IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 5, May 2025

DOI: 10.17148/IJARCCE.2025.145127

Secure Voting System Using Ethereum

Padmanabh Madaswar [1], Sanved Barkade[2],Anish Mane [3], Sakshi Dhekane [4], Shreya Yadav[5]

UG Student, PES's Modern College of Engineering, Pune, India [1,2,3,4]

Assistant Professor, PES's Modern College of Engineering Pune, India [5]

Abstract: Secure voting using the Ethereum blockchain is a modern, transparent, and tamper-proof method for conducting online elections. This system is implemented as a decentralized application (dApp) on the Ethereum network, allowing voters to cast their votes and view results without the need for intermediaries. Each vote is immutably recorded on the blockchain, making it virtually impossible to manipulate or alter the outcome. Smart contracts automate the voting process, ensuring transparency, accuracy, and security at every step. To further strengthen the system, face detection technology is integrated as a biometric authentication layer, ensuring that only verified users can access and participate in the voting process. By combining blockchain technology, decentralized architecture, smart contracts, and facial recognition, the system offers a secure, reliable, and cost-effective solution for conducting fair and verifiable elections.

Keywords: Ethereum blockchain, online voting, decentralized application, smart contracts, Face detection

I. INTRODUCTION

In every democracy, the security of an election is a matter of national security. Electronic voting machines have been viewed as flawed, and anyone with physical access to such a machine can potentially sabotage it, thereby compromising all votes cast on that machine. To ensure election integrity, transparency, and verifiability, we propose a revolutionary shift from traditional paper-based and electronic voting systems to a secure, blockchain-powered voting platform.

A secure voting system built on the Ethereum blockchain has the potential to revolutionize the way we conduct elections. By leveraging the security, transparency, and immutability of blockchain technology, decentralized voting systems can eliminate many of the challenges and risks associated with traditional voting methods.

In this secure voting system, each voter is assigned a unique digital identity, and their vote is permanently recorded on the blockchain, ensuring that it is tamper-proof and cannot be altered or deleted. Decentralized voting systems also remove the need for intermediaries—such as election commissions or third-party authorities—to manage the voting process, making it more efficient and less susceptible to corruption or manipulation.

To further enhance the security and reliability of the system, **biometric face detection technology** is integrated for user authentication. This ensures that only legitimate, verified individuals are allowed to vote, effectively preventing impersonation, duplicate voting, and other forms of electoral fraud. The use of facial recognition adds a powerful layer of identity verification that supports the integrity of the entire voting process.

Additionally, secure voting systems can boost voter participation by allowing individuals to cast their ballots from anywhere in the world, provided they have internet access. This leads to a more democratic, inclusive, and convenient electoral process with greater engagement and higher turnout.

We are developing this **Decentralized Voting System using the Ethereum Blockchain and integrated face detection authentication** to provide a secure, transparent, and tamper-proof solution for conducting modern, trustworthy elections.

II. LITERATURE REVIEW

[1] A. Khandelwal," Blockchain Implementation on E-Voting System," IEEE, 2019. This research investigates the integration of blockchain technology into electronic voting (e-voting) systems. The study highlights key blockchain features such as immutability, security, and decentralization, which can address challenges in creating a secure and legal e-voting system. By using blockchain, issues like transparency, authenticity, and system integrity are mitigated, offering a viable solution for modernizing voting infrastructures.
[2] V. Silusaree," Blockchain Technology Application for Electronic Voting Systems," IEEE, 2021. This research focuses on the role of blockchain in remote electronic voting systems, emphasizing its potential to increase voter turnout

ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.471 ⁘ Peer-reviewed & Refereed journal ⁘ Vol. 14, Issue 5, May 2025
DOI: 10.17148/IJARCCE.2025.145127

and enhance security. By using blockchain, the system ensures vote security, prevents hacking, and maintains the integrity of the voting process, thereby increasing public confidence in e-voting systems.

[3] Z. Miao," Blockchain-Based Electronic Evidence Storage and Efficiency Optimization," IEEE, 2021. Miao proposes a model for optimizing electronic evidence storage in voting systems by integrating blockchain's Directed Acyclic Graph (DAG) and InterPlanetary File System (IPFS). This approach reduces the costs and complexity associated with traditional storage methods, providing a more efficient and transparent process for storing voting data.

[4] J. Wang," Electronic Voting Protocol Based on Ring Signature and Secure Multi-Party Computing," IEEE, 2020. This study presents a voting protocol that addresses privacy concerns through the use of ring signatures within a blockchain framework. Voters can sign their votes without revealing their identity, maintaining the integrity and immutability of voting records. This approach enhances security in the voting process but poses challenges related to computational complexity and network infrastructure.

[5] S. Singh," Designing a Blockchain-Enabled Methodology for Secure Online Voting System," IEEE, 2023. Singh's research provides a comparative analysis of various blockchain frameworks, proposing a secure online voting system that addresses limitations in existing methods. By evaluating scalability, security, and usability, the study demonstrates the potential of Distributed Ledger Technology (DLT) in ensuring a transparent and secure voting process, though scalability and energy consumption remain issues.

[6] Y. Cheng," Research on Blockchain Technology in Cryptographic Exploration," IEEE, 2020. Cheng explores the use of blockchain to enhance the security of smart factories. The study integrates Internet of Things (IoT) technology with blockchain to develop a tamper-resistant system. Though the research focuses on industrial applications, it provides valuable insights into the security features that blockchain can bring to e-voting systems.

[7] P. Rani," Deploying Electronic Voting System: Use Case on Ethereum Public Blockchain," IEEE, 2022. This study examines the deployment of an Ethereum-based blockchain for real-time e-voting systems. By leveraging Ethereum's distributed ledger, the research demonstrates how blockchain can ensure transparency and security. However, reliance on Ethereum, accessibility, and convenience issues limit the system's scalability and widespread adoption.

[8] V. Bhatnagar," Decentralizing Voting: Blockchain-Based E-Voting System Using Ethereum Smart Contracts," IEEE, 2024. Bhatnagar introduces a blockchain-based voting model designed to improve the transparency, security, and integrity of voting systems. The research evaluates various blockchain frameworks and undergoes iterative testing to refine the proposed model. Challenges regarding scalability, deployment costs, and system performance remain critical factors.

[9] A. Qumzar," E-Voting System Based on Blockchain Technology: A Survey," IEEE, 2021. Qumzar's survey assesses blockchain-based e-voting applications, exploring the potential benefits of improved security, privacy, and cost reductions. The research evaluates public, private, and hybrid blockchain systems, emphasizing the importance of decentralized ledgers in enhancing system security and maintaining voter privacy.

[10] A. Guptha," Secure Vote: AI-Powered Fingerprint Authentication for Next-Generation Online Voting," IEEE, 2023. Guptha's research proposes an AI-enabled online voting system incorporating dual-factor authentication through fingerprints and identification numbers. The system enhances voting security and reliability, though the study indicates that no single solution meets all security needs. A hybrid approach is suggested to address technical limitations and ensure adaptability.

III. SYSTEM ARCHITECTURE DIAGRAM

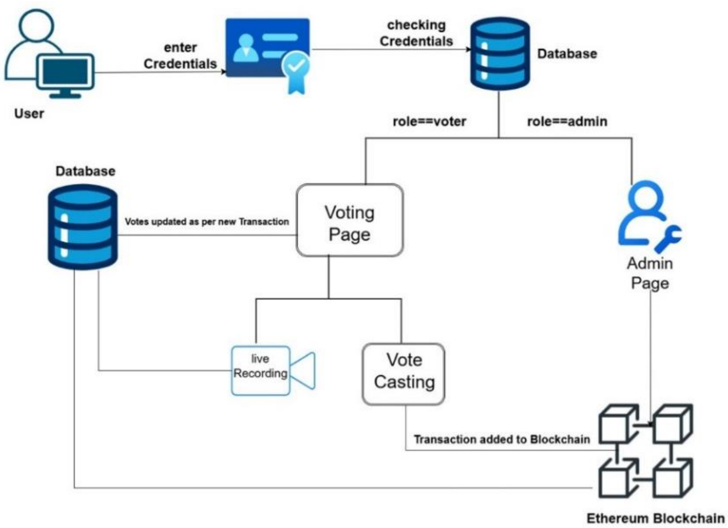

Fig. 1 Architecture Diagram

Impact Factor 8.471 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 14, Issue 5, May 2025

DOI: 10.17148/IJARCCE.2025.145127

The proposed decentralized voting system using Ethereum blockchain and face detection is illustrated in Figure 1. This architecture ensures secure authentication, transparent vote casting, and immutable vote storage by integrating blockchain and biometric technologies.

A. User Authentication and Role Verification

The voting process begins when the user enters credentials on the login interface. The system verifies these credentials against a central database. Depending on the user's role (voter or admin), the system redirects them to the appropriate interface. Voters are taken to the voting page, while admins access the administrative dashboard.

B. Biometric Face Detection Integration

To improve security and prevent fraudulent access, the system incorporates a face detection mechanism. Before a voter can cast a vote, the system captures a live image and matches it with pre-registered facial data. Only verified users are allowed to proceed with voting.

C. Vote Casting and Blockchain Recording

Once the user is verified, they cast their vote through the system. Each vote is treated as a transaction and is submitted to the Ethereum blockchain. Smart contracts record the vote immutably, ensuring that votes cannot be changed or tampered with. At the same time, the local database updates vote counts and records metadata.

D. Admin Dashboard

Users with administrative roles can perform system management tasks via the admin dashboard. These tasks include adding voters, monitoring voting activity, and reviewing statistics. All admin actions are securely logged.

E. Security and Transparency

By combining Ethereum blockchain and face detection, the system provides a highly secure, transparent, and tamper-resistant platform for conducting elections. The use of decentralized architecture eliminates intermediaries, reduces corruption risks, and ensures trustworthiness throughout the electoral process.

IV. IMPLEMENTATION DETAILS

The proposed secure voting system integrates Ethereum blockchain technology with advanced face detection techniques to ensure a tamper-proof and user-authenticated voting process. The system implementation is divided into three main components: Frontend, Backend, and Smart Contracts.

A. Frontend

The frontend is developed using **React.js**, providing a responsive and intuitive user interface. Key features include voter registration, live face detection during authentication, vote casting, and real-time feedback on voting status. HTML5 and CSS3 are used for styling and layout design to ensure cross-browser compatibility.

B. Backend

The backend is implemented using **FastAPI**, a modern, fast (high-performance) Python web framework for building APIs. It exposes RESTful endpoints for user registration, face detection, and vote submission. For face recognition, the system utilizes the **MTCNN** model for accurate face detection and **InsightFace (ArcFace)** for embedding extraction and verification. Face embeddings and user data are securely stored in a **MongoDB** database, providing a scalable and flexible NoSQL storage solution.

C. Smart Contracts

The voting logic is implemented as **Solidity smart contracts** deployed on the Ethereum blockchain. The contract manages voter registration, voting eligibility, and vote recording, ensuring immutability and transparency. Solidity

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.471 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 5, May 2025
DOI: 10.17148/IJARCCE.2025.145127

functions are designed to prevent double voting by tracking voter addresses and restrict voting to authenticated users only.

D. Database

The system uses **MongoDB**, a NoSQL database, to store voter information and facial embeddings. MongoDB's schema-less design supports flexible data structures, facilitating efficient storage of biometric data. Separating biometric data storage from the blockchain optimizes gas costs and maintains voter privacy.

V. RESULT AND SCREENSHOTS

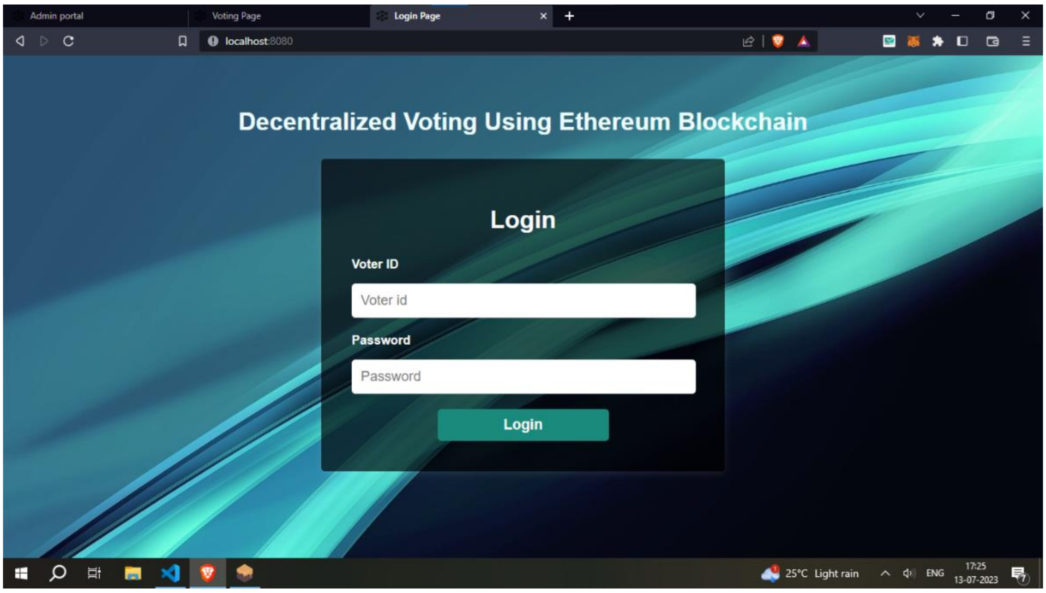

Fig. 2 Login Page

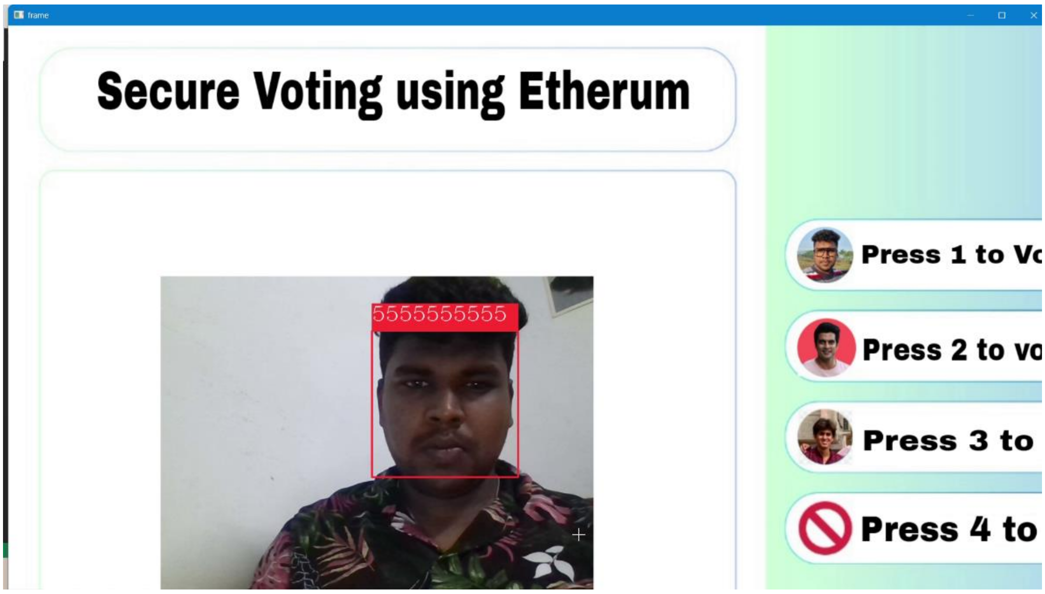

Fig. 3 Face Detection

The proposed secure voting system was tested using multiple voter identities to validate its real-world functionality. The process required each voter to undergo **live face verification** using **MTCNN** and **InsightFace** models. Upon successful face match, the system permitted the voter to cast a vote securely through **Ethereum smart contracts**.

DOI: 10.17148/IJARCCE.2025.145127

Face detection was effective in real-time scenarios and operated accurately under different lighting and camera angles. The smart contract logic ensured that each user could vote only once, and any repeated voting attempts were automatically blocked. All votes were permanently recorded on the Ethereum blockchain, ensuring transparency and immutability.

The user interfaces developed for the system included voter registration, live face detection, the candidate voting page, and the admin dashboard. These interfaces were tested for usability and are shown in the figures earlier in the paper

VI. CONCLUSION AND FUTURE WORK

This paper presented a secure and transparent voting system that combines **Ethereum blockchain** with **face detection-based biometric authentication**. The implementation ensures that only authorized individuals can vote, and every vote is permanently and immutably stored on the blockchain. The frontend developed using **React.js** offers a simple and user-friendly interface, while **FastAPI** and **MongoDB** efficiently handle backend logic and data storage. Face recognition is achieved through **MTCNN** for detection and **InsightFace** for high-accuracy identity verification.

The system successfully addresses critical challenges in traditional voting systems such as vote tampering, impersonation, and double voting. The use of blockchain guarantees transparency and trust, while facial verification ensures voter authenticity without the need for manual validation.

A. Future Work

Although the system performs well under test conditions, several areas can be explored to improve its performance and scalability:

- **Multi-modal Biometric Authentication**: Incorporating other biometrics like iris or fingerprint for higher accuracy and security.
- **Scalability Enhancements**: Using **Layer 2 blockchain solutions** (e.g., Polygon, Optimism) to reduce transaction fees and improve speed.
- **IPFS Integration**: Securely storing voter images or documents off-chain while preserving immutability through content hashes.
- **Improved Face Recognition**: Enhancing accuracy in low-light environments and with partially covered faces (e.g., masks).
- **Mobile App Deployment**: Extending the platform for mobile-based secure remote voting with device-specific security layers.

These enhancements will contribute to building a more robust, scalable, and widely deployable voting infrastructure suited for national-level elections and organizational polls.

REFERENCES

[1] A. Khandelwal," Blockchain Implementation on E-Voting System," IEEE, 2019. This research investigates the integration of blockchain technology into electronic voting (e-voting) systems. The study highlights key blockchain features such as immutability, security, and decentralization, which can address challenges in creating a secure and legal e-voting system. By using blockchain, issues like transparency, authenticity, and system integrity are mitigated, offering a viable solution for modernizing voting infrastructures.
[2] V. Silusaree," Blockchain Technology Application for Electronic Voting Systems," IEEE, 2021. This research focuses on the role of blockchain in remote electronic voting systems, emphasizing its potential to increase voter turnout and enhance security. By using blockchain, the system ensures vote security, prevents hacking, and maintains the integrity of the voting process, thereby increasing public confidence in e-voting systems.
[3] Z. Miao," Blockchain-Based Electronic Evidence Storage and Efficiency Optimization," IEEE, 2021. Miao proposes a model for optimizing electronic evidence storage in voting systems by integrating blockchain's Directed Acyclic Graph (DAG) and InterPlanetary File System (IPFS). This approach reduces the costs and complexity associated with traditional storage methods, providing a more efficient and transparent process for storing voting data.
[4] J. Wang," Electronic Voting Protocol Based on Ring Signature and Secure Multi-Party Computing," IEEE, 2020. This study presents a voting protocol that addresses privacy concerns through the use of ring signatures within a blockchain framework. Voters can sign their votes without revealing their identity, maintaining the integrity and

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⫘ Peer-reviewed & Refereed journal ⫘ Vol. 14, Issue 5, May 2025

DOI: 10.17148/IJARCCE.2025.145127

immutability of voting records. This approach enhances security in the voting process but poses challenges related to computational complexity and network infrastructure.

[5] S. Singh," Designing a Blockchain-Enabled Methodology for Secure Online Voting System," IEEE, 2023. Singh's research provides a comparative analysis of various blockchain frameworks, proposing a secure online voting system that addresses limitations in existing methods. By evaluating scalability, security, and usability, the study demonstrates the potential of Distributed Ledger Technology (DLT) in ensuring a transparent and secure voting process, though scalability and energy consumption remain issues.

[6] Y. Cheng," Research on Blockchain Technology in Cryptographic Exploration," IEEE, 2020. Cheng explores the use of blockchain to enhance the security of smart factories. The study integrates Internet of Things (IoT) technology with blockchain to develop a tamper-resistant system. Though the research focuses on industrial applications, it provides valuable insights into the security features that blockchain can bring to e-voting systems.

[7] P. Rani," Deploying Electronic Voting System: Use Case on Ethereum Public Blockchain," IEEE, 2022. This study examines the deployment of an Ethereum-based blockchain for real-time e-voting systems. By leveraging Ethereum's distributed ledger, the research demonstrates how blockchain can ensure transparency and security. However, reliance on Ethereum, accessibility, and convenience issues limit the system's scalability and widespread adoption.

[8] V. Bhatnagar," Decentralizing Voting: Blockchain-Based E-Voting System Using Ethereum Smart Contracts," IEEE, 2024. Bhatnagar introduces a blockchain-based voting model designed to improve the transparency, security, and integrity of voting systems. The research evaluates various blockchain frameworks and undergoes iterative testing to refine the proposed model. Challenges regarding scalability, deployment costs, and system performance remain critical factors.

[9] A. Qumzar," E-Voting System Based on Blockchain Technology: A Survey," IEEE, 2021. Qumzar's survey assesses blockchain-based e-voting applications, exploring the potential benefits of improved security, privacy, and cost reductions. The research evaluates public, private, and hybrid blockchain systems, emphasizing the importance of decentralized ledgers in enhancing system security and maintaining voter privacy.

[10 A. Guptha," Secure Vote: AI-Powered Fingerprint Authentication for Next-Generation Online Voting," IEEE, 2023. Guptha's research proposes an AI-enabled online voting system incorporating dual-factor authentication through fingerprints and identification numbers. The system enhances voting security and reliability, though the study indicates that no single solution meets all security needs. A hybrid approach is suggested to address technical limitations and ensure adaptability.