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# Ethereum Based Blockchain Technology for Online Voting System using Decentralized Peer to Peer Network

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**ABSTRACT:** Democratic voting is a crucial and serious event in any country, the current voting scheme in any country is through ballot paper or by use of EVM. These processes have many drawbacks such as transparency, low voter turn-out, tampering of votes, distrust in the election body, forging of unique Id (voter id card), delay in giving out results and the most important is security issues. Security of digital voting is always the biggest concern when considering to implement a digital voting system. With such monumental decisions at stake, there can be no doubt about the system's ability to secure data and defend against potential attacks. One way the security issues can be potentially solved is through the use of blockchain technology. Blockchain technology offers infinite number of applications. Blockchain is a distributed ledger technology that allows digital assets to be transacted in a peer-to-peer decentralized network. A distributed ledger technology is an exciting advancement in this regard. Block is a collection of all the transactions. Blockchain possess salient features such as immutability, Decentralization, Security, Transparency and anonymity. Blockchain with smart contracts emerges as a promising candidate for building a safer, secure and transparent E-voting systems. So we are looking to implement a sample e-voting application as a smart contract for the Ethereum network using the blockchain technology through wallets and the Solidity language. Limited amount of token (gas) is given in the wallet which is exhausted when the user votes thus preventing duplicity of vote.

**KEYWORDS:** Blockchain, Ethereum, Security, Transparency, Vote Integrity, Decentralization, Digital Voting

## I. INTRODUCTION

### 1.1 Importance of Security and Transparency in Voting Systems

Elections are a core element of democratic systems, as they allow citizens to take part in governance and decision-making. However, traditional voting methods such as paper ballots and Electronic Voting Machines (EVMs) face several limitations. These include low transparency, centralized management, vulnerability to manipulation, and slow result declaration. Studies suggest that these challenges often reduce voter confidence and participation, particularly in large-scale elections where proper monitoring and verification are difficult [1], [2].

Security remains one of the most serious issues in present electronic voting systems. Problems like voter impersonation, vote data manipulation, insider threats, and reliance on central authorities create major risks to election fairness. Studies indicate that when voting systems are centralized, they form a single point of failure, which makes them vulnerable to technical issues as well as deliberate cyber and internal attacks [3], [4].

Blockchain technology has gained attention as an effective approach to solve security and transparency problems in electronic voting systems. It works as a decentralized and distributed ledger where all transactions are permanently stored and shared among many network nodes. Because blockchain records cannot be changed or removed, it guarantees that once a vote is submitted, it remains secure. Previous studies show that decentralization lowers the chances of vote manipulation and removes dependence on a single central authority [2], [5].

Even though blockchain-based voting systems provide high levels of security, they still face issues related to scalability, transaction fees, and ease of use. Recent research highlights the need to build efficient and practical voting system designs that maintain strong security while also ensuring good performance and user accessibility [5], [7].



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### 1.2. Limitations of Existing Systems.

Traditional voting methods, such as paper ballots and Electronic Voting Machines (EVMs), depend largely on central authorities for tasks like voter registration, vote recording, and result calculation. This centralized setup leads to a single point of failure, meaning that any technical issue or intentional attack can affect the whole election process. Research shows that centralized control raises the chances of insider threats, manipulation, and abuse of power, which ultimately lowers public confidence in the electoral system [1], [3].

Security continues to be a major limitation in current voting systems. Conventional voting methods are exposed to risks such as ballot stuffing, vote tampering, hardware interference, and cyberattacks in electronic voting setups. Many studies point out that electronic voting systems do not have strong end-to-end security, which allows unauthorized access and possible modification of voting data. [2], [4].

One of the key weaknesses of present voting systems is security. Traditional voting approaches face threats like ballot stuffing, manipulation of votes, hardware tampering, and cyberattacks in electronic voting environments. Research has shown that many electronic voting systems lack effective end-to-end security measures, making them vulnerable to unauthorized access and changes to voting data. [3], [5].

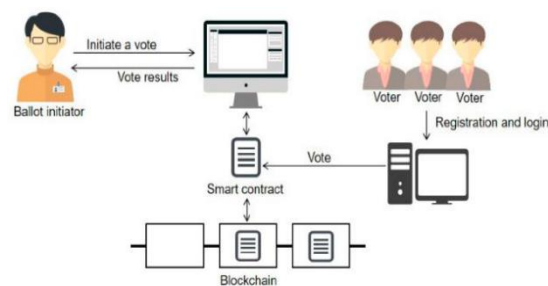


Fig.1. Blockchain-based E-Voting Architecture

### 1.3. Motivation for Blockchain-based E-Voting

The main reason for using blockchain-based e-voting systems is the increasing need to rebuild trust and integrity in election processes. In traditional voting systems, voters must depend on centralized authorities to handle and verify election results, which often creates doubt and reduces confidence. Studies emphasize that elections require a transparent and tamper-resistant system to maintain fairness and gain public acceptance of the outcomes [1], [2].

Decentralization is another important reason behind the adoption of blockchain voting systems. Unlike centralized voting setups, blockchain spreads data across many nodes, which lowers the risk of system breakdowns and targeted attacks. Research shows that decentralized designs remove single points of failure and strengthen protection against cyber threats and insider attacks [2],[5]. As a result, blockchain becomes a suitable and reliable platform for secure election processes.

The adoption of blockchain-based e-voting is further encouraged by the use of smart contracts on platforms like Ethereum. Smart contracts automatically handle important election tasks such as checking voter eligibility, controlling the voting duration, and counting votes. By reducing human involvement, this automation lowers operational mistakes and ensures that election rules are applied consistently. Research indicates that voting systems built on smart contracts increase efficiency and reliability while still providing strong security [5], [7].

Transparency plays a vital role in increasing voter trust, and blockchain supports voting systems that are transparent while still protecting voter privacy. With blockchain, all transactions can be publicly verified, and voter identities remain anonymous through cryptographic methods. Studies show that transparent verification processes allow both voters and authorities to independently confirm election results, which improves accountability and helps reduce election-related disputes [4], [6].

Immutability is another important reason for adopting blockchain technology in voting systems. After information is stored on the blockchain, it cannot be changed or removed without approval from the network. This feature helps



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prevent common problems in traditional voting systems, such as vote manipulation and tampering with results. Research highlights that immutable blockchain records greatly improve election security by keeping votes permanent and verifiable during the entire election process [3], [4].

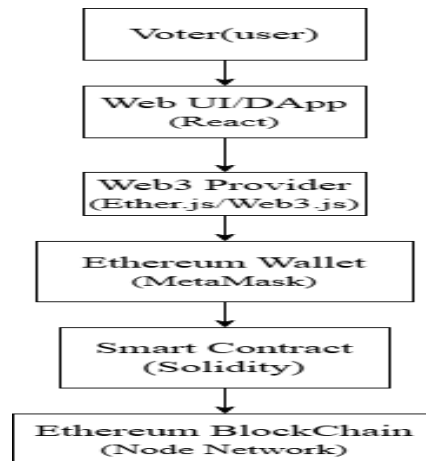


Fig.2. Smart Contract Voting Flow

This research focuses on developing and implementing a decentralized electronic voting system based on blockchain technology. Unlike conventional centralized voting models, the proposed system uses the decentralized features of the Ethereum blockchain to remove single points of failure and minimize reliance on trusted third parties. By storing votes on an immutable distributed ledger, the system improves transparency, security, and confidence in the voting process, while ensuring that recorded election data cannot be modified.

One of the main contributions of this work is the creation of a voting system based on smart contracts that automatically applies election rules. The smart contract manages important functions such as registering candidates, validating the voting duration, recording votes, and counting results without human involvement. This automation guarantees fairness and uniform rule enforcement, supports the one-voter-one-vote policy, and reduces both accidental errors and deliberate manipulation during elections.

The proposed system uses a secure voter authentication approach based on blockchain wallets rather than conventional identity databases. Each voter takes part in the election using a unique blockchain address, which prevents impersonation and multiple voting. Cryptographic wallet-based authentication improves identity verification while keeping voter identities anonymous, thus enhancing both security and privacy in the voting process.

Another important contribution of this research is the practical development and evaluation of the decentralized voting system using Ethereum smart contracts, MetaMask wallets, and a local blockchain setup. The implementation shows how blockchain-based voting can work in real-world conditions and demonstrates the practicality of smart contracts for conducting secure and transparent elections. Experimental findings confirm that the proposed system successfully prevents vote manipulation and provides accurate vote counting.

Finally, this research presents a basic framework that can support future blockchain-based e-governance solutions. By solving major issues related to transparency, security, and trust in electronic voting, the proposed system can be expanded to handle large-scale elections and other decision-making activities. The results of this study add to existing research on decentralized systems and highlight the ability of blockchain technology to improve and modernize democratic processes.



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### II. LITERATURE SURVEY

Many researchers have studied the use of blockchain technology in electronic voting systems to address the weaknesses of traditional voting methods. In [1], the authors present a detailed review of blockchain-based voting solutions and explain how decentralization and immutability enhance election security and transparency. The study points out that blockchain removes centralized control and lowers the chances of vote manipulation, which makes it a reliable option for democratic systems.

The study in [2] concentrates on the development of an online voting system based on blockchain to improve both security and transparency. The authors suggest the use of cryptographic methods along with distributed ledger technology to make sure that votes remain unchanged after they are submitted. Their results show that blockchain voting systems increase voter trust by enabling public verification of results while still protecting voter anonymity.

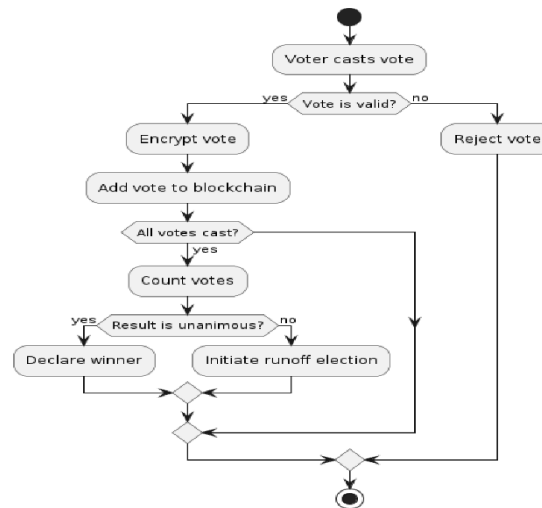


Fig.3. System Architecture

In [3], the researchers present a voting system developed on the Ethereum blockchain that uses smart contracts to automate election processes. The study explains how smart contracts can automatically apply voting rules, including voter eligibility checks, control of the voting period, and enforcement of the one-vote-per-user rule, without manual involvement. This automation helps reduce operational mistakes and improves the overall reliability of the voting system.

In [4], the authors examine how decentralization helps avoid single points of failure in voting systems. Their model replaces centralized identity databases with blockchain wallets for voter authentication. This method reduces identity fraud and repeated voting while protecting voter privacy through cryptographic techniques.

Although blockchain-based voting systems provide high levels of security, many studies point out practical issues such as scalability, transaction costs, and overall system performance. The work in [5] explains that public blockchains can experience delays and higher costs during large-scale elections. To address these problems, the authors recommend optimizing smart contracts and using controlled blockchain environments to enhance efficiency.

The comparative analysis in [6] reviews multiple blockchain-based e-voting approaches and finds that systems built on Ethereum offer greater flexibility because of smart contract functionality. At the same time, the study points out that proper system design is necessary to maintain a balance between transparency and voter privacy. In a similar manner, [7] highlights that usability and accessibility are crucial factors for encouraging broader voter participation in blockchain-based voting platforms.



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Based on the reviewed literature, it is clear that while many blockchain-based voting solutions have been suggested, most of them concentrate on theoretical designs or limited implementations. Challenges related to real-world deployment, user experience, and complete system validation are still unresolved. This research seeks to address these gaps by developing a practical decentralized voting system using the Ethereum blockchain and smart contracts, with emphasis on security, transparency, and usability in real-world scenarios.

### III. PROPOSED METHODOLOGY

The proposed methodology introduces a decentralized electronic voting system developed on the Ethereum blockchain to provide security, transparency, and trust in elections. By using the distributed ledger and smart contract features of blockchain, the system removes the need for centralized control. Key voting activities, including candidate registration, voter participation, vote submission, and result calculation, are handled through Ethereum smart contracts, which automatically and transparently enforce all election rules.

The system defines two main roles: administrator and voter. Authentication is achieved using both backend verification and blockchain wallet integration. The administrator manages the setup of the election, such as registering candidates and setting the voting schedule. Voters log in using their unique blockchain wallet addresses through MetaMask, enabling secure cryptographic identity verification without saving personal information. This method avoids impersonation and guarantees that every voter is uniquely recognized.

A smart contract is deployed on the Ethereum blockchain to control the main voting operations. After deployment, the contract maintains information such as candidate details, voting start and end times, and voter participation records. The administrator communicates with the smart contract to register candidates and set the voting schedule. Since these settings are stored immutably on the blockchain, they cannot be changed once the voting process has begun.

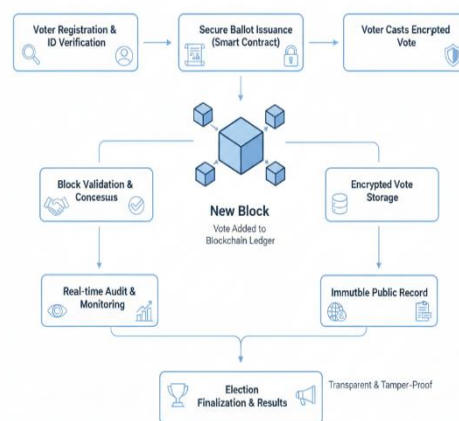


Fig.4.Proposed Model Framework

In the voting stage, verified voters link their blockchain wallets to the system and choose their desired candidate using the user interface. Casting a vote creates a transaction that is submitted to the smart contract. The smart contract checks voter eligibility, confirms that the voter has not voted before, and verifies that the voting window is open. Once all conditions are met, the vote is permanently stored on the blockchain, making it secure and resistant to tampering. To avoid multiple voting, the smart contract keeps track of blockchain addresses that have already taken part in the election. After a vote is successfully submitted, the voter's address is flagged as voted, and any additional voting attempts from that address are automatically denied.



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### IV.RESULT

#### 4.1 Results

The proposed blockchain-based e-voting system aims to deliver a secure, transparent, and tamper-proof voting solution. By assigning each voter a unique blockchain wallet address, the system allows only one vote per voter, effectively preventing duplicate voting and identity misuse. All votes are permanently stored on the Ethereum blockchain, ensuring that the voting process remains immutable and easily verifiable. Smart contracts automate key functions such as candidate registration, vote submission, and vote counting, which removes manual involvement and minimizes human errors. Furthermore, election results can be produced immediately once the voting phase concludes, greatly reducing delays in result announcement.

#### 4.2 Advantages

One of the key benefits of the proposed system is improved security, as blockchain cryptography protects votes from unauthorized changes. Since the system is decentralized, it does not depend on a single authority, which lowers the risk of manipulation and eliminates single points of failure. Transparency is strengthened because votes stored on the blockchain can be independently verified, helping to build voter confidence in the results. At the same time, voter privacy is preserved while accountability is maintained through wallet-based authentication. In addition, smart contract automation lowers operational costs, increases efficiency, and enhances the reliability of the voting process. Overall, this system provides a scalable and trustworthy alternative to conventional voting approaches.

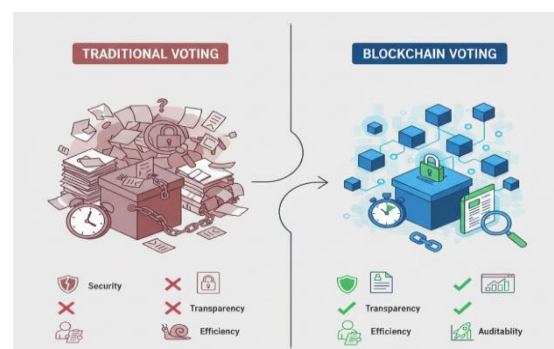


Fig.5.Traditional Voting Vs Blockchain Voting

### V. CONCLUSION

This research introduced a decentralized electronic voting system built on Ethereum blockchain technology to overcome security, transparency, and trust problems found in traditional voting methods. By using key blockchain properties such as decentralization, immutability, and cryptographic protection, the proposed system guarantees that votes are securely stored and cannot be changed after they are submitted.

Smart contracts are used to automatically manage important election tasks such as candidate registration, vote verification, and result calculation, which reduces human involvement and operational mistakes. Wallet-based authentication guarantees that each voter is unique while protecting anonymity and preventing multiple voting attempts.

Experimental implementation and testing show that the system delivers reliable, transparent, and tamper-resistant voting operations. Overall, the proposed blockchain-based e-voting system demonstrates strong potential as a secure and trustworthy alternative for modern digital elections



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