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Blockchain for Secure Voting Systems

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Abstract: The employment of blockchain technology in electronic voting (e-voting) systems is attracting significant attention due to its ability to enhance transparency, security, and integrity in digital voting. This paper provides a thorough examination of the implementation of a blockchain-based voting system. The proposed system employs cryptographic methods to protect voters' privacy and anonymity while ensuring the verifiability and integrity of election results. The study suggests solutions to problems such as managing voter identification and authentication, ensuring accessibility for all voters, and dealing with network latency and scalability. The suggested blockchain-based voting system can provide a safe and transparent platform for casting and counting votes, ensuring election results' privacy, anonymity, and verifiability.

Keywords : Blockchain; Voting; genetic algorithm; Electronic voting; digital transformation; E-voting systems; security; scalability; systematic review;

3.INTRODUCTION:

Blockchain technology has been recognized as a potential solution for secure and trans parent e-voting systems. By leveraging the decentralization, immutability, and transparency of blockchain technology, e-voting systems can prevent fraud and manipulation, improve voter anonymity, and increase trust in the electoral process. Moreover, blockchain-based e-voting systems can reduce the cost and time associated with traditional voting systems.The growing interest in blockchain-based e-voting systems indicates the importance of a comprehensive and systematic evaluation of the current knowledge in this domain.

Traditional voting mechanisms commonly rely on centralized entities, which can give the opportunity for vulnerabilities such as the tampering of results or electoral fraud.Blockchain technology has the ability to create a tamper-proof and transparent platform for conducting e-voting. The growing interest in blockchain-based e-voting systems indicates the importance of a comprehensive and systematic evaluation of the current knowledge in this domain. One of the aims of this review is to identify the main benefits of e-voting systems based on blockchain technology through an in-depth review of the previous research.

4.OBJECTIVES

The purpose of this project is to

1. The electoral process should be openly verifiable and transparent.

2. Voter registration would be guaranteed by the election process.

3. Only legitimate electors may cast ballots.

4. Voting procedures must be unbreakable.

5. Election influencing and rigging should not be permitted by any organization with a desire for power.

6. Accuracy, anonymity, scalability, and speed are the four fundamental characteristics of voting systems.

Blockchain technology is being used for electronic voting applications, and initiatives are being made to use it to meet these four requirements:

1. Accuracy: Each voter's intent must be ascertained and translated into a final result by the voting process.

2. Anonymity- Anonymity is a challenging task. The voter needs to be discrete and won't leak or altered. Blockchain has a hashing function that would make it impossible to retrieve the data without a specific key.

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3. Scalability- India is with the highest growing population. It is most important to keep scalability because each and every vote should be recognized and can be calculated.

4. Speed- The process of voting is fast and the result will be displayed as soon as the election gets completed. Blockchain provides a platform for creating a decentralized, highly secure, and maintain anonymity. The same technology can use to record votes, report votes, display votes, and helps to prevent many types of voter fraud.

5. LITERATURE SURVEY:

The Author Prof. Mrunal Pathak, Amol Suradkar, Akansha Ghodeswar, and Assistant Professor at Information Technology Department, AISSMS Institute of Information Technology, Pune. This research discusses adopting blockchain in the distribution of databases on an online voting system, Which can reduce one of the cheating sources of database manipulation. The pre-election registrationprocess, like counting, voting, final election results, and auditing was explained. Author Prof. Anita A. Lahane, Junaid Patel, ITM Web of Conferences Andheri West, Mumbai, Maharashtra 400053. The paper proposed that the consensus algorithm is proof of work and that all the election properties such as validity, privacy, individuality, flexibility, etc. were satisfied. Author Prof. Pravin Nimbalkar Department of Computer Engineering JSPM's Imperial College of Engineering, research Pune, India. This Paper discusses the benefits of blockchain like cryptographic foundations and also achieving end-to-end verifiability.

6.EXISTING SYSTEM ARCHITECTURE :

The casting and counting of votes is aided or managed by an electronic voting system known as an electronic voting machine (EVM). An electronic voting machine is made up of two main parts: the control unit and the balloting unit. The link associates these parts, and the EVM's control unit ought to be kept with either the directing official or the surveying official. The balloting unit is located in the voting compartment, where voters can cast their ballots. A symbol and a list of candidate names will be displayed on a machine with a blue button next to it. By pressing the blue button next to a candidate's name, voters can select their favorite. As it designs the voting chain for a crowded nation, the system will be secure. The data might not bechanged. Humans are necessary for this kind of system.

7. VOTING SYSTEM TYPES AND REQUIREMENTS

Wefirst categorize the types of voting systems before defining relevant requirements for them.

Voting Systems

Voting systems have been combined with advancements in information technology, making them increasingly efficient and accessible.

Classification of Voting Systems

Traditional Voting Systems

- **Paper-based voting** involves voters manually marking ballots, which are later counted by officials.
- Paper-based voting can be:
  - **Remote voting** (e.g., postal ballots)
  - **On-site voting** (polling stations)
- **Mechanical lever machines**, introduced in the 1890s, allow voters to select candidates using levers, with votes counted mechanically.
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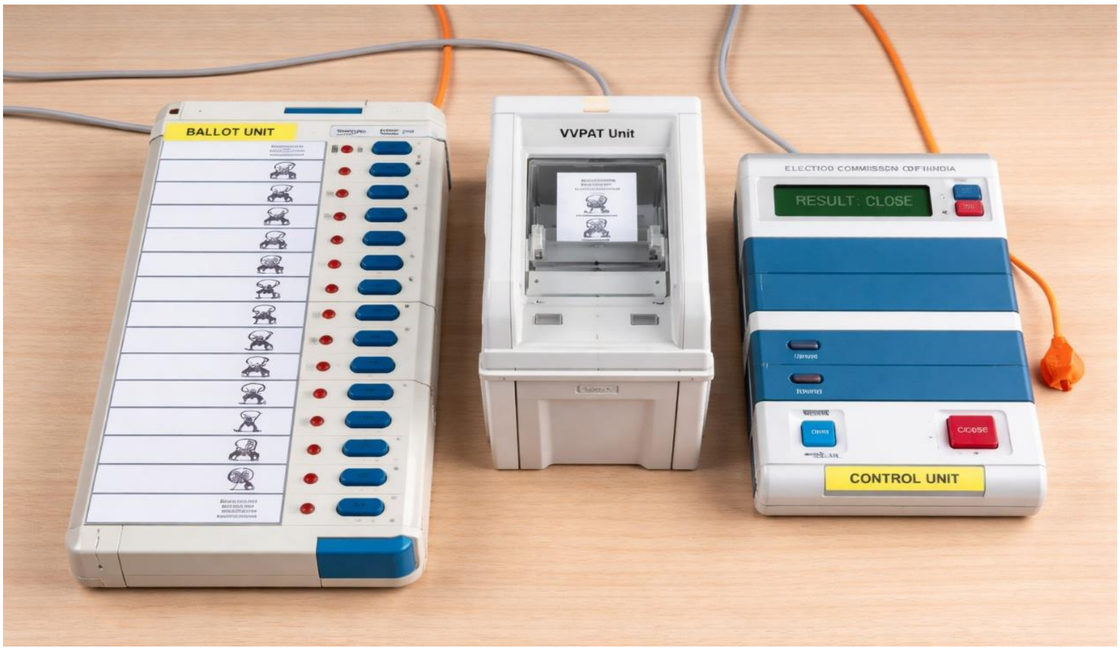
ELECTRONIC VOTING (E-VOTING) SYSTEMS

- **Punch-card systems** use punched cards to record votes, which are later read by machines.
- **Direct Recording Electronic (DRE) systems** store votes digitally using touchscreens or buttons, often supported by **Voter Verified Paper Audit Trails (VVPATs)**.
- **Optical scanning systems** read marked paper ballots using scanners, either at polling stations or centralized locations.
- **Ballot-Marking Devices (BMDs)** allow voters to select options electronically but produce a paper ballot without storing votes digitally.
- **Internet voting (I-voting)** enables vote casting and transmission via the internet, including mobile and online voting systems.
- **Blockchain-based e-voting** leverages decentralized peer-to-peer networks to enhance transparency, integrity, and immutability of votes.



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VOTING SYSTEM REQUIREMENTS

Voting systems must meet both **functional** and **non-functional** requirements, categorized into **non-security** and **security** requirements.

NON-SECURITY REQUIREMENTS

Functional Requirements

- **User-centric design**: The system must be easy to use, intuitive, and unbiased toward any candidate.
- **Flexibility**: Ability to support multiple languages, ballot formats, platforms, and adaptable voting rules.

Non-Functional Requirements

- **Equality**: Ensures equal voting rights and access for all eligible voters.
- **Accessibility**: Enables participation of voters with disabilities or functional limitations.
- **Openness**: Transparency of system hardware and software to allow public understanding and trust.
- **Auditability**: Ability to verify election results through reliable and permanent audit trails.
- **Cost-effectiveness**: Affordable implementation, operation, and maintenance compared to traditional systems.
- **Interoperability**: Compatibility with different technologies using standardized and open protocols.

SECURITY REQUIREMENTS

Functional Security Requirements

- **Authentication and eligibility**:
  - Ensures only registered and eligible voters can vote.
  - Prevents multiple voting by the same individual.
- **Anonymity and secrecy**:
  - Voter identity must not be linked to their vote.
  - Ballot content must remain confidential.
- **Uncoercibility**:
  - Prevents vote-buying, coercion, and external influence.
- **Non-valid voting capability**:
  - Allows voters to intentionally cast invalid ballots without affecting election integrity.

Non-Functional Security Requirements

- **Integrity and reliability**:
  - Ensures votes are recorded accurately and protected from tampering.
  - Maintains system functionality even during failures.
- **Detection and monitoring**:
  - Includes system testing, event logging, real-time error reporting, and monitoring.
- **Fairness**:

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  - Prevents early disclosure of voting trends and avoids influencing voter decisions.
- **Verifiability and accuracy**:
  - Enables voters and observers to verify correct vote recording and counting.
- **Availability**:
  - Ensures continuous system access, resistance to denial-of-service attacks, redundancy, and disaster recovery.

ROLE OF BLOCKCHAIN IN E-VOTING

- Blockchain technology can enhance transparency, integrity, auditability, and trust.
- Despite its advantages, several technical, security, and societal challenges remain unresolved, requiring further research.

1. Security

- Blockchain significantly enhances the security of e-voting systems through:
- **Integrity**: Ensures votes are recorded correctly and protected throughout the process.
- **Immutability**: Once recorded, votes cannot be altered or deleted
- **Stability**: Resistant to cyberattacks and system manipulation through cryptographic mechanisms.

2. Transparency

- Enables open and verifiable voting, recording, and tallying processes.
- Allows independent audits by stakeholders.
- Ensures all voting transactions are visible and verifiable on the blockchain ledger.

3. Privacy

- Blockchain-based systems protect voter identity and ballot secrecy through:
- **Anonymity**: Voter identities remain hidden.
- **Confidentiality (Secrecy)**: Voting choices are kept private until election completion.

4. Accessibility

- Blockchain-based e-voting systems improve voter participation through:
- **Availability**: Continuous access to voting during the election period.
- **Broad turnout**: Encourages higher participation due to remote and digital access.
- **Universal access**: Ensures usability for all eligible voters.

5. Decentralization

- Eliminates reliance on a central authority.
- Distributes control across multiple nodes, reducing the risk of corruption or manipulation.
- Enhances voter confidence and system resilience.

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6. Usability

- Improves the overall voting experience by:
- **Simplicity**: Easy-to-use voting interfaces.
- **Understandability**: Clear system operations ensuring voters cast votes as intended.

7. Efficiency

- Blockchain enables efficient election processes through:
- **Cost efficiency**: Reduces infrastructure, manpower, and material costs.
- **Time efficiency**: Speeds up vote casting and result declaration.
- **Performance efficiency**: Handles large-scale voting securely and accurately.

8. Trustworthiness

- Blockchain-based e-voting systems increase public trust by ensuring:
- **Eligibility**: Only authorized voters can participate.
- **Fairness**: Results are not disclosed before voting concludes.
- **Accountability**: Errors or inconsistencies can be identified.
- **Uniqueness**: One voter is allowed only one vote.

CONCLUSION:

A systematic review of blockchain-based e-voting research from **2017–2023** was conducted.The study followed the **PRISMA protocol**, resulting in the selection of **252 relevant papers**. Blockchain technology shows strong potential for implementing secure and transparent e-voting systems.**Transparency and auditability** are the most widely recognized advantages of blockchain-based voting.**Security and privacy** are critical requirements and remain major research challenges.Privacy-preserving and **coercion-resistant protocols** have gained increased attention in recent years. Research focus has shifted from basic frameworks to **security enhancement**, and more recently to **scalability and cost efficiency**.**Scalability** is identified as the most significant non-security limitation of blockchain systems.

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