

SECURE ONLINE VOTING SYSTEM WITH FACE RECOGNITION TECHNOLOGY

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Abstract: *The digital election platform proposed by the project "Online Voting System with Face Recognition" is a highly secure and efficient one, which provides all the benefits of digital voting while at the same time eliminating the drawbacks of traditional voting. The system uses facial recognition for voter authentication thus eliminating impersonation and long queues, administrative overhead and other problems associated with traditional voting. To achieve this, the system has React JS at the front end, Spring Boot at the back end and MySQL for the management of the database. The team also uses Python and OpenCV to implement the LBPH algorithm for real-time face recognition during authentication and voting. For the initial voter registration, the voter has to provide details like Voter ID or Aadhaar number, date of birth, constituency along with live facial verification and thus the registration is complete. The voting process starts with the user log in and face authentication which must be completed before voting; this way nobody can cast a vote for another person thus maintaining the one-person-one-vote principle. The election management, candidate and voter data, and results management are done securely through an admin module assigned to authorized officials. Data and credentials are protected by AES encryption and SHA hashing, and cloud deployment provides scalability.*

Keywords: *Online Voting, Face Recognition Authentication, React JS Spring Boot.*

INTRODUCTION

Voting is a basic right that maintains the existence of democracies. However, traditional voting systems are prone to malpractices like impersonating the voters, manual errors, long waiting times, and, in general, the complexity of the process. These problems can lead to issues like reduced turnout and untrustworthy elections since they are frequently perceived as unfair and not credible. At the same time, there are voters who, because of living far away or being unable to walk, have a hard time getting to the voting places and therefore their participation is limited. Technology as modern as today comes up with solutions that are actually pretty promising. In this regard, the current project is suggesting an Online Voting System that will be the face recognition-based electoral platform making it secure, and at the same time, efficient and readily available. The system guarantees authenticity of the voter through verification process making it nearly impossible for impersonation and multiple voting. The React JS is used for the development of the front-end which provides a very user-friendly and quick-to-react interface for voters and the administrators. The Spring Boot is used on the back-end to deal with business logic as well as RESTful APIs while the data is stored by MySQL. The Python is used along with OpenCV's LBPH (Local Binary Pattern Histogram) algorithm to implement face recognition which at the time of authentication, captures and matches live images of the face with that of registered voters. Security is one of the main issues that comes with the system and it is taken seriously by using AES encryption for sending data over the internet securely and SHA for making it difficult to get passwords of sensitive information. The system not only ensures security but also provides election management facilities to the administrators including the candidate registration, voter list management, and publication of results.

A. Objective

The central premise of the initiative is the development of an Online Voting System that is both secure and easy to use and that employs facial recognition technology for voter identity verification and fraud detection in elections. The selection of React JS, Spring Boot, Python with OpenCV (LBPH algorithm), and MySQL ensures effective communication, robust back-end support, and secure data storage. The system plans to allow voting from a distance for registered voters, but only after real-time facial authentication is successfully performed. Therefore, the vote's validity is confirmed and the voter is checked not to have cast multiple votes. The whole process is simplified for the election officers; they can create elections, control candidates, upload the lists of eligible voters and declare the results.

B. Scope

The aim of this project is to develop an Online Voting System that is not only secure but also efficient, and this system is going to be integrated with face recognition technology to validate voters. Users will be able to do online registration, log in, and vote only after the successful verification of their faces in real-time using OpenCV LBPH. The front side of the system is created with React JS, the back side is built with Spring Boot, and for data management, MySQL is being used. The system has applied AES encryption and SHA hashing for security purposes. The administrators have the functionality to manage elections, candidates, and voter lists. The system can be applied in schools, the private sector, or even in major public elections, due to its scalability and cloud integration for remote access.

LITERATURE SURVEY

[1]The creation of the paper was started by authors S. P. K. Shankar et al. (2020) who presented a new and secure electronic voting system called “E-Voting System Using Facial Recognition”.

[2]The researchers had as their main goal the total eradication of impersonation and multiple voting incidents, but at the same time, [3]they pointed out the issue of scalability problems, which resulted from the size of the image datasets and the implementation of the technique's unencrypted data transmission.

[4]P. Agarwal and R. Singh (2021) came up with a voting system that is very secure and is based on Aadhaar authentication combined [5]with OTP generation and facial recognition for voter verification. [6]Their approach not only guaranteed the uniqueness of voters but also strongly depended on network connectivity and was subject to delays during the majority of voting hours.

[7]M. Al-Hubaishi et al. (2019) proposed a Blockchain-based e-voting system that provided the transparency and immutability of votes interlinked by blockchain.

[8] In the meantime, blockchain offered secure data storage but the absence of [9]biometric integration rendered the system open to unauthorized access through credential theft.

[10]A. Ramesh and S. Kumar (2022) came up with a Smart Voting System That Uses Face Recognition and Cloud Integration. [11]The solution was made such that the encrypted data of voters was stored in cloud servers [12]and the detection of faces was done through OpenCV. It was very precise, could be accessed from distant locations but still needed a high-speed internet connection and well-optimized face datasets for real-time processing.

[13]N. Gupta et al. (2023) presented an AI-based Voting System that fused the recognition of faces and emotions with machine learning to put a stop to voting frauds. [14]Their approach improved system intelligence but required high computational [15]power and raised privacy concerns regarding facial data storage.

PROPOSED SYSTEM

The proposed system is an online voting platform that is both safe and secure, and it uses face recognition technology to validate voters and maintain the elections' integrity. A voter must first register and provide personal information, such as identity documents, which will then be scanned using OpenCV's LBPH algorithm, before the voter is allowed to cast his or her vote. The facial recognition data will be securely stored for later verification. When the voter attempts to log in and cast their vote, real-time facial recognition will take place to confirm the voter's identity, thus completely eliminating the risks of impersonation, fraud and double voting. The system's front end uses React JS to guarantee a responsive and user-friendly interface while the back end is built with Spring Boot and MySQL for fast data processing and storage. Security measures have been implemented such as AES encryption for safe data transmission and SHA hashing for user credential protection, among others. Moreover, an administrative module is available for authorized personnel to conduct, manage, and publish elections in such a way that the digital voting process is transparent, accurate, and accessible.

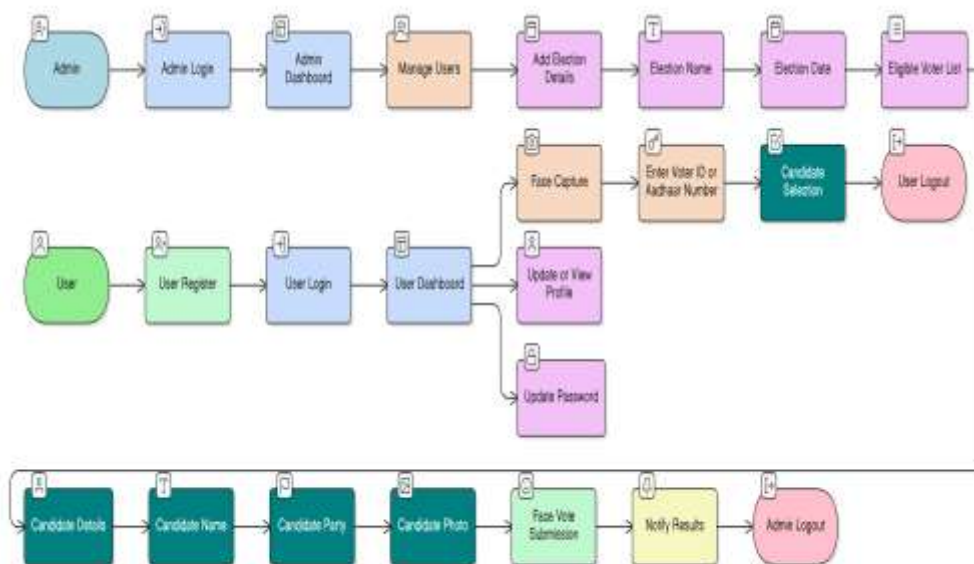


Fig 1 : Block diagram for proposed system

METHODOLOGY

The creation of the Online Voting System with Face Recognition project has passed through the stages of a rigorous structured software engineering process i.e., requirement analysis, system design, implementation, and testing. Requirement Analysis: The needs of the project were organized into two principal categories; the User Module and Admin Module. The User Module encompassed the entire journey of a voter (registration with personal details - Name, Voter ID/Aadhaar, DOB, address, phone, and password, live face capture using OpenCV LBPH, secure login with facial authentication, access to the dashboard, viewing candidates and voting, profile management, and password change - voting). As for the Admin Module, first, the secure admin login to the system was performed, then followed by dashboard access, elections management (name, date, list of eligible voters), candidates management (name, party, photo), management of the voter list, monitoring of the voting process, and secure publishing of results. The non-functional requirements called for security through AES encryption and SHA hashing along with the capability to accommodate more users through cloud deployment, high availability, performance efficiency, data integrity, and usability. System Design: The design of the system was represented with UML diagrams like Use Case, Activity, Sequence, Class, and Deployment diagrams that depicted the structure, workflows, and interactions of the system. Data Flow Diagrams at Level 1 and Level 2 successfully conveyed the data flow related to the voter and admin through various components of the system. Implementation: The system was constructed with ReactJS for the user-friendly mobile front end, Spring Boot (Java) for backend RESTful services, and MySQL for the secure storage.

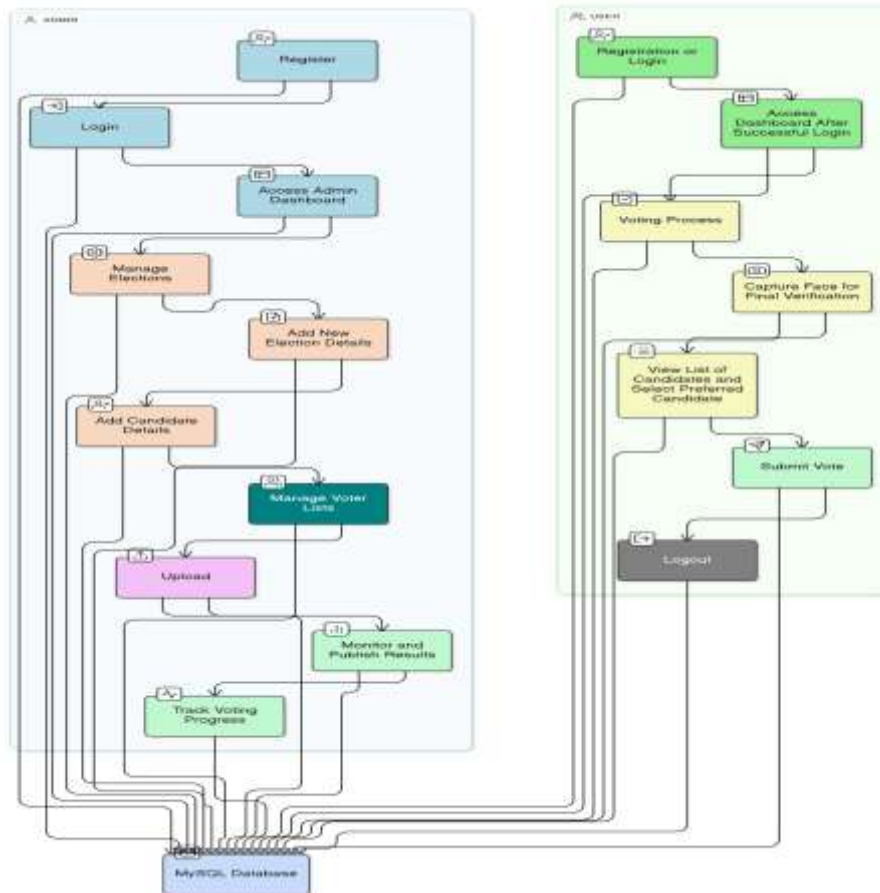


Fig 2 : Architecture

A. Working Principle

The Online Voting System using Face Recognition aims to combine the voter authentication process through face recognition and thus create a safe and efficient online voting platform. The system tries to mitigate the typical problems of traditional voting systems like impersonation of voters, waiting for a long time, and logistics issues. The main aim of the whole process is to make election security as well as accessibility better by allowing only certified, authenticated voters to participate in the election.

Besides, when the user is being registered, the voter's system input their personal information (e.g. Voter ID or Aadhaar number, date of birth, and constituency) along with a live face verification. OpenCV's LBPH algorithm (Local Binary Pattern Histogram) is utilized for this purpose, which extracts the facial features of the voter and stores them securely for future authentication. The second face verification is basically conducted when the users log in with their credentials during the voting process. This means that the system verifies that the one who is voting is the one who is registered. Machine learning algorithms along with deep learning models in particular are deployed to increase the efficacy of the face recognition system.

The models undergo training with huge datasets to pinpoint unique facial characteristics, thus making it possible for the system to identify and authenticate voters in real-time with high accuracy. The admin module gives the right to create and manage elections for the authorized officials, let them add candidates, upload voter lists, and securely publish results. Data transmission is secured by AES encryption, and MySQL is used to store all the system data, which is comprised of user profiles, election details, and voting results. The system is placed on the cloud for scalability that enables it to conduct major elections remotely.

B. Technical Tools and Frameworks:

Front-End: React JS to design modern and mobile-friendly user interfaces which will create a non-stop experience for voters, administrators, and candidates alike.

Back-End: Spring Boot (Java) for the implementation of business logic, user authentication, and election management.

Face Recognition: OpenCV and Python with LBPH algorithm for the authentication of voters in real-time.

Machine Learning: The usage of deep learning models that enhance the robustness and accuracy of the facial recognition issue.

Database: MySQL to provide the functionality of controlling and holding the users' data, election information, and results.

Security: AES encryption for the safe transfer and storage of data, thus providing voter privacy and data integrity.

Cloud Integration: Provides the capacity for the election to be conducted and the results to be remote accessed at the same time.

c. *Methods*

- The LBPH algorithm that is applied in the recognition of human faces is a vital part of the authentication of voters during the entire process of registration and voting.
- Face Detection: Initially, the presence of the voter's face is sensed by the application through usage of OpenCV Haar cascades.
- Feature Extraction: It converts the face image into black-and-white and derives the local binary patterns from the face image.
- Face Matching: The system associates the features extracted at registration and voting with the already existing templates to authenticate the voter's identity.
- Machine Learning Integration: The Deep Learning Models applied for the recognition of the face features have a great accuracy level. They are trained to detect and authorize the face of a voter which makes impersonation quite difficult.
- Voting Process:
- User Registration: A voter registers him/herself by submitting his/her personal details and taking a photograph of his/her face for confirmation.
- The system produces a distinct facial template and stores it securely for future validation.
- User Login: The voter logs in using his/her (i.e., Voter ID/Aadhaar) credentials. Face verification is done by the system

simultaneously to validate the voter.

- **Voting:** After the voter logs in successfully and gets his/her face verified, he/she is then allowed to view the candidates and choose one by casting his/her vote. Votes are guarded through secure methods, data integrity is ensured, and double voting is not allowed.
- **Admin Management:** The administrator has the power to supervise not only elections but also candidates, taking care of voter lists and managing voting activities as well. The election will be over before the results are unconditionally secure and the publication made.
- **Security Features:** Data is made safe using AES encryption during transit and while in storage.
- The system that identifies through facial recognition is the one that guarantees that only the registered voters can cast their votes.

MODULES AND ITS IMPLEMENTATION

1. Admin Module

Description:

The Admin module grants a secure login opportunity for administrators and directs them to the admin panel. It provides election management by introducing details such as election name, date, and candidates. Administrators are able to make changes to the voter lists, keep an eye on the progress of the voting, and make the results of the elections public in a secure way, which will make the whole process more transparent and accurate.

Features:

- **Admin Login:** Type in the administrator's user name and password. Get into the admin panel after authenticating successfully
- **Manage Elections:** Input new election particulars (Name, Date, Eligible Voter List) Add candidates' particulars (Name, Party, Photo)
- **Manage Voter Lists:** Bring in or refresh the list of qualified voters for every election
- **Monitor & Publish Results:** Observe the rate of voting Make known and securely inform the results of the elections.

2. User Module

Description:

The Voter module permits those who participate in elections to register through the disclosure of their personal information plus a live facial photograph which is then stored in the database securely. The identification procedure after signing in is carried out through live face detection. The authenticated user can access the voting interface, choose a candidate, and then cast his/her vote securely through the election process.

Features:

- **User Registration:** Input personal information (Name, Voter ID/Aadhaar, Date of Birth, Address, Phone number, Password) Registration through live face capture. Data and face template are securely stored in the database.
- **User Login:** Enter Voter ID/Aadhaar and the password. The system checks the credentials Conduct real-time face recognition for authentication.
- **Voting Process:** Open the dashboard after successful login Take the face image again for final verification See the candidates' list and pick the one you like best Cast the vote, which is recorded safely.

DISCUSSION AND RESULTS

C. Homepage:

This is the first page will be displayed after execution started.



Fig 3: Homepage functionality

D. Register Page

This is the register page for the user.

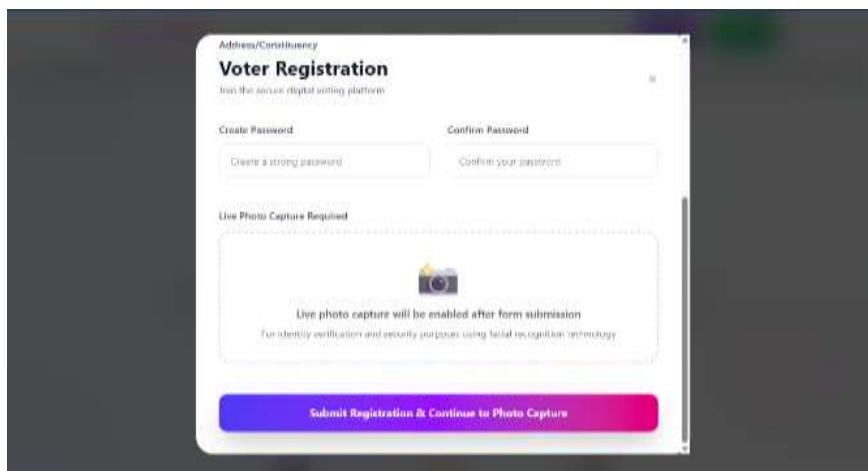


Fig 4: Register page functionality

E. Login Page:

This is the login page for user.

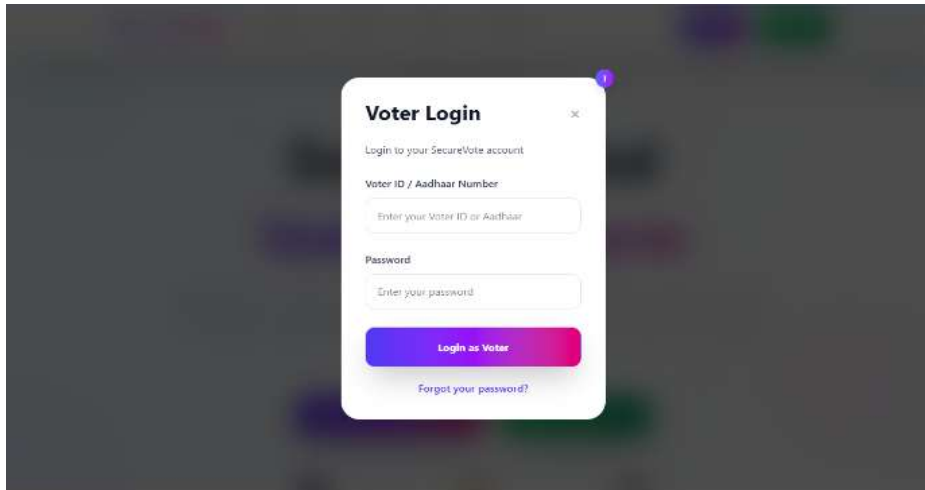


Fig 5: Login page functionality

F. Admin Login Page:

This is the login page for admin.

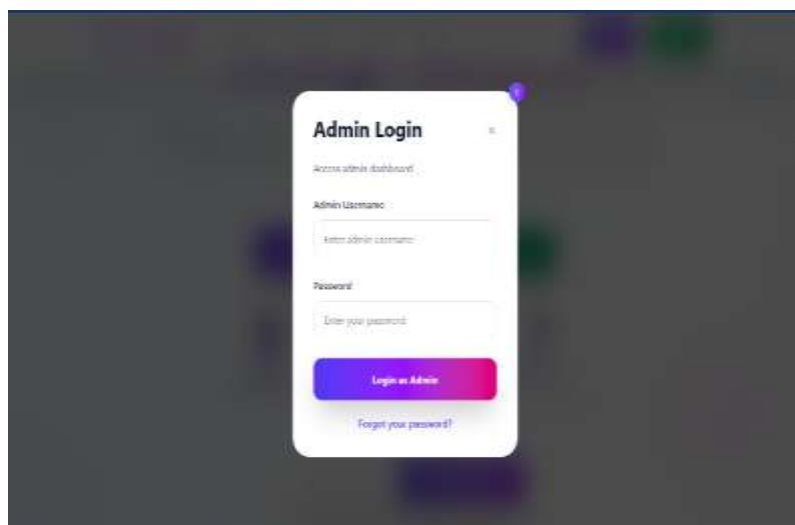


Fig 6: Admin Login page functionality

G. Admin Dashboard

After the successful login of admin with default credentials this page will be displayed.

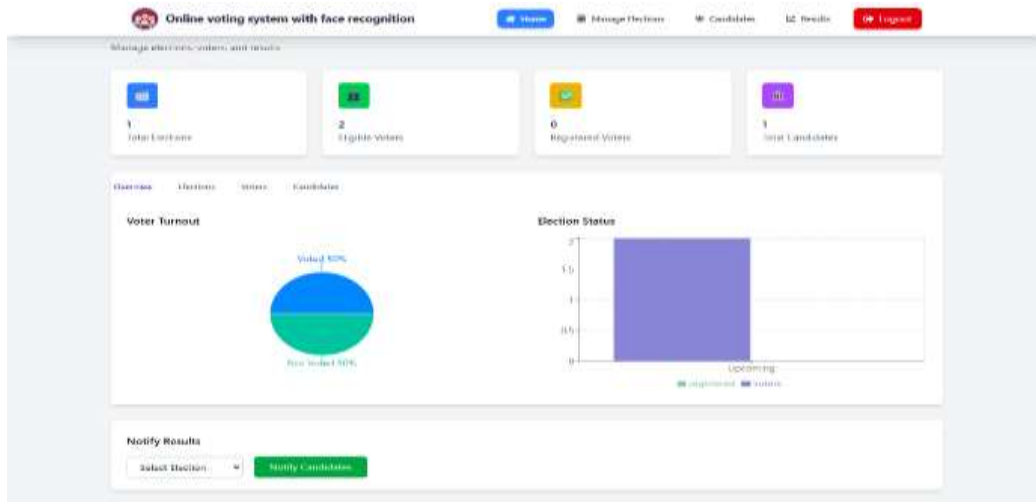


Fig 7: Admin Dashboard functionality

H. Manage Candidates

In this page the admin can see all the candidates.

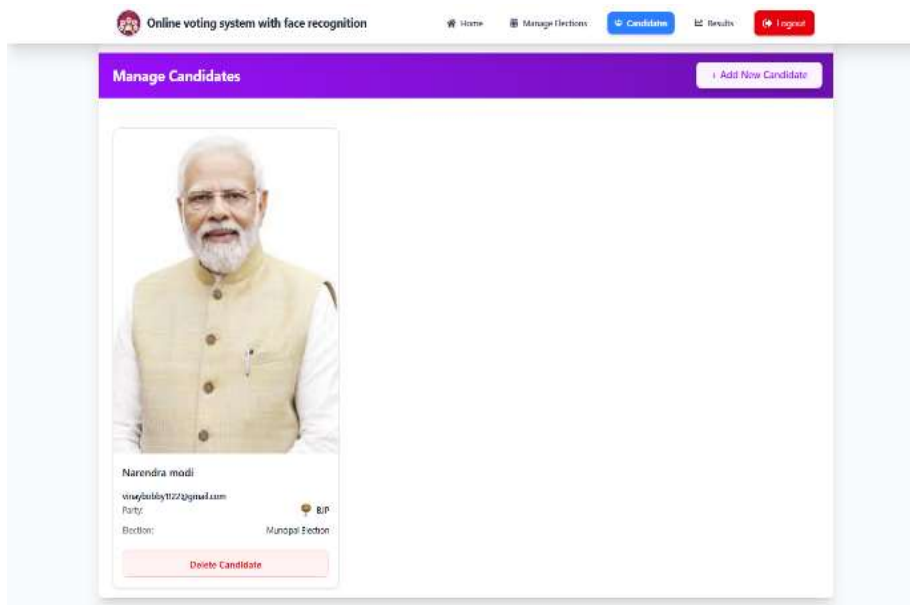


Fig 8: Manage Candidates functionality

I. Manage Elections:

In this page the admin can manage elections.

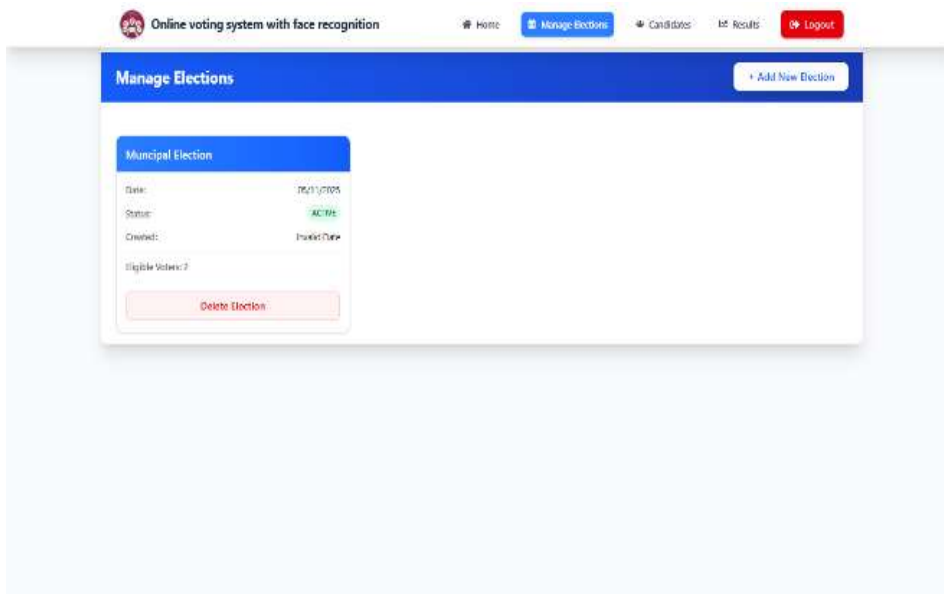


Fig 9: Manage Elections functionality

J. View Results:

In this page the admin can view results.

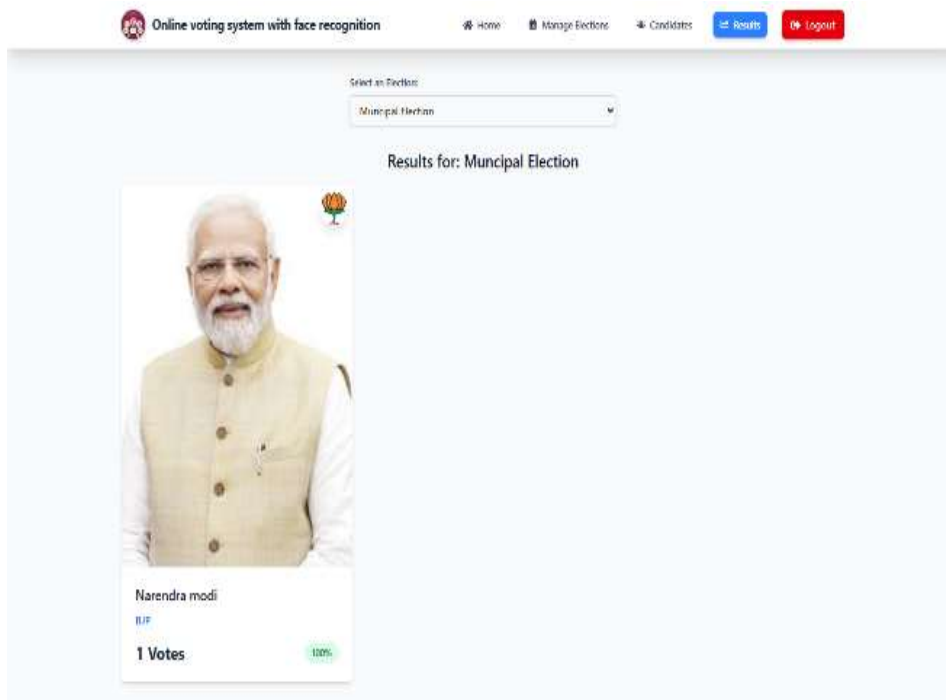


Fig 10: View Results functionality

K. User Dashboard:

After the successful login of user this dashboard will be displayed.

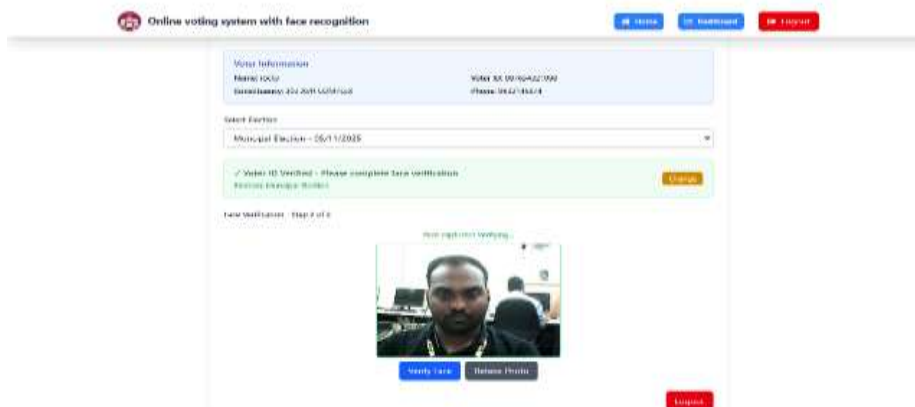


Fig 13: User Dashboard functionality

CONCLUSION

The project called "Online Voting System with Face Recognition" merges advanced technologies to change the voting process remarkably that it wouldn't only be more secure and efficient but also more user-friendly. The system gets advantage of eliminating the outdated and very typical problems of impersonating voters, organization that is very difficult and very expensive, and finally long queues and it thus gives a proper voting experience that is clearer and more trustworthy. The identification of the voter through facial recognition technology at the time of registration and at the polling station, along with the AES encryption and SHA hashing for data security, ensures that the process of voting is safe and confidential. Due to its cloud-based architecture, the system becomes easily scalable and can be accessed remotely, thus making it suitable for large-scale elections and different types of people's demands. The combination of a user-friendly interface developed with React JS and a powerful backend backed by Spring Boot and MySQL very clearly indicates that the system is both reliable and easily maintainable. The LBPH method utilized in facial recognition technology plays the role of extra security giving assurance that only valid voters are let in to vote. This system not only enhances the voting experience by being simple and user-friendly but also wins people's trust in the democratic process by applying contemporary technologies for ensuring transparency and security. The effective deployment of such a system can be seen as a model for coming digital elections and can help to bring about the voting process to be modernized worldwide.

Author(s) Contributions

All authors contributed to system design, implementation, experimentation, and manuscript preparation.

FUTURE ENHANCEMENTS

The "Online Voting System with Face Recognition" opens itself for a number of future enhancements which will make it more functional, user-friendly, and secure overall. The biggest upgrade would be to include multi-factor authentication (MFA) where voters will authenticate through one or more additional methods besides their regular ones. For instance, they will receive a One-Time Password (OTP) on their registered mobile number or email and then enter that to authenticate themselves. Thus, the security level is raised and it is ensured that only the legitimate voter gets to cast his vote. Another future step of development is to implement the blockchain tech that would guarantee the votes' integrity. Blockchain, through the use of a distributed and unchangeable ledger, ensures no one can alter the votes once they are cast, and thereby, transparency and trust in the election process increase. Besides, it will be possible to have the creation of a clear record of each vote, thus ensuring auditability. Real-time monitoring and analytics could be introduced for the election staff as well. A dashboard would be set up where the insights into voter turnout will be provided, fraud detection will be possible, and any tech-related issues will be identified immediately so that the personnel can respond quickly and effectively. Such a move would lead to better election system management and the promptness of elections being run. Moreover, the new system could also be made multilingual to win over more people. The technology will be made easy for voters with varying languages. This will not only make everyone feel included but will also increase the number of participating voters. Furthermore, the integration of more sophisticated biometric authentication, such as fingerprint or iris scanning along with that of the face, could more or less still the verification of the voters.

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