Electronic Voting Machine Using Raspberry Pi

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Abstract- This project presents an *Electronic Voting Machine (EVM)* using a *Raspberry Pi* to offer a reliable, cost-effective, and user-friendly alternative to traditional paper-based voting systems. The system includes a Raspberry Pi as the controller, LCD display for candidate names, push buttons for vote casting, and LEDs for feedback. Votes are recorded and stored digitally, with a simple interface that ensures ease of use. The Raspberry Pi's ability to run Python scripts and control GPIO pins makes it ideal for such embedded applications. Designed for modularity and offline operation, the system avoids cloud storage to minimize complexity and security risks. It was successfully tested in simulated environments, accurately recording votes and providing user feedback. The project highlights practical skills in hardware-software integration and demonstrates how embedded platforms can improve voting processes. This EVM model serves as a scalable foundation for further enhancements like biometric authentication and secure result transmission in future applications.

Keywords - Electronic Voting Machine, Raspberry Pi, Embedded Systems, Digital Voting, Python, GPIO, LCD Display, Offline Voting.

I. Introduction

In recent years, there has been a notable rise in the demand for secure, transparent, and technology-driven voting systems, especially as the limitations and inefficiencies of traditional paper-based voting methods have become increasingly evident. These conventional systems frequently experience issues such as human error, a lack of transparency, time-consuming manual counting, and challenges in ensuring accessibility for all voters. To address these issues, this project presents a low-cost, efficient, and user-friendly Electronic Voting Machine (EVM) that utilizes the Raspberry Pi microcontroller.

The Raspberry Pi, recognized for its programmability, compact design, and low power consumption, acts as the central unit that controls all components of the system. The features of the EVM include an LCD display to present candidate names, push buttons for vote casting, LED indicators for visual feedback, and internal memory to securely store vote counts. The system is programmed in Python, taking advantage of the Raspberry Pi's GPIO (General Purpose Input/Output) capabilities to manage hardware components such as buttons, LEDs, and I2C-based display modules. When a vote is cast, the system promptly records the input, updates the vote count, and displays a confirmation message to reassure the voter of a successful submission. Basic error handling mechanisms are in place to ensure that each voter can cast only one vote per session, thereby minimizing the risk of tampering or double voting.

This EVM is designed with modularity and simplicity in mind, allowing for easy enhancements with additional features like biometric authentication, data encryption, or even wireless result transmission in future versions. The current implementation is well-suited for educational institutions, small-scale elections, or remote voting locations, showcasing how embedded systems like the Raspberry Pi can significantly contribute to the modernization of democratic processes.

II. Related work

A multitude of studies and patented technologies have addressed the challenges of secure and efficient electronic voting. **Garg (2022) [1], "Secured Voting System"**, proposed a system with patent-level innovations aimed at protecting vote integrity through advanced encryption and secure transmission methods. **Kumar (2017) [2], "Electronic Voting Machine with Ballot Paper Like Functionality"**, introduced a design that replicates the feel and usability of traditional paper ballots while eliminating the need for physical paper, enhancing user familiarity and reducing waste.**Aswathy et al. (2021) [3], "Blockchain Voting System"**, explored the application of blockchain technology to ensure transparency, immutability, and verifiability in electronic voting processes, establishing trust through decentralized ledgers. **Banalamath et al. (2023) [4], "Online Voting System"**, focused on improving both security and accessibility using modern digital tools, making the voting process more inclusive and efficient. **Brintha Asha et al. (2019) [5], "Token Authentication and AI Bot Based Voting System"**, implemented token-based authentication along with AI bots to verify voter identity and increase election security. **Bhanupriya et al. (2017) [6], "Smart Voting"**, proposed an embedded system and IoT-based voting method, aiming for real-time monitoring and smart infrastructure integration. Budaragade **and Biradar (2008) [7], "Client-Server Based Voting System Using Magnetic Stripe Voter ID Cards with Cloud Storage"**, combined physical voter ID verification with cloud technology to securely store votes and enhance accessibility. **Chaudhari et al. (2021) [8], "Next Generation E-Voting"**, addressed scalability and cybersecurity, proposing frameworks for large-scale, tamper-proof elections. Finally,

Dandekar et al. (2022) [9], "Online Voting System Using Cloud Computing", and **Govindaraj et al. (2020) [10], "Online Voting System using Cloud"**, both highlighted the advantages of cloud-based systems for centralized management, real-time result computation, and remote voter access, paving the way for flexible and widely deployable e-voting platforms.

III. *METHODOLOGY.*

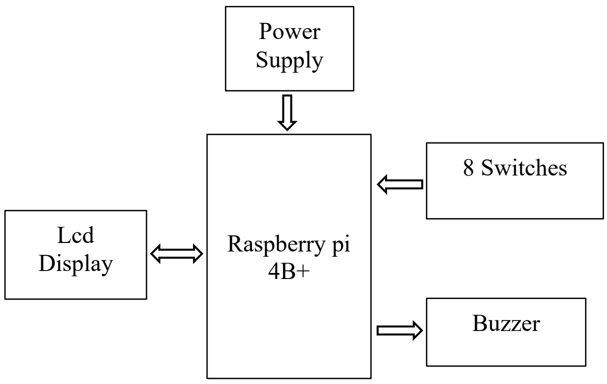


Fig 2. Block Diagram of Electronic Voting Machine

1.**Power Supply and System Initialization**: The system operates on a consistent 5V power supply, ensuring the Raspberry Pi and its connected peripherals function reliably. The initialization process of the Raspberry Pi sets up GPIO pins for both input and output, initializes the LCD display through the I²C bus, and organizes internal data structures for collecting votes. This phase is essential for guaranteeing that all hardware components are primed for seamless operation without any failures.

Reference Support: In the research conducted by Bhuvanapriya et al. (2017) [6], embedded computing platforms such as the Raspberry Pi are acknowledged for their adaptability in handling multiple input/output devices at once. The paper discusses how effective system initialization improves the reliability and responsiveness of electronic voting systems, ensuring that voters experience no errors.

2. **User Interface Display**: The LCD functions as the main feedback tool to assist voters throughout the process. A welcoming message followed by details about the candidates helps to minimize voter confusion and facilitates smooth operation. Clearly displayed options also help to decrease errors during the voting process.

Reference Support: Bhuvanapriya et al. (2017) [6] highlight the significance of user-friendly interfaces in smart voting machines. The study indicates that well-structured displays and straightforward instructions greatly enhance voter confidence and system usability, resulting in improved accuracy and satisfaction

3. Vote Casting Mechanism: Votes are captured in real-time using physical push buttons connected to the GPIO pins of the Raspberry Pi. This immediate input capture reduces voter wait times and lowers the likelihood of missed or duplicate votes. The LCD provides instant feedback to confirm the vote.

Reference Support:

As noted by Kumar (2017) [2], substituting paper ballots with physical buttons linked to digital systems preserves familiar voter interactions while offering an eco-friendly and efficient voting method. This strategy combines traditional voting practices with contemporary digital processing.

4. Vote Storage and Security:

Vote information is securely kept on the local storage of the Raspberry Pi in a straightforward, tamper-evident file format. The system refrains from external connectivity during the voting process, thereby eliminating the possibility of remote interference and ensuring that the integrity of the votes is maintained until they are manually retrieved.

Reference Support:

Garg (2022) [1] emphasizes the vital importance of secure storage in voting systems. The research highlights that keeping voting data isolated and stored locally helps safeguard against unauthorized access, thereby maintaining the confidentiality and authenticity of the votes.

5. Result Compilation and Display:

An administrative control system initiates the vote tallying process. The Raspberry Pi processes the stored votes, counts them for each candidate, and presents the final results clearly on the LCD screen, ensuring transparency and immediate accessibility.

Reference Support:

Chaudhari et al. (2021) [8] examine how digitized vote counting significantly minimizes human error and delays in result announcements. Their study emphasizes that automated counting improves election efficiency and fosters trust in the electoral process.

IV. COMPONENT SPECIFICATION AND WORKING PRINCIPLE

1. Raspberry Pi 4B+ (Central Processing Unit)

Principle:

The **Raspberry Pi 4B+** is a compact single-board computer that functions on embedded Linux, offering general-purpose input/output (GPIO) pins to interact with electronic components. It supports Python-based scripting and communicates with peripheral devices using UART, I2C, and SPI protocols.

Working:

In this project, the Raspberry Pi acts as the core processing unit. It takes input from 8 tactile switches (each assigned to a candidate), processes the selection, updates vote counts, and gives immediate feedback via LCD and buzzer. The Raspberry Pi stores the vote data internally (in a file or database), ensuring persistence and accuracy. It is also capable of running real-time scripts that validate inputs and prevent multiple votes per session. The Pi receives power from a regulated power supply (typically 5V/3A), which supports its operation and all connected modules.

2.Switches (Input Interface for Voting)

Principle:

Each switch works on a simple contact mechanism — when pressed, it completes an electrical circuit. This allows the Raspberry Pi to detect a digital HIGH (1) signal on its GPIO pin, indicating a vote selection.

Working:
Each of the 8 push buttons corresponds to a different voting candidate or party. When a button is pressed, the Pi registers this event and disables the other buttons to prevent multiple selections. This single-input detection mechanism ensures that only one vote is cast per user interaction, improving system reliability and preventing fraudulent inputs.

3. LCD Display (Visual Output Module)

Principle:
The Liquid Crystal Display (LCD) uses liquid crystal molecules that align in response to electrical signals to display alphanumeric characters. Using the I2C protocol minimizes wiring complexity by using only two data lines (SDA and SCL).

Working:
The LCD shows real-time messages like “Select Candidate”, “Vote Recorded”, or “Thank You” once the vote is cast. It can also be programmed to display candidate names, election status, or total votes during administrative access. The display enhances user interaction by providing clear visual confirmation of actions performed during the voting process.

4. Buzzer (Audio Feedback Module)

Principle:
A buzzer converts electrical energy into sound using either a piezoelectric or electromagnetic mechanism. When voltage is applied, the buzzer vibrates to emit an audible tone.

Working:
The buzzer is triggered by the Raspberry Pi once a vote is successfully recorded. A short beep provides an audio acknowledgment, reinforcing the visual message on the LCD. It may also emit different tones to signal errors (e.g., trying to vote twice) or to indicate system startup and shutdown, enhancing accessibility for visually impaired users.

5. Power Supply (Energy Source)

Principle:
A regulated DC power supply converts an AC or DC input (like mains electricity or a battery) to a constant 5V output, which is essential for safe and stable operation of the Raspberry Pi and its peripherals.

Working:
The Raspberry Pi requires 5V @ 2.5A–3A for stable operation, especially when driving multiple peripherals. The power supply unit (PSU) ensures all components receive appropriate voltage without fluctuation.

6.I²C Module (Communication Bridge):

Principle:
I²C, or Inter-Integrated Circuit, is a multi-master, multi-slave, packet-switched, single-ended, serial communication bus developed by Philips Semiconductor (now NXP). It operates on two bidirectional lines:

SCL (Serial Clock Line) – for clock signals.

SDA (Serial Data Line) – for data transmission.

Working:
It connects the Raspberry Pi to the LCD with minimal GPIO usage. It transmits display data efficiently by addressing the module through the I²C bus.

V. FLOWCHART

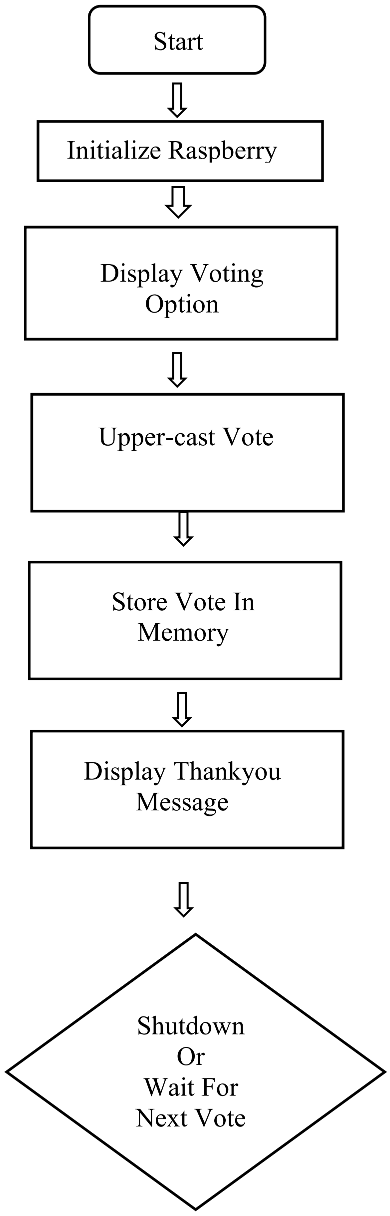


Fig 3: Flowchart Of Electronic Voting Machine.

Once the Raspberry Pi is turned on, it initializes its pre-configured operating system, which is usually a lightweight Linux distribution.

During this startup process, all essential software components, libraries, and hardware drivers are loaded, guaranteeing that the display (such as an LCD or touchscreen) and input devices (like push buttons or a touch interface) operate correctly. After the system setup, the interface displays a clear and interactive list of candidates or political parties on the screen. The system then enters a standby mode, awaiting the voter's selection.

When a voter engages with the device—either by pressing a physical button or tapping an option on the touchscreen—the system captures the input and provides immediate feedback. This feedback can be visual (such as highlighting the chosen candidate), auditory (a beep or voice prompt), or may require a secondary confirmation to avoid accidental votes. Once

confirmed, the chosen vote is securely stored in local memory, typically within a protected file or local database. More advanced systems might also update a checksum or digital hash to ensure the integrity of the vote and detect any tampering.
After successfully recording the vote, a brief thank-you message appears on the screen, acknowledging the voter's participation. Depending on the system's setup, the device may either shut down automatically (in single-use polling scenarios) or reset the interface, clearing any previous input. In the latter scenario, the system returns to the initial screen displaying the voting options, prepared for the next voter in a continuous loop. This guarantees smooth and uninterrupted operation throughout the voting session.

VI. RESULT

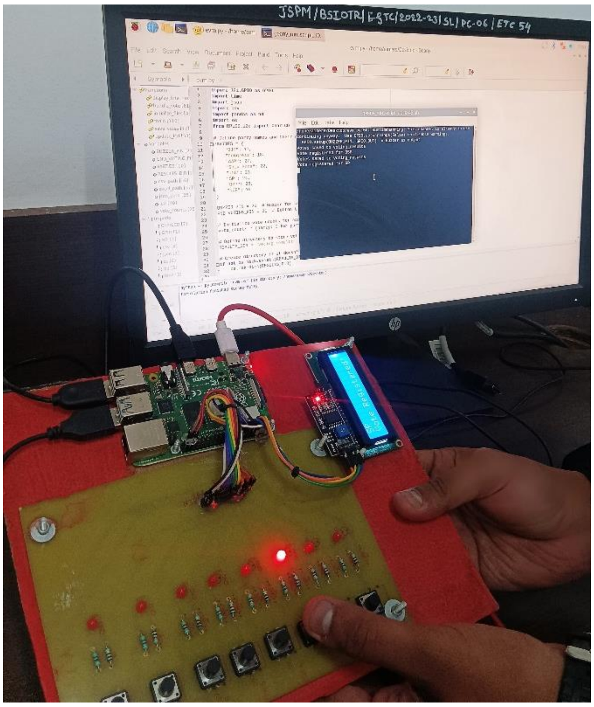


Fig : System Set-up

The Electronic Voting Machine (EVM) system using Raspberry Pi was successfully implemented and tested. The system efficiently records votes, ensures data security, and facilitates a smooth voting process, leveraging the low-cost and flexibility of Raspberry Pi. The interface is designed to be user-friendly, and all components function seamlessly, allowing for real-time vote recording and result generation. Thonny is an integrated development environment (IDE) specifically designed for beginners who are learning Python programming. It provides a simple, intuitive interface that makes it easier for new users to start coding without being overwhelmed by the complexity of other IDEs. Below is a theoretical overview of Thonny and its features:
Purpose and Target Audience:
Thonny is designed primarily for beginners who are just starting with Python programming. It offers a straightforward interface without the extra features that might confuse new learners. It is ideal for people learning Python in educational settings, such as schools or coding boot camps, and is especially useful for teaching and debugging simple Python programs.

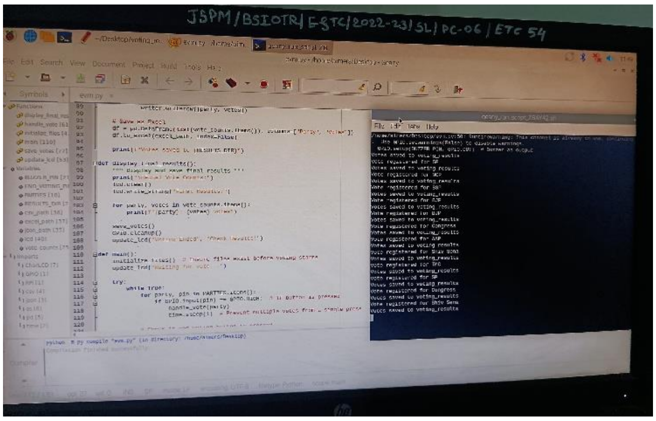
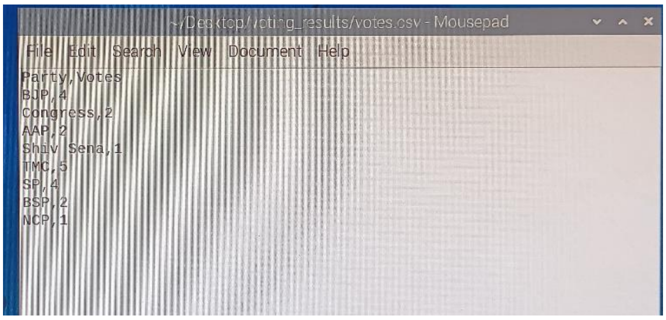


Fig: Thonny Software UI



~/Desktop/voting_results/votes.csv - Mousepad
File Edit Search View Document Help
Party,Votes
BJP,4
Congress,2
AAP,2
Shiv Sena,1
TMC,5
SP,4
BSP,2
NCP,1

Fig : Voting Counts in CSV File

Key Features of Thonny:
Simple Interface: Thonny's user interface is minimalistic, showing only the essentials. It includes the editor window, a shell window for interactive Python execution, and a simple toolbar.

VII. CONCLUSION

The creation of an Electronic Voting Machine (EVM) based on the Raspberry Pi showcases a practical, cost-effective, and dependable alternative to conventional paper-based or intricate electronic voting systems. Crafted with a focus on simplicity and accessibility, this EVM guarantees precise vote registration and counting while providing a seamless, user-friendly experience through features such as an LCD display and tactile push buttons. Importantly, the system functions entirely offline, removing the need for internet connectivity and thus improving its applicability in remote or resource-limited regions, including rural polling places or educational institutions.
reIn addition to its primary functions, the system's modular design offers considerable benefits. It can be readily modified or enhanced to incorporate advanced functionalities like biometric verification, RFID card authentication, or even voice-activated interfaces, positioning it as a scalable solution for future electoral technologies. This project not only showcases the technical adaptability of the Raspberry Pi and embedded systems but also highlights the potential for making secure voting processes more accessible at grassroots levels through innovation and localized design. Ultimately, it

serves as a link between traditional voting methods and contemporary digital advancements—promoting transparency, accessibility, and confidence in electoral systems.

VIII. REFERENCES

[1] Ajay Kumar Garg. (2022). Secured Voting System (Application No. 202211042661). In Official Journal of The Patent Office. Controller General of Patents, Designs and Trade Marks Indian Patent Office India.

[2] Aashutosh Kumar. (2017). Electronic Voting Machine (EVM) With Ballot Paper Like Functionality Too, Without Using Any Paper (201743020537). In Official Journal of The Patent Office. Controller General of Patents, Designs and Trade Marks Indian Patent Office India.

[3] Aswathy, J.S., Bertila, M., Maria, M., Joseph, S.A.S., & Nisha J.R. (2021). Blockchain Voting System. National Conference on Smart Systems and Technologies, 159–164.

[4] Banalamath, A. V, Basavaraj, A. K., Chetan, J. B., & Kallesha, H. U. (2023). A Design & Development of Online Voting System (11/2023). In Official Journal of The Patent Office. Controller General of Patents, Designs and Trade Marks Indian Patent Office India.

[5] Brintha Asha, S., Ganaka Durga, P., Sivaranjani, R., & Steffi E F Shaniya. (2019). Token Authentication based Election System with AI BOT. International Journal for Research in Applied Science and Engineering Technology, 7(3), 288–295.

[6] Bhanupriya's, Rozil banu.S, Sivapriya.P, & Kalaiselvi.V.K.G. (2017). Smart Voting. Second International Conference on Computing and Communications Technologies (ICCCT'17), 143–147.

[7] Budaragade, A. P., & Biradar, V. R. (2008). Smart and Secured Voting System using Magnetic Stripe Voter ID Card and Cloud Storage: A Client-Server Paradigm. International Research Journal of Engineering and Technology, 6(4), 4089–4093.

[8] Chaudhari, N., Shinde, V., Gajare, N., Suryawanshi, P., & Bhosale, S. (2021). E-Voting: The Next Generation Election. International Journal for Research in Applied Science and Engineering Technology, 9(5), 2105–2107.

[9] Dandekar, D. B., Umratkar, G., Manwar, P., Sute, S., Ansari, Z., Khan, H., Ansari, B., & Joshi, B. (2022). Online Voting System Using Cloud Computing. International Research Journal of Modernization in Engineering Technology and Science

[10] Govindaraj, R., Kumaresan P, & Sree Harshitha, K. (2020). Online Voting System using Cloud. International Conference on Emerging Trends in Information Technology and Engineering, IC-ETITE 2020, 1-4.