTER 1
INTRODUCTION

In democratic systems, elections are essential for ensuring that citizens have a voice in their governance. However, the credibility of these elections is contingent on the security, transparency, and efficiency of the voting process. Traditional paper-based ballots, while widely used, have faced several challenges, including the risk of vote tampering, multiple voting, long counting times, and the potential for human error. These issues can undermine public trust in the electoral process, making it essential to explore alternatives that address these concerns while maintaining the integrity of elections.

The introduction of Electronic Voting Machines (EVMs) has provided a solution to some of these problems by automating vote counting and reducing human intervention. EVMs significantly decrease the time it takes to tally votes, making the election process faster and more efficient. However, despite their advantages, EVMs still face concerns, particularly in terms of ensuring the authenticity of the voters. The risk of unauthorized access to the system or the possibility of individuals casting multiple votes remain significant threats, necessitating the need for additional layers of security to safeguard the election process.

Biometric-based authentication, particularly fingerprint recognition, has emerged as a promising solution to address these security challenges. By integrating fingerprint technology with an Arduino Uno microcontroller, an electronic voting system can ensure that only registered voters are allowed to cast their vote. This fingerprint-based system effectively eliminates the risks of duplicate voting and voter impersonation, enhancing the overall security and reliability of the election process. With automated authentication, voting, and result compilation, such a system offers a more transparent and efficient electoral process, building greater public confidence in the democratic process.

CHAPTER 2
LITERATURE REVIEW

2.1 FINGERPRINT BIOMETRIC VOTING MACHINE USING IOT

Authors: Zakiah Mohd Yusoff, Yusradini Yusnoor, Arni Munira Markom, Siti Aminah Nordin, Nurlaila Ismail

This paper presents a fingerprint biometric voting system integrated with IoT to enhance election security and efficiency. The system addresses challenges in traditional voting methods by ensuring free, fair, and secret elections. It eliminates unauthorized voting by authenticating users through fingerprint biometrics before allowing them to cast their vote. The study highlights the impact of biometric authentication in reducing electoral fraud and improving voter accessibility.

2.2 FINGERPRINT-BASED VOTING SYSTEM

Authors: Gangadurai, S.

This study introduces a fingerprint-based voting machine leveraging Aadhaar card data to prevent electoral fraud. The system ensures that only registered voters can participate, eliminating duplication and identity theft. It utilizes an Arduino microcontroller and fingerprint sensor to authenticate users before allowing them to select candidates. The research emphasizes the need for biometric authentication to enhance voting transparency and reduce election malpractice.

2.3 REVIEW ON FINGERPRINT-BASED ELECTRONIC VOTING

Authors: A. Kumar, B. Kumar, C. Kumar

This review discusses various fingerprint-based electronic voting systems, emphasizing the integration of Aadhaar card details and biometric authentication to enhance security. The paper compares different technologies used in biometric voting systems and assesses their reliability and efficiency. It also explores the challenges of implementing large-scale biometric voting, such as data security, system accuracy, and response time.

2.4 BIOMETRIC EVM USING ARDUINO AND FINGERPRINT

Authors: Marwa Adeeb Al-Jawaherry

This paper details the design and implementation of an electronic voting machine using an Arduino microcontroller and fingerprint sensor for voter authentication. The system prevents unauthorized access and ensures that each voter can cast only one vote. The study discusses the advantages of Arduino-based voting machines in terms of cost-effectiveness, ease of implementation, and improved security compared to traditional voting systems.

2.5 ADVANCED FINGERPRINT-BASED VOTING MACHINE

Authors: S. Kumar, R. Singh

This research proposes an advanced voting machine utilizing fingerprint devices for voter verification, eliminating the need for physical ID cards. The system enhances election security by preventing multiple votes from a single individual and ensuring that only registered users can access the voting process. The study highlights the advantages of using biometric authentication over traditional voting methods and explores potential applications in government elections.

2.6 REAL-TIME BIOMETRIC EVM FOR SECURE ELECTIONS

Authors: A. Sharma, P. Verma

This study develops a controller-based electronic voting machine using the R305 fingerprint sensor for biometric authentication, aiming to prevent rigging and ensure fair elections. The system is designed for real-time implementation and provides a secure method for voter verification. The research examines the effectiveness of biometric authentication in elections and discusses potential improvements for future EVM models.

CHAPTER 3
PROJECT DETAILS

3.1 OBJECTIVES

- Develop a cost-effective electronic voting system using Arduino.
- Develop a fingerprint-enabled EVM for secure voter identification.
- Prevent duplicate and unauthorized voting.
- Ensure an accurate and secure vote-casting process.
- Provide clear, user-friendly instructions via an LCD display.
- Enable real-time vote tallying and result display.
- Demonstrate the feasibility of small-scale electronic voting for educational or prototype applications.
- Highlight the potential of Arduino in creating accessible electronic voting solutions.

3.2 PROBLEM STATEMENT

Traditional voting systems face security issues and inefficiencies, leading to fraud and counting errors. Weak voter verification allows unauthorized access, and manual counting is slow and prone to mistakes. This project develops an advanced EVM using a fingerprint sensor for voter authentication, ensuring only valid votes are cast. Real-time vote tallying enhances efficiency and accuracy, improving trust in the process.

3.3 APPLICATION

- **Government Elections:** Ensures transparency, prevents fraud, and speeds up result declarations.
- **University Elections:** Streamlines student elections with secure, paperless vot-

ing.

- **Corporate Voting:** Enables authorized voting for important corporate decisions.
- **Membership Organizations:** Ensures secure elections and reduces manipulation in clubs and societies.
- **Community Elections:** Facilitates fair elections in housing societies, eliminating disputes.
- **Polls and Surveys:** Ensures accurate, authenticated participation in surveys.
- **Remote Voting:** Allows secure voting for military personnel and remote workers.

3.4 CIRCUIT DIAGRAM

The Circuit Diagram of proposed system is given below:

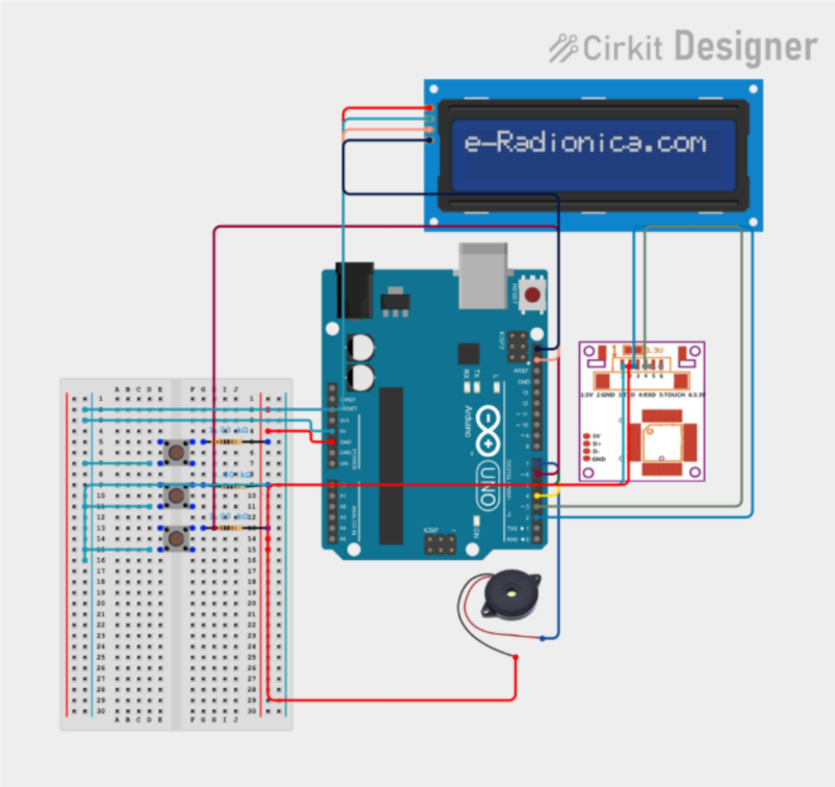


Figure 3.1: Circuit Diagram

Circuit Connections

1. **Power Supply Section:** The Arduino is powered through either a USB connection or an external power source. The I2C LCD module and the sensor module receive power from the 5V and GND pins of the Arduino, ensuring stable operation.

2. **LCD Display (I2C 16x2 LCD Module):** The LCD module is connected to the Arduino using the I2C protocol. The VCC pin of the LCD is connected to the 5V pin of the Arduino, while the GND pin is connected to the GND pin of the Arduino. The SDA pin of the LCD is connected to SDA, and the SCL pin is connected to SCL of the Arduino, enabling communication.

3. **Push Buttons:** Three push buttons are used in the circuit, each connected to a digital pin of the Arduino. The first button is connected to D4, the second to D5, and the third to D6. One terminal of each button is wired to the respective digital pin, while the other terminal is connected to GND via pull-down resistors, ensuring stable input readings.

4. **Buzzer:** A buzzer is included in the circuit to provide audio feedback. Its positive terminal is connected to D7 of the Arduino, while its negative terminal is connected to GND. This allows the Arduino to control the buzzer and produce sounds when required.

5. **Fingerprint Sensor Module:** The sensor module is powered by the 3.3V output from the Arduino, ensuring compatibility with its operating voltage. The GND pin of the sensor is connected to the GND of the Arduino. The data communication pins, such as TX and RX, are connected to D2 and D4 of the Arduino, enabling data exchange between the sensor and the microcontroller.

3.5 MAIN COMPONENTS

3.5.1 Arduino Uno

- **Specifications:**

  - Microcontroller: ATmega328P

  - Operating Voltage: 5V
  - Input Voltage (recommended): 7-12V
  - Digital I/O Pins: 14 (of which 6 provide PWM output)
  - Analog Input Pins: 6

- **Purpose:** The Arduino Uno serves as the control unit for the voting machine. It processes input from push buttons, manages data storage, and updates the display.

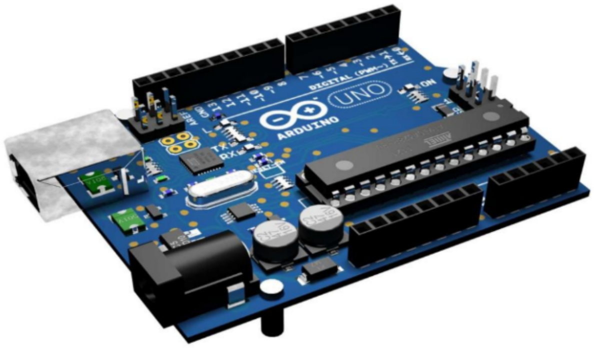


Figure 3.2: Arduino UNO

3.5.2 I2C LCD Display

- **Specifications:**
  - Type: 16x2 character LCD
  - Interface: I2C, reducing pin usage
  - Operating Voltage: 5V
  - Backlight: Integrated LED backlight for clear display

- **Purpose:** Displays instructions for users and shows voting options. At the end of voting, it displays results or any necessary messages.

Figure 3.3: I2C LCD Display

3.5.3 Push Buttons

- **Specifications:**
  - Type: Momentary push buttons
  - Operating Voltage: 5V
  - Debouncing Circuit: Required for stable signal
- **Purpose:** Each button represents a different candidate, allowing the user to select. Once pressed, the Arduino records the corresponding vote.

Figure 3.4: Push Button

3.5.4 Fingerprint Sensor Module R307S

- **Specifications:**
  - Interface: UART (TTL)
  - Operating Voltage: 5V
  - Fingerprint Capacity: 1000 templates
- **Purpose:** Used for biometric authentication in the voting machine, ensuring secure and unique voter identification.

Figure 3.5: Fingerprint Sensor

CHAPTER 4

WORKING

4.1 BLOCK DIAGRAM

The Block diagram of proposed system is shown below:

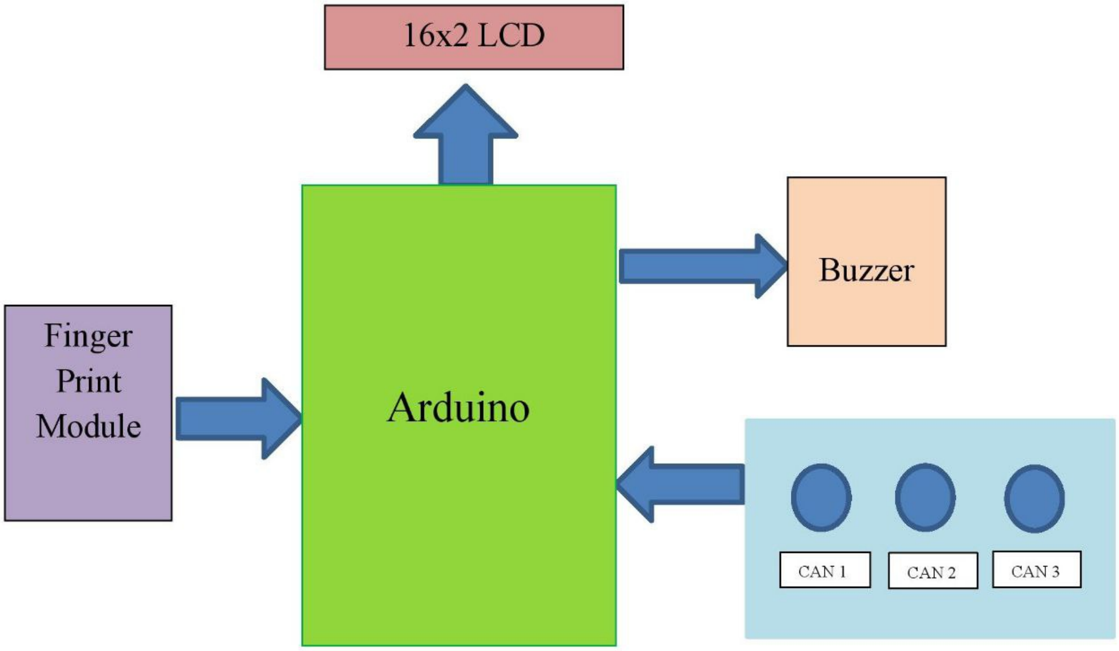


Figure 4.1: Block diagram

- **Power Supply**: Provides the required voltage and current to power the Arduino and prevents power fluctuations.

- **Arduino Microcontroller**: Acts as the central processing unit of the system. It receives input from the fingerprint module and buttons, processes the data, and controls the output components such as the buzzer and LCD display.

- **Fingerprint Module**: Captures and verifies the fingerprint of the user. It compares the scanned fingerprint with stored data and sends authentication results to the Arduino. If the fingerprint matches, the system proceeds with further actions.

- **16x2 LCD Display**: Displays real-time system information such as authentication status, error messages, or system prompts. It provides a clear visual interface for users to interact with the system.

- **Buzzer**: Acts as an alert mechanism. It emits sound signals to indicate different events, such as successful or failed authentication attempts. A short beep might indicate success, while a long or multiple beeps could signal an error or unauthorized access.

- **Buttons/Input Panel**: Provides manual input options for the user. These buttons can be used for additional functionalities such as selecting options, resetting the system, or initiating authentication manually.

4.2 THEORY AND WORKING MECHANISM

The Smart Electronic Voting Machine (EVM) using a fingerprint sensor is a biometric-based voting system designed to enhance election security and prevent duplicate voting. The system operates by authenticating voters through their unique fingerprints, ensuring that only registered individuals can cast their votes.

The system consists of an Arduino UNO microcontroller, a fingerprint sensor, a 16x2 LCD display with an I2C module, push buttons for voting, and a buzzer for audio feedback. When a voter places their finger on the fingerprint sensor, the system verifies their identity by matching it against stored templates. If a match is found and the voter has not voted before, they are prompted to press a button corresponding to their preferred candidate, which increases the respective party's vote count. If the same fingerprint is detected again, the system triggers the buzzer and prevents multiple voting.

The LCD display provides step-by-step guidance, showing authentication messages, voter ID confirmation, and voting results. The Administrator, identified by a specific fingerprint ID, can access the results at any time, with the machine determining the winning party based on the highest vote count.

The fingerprint sensor operates using optical recognition, capturing fingerprint images and converting them into digital templates for comparison. The Arduino acts as the central controller, handling fingerprint authentication, vote recording, and user interactions. The I2C-based LCD display simplifies wiring and improves efficiency in displaying results. The buzzer is used for feedback, providing confirmation for successful votes and alerting in case of duplicate voting attempts.

This system improves the security and accuracy of elections by eliminating manual errors and reducing the risk of electoral fraud. Future enhancements can include EEPROM storage for persistent vote counts, cloud-based vote tallying, and support for additional security measures such as facial recognition or RFID authentication.

4.3 HOW IT WORKS

1. System Initialization:

- The LCD displays ”Smart Electronic Voting Machine.”
- The fingerprint sensor is initialized and checked for proper connection.
- The microcontroller waits for a voter to place their finger on the scanner.

2. Voter Authentication:

- The voter places their finger on the fingerprint scanner.
- The scanner matches the fingerprint against stored templates.
- If a match is found, the voter’s unique ID is displayed.

3. Voting Process:

- The system checks if the voter has already voted.
- If not voted, the voter is prompted to press a button to cast a vote.
- The corresponding party’s vote count is increased.
- A ”Thank You” message is displayed, and a buzzer sounds to confirm voting.

4. Preventing Duplicate Votes:

- If the same fingerprint is detected again, the system displays ”Duplicate Vote” and activates the buzzer multiple times.

- The voter is not allowed to vote again.

5. Admin Access & Result Display:

- If the fingerprint ID is 4 (admin), the system checks vote counts and declares the winning party based on the highest votes.

- The result is displayed on the LCD.

CHAPTER 5

RESULT

5.1 EXPERIMENTAL RESULTS:

The developed paradigm has been tested underneath totally different in operation conditions. The work is completed within the sequence begin from the primary stage that is pre-processing. The results of pre-processing stage are displayed on Serial Monitor. The system is programmed to show 3 statements in making the database. Initial it shows, R307S module is connected properly or not. when inserting identical finger twice on optical sensor of module it shows, each fingerprint is matched properly or not. When matching the fingerprints serial monitor displayed, templates are kept or not. Alternative outcomes and directions associated with identification, verification and mechanical device are showed on 16x2 liquid crystal display and serial monitor each.

When finger is placed on fingerprint module throughout the method of Identification and verification, then serial monitor shows the name of example that is matched with placed finger and additionally provides the arrogance level supported trivialities points matched. If user has not voted, then only vote is allowed to the user otherwise not permissible for ballot. When the method of verification, ballot is to be done and also the liquid crystal display is employed to point out that the vote given by the user goes to that candidate when pressing the vote button.

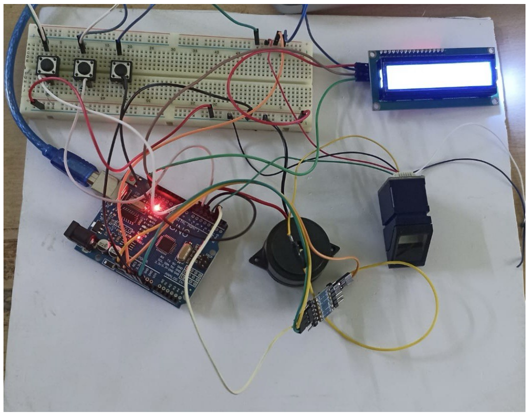
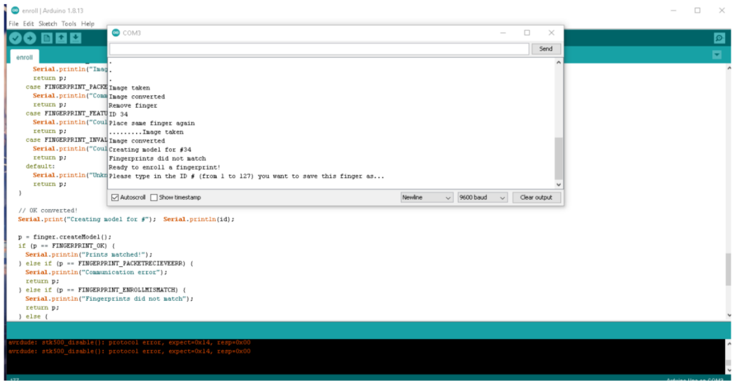


Figure 5.1: Hardware Prototype Setup

5.2 ENROLLMENT:

The Enrollment Result of proposed system is shown below:



```
      Serial.println("Imag
      return p;
    case FINGERPRINT_PACKE
      Serial.println("Comm
      return p;
    case FINGERPRINT_FEATU
      Serial.println("Coul
      return p;
    case FINGERPRINT_INVAL
      Serial.println("Coul
      return p;
    default:
      Serial.println("Unkn
      return p;
  }

  // OK converted!
  Serial.print("Creating model for #");  Serial.println(id);

  p = finger.createModel();
  if (p == FINGERPRINT_OK) {
    Serial.println("Prints matched!");
  } else if (p == FINGERPRINT_PACKETRECIEVEERR) {
    Serial.println("Communication error");
    return p;
  } else if (p == FINGERPRINT_ENROLLMISMATCH) {
    Serial.println("Fingerprints did not match");
    return p;
  } else {
```

```
.
.
.
Image taken
Image converted
Remove finger
ID 34
Place same finger again
.........Image taken
Image converted
Creating model for #34
Fingerprints did not match
Ready to enroll a fingerprint!
Please type in the ID # (from 1 to 127) you want to save this finger as...
```

```
avrdude: stk500_disable(): protocol error, expect=0x14, resp=0x00
avrdude: stk500_disable(): protocol error, expect=0x14, resp=0x00
```

Figure 5.2: Enrollment results

5.3 MATCHING WITH DATABASE:

The eligibility of an elector to vote is proscribed to just one time for one balloting session, because the system is meant to deny balloting by aborting access to vote for constant finger image over once. The portion of the code that checks the standing of elector either has already voted or not is outlined within the void loop. The standing is 49 monitored by flag register, once the vote is casted the flag is assigned to zero whole number, therefore if constant user tries to vote for second time the flag value is evaluated before authorizing vote access to vote, and if flag has worth one, the procedure is aborted. Thus, the authenticity of the system is maintained.

5.4 FINAL RESULT

The Final Result of proposed system is shown below:

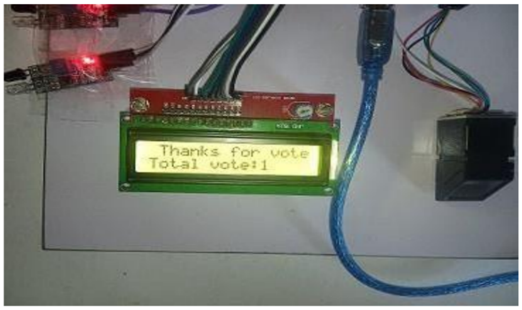


Figure 5.3: Final Result

CHAPTER 6

ADVANTAGES AND DISADVANTAGES

6.1 ADVANTAGES

- **Enhanced Security:** The fingerprint authentication ensures that only registered voters can cast their votes, preventing impersonation and fraudulent voting.

- **Elimination of Multiple Voting:** The system detects and prevents duplicate votes, ensuring each voter can vote only once.

- **Accuracy and Reliability:** Automated vote counting reduces the chances of human errors, making the system highly reliable.

- **User-Friendly Interface:** The LCD display provides clear instructions, making it easy for voters to use the system without confusion.

- **Real-Time Vote Counting:** Votes are counted immediately, reducing the time needed for result declaration.

- **Tamper-Proof:** Unlike paper ballots, which can be manipulated, the digital system is more secure and resistant to tampering.

- **Reduces Manual Effort:** Eliminates the need for manual vote counting, reducing workload and speeding up the election process.

- **Cost-Effective:** Once implemented, the system reduces costs associated with paper ballots, printing, and human resources.

- **Scalability:** The system can be expanded with additional features such as wireless communication, cloud storage, or blockchain for higher security.

6.2 DISADVANTAGES

- **Dependency on Fingerprint Recognition:** If the fingerprint sensor fails to recognize a voter due to dirty, damaged, or worn-out fingerprints, the person may be unable to cast their vote.

- **Limited Storage Capacity:** The fingerprint module has a restricted number of fingerprint entries, which may not be suitable for large-scale elections without external storage solutions.

- **Voter Privacy Concerns:** Storing fingerprints raises privacy and security concerns, as improper handling of biometric data can lead to unauthorized access or misuse.

- **Power Failure Issues:** Since the system runs on electricity, a power outage or voltage fluctuation may disrupt the voting process unless a backup power source is available.

- **Hardware Malfunction:** Components like the fingerprint sensor, LCD, or Arduino may malfunction over time, leading to system failures and affecting the election process.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

The development of an Arduino-based electronic voting machine (EVM) presents a significant step toward improving the accuracy, security, and efficiency of the voting process. By integrating an LCD display, push buttons, and real-time vote recording mechanisms, the system ensures a smooth and transparent voting experience. The simplicity of the hardware and software design makes it a cost-effective and scalable solution, suitable for small-scale elections and community-based voting. The project successfully demonstrates how embedded systems can be utilized to modernize traditional voting methods, reducing human errors and increasing reliability. Furthermore, the secure vote storage mechanism helps prevent tampering, ensuring the integrity of the election process.

For future enhancements, the system can be integrated with biometric authentication using fingerprint scanners or RFID cards to further strengthen voter verification. Additionally, incorporating wireless communication modules such as WiFi or Bluetooth could enable remote monitoring and centralized vote tallying. The implementation of encrypted data storage would provide higher security, preventing unauthorized access to election records. Moreover, scalability improvements, such as increasing candidate capacity and multi-region voting support, can make the system viable for larger elections. By adopting these advancements, the proposed EVM system can serve as a foundation for more secure, transparent, and efficient electronic voting solutions, paving the way for its adoption in real-world electoral processes.

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