

Electronic Voting Machine Using Biometric System (Solar Powered Smart Voting System)

Shivansh Singh¹, Sumit kr. Singh², Dr. Apoorva Driwedi³

^{1,2}Dept. Electronics and Communication Engineering, Galgotias College of Engineering and Technology, G. Noida, India

³Assistant Professor, Department of Electronics and Communication Engineering, Galgotias College of Engineering and Technology

Abstract

The use of electronic voting machines has been common in most countries in the aim of enhancing efficiency and reliability of the election process. Nevertheless, the problems that traditional systems have to deal with are voter impersonation, dependency on power, and security concerns. In this study, the author introduces the design and development of a Solar Powered Biometric Electric Voting Machine (EVM) based on an Arduino Uno microcontroller and fingerprint authentication. The voters are authenticated by the system against a biometric fingerprint sensor and then allowed to vote. A battery system is powered by a solar panel and can operate without much interruption even in regions where there is low supply of electricity. The voting can be done easily: once biometric authentication is performed, the voter will then be able to choose his/her candidate by means of push buttons. The result button enables the authorized individuals to check the vote count in an LCD screen when the voting is over. The system is meant to minimize the electoral fraud, enhance transparency and offer the electoral system with a credible solution to rural and remote voting. Through experimental implementation, the proposed system proves to be efficient, easy to use, energy efficient and will help prevent duplicate voting. This system is a combination of biometric authentication and renewable energy power supply that makes the system. It fits in the contemporary intelligent election infrastructure.

Keywords: Electronic Voting Machine, Biometrics, Fingerprint Sensor, Solar Energy, Arduino UNO, Secure Voting.

I. Introduction

Among the processes in a democratic country, the most significant is the elections. An effective voting system that is transparent and safe will provide a fair representation of the opinion of the people. Historically, balloting was made through the use of paper. Even though paper ballots are easy to deal with, they are likely to cause issues of human error in counting the ballots, ballot mishandling, and increased time of processing the results.

In order to solve these problems, Electronic Voting Machines (EVMs) were implemented. EVMs help lessen the amount of time that had to be spent counting the votes and the human error. Nevertheless, there are still certain problems. Voter impersonation is one of the major concerns whereby unauthorized people seek to impersonate the legitimate voters. The other issue is the availability of power and power supply especially in remote or rural regions where power supply is not always reliable.

As a way of dealing with such problems, scientists and technologists have begun incorporating biometric system of authentication into voting machines. Biometrics are some of the distinctive body features like underprints, iris scan or facial recognition. Among them, fingerprint recognition is a well-known one since it is dependable, affordable, and simple to introduce.

This study is a proposal of Biometric Electronic Voting Machine that operates using solar energy. The system also verifies the voters with a fingerprint sensor so that individuals can only vote once each. Also, the system will have a solar panel and rechargeable battery to ensure the supply of power at all times.

Arduino UNO is used to implement the project, and it regulates the whole process of voting.

It also has an LCD display that would display the status of the system and voting results and push buttons to choose the candidates, and a result button that would present the end voting tally.

This study aims at coming up with a secure, efficient and energy independent voting system that can be used in the contemporary democratic practices.

II. Literature Review

A few scholars have engaged in the enhancement of the security and efficiency of the voting systems. Digital technologies have brought electronic voting machines that have undergone a great transformation. The initial EVMs were more aimed at using electronic buttons and electronic vote counters instead of paper ballots. These mechanisms enhanced the speed of counting, but failed. Not entirely address the issue of voter authentication.

In recent times, there have been the suggestions of combining biometric technologies and the voting machines. One of the most popular ways to implement the system is through fingerprint-based voting as fingerprints are recognizable by each person and that they cannot be copied.

Microcontrollers, including Arduino and Raspberry Pi have also been investigated to be used as a low-cost voting system. These microcontrollers enable simple combination of input devices, displays and sensor.

The other field of research that is of significance is this one that is concerned with renewable energy powered voting systems. In most of the developing nations, the elections are carried out in remote places where power supply is not guaranteed. Another alternative that is clean and dependable is solar powered systems.

Notwithstanding, a lot of the current system only looks at biometric verification or electronic voting, but few systems are on the integration of biometric authentication and renewable energy powered operation.

The proposed project tries to fill this gap by incorporating:

Fingerprint Biometrical authentication.

- Solar powered energy system
- Arduino-based control
- Fraud-proofed electronic voting.

This combination will make the voting system more secure and reliable.

III. Problem Statement

Even though the current state of the voting system has made progress in the technological aspect of voting, there are still a number of challenges in the current voting systems.

Voter impersonation is one of the biggest issues. Unauthorized votes may be cast in case of lack of proper identity verification. This undermines the character of elections.

The other problem is the case of duplicate voting whereby the voter tries to cast several votes on the same ballot.

Also, a great number of electronic systems are very reliant on external power supply. Power outage or failure in rural or remote regions may disrupt the voting.

In most systems, manual supervision is also needed which complicates operations and human error.

A system of voting is therefore required whereby:

- Voter authentication in a safe manner.
- Prevents duplicate voting
- Works in areas with a poor power supply.
- Gives rapid and open-ended vote counts.

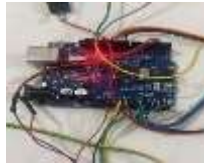
The Solar Powered Biometric EVM proposed will address these issues by integrating Biometric authentication with a renewable power source.

IV. System Architecture

The system architecture is a combination of a number of hardware elements that collaborate in order to secure voting.

A. Arduino UNO Microcontroller

The main controller of the system is the Arduino UNO. It is a processing of the fingerprint data. sensor, controls the voting inputs and displays the results on the LCD.



B. Fingerprint Sensor



The fingerprint sensor undertakes the task of determining voters identity. Every voter is supposed to enrols his/her fingerprint before the election. Using the sensor, it is determined whether the fingerprint is the same as the one stored in the database during voting.

C. Solar Power System



The system will contain a solar panel with a connection to a panel. chargeable battery via a charging unit. This ensures that the voting machine is able to run continuously even when it is not connected to external electricity.

D. Voting Buttons



The candidates are represented by the use of the push buttons. All the buttons match various candidates. Once the voter has been authenticated, he/she can press one of these buttons and vote.

E. LCD Display



The display on the LCD is a message that the system is giving:

- Place Finger
- Authentication Successful
- Vote Cast Successfully
- Election Result

F. Result Button



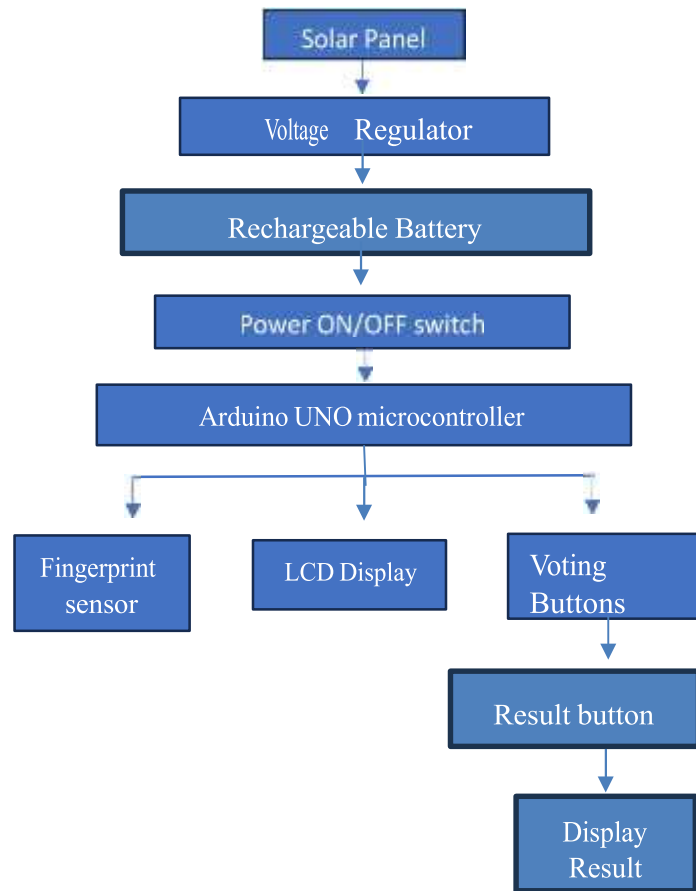
Once there is voting, the result button can be selected to show the number of votes each candidate has won.

G. Power ON/OFF Button



The system also has a power button so that election officials can easily start or close the system.

1.1 Flow Chart of the System



V. Methodology

The system operates in a number of steps in sequence to make sure of safe voting.

Step 1: System Initialization

Upon switching on the power supply with the power button, the Arduino initiates all the components connected to it such as the fingerprint sensor, LCD display, and voting buttons. Step 2: Voter Authentication

The voter inserts his/her thumb on the fingerprint sensor. The sensor reads the fingerprint and matches it with the database.

In a case where the fingerprint is that of a registered voter and the individual is a first-time voter then the system will allow the voter to vote.

Step 3: Vote Casting

The successful authentication is followed by the appearance of options of the candidate on the LCD. The voter presses a button, which is related to the candidate of his/her choice.

The vote is saved and the vote count is stored using the Arduino.

Step 4: Prevention of Duplicate Voting.

Once a vote has been cast the system identifies the voter as already voted.

The system will reject the vote in case of scanning the same fingerprint.

Step 5: Result Display

At the expiry of the election procedure, an authorized body presses the result button. The vote count of different candidates is then displayed on the LCD screen.

Step 6: Power Management

The battery is constantly replenished by the solar panel and the operation of the whole panel will not be interrupted during the election.

VI. System Implementation

The proposed biometric electronic voting machine was developed based on the system architecture and methodology after designing it and then implemented it using the electronics components that are readily available. The Arduino UNO microcontroller, which is the principal controller in the system, is used to organize communication between all the hardware that can be used in the system such as the fingerprint sensor, LCD display, voting buttons, and the power management system. A prototype board was used to assemble the system first to check the connection and to check whether the system was working correctly. The fingerprint sensor device was made to store and identify the fingerprints of registered citizens. At the voter registration stage, each underprint template is written in the sensor memory. The sensor reads the fingerprint and compares it to the templates held by the sensor during the voting process. In case the match is detected, the Arduino enables the voter to pass to the voting phase. In case the fingerprint falls outside of any existing template, the system will deny the user access and prompt him or her to reenter.

Using the LCD display module an LCD display is attached to the Arduino to deliver visual instructions and system feedback. The screen displays messages, like Place Finger, Authentication Successful, Cast Your Vote and Vote Recorded Successfully. These guidelines render the system user-friendly. easy to approach and user- friendly even to first- time voters.

The voting interface is made out of several push buttons, each having a candidate associated with it. Once the voter has been authenticated, he or she uses one of the buttons to vote. The Arduino accepts the button input and adds the score to the internal memory of the vote to the selected candidate. After casting a vote, the system does not allow the one who has voted to vote the second time by marking the fingerprint ID as utilized.

The device power system is also energy efficient and does not require electricity supply. A charging module is attached to a solar panel that has the ability to produce electrical energy that is stored in a rechargeable battery. The Arduino and other components use this stored energy on their operation. The solar energy usage would make the voting machine operational in the remote or rural areas, where electricity supply might be unpredictable.

The system was also tested to respond to the sensors correctly, stable power supply and proper wiring connection before conducting final tests. To test the accuracy of the system, it was under test conditions of simulated voting after all modules could be proved to work properly.



Fig. Experimental setup of the biometric electronic voting machine using Arduino UNO

VII. Working Principle of the Proposed System

The principle of operation of the proposed solar powered biometric electronic voting machine is the principle of biometric authentication and electronic recording of the votes. On start up the Arduino UNO loads all the hardware modules that can be connected to the system such as the fingerprint sensor, LCD display, and voting buttons.

Through the voting, the voter verifies his/her fingerprint by putting the fingerprint on the fingerprint sensor. Fingerprint sensor reads the fingerprint and matches it to the registered voter database. In case, the fingerprint is a match to a stored record, the system authorizes to vote.

Once the authentication is carried out successfully, the LCD display asks the voter to pick a candidate. The voter activates the respective push button in order to vote. The Arduino takes the vote and it is put in the memory.

After voting, the system does not allow one to vote again by indicating that the voter has already voted. In case of repetition of the same finger print, voting will be rejected.

The authorized officer can press the result button at the end of the election process and then the vote count can be shown on the LCD screen in front of all voters.

VIII. Power Management Using Solar Energy

The voting system proposed makes use of solar power supply to maintain a continuous power supply. The solar panel transforms the sunlight to electrical energy that is kept in a rechargeable lithium battery by charging module.

This is an energy that is stored to drive the Arduino microcontroller, fingerprint sensor, LCD display and other electronic parts. This is because the system can be used in rural and remote locations whereby electricity source might be unreliable due to use of solar energy.

Besides offering a renewable source of power, the solar powered system also minimizes the cost of operation and enhances the sustainability of the voting system.

VIII. Security Features of the System

Any electronic voting system should have security as a major requirement. The suggested biometric voting system will include a series of security measures that were adopted to make it sustained and resistant to tampering.

First, biometric fingerprint authentication will reduce instances of voting by unauthorized voters. This eliminates impersonation and identity fraud since every person has fingerprints that are unique.

Second, duplicate voting is avoided because the system is used to store the voting status of a particular fingerprint ID. After a voter has cast his/her vote, the system strips away any additional attempts of voting with the same fingerprint.

Third, the votes are counted automatically and electronically on the Arduino which minimizes the chances of manual error. The voting process must be finished before accessing the result which can only be available through the result button. These security measures enhance transparency and reliability of the election process.

IX. Results and Discussion

The prototype system was developed using Arduino UNO and it was tested in various situations.

The fingerprint identification system was able to identify registered people with high accuracy. The system was efficient to check on the voting status of an individual registered fingerprint to avoid the occurrence of duplicate voting.

The voting system was easy and convenient. The LCD was easy to use as it had clear instructions to be followed by the voters and even a novice user could easily navigate the system.

The rechargeable battery system and the solar panel proved to be very stable in power supply. This also makes the system appropriate in the rural regions where the power supply might be scarce.

In testing, the system proved to be reliable in terms of authentication, vote recording and display of results. The use of biometric authentication enhanced security highly than the use of the conventional systems using buttons to vote.

X. Future Improvements

Even though the suggested solar powered biometric based electronic voting machine is very efficient, a number of enhancements can be done when new models are made. Another potential improvement is the application of cloud-based storage whereby this would enable the backup of voting information and also be monitored centrally. Voter verification can also be enhanced by linking the system to the Aadhaar or other national identification databases.

Also, it can be wireless communication technologies like Wi-Fi or GSM used to send the vote results directly to the election authorities, eliminating the use of manual data gathering. It is also possible that future systems will incorporate multi-factor biometric authentication, e.g. face recognition combined with fingerprint verification, to enhance security.

This would enhance the voting system to be more secure, scalable, and appropriate to use in big election applications.

XI. Conclusion

The project describes the design, as well as the implementation of a Solar Powered Biometric Electronic Voting Machine based on the Arduino UNO. The designed system will be a biometric fingerprint recognition system that integrates with electronic voting technology to improve the security of elections. The system ensures that there is no case of voter impersonation and multiple voting as it uses fingerprint recognition to verify the identity of each voter. Also, the solar power will be incorporated to allow it to operate even where there is minimal power supply.

Tests conducted experimentally proved that the system is dependable, safe, and convenient. The system is highly economical because of the use of inexpensive boards like the Arduino UNO which is easy to implement in practice.

The system can be further enhanced in future by adding the following features:

- Cloud based vote storage
- Transmission of wireless results.
- Voter checking through Aadhaar.
- Extra security encompassing face recognition.

In general, the suggested system offers a viable solution to secure electronic voting systems that are transparent and sustainable.

XII. References

1. K. Jain, A. Ross, and S. Prabhakar, "An Introduction to Biometric Recognition," IEEE Transactions on Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 4—20, Jan. 2004.
2. R. L. Rivest, "Electronic Voting Systems," IEEE Security and Privacy Magazine, vol. 6, no. 1, pp. 24—29, Jan. 2008.
3. Arduino, "Arduino UNO Rev3 Datasheet," Arduino Official Documentation, 2021.
4. A. Juels, D. Catalano, and M. Jakobsson, "Coercion-Resistant Electronic Elections," ACM Workshop on Privacy in Electronic Society, pp. 61—70, 2005.
5. S. Madakam, R. Ramaswamy, and S.
6. Tripathi, "Internet of Things (IoT): A Literature Review," Journal of Computer and Communications, vol. 3, no. 5, pp. 164—173, 2015.
7. M. Conti, R. Di Pietro, and L. V. Mancini, "Electronic Voting Systems: Security Issues and Challenges," Computer Standards & Interfaces, vol. 36, no. 3, pp. 543—556, 2014.
8. International Energy Agency, "Solar Energy: Renewable Energy for Sustainable Development," IEA Report, 2022.
9. N. K. Ratha, J. H. Connell, and R. M. Bolle, "An Analysis of Minutiae Matching Strength," International Conference on Audio and Video-Based Biometric Person Authentication, pp. 223—228, 2001
10. S. Bhosale and P. Kulkarni, "Fingerprint Based Electronic Voting Machine Using Microcontroller," International Journal of Engineering Research and Technology (IJERT), vol. 5, no. 4, pp. 325—328, 2016.
11. K. Prasad, B. Ramesh, and P. Srinivas, "Biometric Based Electronic Voting System Using Arduino," International Journal of Advanced Research in Computer Engineering & Technology, vol. 6, no. 3, pp. 245—249, 2017.
12. M. Kaur and P. Singh, "Secure Electronic Voting System Using Fingerprint Authentication," International Journal of Computer Applications, vol. 145, no. 12, pp. 20—24, 2016.
13. A. S. Tolba and A. H. El-Baz, "Biometric Authentication for Secure Electronic Voting Systems," International Journal of Information Security, vol. 18, no. 2, pp. 137—148, 2019. []