

Intelligent Voting System with Biometric Face Recognition

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Abstract - This paper presents an Intelligent Voting System that uses biometric face recognition to improve the security and accessibility of elections. Traditional voting methods often face issues like identity fraud and limited access. To solve these problems, we propose a secure, remote voting platform developed with Python, React JS, Vite, TypeScript, JavaScript, and FastAPI. It uses facial recognition tools such as Tiny Face Detector and the face recognition library. Voters are authenticated through real-time face scans and verified against a database before being allowed to vote, ensuring one vote per person. The system enables voting from any location while maintaining high security and accuracy. By combining biometric verification with modern web technologies, this solution offers a scalable, efficient, and trustworthy approach to digital voting.

Key Words: Python, Voting System, Face Recognition, PostgreSQL, Vite, TypeScript, JavaScript, React, FAST API, Tiny Face Detector

1. INTRODUCTION

In Elections form the foundation of any democratic society, serving as a critical mechanism through which citizens express their collective will. However, traditional voting systems, including manual paper-based voting and Electronic Voting Machines (EVMs), have long been associated with several limitations such as identity fraud, delayed results, voter impersonation, lack of accessibility, and the logistical burden of setting up and managing physical polling stations. These challenges are further amplified during extraordinary circumstances such as pandemics, natural disasters, or for voters residing away from their home constituencies, leading to reduced participation and undermining the fairness of the electoral process.

With the advancement of digital technologies, there is a growing opportunity to modernize the voting infrastructure to ensure higher levels of security, reliability, and voter convenience. This paper introduces

an **Intelligent Voting System** designed to overcome the drawbacks of conventional systems by integrating **biometric facial recognition** for voter authentication and **location-independent online voting capabilities**. The proposed system leverages a full-stack technology framework comprising **Python, React JS, Vite, TypeScript, JavaScript**, and **FastAPI**, while utilizing lightweight and highly accurate facial recognition models such as **Tiny Face Detector** and the **face recognition** library.

The system incorporates a multi-layered verification process in which voters are identified in real-time using webcam-enabled face detection. The captured facial features are then encoded and compared against a secure database of pre-registered voters. Upon successful validation, the user is granted access to the digital ballot interface to cast their vote. This biometric-first approach eliminates the need for manual ID checks, physical polling infrastructure, or OTP-based verification, thereby reducing the risk of impersonation, duplication, and system manipulation.

Furthermore, the platform is developed to support scalability, user-friendliness, and remote access, making it especially beneficial for voters with mobility issues, overseas citizens, or those unable to visit polling centers. By ensuring data integrity, confidentiality, and real-time verification, the system enhances the overall security and trust in the electoral process.

In conclusion, this intelligent voting system aims to revolutionize the way elections are conducted by introducing a highly secure, efficient, and accessible method of voting that aligns with modern technological standards and democratic principles. It marks a significant step forward in promoting inclusive governance and addressing the pressing challenges of conventional voting methods.

1.1 PROBLEM STATEMENT

The current voting systems, including manual and electronic methods, face major issues such as identity fraud, limited accessibility, and dependency on physical polling stations. Voters who are unable to reach their designated locations due to distance, disability, or external conditions are often excluded from the process. Existing online solutions using OTPs offer limited security and are vulnerable to misuse. There is a critical need for a secure, user-friendly, and location-independent voting system that ensures only legitimate voters can cast their vote, while preventing impersonation and duplicate entries. This project aims to solve these problems using biometric face recognition for real-time voter verification.

1.2. LITERATURE REVIEW

1) Robust Real-Time Face Detection

In the research conducted by P. Viola and M. J. Jones [1], a robust framework for real-time face detection is introduced using a cascade of simple classifiers based on Haar-like features. This approach laid the foundation for fast and accurate face detection techniques in low-resource environments. Its application in biometric systems enhances both speed and precision, making it suitable for intelligent voting systems where real-time face verification is critical.

Advantage: High-speed, reliable face detection suitable for embedded and web-based systems.

Disadvantage: Limited accuracy in low-light or occluded conditions.

2) Secure Electronic Voting Machine Using Biometric Authentication

M.A. Zamir et al. [2] present a secure electronic voting machine that employs biometric fingerprint authentication to validate voter

identity. The system emphasizes the importance of integrating hardware-level biometric checks to prevent impersonation and multiple voting attempts.

Advantage: Strong voter verification and prevention of duplicate votes.

Disadvantage: Relies on physical devices and may not support remote or location-free voting.

3) Parameterized Direct LDA for Face Recognition

The study by F. Song et al. [3] explores a parameterized Direct Linear Discriminant Analysis (LDA) method for facial recognition. The technique improves recognition accuracy, especially in small training sample scenarios, which is essential for systems with limited facial data.

Advantage: Enhances recognition accuracy with minimal training data.

Disadvantage: May require careful parameter tuning and preprocessing.

4) Speeded-Up Robust Features (SURF)

H. Bay et al. [4] propose SURF, a feature extraction technique designed for fast and robust object recognition, including faces. Its use in biometric systems allows for efficient and scalable matching of facial features under various lighting and angle conditions.

Advantage: Fast and efficient feature extraction useful for real-time facial recognition.

Disadvantage: Less effective for low-resolution or noisy images.

5) Biometric Fingerprint-Based Secure E-Voting System

Kashif Hussain Memon et al. [5] describe a next-generation secure e-voting platform that uses biometric fingerprint verification. The system demonstrates how biometric security can be applied to ensure election integrity, offering insight into multi-modal biometric systems.

Advantage: High reliability and fraud prevention using fingerprints.

Disadvantage: Not ideal for remote or online systems; accessibility concerns for individuals with unreadable fingerprint

Literature survey

Title	Authors & Year	Methodology	Advantages	Results	Disadvantages
Robust real-time face detection	P. Viola, M. J. Jones (2004)	Viola-Jones algorithm using Haar features and AdaBoost	High-speed and accurate face detection	Fast and efficient in real-time	Weak in poor lighting or occlusion
Secure Electronic Voting Machine using Biometric Authentication	M. A. Zaman et al. (2014)	Biometric (Fingerprint) authentication	Enhanced voting security and reduced impersonation	Simple and effective	Needs additional hardware
Face Recognition Based Attendance System using DeepNet	K. Taimur et al. (2023)	Pretrained deep learning face recognition	Accurate identity verification in attendance	High accuracy	Needs high computational power
Face Recognition Based Attendance System	G. Joshi et al. (2023)	Face recognition for automated attendance	Efficient in tracking presence in institutions	Reduces manual errors	Affected by image quality

1. Proposed Solution

Our proposed system introduces a secure and intelligent online voting platform that utilizes biometric face recognition to ensure accurate voter authentication and eliminate traditional challenges such as impersonation, vote duplication, and limited accessibility. Built using modern technologies including Python, React JS, Vite, TypeScript, JavaScript, and FastAPI, the system integrates facial recognition models like Tiny Face Detector and the face recognition library to perform real-time identity verification through webcam input. Upon capturing a live image, the system extracts facial features and matches them against a secure database of registered voters. Only verified users are allowed to access the digital ballot and cast their vote. This face-based authentication removes the need for physical presence or OTP-based methods, enabling secure, transparent, and location-independent voting. The platform is designed to

be lightweight, scalable, and user-friendly, providing a trustworthy alternative to conventional voting systems and supporting the broader goal of enhancing democratic participation through advanced technology.

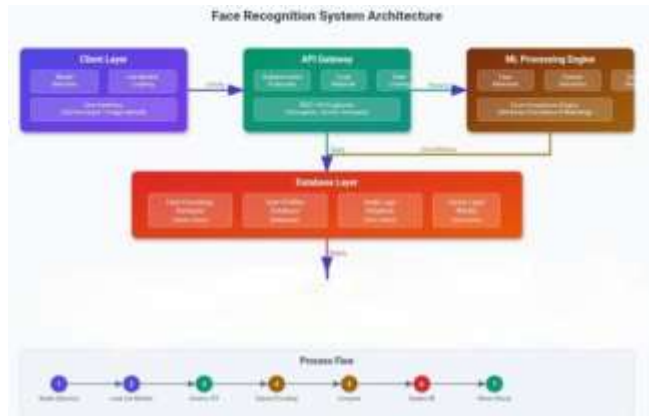


Fig. 1: System Architecture

2.CONCLUSION

This project presents a secure and efficient real-time voting system using facial recognition technology. It verifies the identity of each voter through live video and pre-stored facial data, ensuring authenticity. The system prevents duplicate and fraudulent voting, enhancing the reliability of the election process. It is designed to be user-friendly and scalable for use in various election scenarios. By leveraging biometric verification, it eliminates the need for physical ID cards or manual checks. The face recognition approach increases transparency and trust in digital voting systems. Overall, the project offers a modern, fraud-resistant solution for conducting secure elections.

3.FUTURE SCOPE

The future scope of this intelligent voting system includes the integration of advanced features such as liveness detection and anti-spoofing mechanisms to further strengthen biometric authentication. The system can be extended to include blockchain technology for transparent and immutable vote recording, ensuring end-to-end verifiability. Development of multilingual support

and mobile application interfaces can improve accessibility and user experience across diverse demographics.

Additionally, incorporating AI-driven analytics for real-time voter turnout tracking and fraud detection can make the system more robust. With continued research and regulatory alignment, the proposed solution holds potential for deployment at regional and national election levels, paving the way for a fully digital, secure, and scalable electoral framework.

ACKNOWLEDGEMENT

We would like to thank Dr. Chandru AS for their support and guidance in completing our project, the topic Intelligent Voting System with Biometric Face Recognition. Your expertise and guidance have been instrumental in its success. A heartfelt gratitude for your invaluable assistance and support throughout the project.

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