



# Secure E-Voting System With Biometric Authentication

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**Abstract.** Secure web-based voting systems improve the accessibility of elections, especially for NRIs and the disabled, through internet-enabled device-based voting from anywhere. Incorporating OTP authentication, facial recognition, and surveillance via cameras enhances security and authenticity of voters. An admin phase offers accurate vote counting, promoting transparency and trust in the democratic process.

**Keywords:** Real-time vote verification, Multi Factor Authentication, Automated Vote Counting, Fraud Prevention, Secure Ballot Casting.

## 1 Introduction

With the ongoing development of technology, the need for secure and accessible voting systems is increasing. Conventional voting systems tend to be challenged by issues like restricted accessibility, security vulnerabilities, and diminished transparency, which can adversely affect voter turnout and confidence. Secure Online Voting Systems provide a contemporary solution by using advanced technologies to develop a more trustworthy and inclusive electoral process. By enabling distant voting through internet-connected devices, these systems address the needs of many categories of voters, including Non-Resident Indians (NRIs) and physically handicapped persons. Integrated features such as biometric verification, OTP authentication, and live camera surveillance reinforce one another to authenticate every vote for its authenticity without violating voter privacy. This amalgamation of face recognition and live monitoring increases transparency and security of the system and instills faith, leading to increased voter participation. With society ever more embracing digital innovation, the creation of such safe voting platforms is an important step toward a more robust, inclusive, and credible democratic process.

### 1.1 Research Objectives

The goal of the Secure Online Voting System project is to address the challenges and limitations associated with traditional voting methods, such as security vulnerabilities, voter accessibility issues, and the manual counting of votes. This system integrates modern technologies like biometric authentication and online verification methods to ensure security and user convenience

The primary research objectives of the project are:

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RO1: To analyze and identify the challenges faced in traditional voting systems and the importance of a secure online voting system in addressing those issues.

RO2: To explore the role of biometric authentication (facial recognition and fingerprint scanning) in enhancing the security and accuracy of online voting.

RO3: To examine the system's architecture and evaluate the integration of secure OTP (One-Time Password) verification and voter ID card validation.

RO4: To assess the user accessibility features, such as remote voting for physically challenged individuals and Non-Resident Indians (NRIs), ensuring inclusivity in the electoral process.

RO5: To verify the effectiveness of the system in reducing manual errors and improving the efficiency of vote counting through automation and real-time updates.

## **2 Review Methodology**

The research process emphasizes reviewing the existing technology and methodologies on secure online voting systems and biometric authentication. Academic papers, technical reports, and practical case studies were reviewed in combination. The aim is to assess the ability of biometric authentication and internet voting systems to improve the security, efficiency, and accessibility of elections. This research summarizes reports from credible journals and industry reports to conclude how recent advancements in the e-voting technology field have enhanced electoral integrity.

## **3 Security and Integrity in Online Voting System**

A Safe E-Voting system aims to ensure that votes are cast by legitimate voters alone and that they remain anonymous as well as tamper-proof. Biometric identification (facial recognition and fingerprint reading) is present in authenticating the voters and preventing vote rigging. The system incorporates OTP-based verification to authenticate the voter's identity, enhancing security and voter faith. Use of encryption ensures that vote data is secure and cannot be altered, ensuring integrity and transparency. The online voting process also has multiple verification steps: voter ID verification, biometric verification, OTP generation, and face verification. It minimizes impersonation risks and secures the voting process end to end.

## **4 The Role of Biometric Authentication in Secure Voting**

Biometric authentication, in the form of face recognition and fingerprint scanners, provides an additional layer of security in voting. The technology employs biometric data to authenticate the voter as being the actual voter, thereby reducing the risk of identity spoofing or tampered votes. Additionally, biometric data is very difficult to counterfeit, hence it is a reliable security feature. Facial recognition allows the system to verify the voter from their facial features, and fingerprint scanning adds an addi-

tional level of verification. Together, they allow only real voters to participate in the election, adding another level of security and dependability to the system.

## **5 System Architecture for Secure Online Voting**

The Secure Online Voting System is carefully designed to offer a trustworthy, secure, and accessible digital voting experience for everyone—no matter where they are. Every element of the architecture works together to create a seamless flow, from verifying a voter's identity to ensuring their vote is counted without error. It's not just about putting a vote online—it's about doing it responsibly, safely, and in a way that people feel confident using. At its core, the architecture is built with several specialized modules. Each module has a specific role, and together, they form a complete, end-to-end solution for secure online voting.

Key Features of the Architecture:

### **5.1 Voter Authentication and Verification Module**

This module forms the backbone of the system, ensuring that only eligible voters can cast their vote. The process starts with the voter entering basic details like their name, voter ID, and registered email. Next, they upload an image of their official voter ID card, which is scanned using OCR (Optical Character Recognition) to extract data. That data is matched with official records for accuracy. Once verified, the user proceeds to Aadhaar-based OTP verification, and finally, a biometric face recognition step confirms the identity of the voter. These layers work together to eliminate fraud and protect voter authenticity.

### **5.2 Live Monitoring Module**

One of the standout features of this system is its real-time monitoring capability. As the voter moves through the voting steps, the system keeps a watchful eye to ensure everything is being done properly. This module continuously tracks user activity—right from login to vote submission—and raises alerts if it detects any unusual or suspicious behavior. This live feed is connected to the admin dashboard, giving election officials complete visibility and control throughout the process.

### **5.3 Chatbot for Query Response**

To make sure no voter feels lost or confused, the system includes an AI-powered chatbot right on the homepage. Whether it's a simple question about how to log in, or confusion about the next step in the process, the chatbot is available 24/7 to provide instant help. It simulates human-like conversations to make the support experience feel natural and responsive. This way, voters can move forward confidently without delays or frustration.

## 5.4 Voter Support and Feedback System

Because every voter's experience matters, the system offers a direct feedback and support channel. After casting their vote, users receive an email containing a feedback form. They can use this to report issues, share suggestions, or simply rate their experience. This feedback plays a crucial role in shaping future improvements and helps the team address any flaws in the system proactively.

## 5.5 Admin Panel

Behind the scenes, the admin panel acts as the central command hub for election officials. It provides real-time statistics, such as voter turnout and vote status. Admins can validate voter identities, monitor flagged issues, and ensure that the voting process is running smoothly. This module also helps ensure that every step of the election follows strict security protocols and guidelines.

## 5.6 The Security and Data Protection

Security is baked into every layer of the system. All data transfers—especially those involving personal details and voting decisions—are fully encrypted. Face recognition and OTP verification steps are put in place to lock out any unauthorized access. Every action is logged and monitored to maintain transparency and accountability. The system is regularly updated to stay ahead of cyber threats, keeping both voter data and election integrity safe.

### Process Flow

- **Voter Registration and Authentication:** The voter begins by entering their details and uploading a voter ID card, which the system scans and verifies through OCR.
- **Verification:** The system then moves on to Aadhaar verification, which involves OTP authentication and biometric face recognition.
- **Live Monitoring:** Throughout the voting session, the system actively monitors the user's behavior to ensure a proper and secure flow.
- **Vote Casting:** Once verified, the voter selects and submits their choices. The vote is securely recorded without any manipulation.
- **Feedback and Support:** After voting, the user is encouraged to provide feedback and can use the chatbot to ask questions or report concerns.

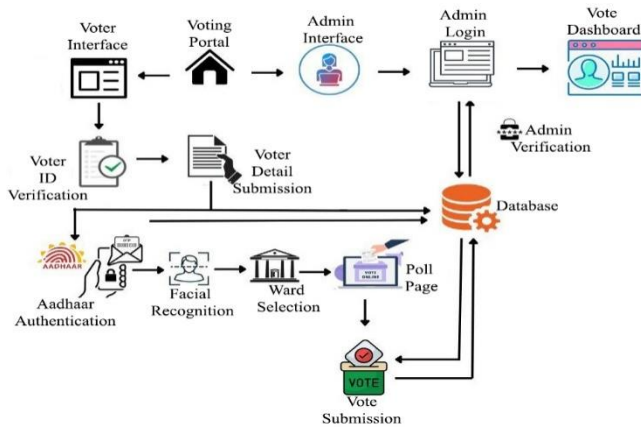


Fig. 1. System Architecture Diagram for Secure Online Voting

## 6 Enhancing Accessibility in the Voting Process

One of the primary objectives of the Secure Online Voting System is to provide voting facilities to all, including disabled citizens, senior citizens, and Non-Resident Indians (NRIs). The system is developed in such a manner that it is platform-independent and can be accessed via any internet device, such as smartphones, tablets, and personal computers. This allows citizens to vote from anywhere in the world, overcoming geographical, physical, and logistical constraints.

To enable inclusive participation, the system has a simple, clear, and intuitive user interface that is accessible to a broad user base. Special attention is given to offering accessibility features such as:

- Voice guidance for visually impaired users.
- High contrast colors and increased font sizes for visually impaired users.
- Keyboard-only navigation with support for people with impaired motor skills.
- Language toggle is offered to support speakers of local languages so that understanding and functionality are supported.

Furthermore, the system is compatible with assistive technologies such as screen readers, thus becoming accessible to the users who rely on them. With the application of universal design, the system erases digital barriers, making it possible for all eligible citizens to vote alone, securely, and confidently within the democratic process.

## 7. Reducing Manual Errors through Automation

One of the advantages of an online system of voting is reducing human error in vote counting. Conventional voting systems depend on human interaction, and thus, they are prone to error in counting votes and reporting. In contrast, a computer system can count votes fast, accurately, and promptly. Additionally, encryption and secure databases make the results impossible to manipulate once transmitted. Real-time updates of voters' turnout and results give transparency, raising voters' confidence in the electoral process. The capability of the system to track and report progress assures the accuracy of the results of the elections and accessibility to stakeholders at the end of voting.

## 8. System Evaluation and Future Enhancements

The Secure Online Voting System can revolutionize the way we vote for the better by making the entire process more secure, efficient, and accessible to everyone. As technology improves, voters' needs and expectations improve as well—and this system is poised to directly answer them. There is much to expand on in the years to come. Future enhancements can include the use of more advanced biometric authentication in the form of iris or voice recognition to make verification even more reliable. Multi-language support and the capacity to adapt the voting traditions of different regions can also make the system more universal and accessible in use no matter where one votes from. Even the use of blockchain can have the potential to render vote records completely untamperable, introducing even more transparency and trust. With more development and focus on user experience, this system can be a valuable asset to conducting elections that are not only secure and equitable but accessible to people all over the world.

## 9. Key Discoveries and Discussions

SVS, which came out of its development, opened doors to improved ways of ease of voting process. In modest experiments involving over five voters, the system dramatically outweighed customary means in the accessibility, security, and user satisfaction. The front-end user interface, coded in HTML, CSS, and JavaScript, has a simple but catchy design which plays its part in the overall voting process, although the future updates are underway which will make it even simpler and richer. One of the major challenges encountered during development was incorporating facial recognition technology for voter authentication. Initial attempts were plagued with accuracy and speed concerns. But with experimentation through many different algorithms, the team managed to identify and implement the best approach that greatly improved the reliability of facial recognition and streamlined the authentication process for users. This is a testament to the importance of continuous testing and tuning in ensuring the security and usability of the system. Backend was developed with PHP and Python, and numerous services and APIs were utilized to perform such critical operations such as OTP and data security. Third-party service integration was extremely important to ensure security for the voting process and prevent any unauthenticated access. The

feature of the system to process sensitive information, like identification and voter details, with encryption and real-time tracking makes the voting process more genuine. End-user feedback gave emphasis to the ease of the system and ease of remote voting. Voters such as voters with physical disabilities and Non-Resident Indians (NRIs) also mentioned that the system was immensely accessible and they were able to vote from their homes without much trouble. Facility to authenticate voters through biometric and OTP-based identification also helped in achieving a high degree of faith in the purity of the process. Although there is still scope for additional optimization—particularly in expanding to accommodate larger voter bases and refining the system's interface—the SVS already available has indeed shown significant progress in securing, streamlining, and clarifying the electoral process. In the future, further developments in security measures, for example, through the utilization of blockchain to make voting ledgers unalterable, will further increase the credibility and trustworthiness of the system so that it can facilitate democratic processes for a broad variety of elections.

## 10. Future Scope

In the coming days, the Secure Online Voting System (SVS) will significantly enhance security, accessibility, and transparency in the electoral process. The system will possess a tamper-proof and indestructible history of cast votes using blockchain technology, reducing the risk of vote tampering and increasing citizens' trust in the electoral system. End-to-end encryption and multi-factor authentication are sophisticated features that will provide enhanced protection against unauthorized access and guarantee confidentiality in data. The platform will become increasingly advanced to recognize and respond to threats in real-time using smart cyber-alert systems, improving safety and reliability. Accessibility will also be the top priority, with voice command integration and multi-lingual functionality making the platform accessible to more voters. For scaling up increasing bases of voters, SVS will be designed scalable with maintaining performance for large elections as well. It will be incorporated into existing election management systems to provide simple administrative processes and real-time notifications to the authorities, making the coordination process easier overall. The development will bring forward the building of a more secure, efficient, and inclusive experience for digital voting, making democratic participation better in the years to come.

## 11. Conclusion

The Secure Online Voting System (SVS) is a major innovation in bringing the electoral process into the modern age through a secure and reliable digital system. By reducing reliance on traditional voting methods, the system effectively addresses fundamental concerns such as accessibility to voters, security against fraud, and the need to build trust in the election result. The biometric verification and real-time monitoring enhance the integrity and secrecy of each vote. Its modular design allows for the system to be adjusted to fit varying types of elections, from national elections to organizational voting, to make it very versatile. With a simple user interface and robust security framework, SVS simplifies voting without compromising transparency and

voter data security. As the system continues to evolve with technological progress, it is poised to further increase the efficiency, reliability, and inclusiveness of elections. Implementing such secure and accessible solutions will be pivotal in shaping the future of democratic engagement and fostering trust in electoral systems worldwide.

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