AI-powered Online Voting System

Akash[1], Basalingappa Pagi[2], Ramakrishna S.[3] And Dr. Rudramurthy V C [4]

1, 2, 3: Department of Information Science and Engineering,

B.M.S College of Engineering, Bengaluru

Abstract

Elections are at the heart of every democratic society, but traditional voting options are still afflicted by accessibility, security, transparency, and efficiency issues. Even with the advent of Electronic Voting Machines (EVMs), there are still issues related to tampering, voting access limitations for some groups, auditing, and slow result tallies. This work proposes an AI-powered online voting system that employs artificial intelligence, blockchain, and biometric authentication to provide a secure, accessible, and transparent voting experience. The goal of the system is to increase overall voting accessibility, by allowing remote voting for demographics, such as migrant workers, Non-Resident Indians (NRIs), the elderly persons, and physically challenged people. This is done by providing mobile and web-based platforms. In some cases, election officials can visit the homes of disabled voters to offer a tablet-based voting. The system provides biometric or One-Time Password (OTP) based voter authentication to ensure election security. It includes anomaly detection via Artificial Intelligence (AI) to identify suspicious voting patterns, and blockchain counting to provide a record that cannot be tampered with.

Keywords

Blockchain, Secure voting, Vote-from-anywhere, Artificial Intelligence

1. Introduction

Voting is an essential part of any democratic country. It allows the citizens in the decision-making process. However, traditional voting systems face many hurdles that affect their effectiveness and trustworthiness. Some of the challenges include limited access for some voter groups, the potential for fraud, physical interference with the vote (tampering), inefficiencies in counting votes, leading to lack of transparency and trust. Concerns have been raised over the integrity of Electronic Voting Machines (EVMs).

Although EVMs are faster than manual methods, especially for vote counting, they are still prone for to interferences, tampering and error.

Difficulties in accessing voting systems cause low turnout with groups like migrant workers, Non-Resident Indians (NRIs), seniors, and disabled people. Each of these groups faces serious logistical and physical challenges to appear physically for voting. Moreover, the people temporarily displaced or traveling are forced to refrain from the voting at their designated polling booth and hence their participation in the electoral process. This potential problem, causing low turnout, is an opportunity for us to create a system that fosters security, inclusivity, and transparency.

This work is an effort to resolve the significant problems with the exiting voting systems. By using the technologies, such as artificial intelligence (AI), biometric authentication and blockchain-based data storage for votes, it will increase security and robustness, allows for remote voting, and strengthens the public trust in the voting process. Biometric or OTP-based authentication confirms that every voter is securely identified with face recognition and OTP verification, preventing impersonation. AI models are employed for to identify any miscreant deletion of genuine voters and insertion of fake voters on the electoral roll. The blockchain ensures that votes are stored permanently, tamper-proof and confirms a verifiable audit trail for votes.

The process holds the voters accountable and avoids lower turnouts. It promotes civic responsibility in the electoral process. It can also help in identifying the people eligible for government benefits. Moreover, election and ballot officials could take the device into the homes of voters with disabilities, by utilizing secure devices to cast their votes with dignity and privacy.

This system has the ability to respond to the present-day electoral problems in a secure, configurable, and scalable manner. The paper presents the design, operation, and impact of the proposed system, which is inclusive, efficient, and inherently trustworthy.

An extensive literature review is carried out to understand the state-of-the-art in the related area. [1] develops a decentralized e-voting system based solely on the Ethereum blockchain, which provides complete transparency, immutability, voter anonymity, and eliminates dependence on central servers. The system comprises four parts: deploying the smart contract, registering citizens with Metamask wallets, authenticating voters with SHA-256 encrypted credentials and OTP requests, and submitting votes. Voter authenticity is ensured using a two-step authentication process at the time of voting, and once the vote is cast, the respective wallet address is locked.

A transparent e-voting solution that uses cloud computing with biometric authentication is proposed in [2]. Specifically, the solution uses smartcards, fingerprint and iris recognition, to assure eligible voters to vote remotely. Authentication is done using either fingerprint or iris scans and authentic voters are allowed to vote through a secure interface.

A study by [3] examines the public perception of a hypothetical voting system powered by artificial intelligence (AI) that would utilize citizens' digital data to ascertain their political attitudes. An electronic voting system, based on a distributed ledger approach using blockchain, and featuring asymmetric key RSA algorithm for secure data transmission and encryption, is proposed [4]. The e-voting system allows voters to remotely interface with the platform using any digital device connected to the internet, thus facilitating access and convenience to involve in the voting process. [5] proposes an electronic voting protocol, which utilizes blockchain technology to define an e-voting process that ensures voter privacy, decentralization, verifiability, and fairness. The proposed protocol treats the blockchain as a transparent and distributed ballot box, thereby enabling voters to cast, change, and verify their votes through a distributed and secure platform. The voting system employs a Central Authority (CA) to authenticate the voters using blind signatures. A secure and user-friendly e-voting system is illustrated which utilizes face recognition in the voting process [6]. The proposed system employs the Viola-Jones algorithm for face detection and the Eigenface algorithm for face recognition, allowing voters to cast their vote via internet or cell phone. The e-voting system employs a threshold-based recognition method, based on optimal eigenvalue selection, to improve overall system efficiency and has achieved over 97% accuracy.

A strong and effective internet-based e-voting system was proposed [7] to ensure voter privacy, integrity, and end-to-end verifiability. The system allows the voters or third-party investigators to verify the proper recording and counting, without violating privacy. D-DEMOS utilizes threshold cryptography and zero-knowledge proofs. [8] proposes a comprehensive e-voting system that performs Aadhaar-based authentication. It uses face recognition and blockchain technologies to ensure secure, transparent, and easy-to-use voting platform.

A decentralized online voting framework based on blockchain technology is presented in [9]. This framework employs an open-source platform based on the Ethereum technology stack to enhance security and verifiability of votes. It treats each vote as an independent transaction where a new block is created for each vote. This block is then connected into the previous

vote using a hash. After this, the block is added to the blockchain pertaining to the candidate of choice. In [10], a mobile-based electronic voting platform is illustrated, which allows voting using smartphones. [11] discusses online voting in general elections focusing on increased voter participation. Another secure, fully automated voting framework that aims to eliminate manipulation and tampering of votes, using biometric authentication, is discussed in [12]. It provides reliability and flexibility and a realistic way to address the problems in voting technologies. A secure online voting protocol that combines both biometric authentication and steganography is proposed in [13]. Fingerprint images are used as both the biometric identifier and cryptographic key image while the secret keys are embedded in stego images through a combination of SHA-256 hashing and Least Significant Bit (LSB) image modification process.

[14] employs electorate-generated credentials with internet voting, for full end-to-end verifiability. A secure, scalable internet voting system, that combines biometrics with blockchain technology, is proposed [15]. It uses facial and fingerprint recognition to verify voter identity. Biometric data is stored securely, and verified on a Hyperledger Fabric blockchain network. It yielded an accuracy of 87% for successful biometric registration and an 88% for vote authentication.

Majority of the reported works are based on internet systems, which are vulnerable to hacking. They also use security measures for authentication with the help of cryptography, steganography and blockchain. Biometric authentication has its own drawbacks. Moreover, face recognition poses additional challenges in the Indian electoral process because the id cards for voting contain old photographs of the voters. Mobile voting is not yet acceptable due to rigging, booth capturing and impersonation. Hence, a secure voting system is proposed in this work, which uses AI along with multiple authentication mechanisms.

The remainder of the paper is organized into four sections. The architecture of the proposed methodology is presented in Section 2. Results are discussed in Section 3. Section 4 concludes the work.

2. Proposed Methodology

The proposed system presents an advanced online voting system with AI capabilities that transforms the traditional voting approach by employing artificial intelligence (AI), biometric authentication, and blockchain. One of the main services of this platform is voter authentication which uses a biometric source, such as fingerprint or facial recognition. The

system can also be set to use a One-Time Password (OTP) for the authentication through mobile devices. Figure 1 shows the proposed methodology.

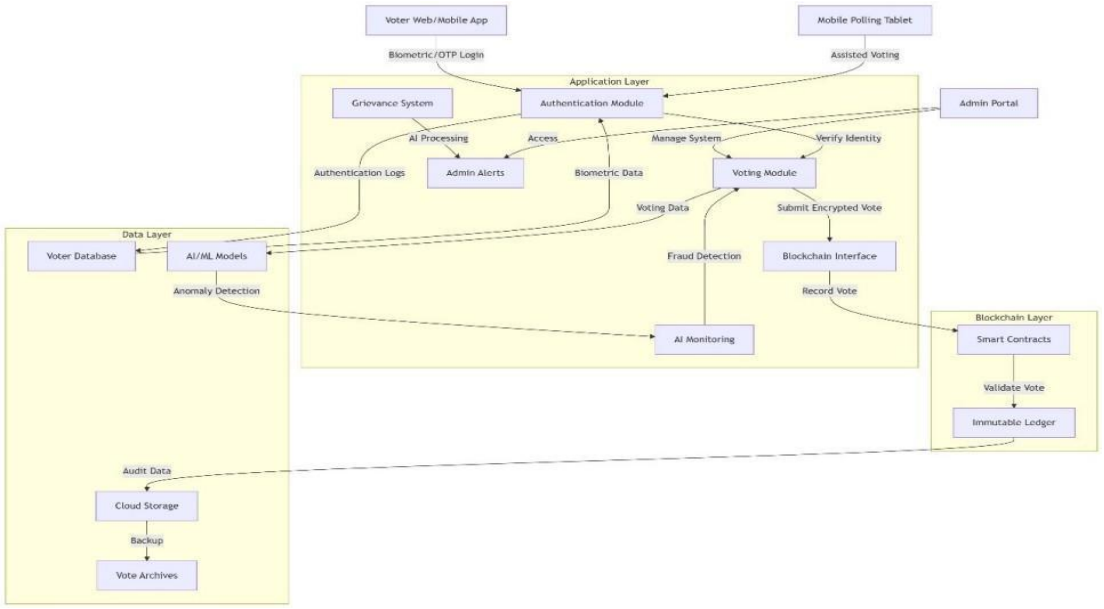

Figure 1. Block diagram of the proposed methodology

AI algorithms are used for monitoring and suspect the voter behavior, ensure the integrity of the data and the validity of the voters list. The system includes an AI-enabled voter list verification system that checks for duplicates, registration errors, and voting list inconsistencies in real-time. Each vote is validated and stored securely on a blockchain network. Blockchain provides non-alterability, traceability, and anti-tamper functionality, creating trust in the integrity of the electoral process. The decentralized ledger prevents manipulation of election outcomes, and enables audits to take place quickly with better transparency.

Another significant aspect of the system is the grievance redressal mechanism, which provides the voters the ability to report technical or procedural issues during the voting process. Complaints are auto-categorized and prioritized by AI tools to allow election officials to resolve them quickly. In addition to this, the platform adopts a voter accountability mechanism that promotes civic responsibility by tracking whether a citizen voted. If an eligible voter does not vote during the election period without a valid excuse, the system will block them for some government services or subsidies. The platform is built using Python and Flask for server-side processing, HTML/CSS for the front-end design, and a blockchain framework, Ethereum testnet, for decentralized storage. The system is responsive, secure, and highly available to ensure a seamless voting experience for a voter using multiple devices and across different geographies. Overall, the proposed system

provides a holistic solution for improving public participation in the democratic process by enhancing security, accessibility and public trust in the electoral process.

Some of the important modules are:

User Profiling Module: It updates and stores user-specific learning styles and progress, continuously.

Vote Casting Module: It handles ballot display, vote selection, and submission to blockchain.

Admin Control Panel: It permits authorized election administrators to manage voting sessions and visualize stats.

AI Fraud Detection Engine: It recognizes suspicious activity and anomalies either in authentication or voting.

Blockchain Recording Module: It records votes using smart contacts immutably and ensures audibility.

Authentication Module: It tracks non-voters and links the participation of the public with civic responsibility checks.

Accessibility & Voice UI: It supports voice-assisted, multilingual interaction for elderly and disabled users.

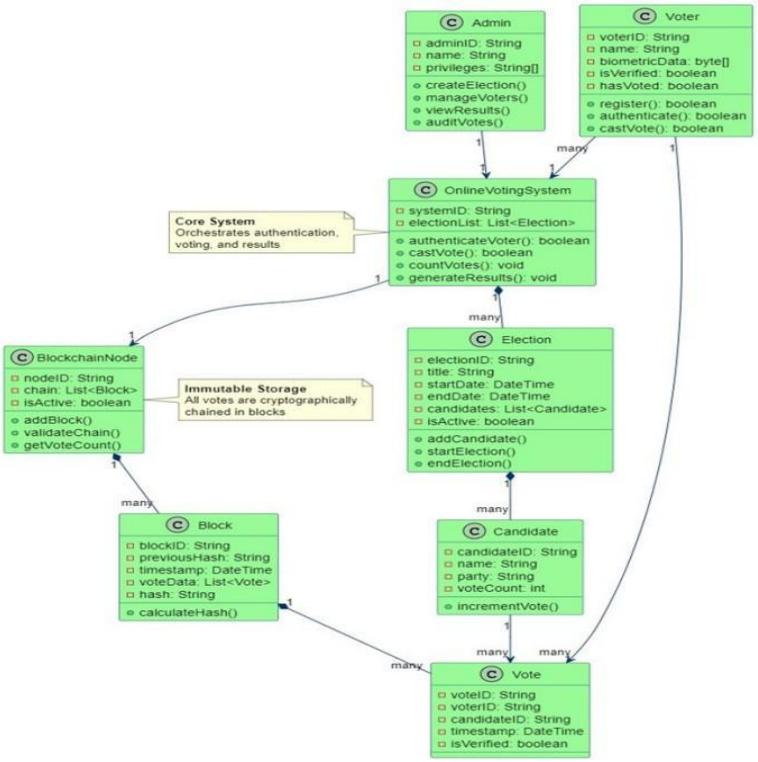

Figure 2. Detailed class diagram

The primary advantages of the proposed application are:

1. **Safe and Inclusive Remote Voting:** The system allows citizens, especially, migrants, NRIs, seniors, and the disabled, to securely vote wherever they are. Secure random

biometric (or OTP) authenticator lets the verified users to participate. It ensures inclusivity without sacrificing security aspects.

2. **AI-Based Fraud Detection and Anomaly Monitoring in Real Time:** AI continuously monitors the voter behavior and activity in the system to detect impersonation and duplicate voting attempts or suspicious log in attempts. These automated whitelist/blacklist checks protect from fraudulent voting, ensuring fairness and integrity of the elections.
3. **Secure Record of Tamper-Proof Votes on Blockchain:** All cast votes get recorded on a blockchain ledger that provides permanence and transparency. The decentralized storage makes tampering impossible, but we can create independent audit trails, and build public trust knowing votes cannot be changed later.
4. **Mobile Voting for Disabled Citizens with Accessibility:** Mobile polling units equipped with biometric scanners and secured tablets allow for physical surveying of the disabled. Our system provides a door-to-door union where all democratic participants are accessible, regardless of their mobility.
5. **AI-Powered Cleanup of the Voter List:** The system uses AI algorithms to cross-verify voter information and checks for duplicates, illegal, or unrecorded voters on the electoral role. This allows for a consistent, accurate, and updated voter list that drastically reduces human error and proxy votes.
6. **Dynamic Voter Response and Monitoring of Responsibility for Voting:** Voter activity is secured for positive confirmation of the voted citizens. If a citizen has not voted and has no valid communications, will be denied the citizen benefits. It promotes good, responsible voting behavior, by strengthening voting habits.
7. **Voice-Assisted and Multilingual Interface:** The voting system embraces the multilingual and diverse Indian population by offering AI voice assistance and multi-lingual functionality. This enables the voters lacking literacy or technical experience.
8. **AI-Enabled Grievance Redressal System:** Voters will be able to report voting issues through a smart complaint portal. With the use of AI, complaints will be automatically categorized, and prioritized. It enables the concerned officials to respond quickly and maintain transparency throughout the electoral process.
9. **Real-Time Voting Metrics and Analytics Dashboard for Electoral Officials:** Election officials have access to a real-time administrator dashboard which provides insight into voter turnout trends, voting system status, regional voting statistics, and any flagged anomalies. It enables the official to make real-time, monitored and

responsive decisions.

10. **A Scalable, Cost Effective Infrastructure for Election Processes:** The implementation of a scalable, digital framework to replace, or supplement, historically expensive physical election systems, introduces cost efficiency regarding in-person staffed logistics, paper ballots, and manual counting of votes. A cost-efficient infrastructure allows elections to be conducted safely, accessible, at sustained scalability, across the country, with a minimal infrastructure overhead.

3. Results and Discussion

The suggested AI-enabled online voting system was tested to determine its performance in authentication accuracy, voting success rate, and system efficiency. A pilot run took place with 100 users, registered for voting. Each user logged into the platform using a either OTP (one time password) or facial recognition. After authentication, votes were preserved on a blockchain. The AI engine was active during the entire voting process for continuous monitoring, to determine any anomalies such as repeated OTP requests, time of the vote, or multiple logins from different locations. Figure 3 shows the screenshots of the trails. Figure 3.1 is the home screen, Figure 3.2 shows the admin login page. Live voting status is shown in Figure 3.3. Statistics of the voting are shown in Figure 3.4. Secure voting with face recognition is depicted in Figures 3.5 and 3.6. Finally, Figure 3.7 shows the election results.

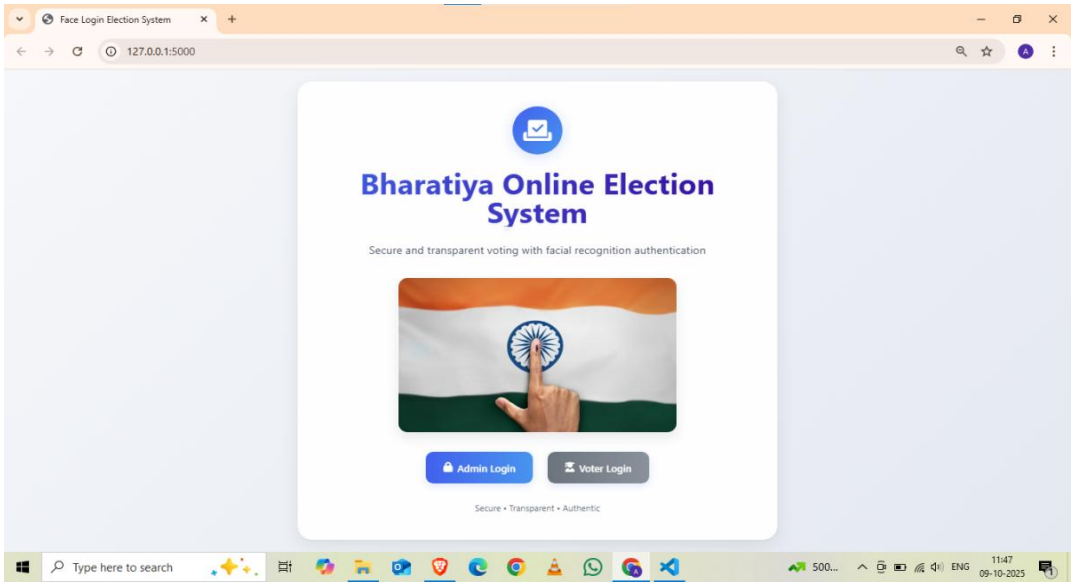

Fig 3.1 Screenshot of the Home page

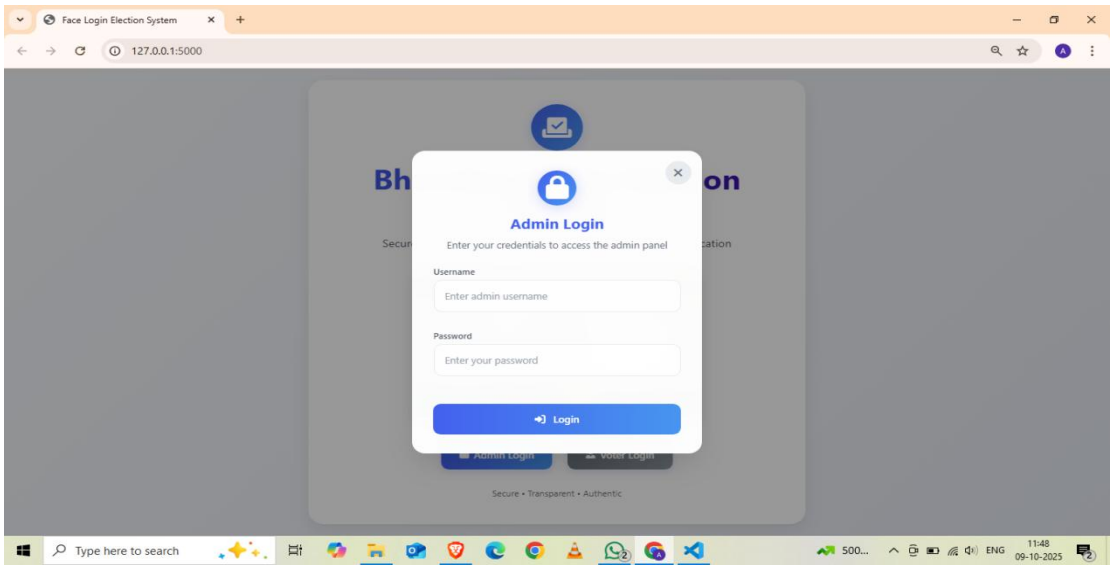

Fig 3.2 Admin Login page

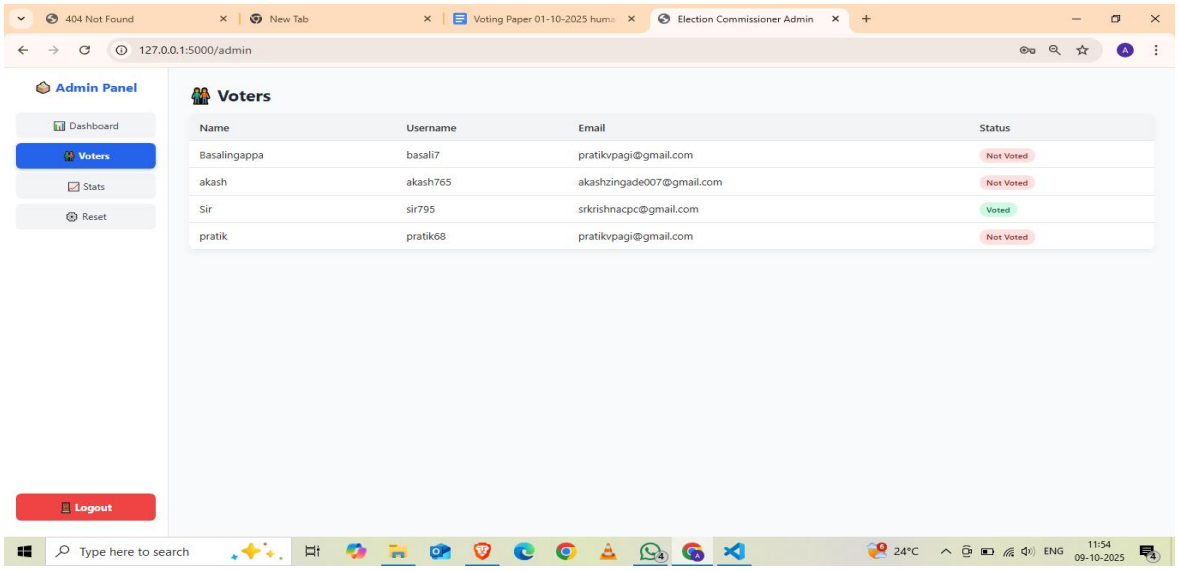

Fig 3.3 Voters Live Status

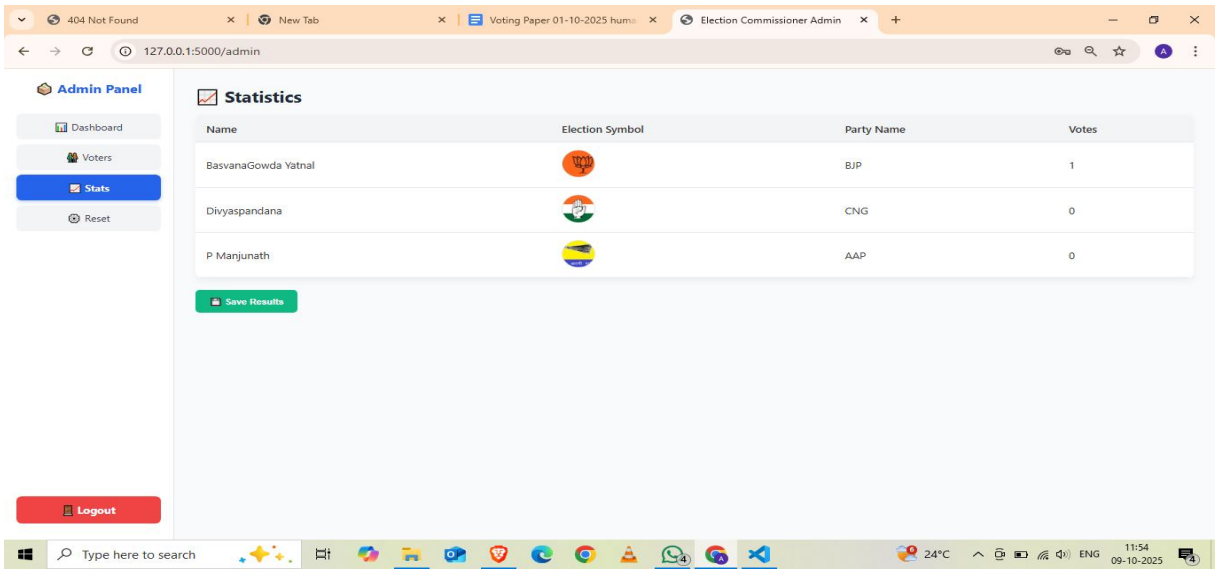

Fig 3.4 Statistics of voting

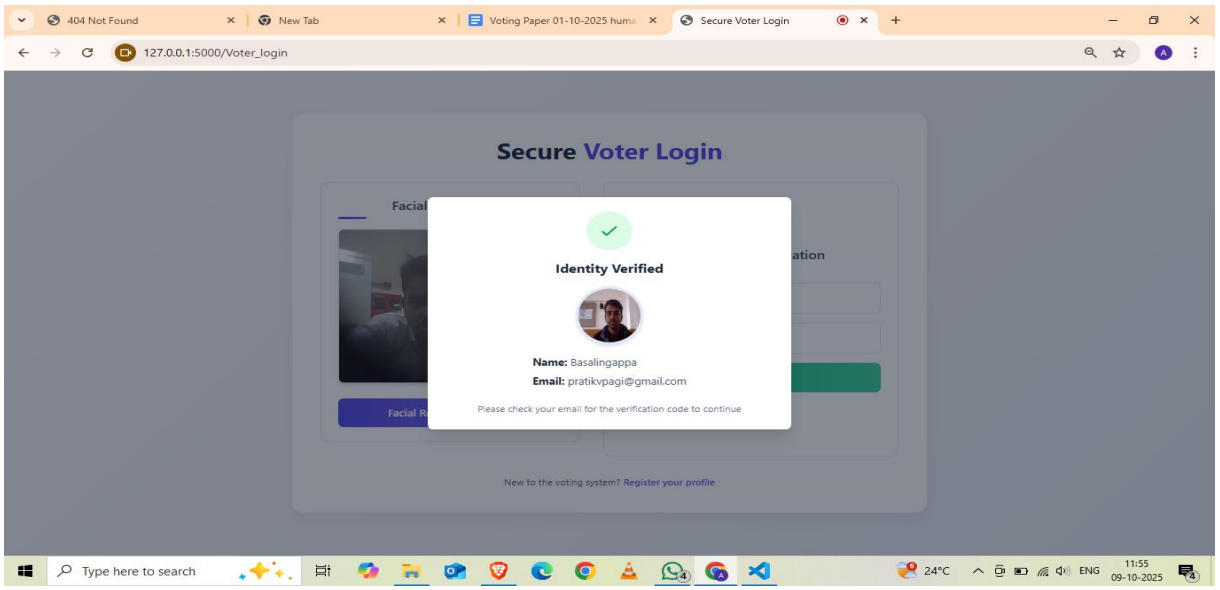

Fig 3.5 Voter identity verification

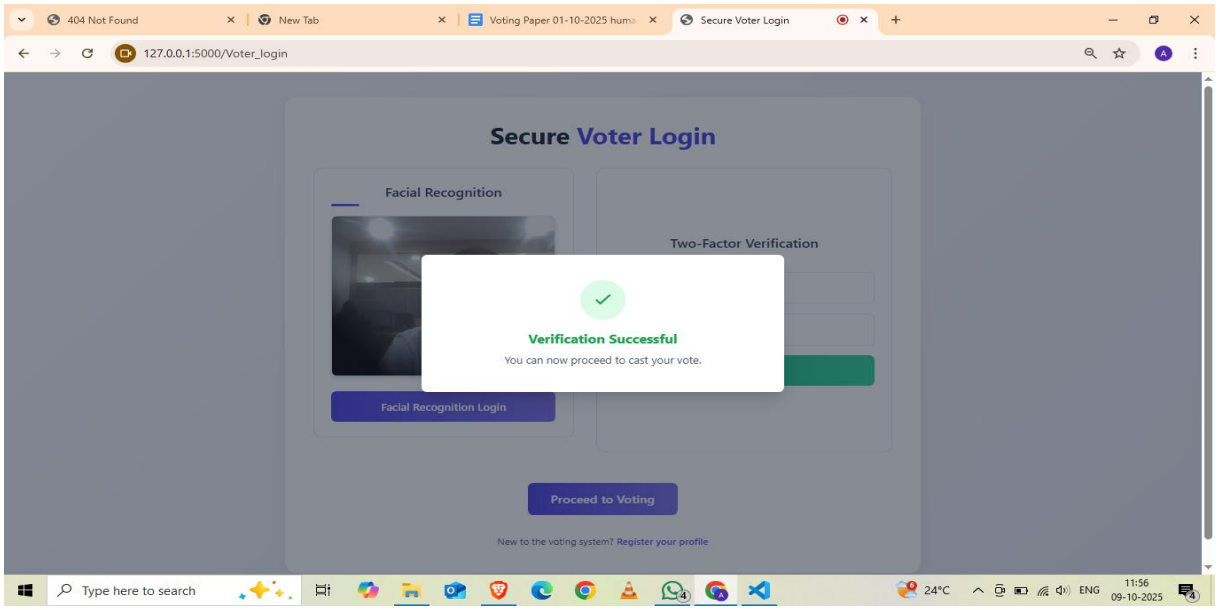

Fig 3.6 Voter Verification

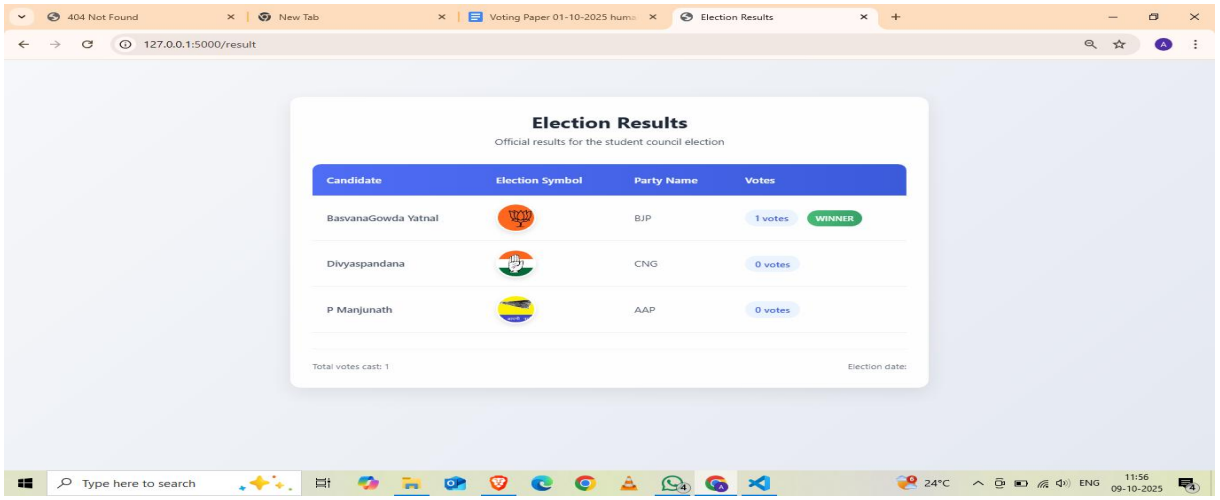

Fig 3.7 Election results

Testing of the system revealed that it achieved good performance. The OTP authentication was quick, and was efficient, averaging 1.2 seconds or total authentication and achieved a 94% successful voting rate. The face recognition took slightly more time, averaging 3.1 seconds of total authentication time with a successful voting rate of 88%. The OTP method also appears to have a lower error rate compared to face recognition, since the face recognition method was influenced by factors such lighting conditions and camera quality. The blockchain ledger recorded and verified all transactions, with no evidence of unauthorized modification or tampering. The AI-based anomaly detection flagged some unusual activities, such as repeated OTP generation from the same device, which were recorded for administrator review.

3.1 Discussion

Use of blockchain technology integrated with OTP and facial recognition provides enhanced security and ensures transparency and efficiency in the voting process. The OTP approach is quick and accurate compared to face recognition. The blockchain distributed ledger also guarantees that votes will be recorded immutably, so that the risk of tampering or unauthorized changes could be reduced, while the AI engine improves trust by detecting unusual voting behavior, in real time. Some challenges were still remain, particularly with face recognition performance: poor lighting environments or low-quality cameras. These limitations could be overcome by employing high quality cameras. Further, the combinations of OTP and face biometrics for multi-factor authentication, will improve the performance significantly. The system also proved to be scalable and be cost effective, as it also completely removed the need for physical polling booths and manual vote counting. In future, additional biometry solutions, such as iris recognition, voice recognition or enhanced AI models for fraud detection, may be employed for large scale, secure, inclusive digital elections.

4. Conclusion

The proposed AI-based online voting technology addresses the issues in the traditional electoral methods. With the introduction of artificial intelligence, biometrics, and

blockchain technology, the online voting system will be secure, transparent, and inclusive. It effectively addresses conventional challenges of electoral processes such as impersonation of votes, tampering with Electronic Voting Machines (EVMs), inaccessibility of voting from remote locations and with disabilities, and delays in counting votes and auditing of elections. By using AI, the reliability of elections can be improved. Blockchain technology helps in keeping each vote immutable and valid. It also serves as auditable and legitimate mechanism for storing election data. Further, it allows future verification and tracking of votes. The proposed tool facilitates blocking the government services, for the citizens not participating in the elections. Use of online voting platform helps for remote voting. Mobile based voting provides a scalable, digital, and reliable way for voting. Ultimately, it strengthens the electoral process and preserves the democratic values globally, by promoting trust, access to elections, and participation.

References

[1] S. Gupta, R. Sharma, and M. Joshi, "A Blockchain-based Electronic Voting System – EtherVote," *Proc. of the International Conference on Secure Computing and Communication (ICSCC)*, 2021.

[2] P. Verma and N. Saxena, "A Biometric-Secure Cloud Based E-Voting System for Election Processes," *International Journal of Computer Applications*, 2020.

[3] A. Vassilakis, K. Watanabe, R. Stray, and C. Petersen, "AI Suffrage: A Four-Country Survey on the Acceptance of an Automated Voting System," *Government Information Quarterly*, 2022.

[4] A. Kumar and B. Singh, "Blockchain Based Online Voting System Using RSA Algorithm," *International Journal of Engineering and Advanced Technology (IJEAT)*, 2020.

[5] T. Lin, M. Wang, and S. Zhao, "E-Voting with Blockchain: An E-Voting Protocol with Decentralisation and Voter Privacy," *Journal of Information Security and Applications*, 2021.

[6] K. Bansal and S. Nanda, "Confidential E-Voting System Using Face Detection and Recognition," *International Journal of Scientific & Technology Research (IJSTR)*, 2020.

[7] G. Kiayias, M. Zacharias, and B. Zhang, "D-DEMOS: A Distributed, End-to-End Verifiable, Internet Voting System," *IEEE Transactions on Dependable and Secure Computing*, 2020.

[8] R. Mehta and A. Rathi, "Empowering Democracy: A Robust and Secure Online Election System," *International Journal of Computer Applications*, 2020.

[9] A. Srivastava and M. Agarwal, "E-Voting Powered by Blockchain," *International Journal of Engineering Research & Technology (IJERT)*, 2019.

[10] N. K. Raj and P. Banerjee, "Implementation of E-Voting via Smart Phone App," *International Journal of Advanced Research in Computer Science*, 2018.

[11] M. Alvarez and J. Hall, "Like Your President: A Case for Online Voting," *Journal of Political Technology*, 2019.

[12] R. Jain and S. Patel, "Online Voting System Using Biometric Verification," *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 2019.

[13] A. Kumar and S. Singh, "Online Voting System Powered by Biometric Security Using Steganography," *International Research Journal of Engineering and Technology (IRJET)*, 2019.

[14] S. Schneider, J. Heather, and P. Y. A. Ryan, "Towards End-to-End Verifiable Online Voting: Adding Verifiability to Established Voting Systems," *Proc. IEEE Symposium on Security and Privacy Workshops (SPW)*, 2019.

[15] M. D. Kumar and A. Roy, "Transforming Online Voting: A Novel System Utilizing Blockchain and Biometric Verification for Enhanced Security, Privacy, and Transparency," *IEEE Access*, 2021.