Blockchain-Based Voting System With AI Verification At Small-Scale Communities

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Abstract

Elections are critical to any democratic institution — from national governments to student unions and residential societies. However, even at small scales, concerns such as voter impersonation, vote rigging, and lack of transparency can compromise the fairness of elections. This research proposes a blockchain-based e-voting system enhanced with artificial intelligence (AI) verification, specifically designed for small-scale, localized elections such as in colleges, universities, housing societies, and community organizations.

Blockchain ensures secure, transparent, and tamper-proof vote recording, while AI strengthens the system by verifying voter identity, detecting anomalies, and preventing fraud. Unlike complex nationwide voting frameworks, this model is lightweight, cost-effective, easy to deploy, and scalable for use by institutions and local bodies. It supports remote voting, real-time authentication, and full auditability, thereby fostering trust and encouraging higher voter participation within communities.

Keywords:

Blockchain Voting, E-Voting System, AI Verification, College Elections, Student Council, Community Governance, Tamper-Proof Voting.

1. Introduction

Elections within smaller institutions such as **universities, colleges, societies**, and **local governing bodies** are often managed manually or via insecure digital tools. These elections may seem less significant than national-level ones, but they **shape leadership**, influence **resource allocation**, and impact **community development** directly.

Traditional pen-paper methods or basic online polls often lack:

- Voter authentication mechanisms
- Data integrity assurance
- Transparent result verification

This research proposes a **hybrid model** combining **Blockchain for secure vote recording** and **AI for voter verification and fraud detection**, customized for small-scale use cases. It aims to:

- Prevent vote tampering
- Reduce administrative burden
- Enhance transparency and trust

2. Literature Survey

2.1 Existing Work

Several academic works explore secure electronic voting:

- **Helios (2008)**: A web-based open-audit voting system offering end-to-end transparency. Not optimized for local use due to technical complexity.
- **Scantegrity (2008)**: Adds verifiability to optical ballots but is hardware-dependent and unsuitable for remote or digital-only voting.
- **STAR-Vote (2013)**: Combines usability and cryptographic verification, though it requires high setup cost and infrastructure.
- **Blockchain e-voting (Kshetri & Voas, 2018)**: Explores blockchain's potential for scalable, secure voting but often focuses on national elections.

None of these models directly address small-scale, **low-budget, user-friendly** election systems for local institutions or communities.

2.2 Research Gap

Existing systems have limitations in:

- Real-time voter verification
- Cost-effective deployment for small-scale elections
- Integration of AI for fraud detection
- Ease of use for non-technical users

3. Problem Statement & Objectives

Despite being smaller in scale, elections in universities, student councils, and housing societies still face:

- **Duplicate votes**
- **Unauthorized access**
- **Opaque counting process**
- **Low technical support or budget**

Our Objectives:

To design a lightweight, cost-effective, **Blockchain-AI based e-voting system** that ensures:

- Transparent vote counting
- Real-time voter verification
- Fraud prevention through anomaly detection
- Ease of access and usability for all voters

4. Proposed System

4.1 Overview

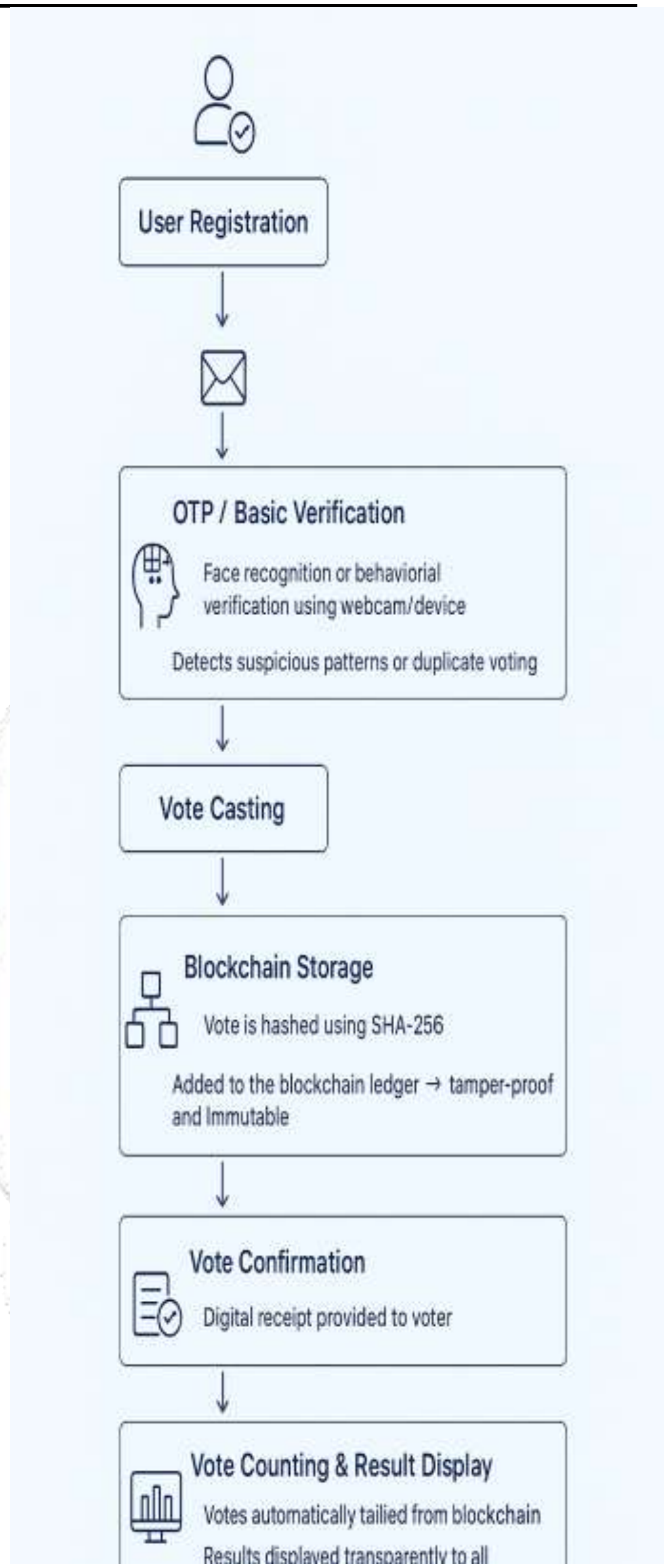
The proposed solution includes:

- **Blockchain for vote recording:** Ensures votes cannot be altered once cast.
- **AI for voter verification and fraud detection:** Uses OTPs or biometrics to confirm identity.
- **Web-based portal:** Enables secure, remote voting from mobile or desktop.

4.2 Workflow (Use Case for College/University Election)

1. **Registration:** Voter registers using email/ID number (e.g., student ID).
2. **OTP Verification:** An OTP is sent to email or phone.

3. **Authentication via AI:** Optional biometric/behavioral checks can be included (e.g., face recognition via webcam).
4. **Vote Casting:** Voter selects candidate and confirms vote.
5. **Blockchain Storage:** Vote is hashed and added to the ledger.
6. **Vote Confirmation:** A digital receipt is shown.
7. **Result Viewing:** Votes are tallied and displayed transparently after voting closes.

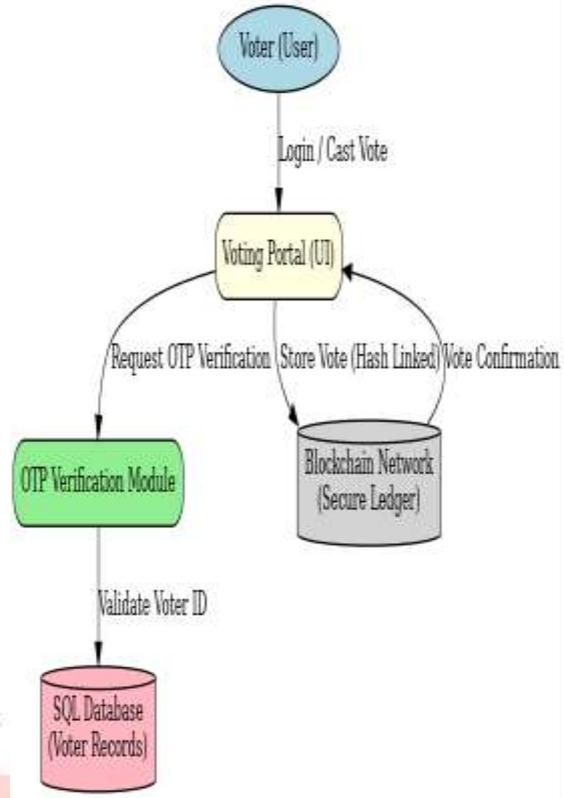


4.3 Technology Stack

Component	Technology / Tools Used	Purpose / Description
Frontend (User Interface)	HTML5, CSS3, JavaScript (React JS / Bootstrap optional)	Develops an intuitive and responsive web portal for voters and administrators; ensures compatibility across desktop and mobile devices.
Backend (Server Layer)	ASP.NET Core (C#) or Flask (Python)	Manages core logic, API handling, and secure interaction between frontend, database, and blockchain modules.
Database Management	Microsoft SQL Server / PostgreSQL	Stores voter records, candidate data, and election logs securely with encryption and controlled access.
Blockchain Layer	Private Blockchain (SHA-256 Hashing)	Records votes immutably, ensuring transparency, traceability, and prevention of data tampering.
AI Verification Module	Python (Scikit-Learn, OpenCV, TensorFlow)	Performs identity verification, facial recognition (optional), and anomaly detection to prevent fraudulent voting activities.
Authentication & Security	OTP-based verification (Email/SMS), SSL/TLS Encryption	Provides secure voter authentication and ensures encrypted transmission of sensitive election data.
Hosting / Deployment	Local Server or Cloud Platform (Azure / AWS / Google Cloud)	Supports flexible deployment depending on election scale — local for campuses or cloud for larger organizations.
Version Control & Integration	GitHub / GitLab with CI/CD Pipeline	Enables collaborative development, version management, and continuous integration for system updates and maintenance.

4.4 Security Highlights

- **SHA-256** for hashing and vote immutability
- **AI anomaly detection** for duplicate logins/voting attempts
- **Encrypted storage** of voter data and ballots
- **Access control** for admin-level operations



5. Advantages of the Proposed System

- **Low-cost, easy to deploy** on campus or society elections
- **Tamper-proof voting records** via blockchain
- **Fraud-resistant authentication** using AI and OTPs
- **User-friendly interface** even for non-technical voters
- **Transparent, auditable results** to prevent disputes
- **Remote participation** for absentee voters (e.g., alumni or off-campus students)

6. Future Scope

The system can be enhanced with:

- **Mobile app integration** for easier access
- **Voice and facial authentication**
- **Edge computing** for local real-time processing
- **Zero-knowledge proofs** for vote verification without exposing voter identity

It can also be extended to:

- NGO elections
- Professional organizations
- Alumni associations
- Corporate decision-making boards

7. Conclusion

This paper presents a practical, secure, and intelligent voting system tailored for small-scale communities. By integrating **blockchain's transparency** with **AI's adaptability**, the system addresses critical issues like **voter fraud**, **data tampering**, and **low trust** in electoral outcomes.

It empowers institutions — from universities to local societies — to conduct trustworthy, efficient, and accessible elections without requiring advanced infrastructure or technical expertise. The solution promotes **higher participation**, **greater accountability**, and a **stronger democratic culture** at the grassroots level.

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