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Advanced electronic voting machine using fingerprint sensor and Arduino

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ABSTRACT: — This project centers on the advancement of an affordable fingerprint-based electronic voting system utilizing Arduino UNO. Such a system digitally records, stores, and processes voters' data. It comprises both hardware and software components. The hardware involves Arduino paired with a fingerprint module. This proposed system offers an efficient solution for expediting voter identification. The FP-EVM design is characterized by its portability, flexibility, and minimal power consumption. Additionally, it boasts a user-friendly interface, easy adaptability, and cost-effectiveness. Its architecture is straightforward, ensuring rapid response times and room for future enhancements. Utilizing thumb impressions for voter identification capitalizes on the uniqueness of each individual's thumbprint. This approach provides an advantage over current voting systems by ensuring that voting rights are exclusively accessed by legitimate users. Preceding elections, a database is created containing the thumb impressions of all eligible voters within a constituency. During the voting process, a voter's thumb impression is inputted into the system and compared against the database. If a match is found, the voter is granted access to cast their vote. Conversely, if there is no match or if there's a duplicate entry, voting access is denied, and the vote is rejected. This method yields instantaneous results, simplifies the counting process, and reduces overall election costs and system maintenance expenses. Offering an alternative to postal voting, the system allows individuals to vote from any location within Karnataka using their pre-saved Aadhar card details. By selecting their specific voting area, this feature facilitates voting for non-residents, enhancing accessibility and participation. Furthermore, age verification is implemented before voting, and individuals failing to vote in three consecutive elections risk cancellation of their citizenship. Disabled individuals are accommodated through the use of a swipe machine where they can vote using their Aadhar card details, ensuring inclusivity in the electoral process.

Key words : Arduino, voting system, Aadhar card, electronic system,

INTRODUCTION:

Voting stands as a fundamental right of every citizen, allowing them to express their preferences and play a pivotal role in shaping the leadership of their nation. In India, a democratic framework ensures that each citizen has the opportunity to exercise their voting rights, thereby influencing the political landscape. Moreover, elections extend beyond the national level, encompassing various institutions such as schools, colleges, banks, and societies, where leaders are chosen through the electoral process.

Biometrics emerges as a dependable technique for recognizing individuals distinguishing characteristics and unique physical characteristics. Among the most commonly utilized biometric identifiers are fingerprints, iris scans, facial features, and voice patterns. Biometric authentication serves two primary functions: one-to-one matching, where a sample is compared against a single stored template, and one-to-many matching, where a sample is compared against multiple stored templates. This method not only provides enhanced security but also offers convenience in user verification, surpassing traditional password-based systems.

Fingerprints, being distinct for each individual, serve as a reliable means of signature, verification, and authentication. In the context of this project, fingerprints are employed for user authentication, granting individuals the ability to cast their votes based on their unique fingerprint images. Fingerprint matching techniques can be categorized into correlation-based matching, minutiae-based matching, and pattern-based matching. Correlation-based matching involves computing the correlation between corresponding pixels in two fingerprint images, while minutiae-based matching focuses on extracting and comparing minutiae points from fingerprints. Pattern-based matching requires aligning fingerprint images to compare patterns and orientations.

The digitalization of various sectors has become a cornerstone of initiatives like Digital India, facilitating tasks through online platforms. Online voting platforms, such as ThingSpeak, enable voters to participate in elections from anywhere globally, enhancing accessibility and convenience. The transition to online voting not only expedites the voting process but also ensures prompt dissemination of results. Traditionally, voting involved physically marking a ballot paper and depositing it into a ballot box, necessitating manual counting. However, online voting simplifies this process, allowing for swift and accurate tabulation of votes, ultimately determining the successful candidates based on the highest vote counts.

LITERATURE SURVEY:

In their study, R. Murali Prasad, Poladian Bojja, and Madhu Nakirekanti [Murali Prasad 2016] delve into the intricacies of user authentication using Aadhar numbers and passwords for

voting eligibility verification. This research critically examines the policies surrounding electronic methodologies and advancements in data storage and transmission. The proposed system requires users to initially authenticate themselves through Aadhar numbers and passwords, followed by fingerprint verification to ascertain voting eligibility. Upon fingerprint detection, the system retrieves voter information from the tag, which is then relayed to the controller for comparison with stored data. If a match is found, the individual is granted voting privileges; otherwise, an error message is displayed on the LCD screen. Voting is facilitated through switches.

In a similar vein, Rahil Rezwan, Huzaifa Ahmed, M. R. N. Biplob, and S. M. Shuvo [Huzaifa 2017] present a system tailored for countries like Bangladesh, centred around an electronic voting machine. Their approach involves creating a database containing voters' fingerprints, enabling real-time verification during elections. The system is adept at identifying unregistered voters and preventing multiple voting attempts. Furthermore, it expedites result publication, ensuring accuracy and efficiency.

Anandaraj S, Anish R, and Devakumar P.V [Anandaraj 2015] explore existing voting methodologies and the drawbacks associated with electronic voting machines (EVMs). They emphasize the absence of acknowledgment post-voting and the reliance on manual vote counting. The paper advocates for a more secure and streamlined voting process through biometric authentication. Leveraging fingerprint modules and government databases, their proposed system enhances flexibility, security, reliability, and scalability. It employs touch screens for user convenience, printers for authentication receipts, and GSM modules for result transmission to relevant authorities.

PROBLEM STATEMENT:

In today's era of rapid modernization, privacy has emerged as a paramount concern globally, especially in democratic nations where governments are elected through the voting process. However, the current voting systems often prove to be inefficient and unreliable, necessitating manual verification methods that consume significant time and resources. Presently, the ballot unit and control unit are essential components for conducting elections, with the former allowing voters to select candidates and the latter facilitating the voting process under the supervision of polling officers.

Unfortunately, the existing system is vulnerable to fraudulent practices such as illegal voting by ineligible individuals, posing a serious security threat. This loophole compromises the integrity of the electoral process, leading to disenfranchisement and undermining the democratic principles of fair representation. To address these challenges, a novel approach is proposed, focusing on a privacy-enhanced authentication system that leverages biometric data, specifically fingerprint templates.

By integrating advanced privacy protection measures, the proposed system ensures the secure authentication of voters, thereby safeguarding the integrity of the electoral process. Utilizing fingerprint templates as a means of biometric identification adds layer of security, making it significantly harder for unauthorized individuals to manipulate or exploit the voting system. This innovative solution not only enhances the privacy of voters but also reinforces the trust and reliability of the electoral process, preserving the fundamental right of citizens to participate in the democratic governance of their countries.

OBJECTIVE:

The recurring expenses associated with the fingerprint voting project become a significant concern in the event of fraud recurrence. Addressing this challenge necessitates a system that demands voters to provide their fingerprints at polling stations, enabling authorities to initiate legal proceedings against specific persons engaging in fraudulent activities. Employing fingerprint technology in this project, however, presents challenges because of the lack of concrete evidence and an audit trail that might be used in legal proceedings. To overcome these obstacles, Arduino Systems are utilized to develop the application, serving as a crucial "Chain of Evidence" for legal professionals.

Another key objective of this project is to generate a system that requires users to authenticate their identity by showing their fingerprints, akin to a scenario in American elections where paper ballots ran out, prompting the production of additional ballots on white paper instead of the usual blue ones. In this setup, individuals hurriedly obtained the new white ballots and swiftly filled them out, depositing them into ballot boxes in a manner that lacked traceability and could potentially facilitate fraudulent submissions. To mitigate such risks, the system reads fingerprint data and verifies it against the pre-existing database. If a match is found, the individual is allowed to cast their vote. Conversely, if the fingerprint data does not align with the stored database, the system immediately triggers an alert, prompting security authorities to intervene and take appropriate action to prevent fraudulent activities. the voting system. This innovative solution not only enhances the privacy of voters but also reinforces the trust and reliability of the electoral process, preserving the fundamental right of citizens to participate in the democratic governance of their countries.

PROPOSED SYSTEM

The recurring expenses associated with the fingerprint voting project become a significant concern in the event of fraud recurrence. Addressing this challenge necessitates a system that demands voters to provide their fingerprints at polling stations, enabling authorities to initiate legal proceedings against specific persons engaging in fraudulent activities. Employing fingerprint technology in this project, however, presents challenges due to the lack of concrete evidence and an audit trail that could be used in legal proceedings. To overcome these obstacles, Arduino Systems are utilized to develop the application, serving as a crucial "Chain of Evidence" for legal professionals.

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METHODOLOGY:

The IoT-based voting machine with fingerprint verification comprises several functional blocks interconnected to ensure seamless operation. At its core lies the controller, an Arduino Uno, orchestrating the system's functions. Power is supplied to the system via a laptop connection. A keypad facilitates voter interaction, enabling them to cast their votes conveniently. Instructions and alerts regarding system operations or any irregularities are communicated through the serial monitor.

Central to the system's security and authentication process is the fingerprint module. This module captures and stores the fingerprints of voters, forming a database for comparison during the electoral process. Upon finger placement, the module identifies the user's fingerprint and cross-references it with the database, displaying a message on the serial monitor to indicate authentication status. The cloud plays a pivotal role in storing the electronic ballot papers and recording the ultimate tally of votes for every contender in separate fields. To achieve this, Thing Speak is employed to store the aggregated vote counts.

Ensuring connectivity, the Wi-Fi module, represented by ESP8266, facilitates communication between the controller and the cloud platform. Additionally, a buzzer serves as an alert mechanism to notify the system of any attempt at multiple voting instances. To streamline operations, the system is divided into two distinct units: the fingerprint unit responsible for biometric verification and the voting unit for ballot casting. This division enhances efficiency and ensures the smooth functioning of the electoral process.

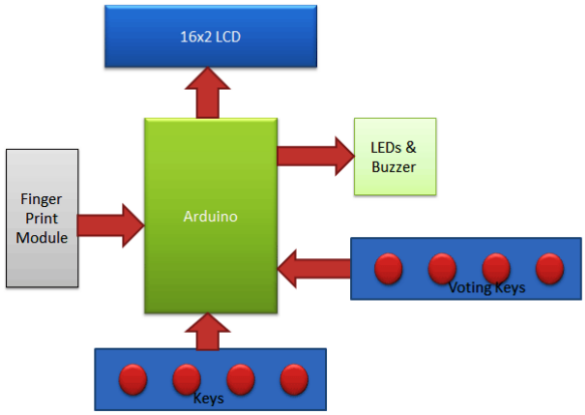


FIG 3.1

Figure 3.1 illustrates the block diagram of the verification unit, primarily focusing on the enrollment and matching processes. At its core lies the fingerprint module, responsible for storing the unique fingerprints of voters and conducting comparisons with the database for authentication purposes. Additionally, the Aadhar number of each voter is stored within the system, enabling verification alongside fingerprint data. The system diligently monitors for any attempts by individuals to cast their votes multiple times, ensuring the integrity of the voting process. To alert administrators of any irregularities, a buzzer is incorporated to signal instances of second voting occurrences.

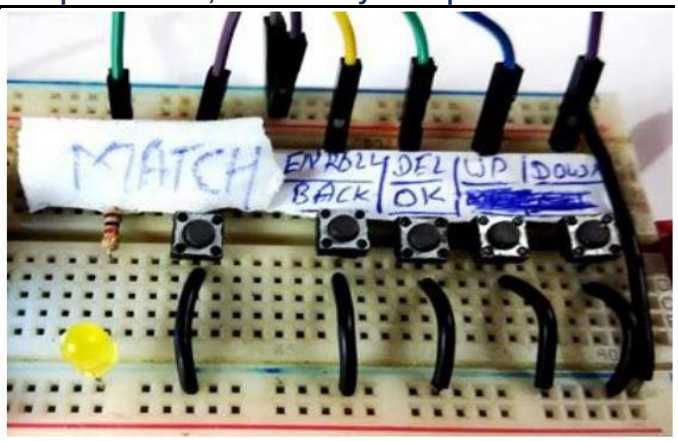
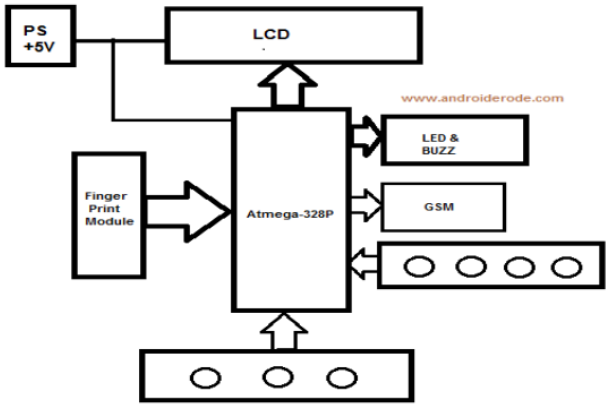


FIG 3.2

Figure 3.2 illustrates the voting procedure, depicting the sequence of actions following eligibility confirmation in the fingerprint unit. Once the system verifies a person's eligibility to cast their vote, they proceed to take action through this unit. Following the casting of each vote, a register is incremented to maintain a record of the overall vote count cast. Voters are afforded the flexibility to select their preferred voting location, facilitated by the use of a keypad for input. The voting process itself is executed through Thing Speak, leveraging the keypad for interaction. Subsequently, the outcome of the electoral process is accessible via the serial monitor interface of the Arduino, providing real-time feedback and transparency in the electoral process.

SYSTEM ARCHITECTURE:



The architecture of the IoT-based voting machine with fingerprint verification comprises several key components meticulously interconnected to ensure seamless operation. At the heart of the system lies the controller, an Arduino Uno, orchestrating the various functions. Power is supplied to the system through a laptop connection, providing the necessary energy to sustain operations. A keypad interface facilitates the casting of votes, offering a user-friendly interaction method.

System instructions and alerts pertaining to any malpractice are conveyed through the serial monitor, ensuring transparency and accountability. The fingerprint module serves as the primary means of biometric identification, capturing and storing voters' fingerprint data for authentication purposes. Upon fingerprint placement, the module cross-references the provided fingerprint with the database, displaying authentication results on the serial monitor.

The ballot paper and voting data are securely stored on the cloud, with each candidate's final vote count stored in dedicated fields. To achieve this, Thing Speak is utilized as the cloud storage platform. Ensuring connectivity, the Wi-Fi module, represented by ESP8266, provides wireless communication between the controller and the cloud platform.

Additionally, a buzzer serves as an alert mechanism to notify the system of any attempts at multiple voting instances, safeguarding the integrity of the voting process. To streamline operations and enhance efficiency, the system is divided into two distinct units: the fingerprint unit responsible for biometric authentication and the voting unit facilitating the casting of votes. This division ensures optimal performance and seamless execution of the voting process.

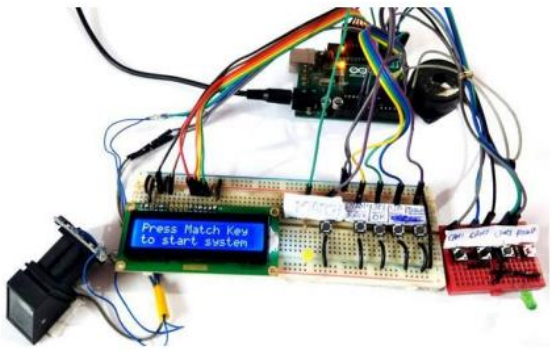
REQUIRED COMPONENTS:

1. Arduino Uno
2. Fingerprint Sensor Module
3. Push Buttons
4. LEDs -2
5. 1K Resistor -3
6. 2.2K resistor
7. Power 9
8. Connecting wires
9. Buzzer
10. 16x2 LCD
11. Bread Board

WORKING EXPLANATION:

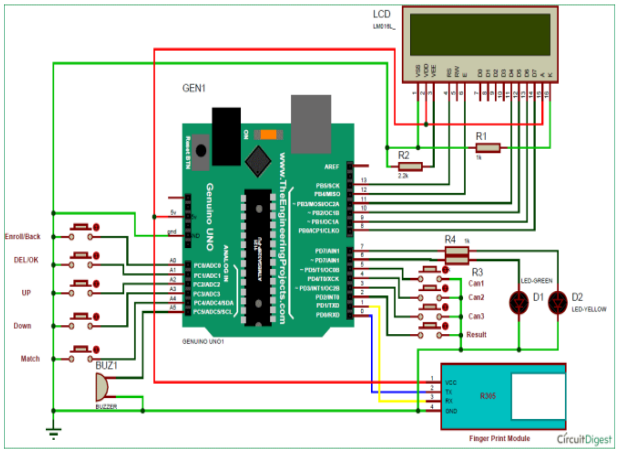
Understanding the operation of the Biometric Voting System for Elections may initially seem daunting for newcomers. To begin with, users are required to enrol their fingerprints or voter data, with the system accommodating a maximum of 25 voters. This enrolment process is initiated by pressing the ENROLL button/key. Upon pressing the ENROLL key, the system prompts the user to input a location or ID where the fingerprint data will be stored. The user can navigate through available locations/IDs using the UP/DOWN keys and confirm their selection by pressing the OK (DEL) key. Subsequently, the system guides the user to place their finger on the fingerprint module for scanning. The LCD prompts the user to remove their finger and then replace it on the module for a second scan. This process allows the fingerprint module to capture an image, convert it into templates, and store it in the module's memory under the selected ID.

Once this process is completed, the voter is successfully registered in the system and becomes eligible to vote. This procedure is repeated for each voter to ensure comprehensive enrolment into the system, thereby facilitating a fair and efficient voting process.



CIRCUIT EXPLANATION:

The circuitry of the Fingerprints-Based Voting Machine Project is designed with simplicity in mind, incorporating essential components to facilitate its operation. At the core of the circuit lies the Arduino microcontroller, responsible for orchestrating the entire project process. Push buttons are strategically placed to enable functions such as enrolling, deleting, selecting IDs, and casting votes, offering user-friendly interaction. An integral component, the buzzer, serves as an alert mechanism to notify users of important events or actions. LEDs are employed for visual indication purposes, with a yellow LED signalling readiness for the fingerprint module to capture finger images, and a green LED indicating that the system is primed for voting or viewing results. To facilitate communication with the user, a 16x2 LCD screen is incorporated into the circuit. This display not only provides instructions to voters but also showcases the results of the voting process. Through the coordinated interaction of these components, the Fingerprints-Based Voting Machine Project offers a streamlined and accessible voting experience, ensuring clarity and efficiency throughout the electoral process.



The push buttons are directly linked to specific pins on the Arduino board: A0 for enrolling, A1 for deletion, A2 for moving up, A3 for moving down, and A4 for matching. Additionally, connections are made from D5 to Can1, D4 to Can2, D3 to Can3, and D2 to Result pins of the Arduino, each grounded through a 1k resistor. The yellow LED is connected to digital pin D7, and the green LED to D6, both with a 1k resistor to ground, serving as visual indicators.

For communication with the fingerprint module, its Rx and Tx pins are directly connected to the Arduino's Rx and Tx pins, respectively. The fingerprint module is powered using a 5V supply drawn from the Arduino board.

A buzzer is integrated into the system, connected to pin A5 of the Arduino board. The 16x2 LCD screen operates in 4-bit mode, with its RS, EN, D4, D5, D6, and D7 pins connected directly to digital pins D13, D12, D11, D10, D9, and D8, respectively, on the Arduino board. This comprehensive wiring configuration enables seamless communication and interaction between the various components of the system, facilitating efficient operation and user engagement.

CONCLUSIONS

Overall, this system effectively addresses numerous challenges encountered during traditional paper ballot voting systems. Its efficiency hinges greatly on the functionality and user-friendliness of the web interface, ensuring a secure voting method essential for the advancement of a developing nation.

The proposed Fingerprint-based voting system presented in this paper represents a significant improvement over previous methodologies, offering enhanced speed and reliability. By employing biometric authentication, the system effectively bars unauthorized individuals from accessing the voting process, promoting transparency and upholding the integrity of elections. Furthermore, it effectively curbs instances of multiple voting by the same individual and verifies the eligibility of voters. A notable feature of this system is its flexibility, allowing individuals to cast their ballot from any

location within electoral boundaries. The implementation of a Fingerprint-based voting system has notably reduced the occurrence of invalid votes, streamlined the voting process, minimized staffing requirements at polling centers, and facilitated accurate and expedited vote counting, all while incorporating provisions for voting fraud prevention measures.

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