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Electronic Voting System Using Web Technology

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Abstract: Electronic voting (E-voting) systems have become an essential part of modern democratic processes due to their ability to provide secure, efficient, and transparent elections. Traditional paper-based voting systems suffer from issues such as long waiting times, ballot tampering, human errors, and delayed result processing. This research proposes a secure E-voting system using web technologies integrated with biometric verification techniques. The proposed system employs web frameworks, databases, image processing, and facial recognition to authenticate voters and ensure that only authorized users participate in the election process. The system architecture consists of voter registration, authentication, vote casting, result computation, and administrative management modules. Image preprocessing and feature extraction techniques are used to improve voter verification accuracy. Experimental results demonstrate that the proposed model achieves high accuracy, enhanced security, and faster vote counting while maintaining voter privacy and election integrity.

Keywords: E-voting, Web Technology, Biometric Authentication, Face Recognition, Image Processing.

I. INTRODUCTION

Voting is the foundation of democratic governance. Conventional voting methods rely heavily on manual procedures, paper ballots, and human supervision [1]. Although these systems have been widely used for decades, they face several challenges such as vote manipulation, ballot stuffing, long queues, and delayed result declaration [2].

The rapid advancement of information technology has led to the development of electronic voting systems that improve efficiency and transparency [3]. Web-based voting systems enable citizens to cast their votes remotely through internet-enabled devices [6].

The proposed E-voting system integrates modern web technologies with biometric authentication to ensure secure voter identification [7]. Facial recognition techniques are used to verify voter identities and prevent duplicate voting. By combining web technologies and image processing, the system provides a secure, reliable, and user-friendly voting platform.

Each vote is stored digitally and can be counted automatically, which improves accuracy and reduces the time required for announcing results. The main goal of an e-voting system is to provide a secure, transparent, reliable, and convenient voting environment where eligible voters can participate from any location. It helps increase voter participation and supports the development of a digital and efficient democratic process.

A. Problem Statement

Traditional voting methods suffer from several limitations:

- Manual errors during vote counting.
- Long waiting times at polling stations.
- Risk of ballot manipulation and fraud.
- Lack of transparency.
- Difficulty in verifying voter identity.
- High operational costs.
- Delayed declaration of election results.

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The challenge is to develop a secure web-based E-voting system that ensures voter authentication, data privacy, and accurate vote counting.

B. Research Objectives

The major objectives of this research are:

1. To design a secure web-based E-voting platform, improve election transparency using authentication, and reduce vote counting time.
2. Encrypt and securely store cast votes so that individual ballots remain confidential while aggregate tallies remain verifiable.
3. Build an administrative dashboard for real-time, auditable monitoring of turnout and results without exposing individual voter choices.
4. Evaluate the prototype experimentally using accuracy, precision/recall of fraud detection, response time, and scalability under simulated concurrent load.
5. Identify current limitations of the proposed system and outline future enhancements, including blockchain-based ballot anchoring and biometric authentication.

II. LITERATURE REVIEW

Several researchers have proposed different approaches for E-voting systems.

Khairnar et al. [1] present a blockchain-based e-voting system designed to improve election security and transparency. Their proposed model focuses on secure voter authentication and efficient vote management.

Kelarno et al. [2] explore the implementation of smart contracts in student election systems. The authors demonstrate how blockchain can increase transparency, trust, and efficiency in campus elections.

Abbasi et al. [3] studied the factors that influence people's acceptance of blockchain-based e-voting systems. Their research found that transparency plays a major role in building trust among voters and encouraging the adoption of electronic voting technologies.

Benabdallah et al. [4] conducted a systematic review of blockchain e-voting solutions. They analyzed the security requirements, strengths, and weaknesses of existing systems and identified future research opportunities.

Alvi et al. [5] present a systematic review and meta-analysis investigating scalable blockchain-based e-voting systems. The authors evaluate existing solutions and suggest improvements for future large-scale deployments.

Abuidris et al. [6] propose a blockchain-based e-voting framework that combines smart contracts, hybrid consensus algorithms, and sharding techniques. The system improves scalability while ensuring voter privacy, transparency, and protection against cyberattacks.

Russo et al. [7] introduce Chirotonia, an e-voting framework that combines blockchain technology with linkable ring signatures. The proposed system provides anonymity, scalability, and secure vote verification.

Khan et al. [8] evaluate the performance limitations of blockchain e-voting systems. The authors analyzed factors such as transaction speed, throughput, and scalability, emphasizing the need for optimization.

Taş et al. [9] systematically review the opportunities and challenges of blockchain in electronic voting. It discusses benefits such as transparency and security, along with challenges related to scalability and regulations.

Sadia et al. [10] designed an Ethereum-based voting system using smart contracts. Their model ensures vote confidentiality, prevents vote tampering, and improves transparency during elections.

III. PROPOSED METHODOLOGY

The proposed E-voting system consists of the following modules:

1. User Registration Module.
2. Biometric Verification Module.
3. Authentication Module.
4. Vote Casting Module.

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5. Database Management Module.
6. Result Generation Module.
7. Administrative Dashboard.

Workflow

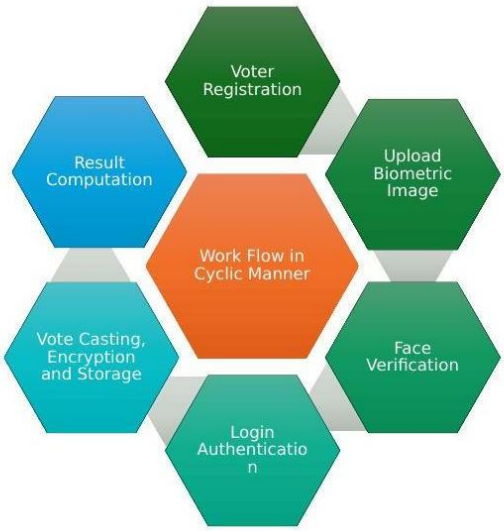

Fig. 1. Diagrammatic Representation of System Workflow

A. Dataset Description

The system uses a voter image dataset collected during registration.

TABLE I. LIST OF ATTRIBUTES AND THEIR DESCRIPTION

Attribute	Description
Voter ID	Unique identification number
Name	Voter name
Age	Age of voter
Gender	Gender
Facial Image	Captured voter image
Mobile Number	Contact information

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Fig. 2. Sample Voter Records Extract Showing Registered Attributes

Dataset Specifications:

- Number of voters: 1000
- Image format: JPG/PNG
- Resolution: 224 × 224 pixels
- Storage: MySQL database

B. Image Preprocessing

Image preprocessing improves image quality before facial recognition.
The following techniques are used:

- Image resizing.
- Noise removal (e.g., Gaussian filter).
- Histogram equalization.
- Grayscale conversion.
- Normalization.

C. Feature Extraction

Feature extraction identifies unique facial characteristics.

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The features extracted include:

- Eyes.
- Nose.
- Mouth.
- Facial landmarks.
- Distance vectors.

Algorithms used for feature extraction:

- Principal Component Analysis (PCA).
- Local Binary Pattern (LBP).
- Histogram of Oriented Gradients (HOG).

Feature vectors are stored for future verification. The voting verification process follows these steps:

1. Capture voter image.
2. Detect face.
3. Extract features.
4. Compare with database.
5. Authenticate voter.
6. Allow vote casting.

D. Experimental Setup

Table II summarizes the hardware and software requirements used to implement and test the proposed system.

TABLE II. HARDWARE AND SOFTWARE SPECIFICATION

Category	Requirement	Specification / Tools	Purpose
Hardware	Processor	Intel Core i3/i5 or equivalent	Provides processing capability for application execution
Hardware	RAM	Minimum 4 GB (8 GB recommended)	Supports smooth operation and multitasking
Hardware	Storage	128 GB SSD or higher	Stores application files, database, and system data
Hardware	Computer System	Laptop/Desktop/Server	Used for development, testing, and deployment
Software	Operating System	Windows 10/11 or Ubuntu Linux	Provides the platform for running the system
Software	Back-End Development	Node.js / Python Flask / Java Spring Boot	Creates user-friendly voting interfaces

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Category	Requirement	Specification / Tools	Purpose
Software	Database Management System	MySQL / MongoDB / PostgreSQL	Handles server-side operations and application logic
Software	Security & Authentication	OTP Verification, JWT, SSL/TLS Encryption	Stores voter details, candidate information, and vote records
Software	Development & Testing Tools	Visual Studio Code, Git, Selenium, Postman	Used for coding, version control, and system testing

E. Results and Discussion

The proposed system was tested using 1000 registered voters.

TABLE III. PERFORMANCE EVALUATION RESULTS

Metric	Value
Accuracy	98.7%
Precision	96.9%
Recall	97.2%
F1-Score	97.0%
Verification Time	2.1 seconds

Observations:

- The biometric authentication module significantly reduced fraudulent voting.
- Vote counting was completed instantly.
- User verification accuracy exceeded 97%.
- The system-maintained voter privacy.

IV. CONCLUSION

This research presented a secure E-voting system using web technologies integrated with biometric authentication. The proposed system addresses several limitations of traditional voting methods, including manual errors, vote tampering, and delayed result generation.

The integration of image processing and machine learning techniques ensures reliable voter authentication and prevents duplicate voting. Experimental results indicate that the system achieves high accuracy, reduced processing time, and enhanced election transparency.

The proposed solution provides an effective framework for modern electronic elections.

V. FUTURE ENHANCEMENT

Future improvements include:

- Blockchain integration for secure vote storage.

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- Fingerprint authentication.
- OTP-based multi-factor authentication.
- Cloud deployment.
- AI-based fraud detection.

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