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Voting Application using Blockchain Technology

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Abstract: ***Voting plays a crucial role in democratic societies, allowing individuals to voice their opinions and shape the direction of governance. However, traditional voting systems encounter challenges regarding transparency, security, and trustworthiness. In recent years, blockchain technology has emerged as a promising solution to address these issues and revolutionize the voting process.***

This research paper presents a novel voting application that leverages blockchain technology to enhance the integrity and efficiency of elections. By utilizing the decentralized and immutable nature of blockchain, the proposed system aims to provide a transparent and trustworthy voting process. Each vote is recorded as a transaction on the blockchain, ensuring a transparent and tamper-resistant ledger that can be verified by all participants.

The implementation of smart contracts, which are self-executing and self-enforcing digital agreements, automates and streamlines the voting process. This eliminates the need for intermediaries, such as election authorities, and enables verifiable and auditable results. Additionally, the integration of cryptographic techniques further enhances the security and privacy of the voting system, safeguarding the confidentiality of voters' choices.

The paper thoroughly examines the advantages and challenges associated with implementing blockchain technology in the voting domain. It explores the benefits offered by blockchain, including transparency, immutability, and decentralized governance, while also addressing concerns related to scalability, voter identification, and accessibility.

Through a comprehensive analysis and evaluation, this research paper aims to contribute to a deeper understanding of blockchain-based voting systems and their potential impact on democratic processes. By harnessing the power of blockchain technology, it becomes possible to create a voting system that is more secure, transparent, and inclusive, ultimately strengthening the foundations of democracy.

Keywords: Blockchain , Blockchain Voting Application , Ethereum Voting , Voting system using solidity , Decentralized voting system

I. INTRODUCTION

In a democratic society, voting holds a critical role as it allows people to elect their government leaders. It is essential for the electoral system to be democratic, independent, and impartial. However, conventional voting systems often lack transparency and security, relying on intermediaries and facing issues such as booth capture, dummy voting, and inadequate monitoring. This has led to a continuous evolution in the approach to voting, with efforts focused on enhancing security, verifiability, and transparency.

Electronic voting, or e-voting, has emerged as a solution to address these challenges. Since its inception as punched-card ballots in the 1960s, e-voting systems have made significant progress, especially with the integration of internet technologies. However, for widespread adoption, e-voting systems must meet specific benchmark parameters, including voter anonymity, vote integrity, and non-repudiation.

Blockchain technology provides a solution to the aforementioned problems. By leveraging blockchain, we can not only save resources but also enhance the transparency and fairness of the voting process. Blockchain is an emerging technology with strong cryptographic foundations, offering resilient security solutions. It functions as a distributed decentralized database that maintains a secure and tamper-resistant record of transactions. Each block in the blockchain is assigned a cryptographic hash, which changes immediately if any data within the block is altered. This ensures the integrity of the data and mitigates against unauthorized transactions.

Integrating blockchain into the voting system brings several benefits. Firstly, it enhances security by providing a secure and immutable ledger for recording votes. Secondly, it promotes accessibility and inclusivity by eliminating the need for centralized authorities and allowing individuals to participate in the voting process more easily. Thirdly, it ensures auditability and verifiability, allowing participants to verify the integrity of the voting process.

The scope of this study focuses on exploring the use of blockchain technology in e-voting applications, with a specific emphasis on assuring voter anonymity, vote integrity, and end-to-end verification.

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Ethereum, a decentralized open-source blockchain platform with smart contract functionality, was chosen for this project. The goal was to develop a simple voting application using Solidity, HTML, CSS, JS, and React JS to create a secure, transparent, immutable, reliable, and fair voting system. The project aims to minimize the cost of running elections while fulfilling security, privacy, and compliance requirements. The objective of this study is to demonstrate how blockchain technology can be utilized in voting systems to create a decentralized application that ensures authenticity and integrity. By implementing this project, we aim to contribute to the understanding of the potential benefits and challenges of using blockchain in voting applications, ultimately promoting secure, transparent, and inclusive democratic processes. The existing voting system suffers from several disadvantages, such as a centralized architecture, susceptibility to attacks, lack of trustworthiness, and non-transparent vote casting processes. This project focuses on overcoming these drawbacks by developing a decentralized voting application that showcases the utilization of blockchain in the voting system. The goal is to provide authentic democratic platforms that are secure, transparent, immutable, reliable, and fair. Overall, this research aims to contribute to the knowledge and understanding of the benefits and challenges associated with implementing blockchain technology in voting applications. By utilizing blockchain, we strive to promote secure, transparent, and inclusive democratic processes, transforming the way elections are conducted.

II. LITERATURE SURVEY

Boshri et al. (2019) suggest a blockchain-based democratic process using the Ethereum network. The system utilizes blockchain for voter data storage and allows biometric verification at designated polling locations. However, the involvement of third parties and the lack of anonymity for voters are drawbacks of this system.

Hjálmarsson et al. (2018) present an electronic voting system that utilizes blockchain as a service. The system consists of district nodes and boot nodes, but it does not adequately protect voters' privacy and lacks a self-tallying process.

Jorge Lopes (2019) proposes a blockchain-based e-voting system using smart contracts. The system involves three categories of individuals (director, developer, and voter) and employs homomorphic encryption for ballot encryption before adding it to the blockchain.

Shahzad et al. (2019) propose an improved form of e-voting using blockchain. Their framework includes a proof of completeness algorithm for block development and management. However, the system requires further enhancements in terms of security, privacy, and transparency.

Dagher et al. (2018) develop BroncoVote, a blockchain-based voting technology for university environments. The system employs blockchain and smart contracts for election administration and auditable results but has limitations in registration, voter authentication, and privacy concerns.

Li et al. (2021) introduce AMVchain, an efficient and scalable blockchain-based voting system. They address the flaws of existing systems and employ linkable ring signatures for voter anonymity.

III. TOOLS AND TECHNOLOGIES

A. Blockchain

A blockchain is a public database that is updated and shared across multiple computers in a network. It consists of sequential blocks where data and state are stored. Transactions, such as sending ETH, need to be added to a block to be successful. Each block cryptographically references its parent, ensuring that changing a block's data requires changing all subsequent blocks, requiring consensus from the network.

B. Ethereum

Ethereum is a decentralized global software platform powered by blockchain technology. It is known for its native cryptocurrency, ether (ETH). Ethereum allows anyone to create secured digital technologies and supports the creation of decentralized applications (dapps) through smart contracts. It is designed to be scalable, programmable, secure, and decentralized.

C. Energy Web Volta Network

The Energy Web Volta network is a decentralized blockchain platform specifically designed for the energy sector. It is built on the Ethereum blockchain and aims to facilitate the transition to a sustainable, low-carbon energy system. The network focuses on providing a secure and scalable infrastructure for applications and services in the energy sector, leveraging blockchain technology for trust, transparency, and interoperability.

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D. Dapps

Decentralized applications (dapps) are distributed open-source software applications that run on a decentralized peer-to-peer network. Unlike traditional applications controlled by a single entity, dapps operate on a decentralized blockchain, ensuring freedom from central authority. They allow multiple individuals to create and consume content without control or interference. Dapps should be open source, decentralized, offer incentives, and demonstrate proof of value.

E. EVM

The Ethereum Virtual Machine (EVM) is a software component that executes smart contracts and computes the state of the Ethereum network after each new block is added. It runs on top of Ethereum's hardware and node network layer, processing smart contracts and compiling them into bytecode.

F. Nodes

Nodes are real-life machines that store the EVM state and communicate with each other to propagate information and state changes. Users can request code execution by broadcasting execution requests from a node. The Ethereum network comprises all Ethereum nodes and their communications.

G. Accounts

Accounts store ether (ETH) and represent user identities. Users can initialize accounts, deposit and transfer ether, and interact with other users. Account balances and information are stored in the EVM state.

H. Transactions

Transactions are formal requests for code execution on the EVM. They result in changes to the EVM state and are fulfilled when validated, executed, and committed to the network by nodes. Examples of transactions include sending ether, publishing smart contract code, and executing smart contract code with specific arguments.

I. Blocks

Blocks are containers of information in a blockchain. They contain transactional data and, once added to the blockchain, cannot be changed. Blocks are secured with cryptographic methods and are added to the chain in batches to handle the high volume of transactions.

J. RPC NODE

An RPC (Remote Procedure Call) node allows remote clients to interact with a blockchain network using RPC protocols. It serves as a gateway for external applications or clients to access and interact with the blockchain network, providing APIs and methods for sending requests and retrieving information.

K. Smart Contracts

Smart contracts are self-executing pieces of code stored on a blockchain. They execute when predetermined conditions are met and enable secure and trusted transactions between anonymous parties without the need for a central authority. Smart contracts on Ethereum are written in Solidity and offer benefits such as speed, efficiency, trust, transparency, and security.

IV. PROPOSED SYSTEM

We have proposed a voting application that utilizes blockchain technology to enhance security, transparency, and reliability. The proposed system offers several advantages over the existing voting systems:

1) *Global Accessibility:* Users can vote from anywhere in the world as long as they possess the citizenship of the respective country.
2) *Tamper-Proof Voting:* The voting data is stored on the blockchain, ensuring its immutability and resistance to tampering.
3) *Time and Workload Efficiency:* Since there is no need to physically stand in queues for casting votes, the proposed system saves time and reduces the workload on election officials.

The proposed system comprises two modules:

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a) *Admin Module:* The admin, or administrator, is an authorized person responsible for creating elections, setting the election time, and adding candidates to the voting contract.

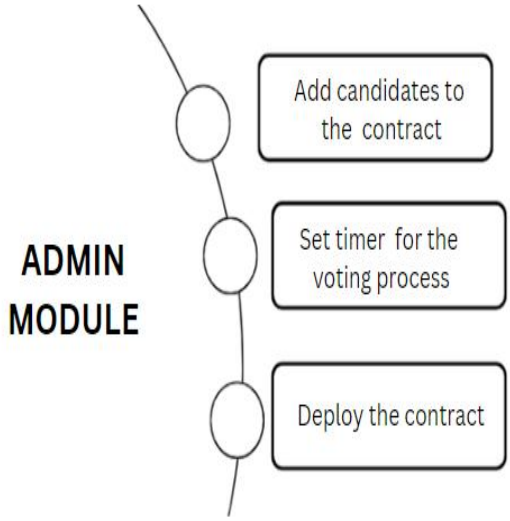


Fig – 1(Admin Module)

b) *Voter Module:* Voters are the users who cast their votes. Each voter can only cast one vote, and attempting to cast multiple votes will result in disqualification. Once a vote is cast, it cannot be changed or undone. The voting process ensures the anonymity of the voters, keeping their identity and chosen candidate secret.

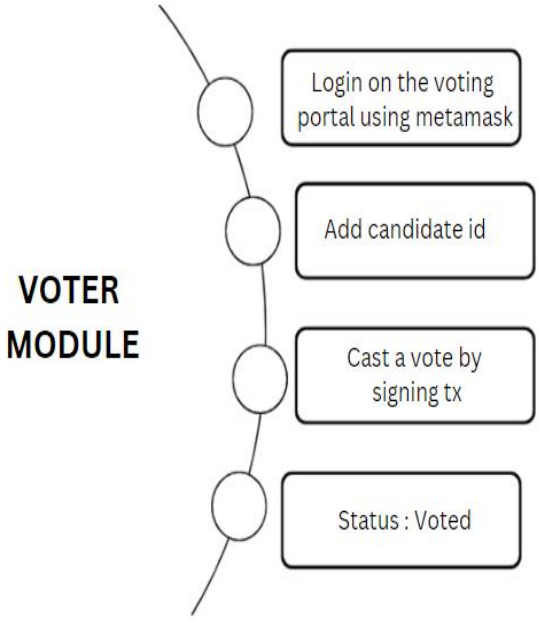


Fig – 2 (Voter module)

The proposed voting mechanism involves three phases:

- *Smart Contract Deployment Phase*: The admin deploys the smart contract by setting the voting time and adding candidates to the contract. The admin uses their own public key to sign the transaction and pays the necessary gas fees.
- *Voting Start Phase:* During this phase, voters log into the voting portal using Metamask, a popular Ethereum wallet. Once logged in, voters enter the ID or index of their preferred candidate and cast their vote by signing the transaction on Metamask.
- *Voting End Phase:* This phase marks the end of the voting period. When the remaining time reaches zero, no more voters can participate or cast their votes.

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Below is the complete flow of how blockchain based voting application works

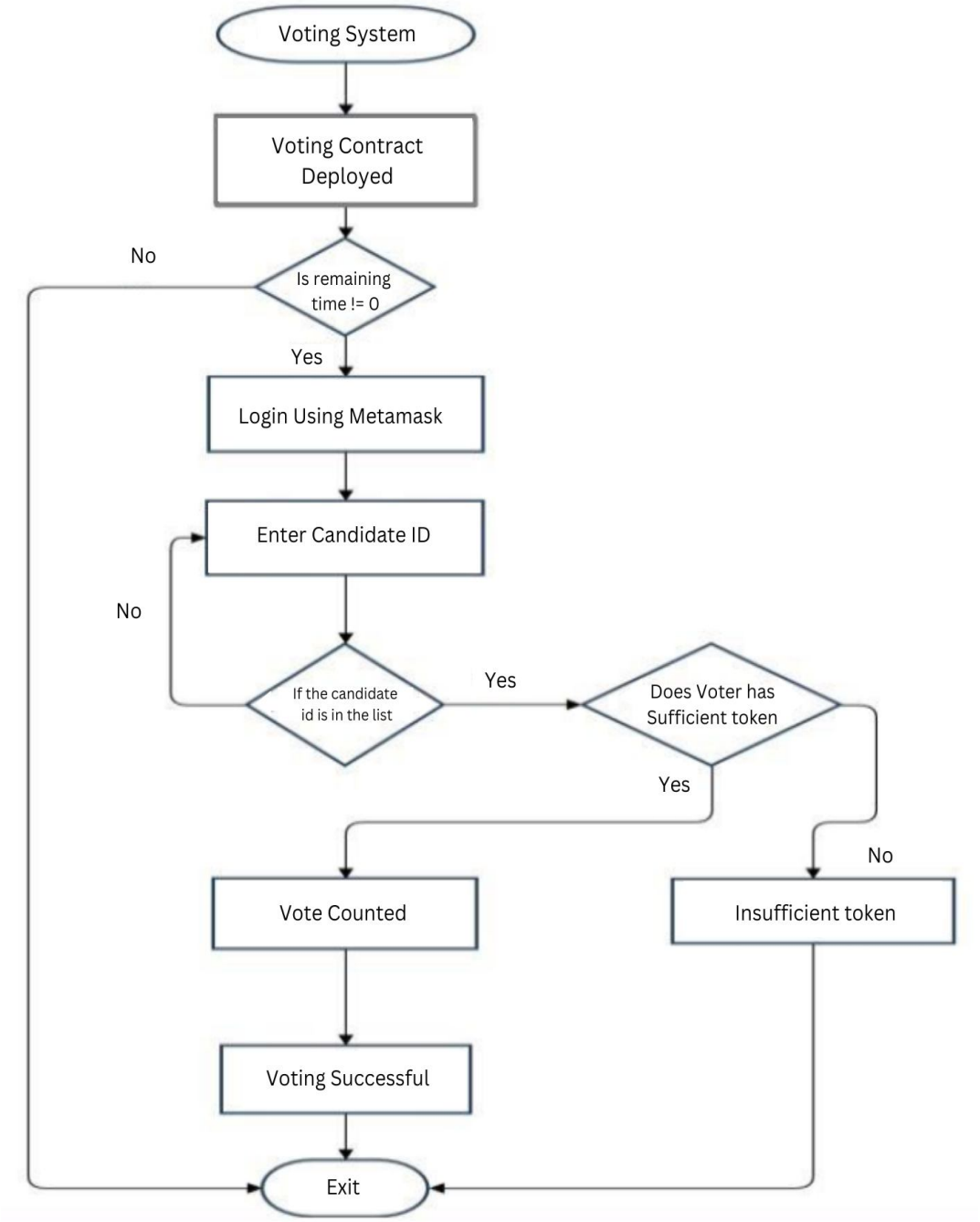


Fig – 3 (Flow chart)

V. IMPLEMENTATION AND RESULTS

To validate the proposed system, we implemented the solution using various technologies. Solidity, a contract oriented programming language for writing voting smart contracts, ReactJS [20], Html, Css for the frontend user interface, Javascript for the backend interface, Database for user authentication for voting.

The Energy web volta test network which is a decentralized blockchain platform specifically designed for the energy sector. It is built on the Ethereum blockchain and aims to facilitate the transition to a sustainable, low-carbon energy system , Metamask as add on which is a web 3 wallet

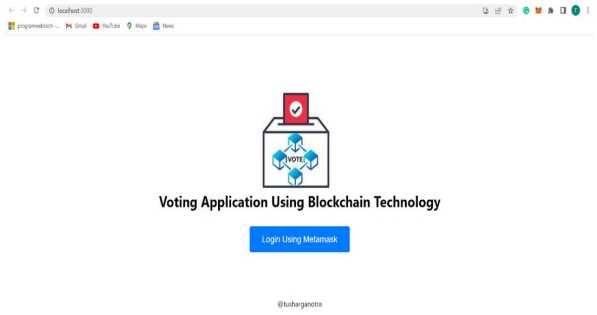


Fig – 4 (home page)

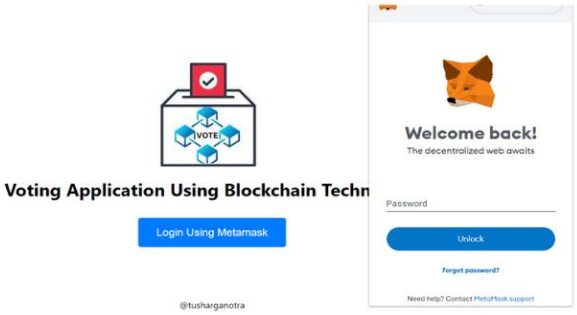


Fig – 5 (voting portal)

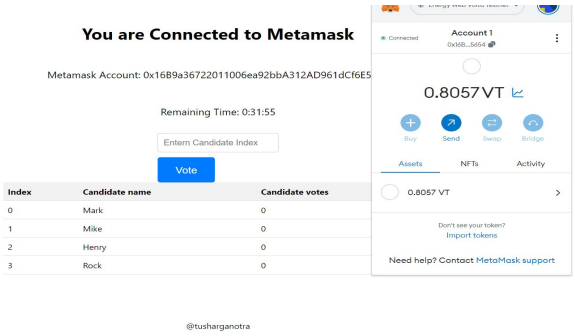


Fig – 6 (Voter connecting to Metamasak)

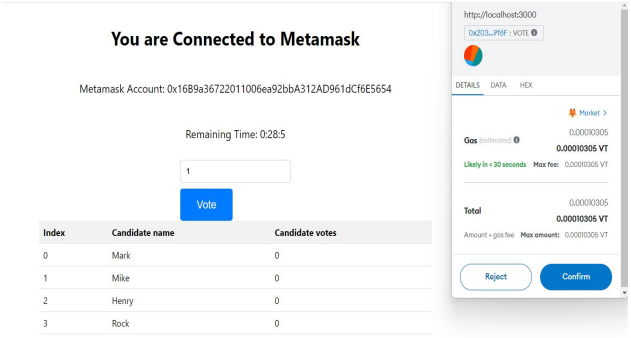


Fig -7 (Voter casts a vote by signing Tx)

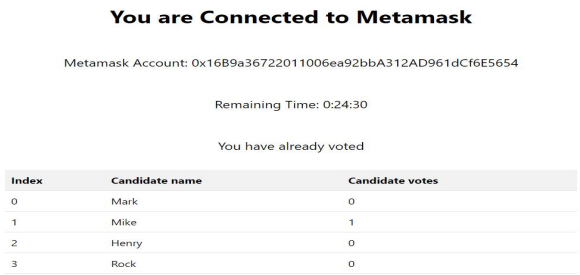


Fig – 8 (voter voted for the respective candidate)

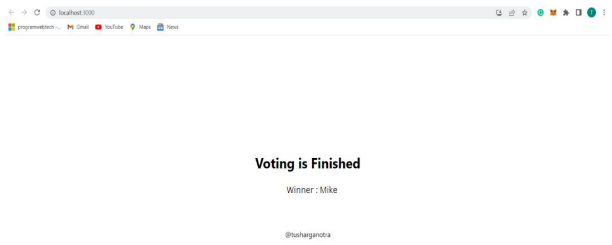


Fig – 9 (Final result is declared)

VI. CONCLUSIONS

A credible and trustworthy electoral system is crucial for the functioning of a democratic society. The success of democracy relies on elections that are perceived as fair and reliable, and citizens must have confidence in the electoral process. However, traditional paper-based elections often fall short in terms of credibility. Therefore, there is growing interest in implementing a digital voting system that can enhance the efficiency, speed, and accessibility of the voting process in today's world.

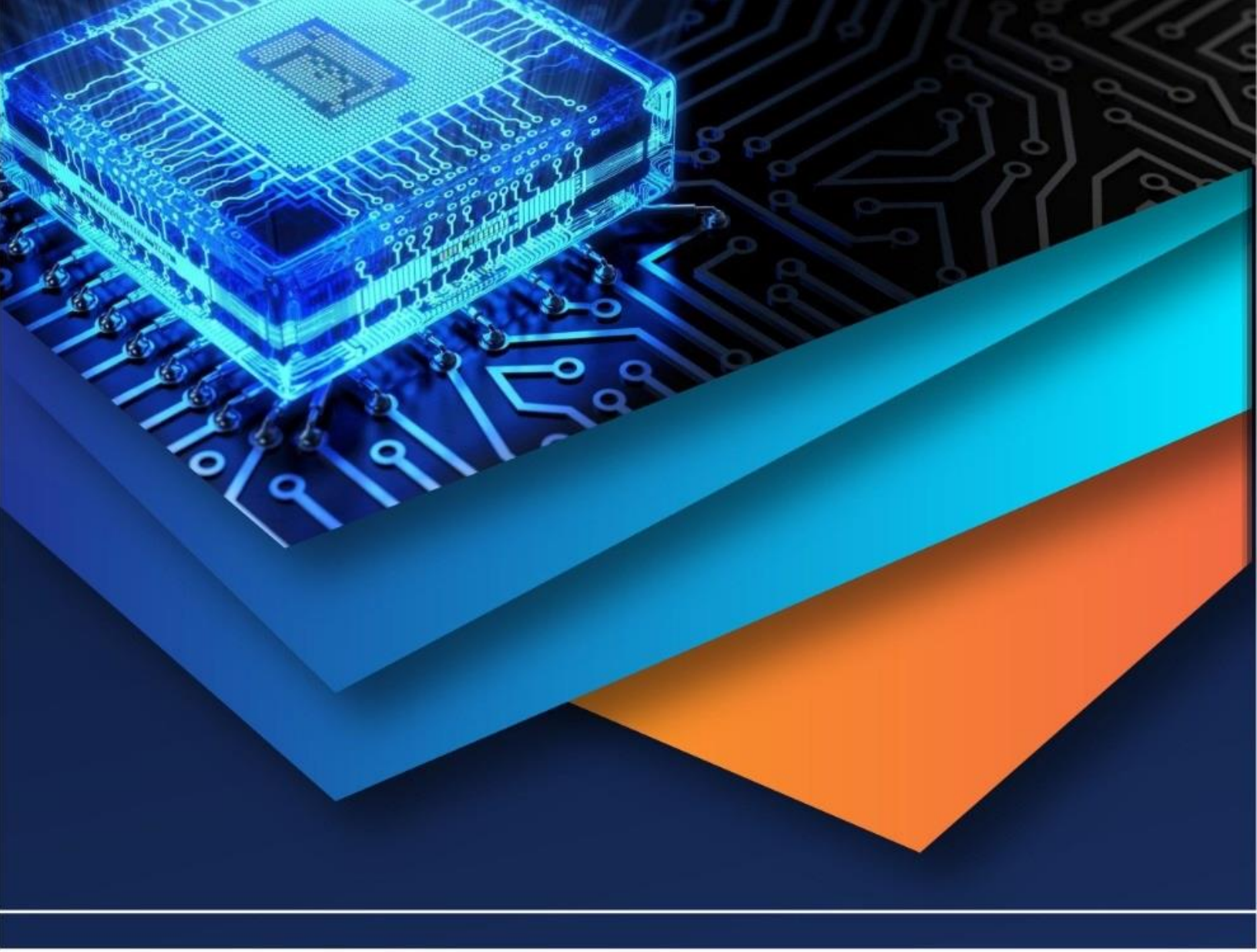
By making elections more cost-effective and efficient, we can improve the perception of the electoral process among voters. This approach not only removes barriers of power between voters and elected officials but also creates accountability for the officials. Furthermore, it opens doors to more direct forms of democracy, enabling voters to express their opinions on specific bills and proposals.

This research paper proposes a blockchain-based electronic voting application that utilizes smart contracts to ensure secure and cost-effective elections while maintaining the privacy of voters. By leveraging the capabilities of blockchain technology, the application overcomes the limitations and challenges associated with traditional electronic voting systems. It enhances election security and integrity while establishing a foundation for transparency in the electoral process.

In conclusion, this study highlights the potential of blockchain technology to address the shortcomings of existing electronic voting systems. By implementing a blockchain-based approach, we can improve the credibility, security, and transparency of elections, thereby reinforcing the foundations of democracy.

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