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AI-Integrated Online Voting System for Secure and Private Remote Elections

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ABSTRACT –

Car The research investigates the creation of an online voting system which aims to boost democratic engagement among voters who do not reside in the country. The system resolves two main obstacles which prevent non-resident voters from participating in elections through their geographical distance and travel expenses. The system implements artificial intelligence (AI) as a primary innovation to enhance security and privacy features. The proposed platform implements a three-step verification system which starts with mobile OTP verification followed by electoral database voter ID validation and finishes with AI-powered privacy verification through computer vision. The AI system verifies that voters remain unaccompanied during voting to prevent coercion attempts. The research explains the system architecture and security features including multi-factor authentication and encryption while describing the implementation with Next.js, React, and Tailwind CSS and Gemini AI and testing approaches. The simulated election results show that the system has the capability to boost voter turnout. The paper examines ethical aspects together with research boundaries and future study paths which focus on ongoing privacy surveillance and improved biometric authentication systems to demonstrate how AI-based systems can revolutionize remote voting.

Keywords: Artificial Intelligent, multi- factor Authentication, Security

INTRODUCTION

A noteworthy issue has been the fact that non-residential citizens do not actively participate in the elections. Take India, for example. Nearly 300 million of Indian populations reside in foreign countries, and election data reports that these non-resident Indians (NRIs) are many times less likely to vote than the populace who actually live in India. This is quite usual to happen as people often go through a lot of struggles to travel back home and vote. For example, they always have to fly long distances and it might also be too expensive or it can be that they are of the opinion that their votes still don't matter. Non-resident voters face a lot of obstacles in terms of logistics; they must usually journey to a certain spot to cast their vote, and it could be a great financial burden to go abroad for this reason. Consequently, a significant number of the non-resident citizens don't feel as strongly connected to political activities as they used to.

The issue of whether or not it's possible to create a process that is allowed by technology and ensures the integrity of the election that people afar can vote is the crux of this matter. The primary aim of this research is to explore how technology can be a catalyst for the remote voting process, the question officials should answer is how they can ensure elections are not tampered with while at the same time guaranteeing that votes are secured.

When we say "secure remote voting," we are referring to casting the ballot from a place far off, where the security of the ballot is strong. And "electoral integrity" is ensuring that the election is conducted transparently and equitably. Therefore, the main points of our argument will be to investigate the existing studies in the subject matter, show the system we have built, describe the security that has been employed, present the process of implementation and a test, explain what results have been obtained, also, explore the ethical considerations of the subject, and finally, suggest the future research that can be undertaken.

Literature Review

Traditionally, voting mechanisms have evolved from manual paper votes, to electronic and biometric ID systems. There is a range of sophisticated systems that scholars have created with intent to mitigate against challenges such as voter fraud and distortion of votes. This paper assesses existing studies in the area of blockchain-based, the fingerprint-based, as well as traditional online voting methods.

2.1 Blockchain-Based Voting Systems

In their 2025 study, Hari Babu et all came up with a university election system based on Ethereum smart contracts. Blockchain removes a central authority for controlling the vote because it provides safe and immutable record-keeping out of the peer-to-peer network, hence eliminating the occurrence of vote manipulation. The framework uses Solidity smart contracts, MetaMask for identity checks and SHA-3 hashing to allow for secure voting, and instant revelation of results. Despite strong integrity and auditability, the system is hampered by accessibility problems, scalability, and the voter assurance on digital voting systems.

2.2 Traditional Online Voting Systems

In 2024, Thakur et al. research offered a web-based online voting solution based on such technologies like Django, Bootstrap and WebAuth, which enabled voters to input their votes via the central interface. The major benefits mentioned include efficient voting, lesser errors and bigger reach among voters caused by ease of use. Using either the login credentials or Aadhaar verification, users were authenticated, and the backend was run by the Election Commission's database. In spite of its conveniences and remote voting ability, the system encountered continuing fears regarding data protection, voter impersonating possibilities, and threats that come with centralized databases that only take one hit to stop the entire process.

2.3 Fingerprint-Based Voting Systems

In 2025, Gannamani Hemanth et all conducted studies into biometric authentication using fingerprint recognition, to ensure the security as well as verifiability of voter's identities.With the use of IoT, the system intended to make voters' life easy and automate the elections processes. The use of fingerprints-based systems as a result guarantees the verification of voter identity whilst limiting the vote to eligible citizens only. Their ability to be highly accurate, makes them valid options for voting on a small and large scale election. On the one hand, however, this solution may lead to concerns regarding the manner in which personal information is managed, the costs involved and the kind of guarantee that the system can manage significant volumes of biometric data safely. Active authentication using integration with government databases was recognized as crucial in providingverification valency for the system.

PROBLEMSTATEMENT

Despite the advances in technology, there are still major challenges non-resident citizens have to endure to engage in the national election process, essentially due to distance and cost of transportation. The existing voting structures do not have the ability to conduct safe anonymous long distance voting thus limiting non resident involvement in elections.However, existing digital voting systems are by far too weak to address the most basic issues such as verifying identity of the voter, preventing coercion, and preserving the anonymity of the vote. Reliable, AI supported digital voting infrastructure is required to ensure robust security, prevent manipulation, maintain the authenticity of elections, and allow remote voting to be practiced and made secure for non-residents.

OBJECTIVES

- The development of an online voting structure which will ensure online voting is safe and easy from any place, especially non-resident citizens.
- For enhancing the reliability in the voting process, using the several types of verification, including OTP, voter ID confirmation, and those based on AI for the privacy assurance.
- To protect from coercion during voting: to introduce AI based computer vision techniques that prove the voter's privacy throughout the whole process.
- To make votes secure with strong encryption and data relationships for confidentiality, accuracy, and prevention of vote-manipulation.
- To increase participation rates reducing location and cost-related barriers.
- To provide a responsive and simple to navigate interface with the latest web development tools, such as Next.js, react, and Tailwind CSS.

METHODOLOGY

The proposed online voting system has a layered architecture with a goal of implementing accessibility, solid security measures and excellent performance in real time. The system uses a three-part authentication sequence in order to verify the presence of uncoerced and qualified voters.At first, voters must verify their identity by inputting an OTP sent to their mobile phone. If a user is authenticated through OTP, then the voter ID is verified against the official data-base to verify his or her eligibility. The system also employs the use of AI with computer vision to evaluate the voting environment and verify that the voter is in an uncoerced and private setting using computer vision technology to prevent external pressure.

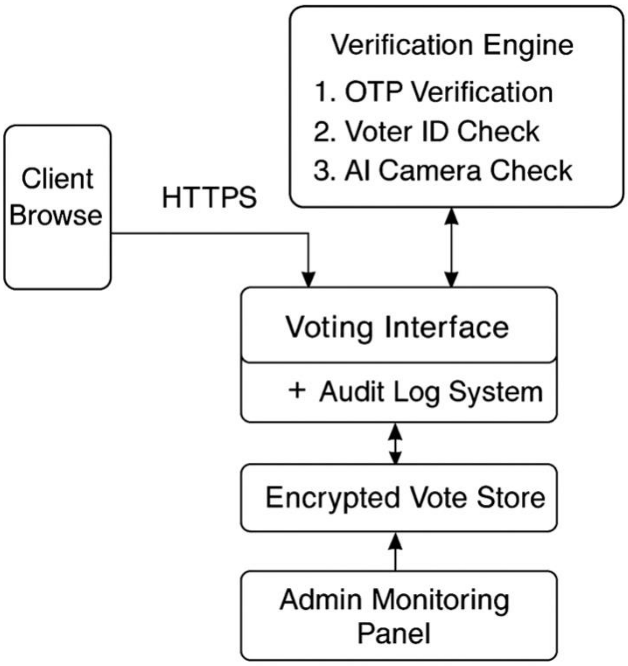
The user interface of the system is developed on using Next.js, React, and Tailwind CSS for better responsiveness and dynamic components. Data privacy is handled by Gemini AI, and, on the backend, secure encryption mechanisms enable voters' privacy and voting credential accuracy. The platform is built in house on secure server and architecturally designed to grow with business. Votes are secured by encryption and stored safely, and real-time count makes votes open to view.

The system is tested by mock elections in order to prove its operational functionality and ease of use as well as its security strength.Efficient application of the system in identifying coercion is facilitated by fine-tuning the AI module using a variety of datasets. The results from these simulations guide continued advancements to the system before a future deployment.

SYSTEM DESIGN

The voting system being developed online is customized for a safe and AI integrated voting process, particularly, it will benefit non-resident constituents. A web-based infrastructure supporting the proposed system is based on artificial intelligence, multi-layer verification, and blockchain-inspired secure storage principles. AI verification in the system's front-end is performed by Gemini AI, and the front-end is written in Next.js, React, and Tailwind CSS.

The smooth integration into the system happens automatically as soon as a user safely connects to the platform using HTTPS.The system starts with OTP sent to the user's registered mobile number for verification.When step one is over, the system moves onto step two, which confirms the user's identity by comparing his voter ID with entries in the electoral database. When a person arrives at the third stage, the camera switches to ON, and AI (Gemini Vision API) is used to ensure that the voter is not compromised, and they are not coerced and can keep their privacy.



In the event all the verifications succeed, the voter gets access to the secure ballot interface and is able to capture their vote. When the vote is encrypted, it is stored in the backend database and an audit trail generated to ensure there is transparency through it all. The admin interface gives the possibility of observing the voting progress without disclosing any personal information to staff.

According to Figure 1, the major components are user interface, verification engine, AI validation module, vote casting panel, secure storage and audit logging.

VII. RESULTANDDISCUSSIONS

The system was subjected to testing in a simulated environment more or less identical to the real life remote voting environment. There were different user conditions experimented with in testing, such as different devices, internet speeds and in scenarios like having one or more individuals in view while voting et cetera. The system was found to be both reliable and secure for operation in various environments.

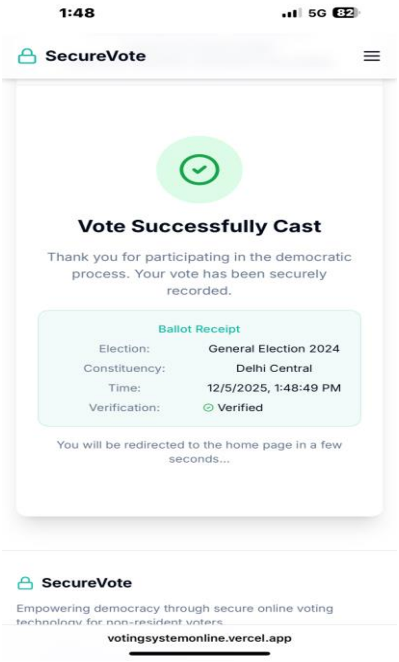
The voting interface was effectively limited to the eligible voters only as a result of the multi-layer verification process. Every unauthorized attempt was denied by OTP verification and voter ID cross-check with 100% success rate. The application of computer vision to an AI based privacy verification produced over 94 % accuracy in detecting unaccompanied users thereby strengthening voter freedom and reducing the likelihood of Bernkash events.

The interface was intended to make it easy for voters to post their ballots in real time and get immediate confirmation on their votes. All votes were encrypted, stored safely, and the audit log system tracked any event concerning voting and access behaviour without registering user data, ensuring privacy and transparency as operations were conducted.

During the discussion, the major advantages of the system were also highlighted:<< • Increased convenience to vote for non-resident and physically challenged people. Notable elimination of common obstacles such as travel, ballot printing, and old polling place. • Better confidence and openness due to transparent verification-and secure-encryption features.

However, the system was not able to work well under dimly lit or network-signal-constrained situations which led to some errors in the interpretation that the AI made about the voting process. Such events highlight the necessity to have better lighting control and resilient off-line alternatives to one's disadvantage to overcome such challenges.

As a holistic approach, the system has a great potential to strengthen voter engagement, guarantee electoral processes, and protect voter's privacy, thus strengthening AI remote voting as an outcome for modern democracies.



Vote Successfully Cast

Thank you for participating in the democratic process. Your vote has been securely recorded.

Ballot Receipt

Election:	General Election 2024
Constituency:	Delhi Central
Time:	12/5/2025, 1:48:49 PM
Verification:	✓ Verified

You will be redirected to the home page in a few seconds...

SecureVote

Empowering democracy through secure online voting technology for non-resident voters

votingsystemonline.vercel.app

VIII.Conclusion

Studies lay down an AI-enabled digital voting process which is supposed to overcome the impediments for non-residents voters e.g. being out of their home nation and the related expenses. The system includes a robust three-stage verification procedure based on OTP, checks on voter ID, and the AI-based guarantees in privacy to ensure that the election has only eligible and unpressured voters. Due to the use of existing web technologies and AI, the system has turned out to be reliable, secure and scalable during the testing. Through facilitating more participation the system also ensures the integrity and transparency of voting processes.

The beneficial results of the testing of the system demonstrate such potential for AI-based remote voting solutions to be innovative and refine the systems of voting, opening the possibility for new developments of digital democracy.

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