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Smart and Decentralized Blockchain Based E-Voting System

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***Abstract* - In modern era of digitalization, the need for secure and transparent electoral processes has become paramount. Traditional voting systems face challenges related to transparency for user, ensure security and accessibility. Blockchain technologies deals with such problem, it is a promising solution to these problems. This abstract presents an idea of a Blockchain based E-Voting System, which transforms the electoral process by utilizing the decentralized and unchangeable features of blockchain technology. The proposed system employs a distributed ledger on a blockchain network to store and verify voting transactions. Voters are provided with a secure digital identity and access to the voting platform, which utilizes cryptographic techniques to ensure the privacy and authenticity of their votes. The blockchain ledger records each vote as a tamper-proof transaction, making it nearly impossible for unauthorized parties to alter or manipulate the results. The transparency and auditability of the blockchain ensure that election results are verifiable and trustable. It provides real-time access to the results for all stakeholders. This system can facilitate remote voting, thereby increasing accessibility and participation, especially for geographically distant or disabled voters. The adoption of such a system has the potential to reshape the methods in which elections are conducted, fostering trust and confidence in the democratic process.**

Keywords: Blockchain, Voting System, Solidity, Decentralised, Security, Transparency.

I. INTRODUCTION

In the modern era of digitalization, ensuring secure, transparent, and accessible electoral processes has become a critical challenge. Traditional voting systems often face issues related to voter fraud, manipulation, and lack of transparency, which undermine public trust in democratic institutions. As societies become increasingly digital, there is a pressing need to modernize electoral systems to address these concerns effectively.

Blockchain technology, with its decentralized, immutable, and transparent characteristics, presents a promising solution to these challenges. A blockchain based e-voting system can fundamentally transform the way elections are conducted by providing a secure and transparent platform for casting and counting votes.

This technology utilizes a distributed ledger to record each vote as an unalterable transaction, ensuring that the electoral process is both tamper-proof and verifiable. In a blockchain-based e-voting system, voters are provided with a secure digital identity, enabling them to access the voting platform and cast their votes with confidence in their privacy and the integrity of their vote.

The use of cryptographic techniques ensures that each vote remains confidential and authentic, preventing unauthorized access and manipulation. Moreover, the real-time transparency of the blockchain ledger allows for immediate verification and auditing of election results by all stakeholders, enhancing the overall integrity and trust in the electoral process. This paper explores the design and implementation of a blockchain-based e-voting system, highlighting its potential to address the shortcomings of traditional voting methods. It discusses the benefits of enhanced security, transparency, and accessibility, as well as the challenges associated with identity verification, scalability, and user-friendliness. By leveraging blockchain technology, this innovative approach aims to foster greater trust and confidence in democratic processes, ensuring that elections are conducted fairly and securely in the digital age.

II. LITERATURE REVIEW

The project's primary objective is to tackle the limitations of paper-based elections by developing a blockchain based voting system. Understanding the significance of a voting system, for a thriving democracy the digital approach aims to create an electoral process more budget friendly, faster and easily accessible. By utilizing contracts this system ensures cost effective elections while prioritizing voter privacy [1].

Future plans involve designing interfaces for roles such as the election commission and candidates strengthening

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authentication methods and incorporating notification prompts to maximize voter participation on Election Day [3].

This innovative solution not modernizes the process but also fosters transparency and trust, in democratic practices. The widespread lack of trust, in both digital voting systems has emphasized the requirement for a secure and transparent solution to protect democratic rights [6].

Essentially this framework offers an approach to achieve a secure democratic voting system that meets the expectations of voters while enhancing electoral integrity [7].

Table 1: Literature Review

Sr. No.	Title	Year	Methodology	Conclusion
1	Blockchain based Evoting System	2020	Using command line terminal and Ethers.js to access EVM	Blockchain-based e- voting ensures secure, transparent, private elections with decentralized integrity.
2	A Research Paper on EVoting Using Blockchain Technology	2022	Creating a database for voting and counting then displaying the results through smart devices.	Explored diverse research on blockchain- based e-voting systems, highlighting multiple approaches and technologies like Ethereum and Truffle.
3	DigiVote: Voting System Using Blockchain	2021	Initialize the process, checking requirements designing accordingly, verifying the votes and deploy the results.	E-voting evolves with blockchain for efficiency, transparency, addressing double-spending concerns.
4	Secure Digital Voting System based on Blockchain Technology	2020	Creating UIs for both admin and user, giving the admin access to check votes	Blockchain e-voting streamlines elections, enhancing democracy, security, and efficiency.
5	Blockchain-Based EVoting System	2022	Creating an election, activating it, closing the election and then observe result before deploying it.	A blockchain-based e-voting system can be used to conduct elections in a secure, transparent, and efficient manner.
6	Online Voting System Based on IoT and Ethereum Blockchain	2022	Implement robust security measures to protect user data from theft and eavesdropping, while using.	Integration of IoT and Blockchain technologies in the development of an Online Voting system.
7	Integrity assured digital voting system by using blockchain technology	2020	Develop a distributed infrastructure that ensures transparency, fairness, and flexibility in the voting process.	The adoption of blockchain technology offers promising solution by introducing decentralization and enhanced database security.

III. METHODOLOGY

A New Era of Secure and Transparent Voting: Unleashing the Power of Blockchain Technology In the heart of democratic societies lies the unwavering belief in the power of an individual's vote.

However, the integrity of traditional electronic voting systems has been repeatedly challenged, raising concerns about security vulnerabilities and potential manipulation.

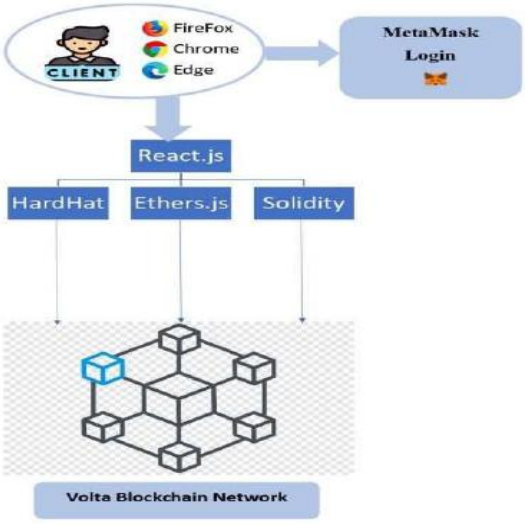

Figure 1: Methodology

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To address these concerns and safeguard the sanctity of the democratic process, a groundbreaking innovation has emerged – the Smart & Decentralized Blockchain Based EVoting System (SDBBES). The SDBBES harnesses the transformative power of blockchain technology to create an impenetrable fortress around the voting process. By utilizing a distributed ledger, this system ensures that every vote cast remains immutable and verifiable, eliminating the possibility of vote tampering or fraud. This inherent immutability is the cornerstone of the SDBBES's security, providing an unwavering guarantee that the will of the people remains untainted.

Furthermore, the SDBBES employs smart contracts, self-executing contracts embedded within the blockchain, to automate the voting process and guarantee accurate vote counting. Voters register with the system using their identity information and receive a unique voter ID and a private key. On election day, they authenticate themselves using these credentials, ensuring that only authorized individuals can participate in the electoral process. Once authenticated, voters cast their votes using their private keys, safeguarding their anonymity and ensuring the verifiability of their votes.

After the voting period concludes, smart contracts automatically tally the votes, producing a transparent and tamper-proof record of the election results. This transparency fosters trust and confidence among voters, election officials, and the public at large. The SDBBES represents a paradigm shift in the realm of electronic voting systems. By leveraging the transformative power of blockchain technology and smart contracts, this system offers a secure, transparent, and tamper-proof platform for conducting elections.

The SDBBES has the potential to revolutionize the voting process, enhancing public trust and confidence in elections worldwide. As we stand at the precipice of a new era in electronic voting, the SDBBES stands poised to usher in a period of unprecedented security, transparency, and trust. Figure 1 gives information about how blockchain based voting system works. To participate in a voting poll using a MetaMask account, the user must first connect their MetaMask account to the voting platform. Once connected, the user can then select the candidates they wish to vote for and submit their vote. The vote will then be registered on the blockchain network, ensuring that it is tamper-proof and transparent. MetaMask account to register his vote on secured blockchain network.

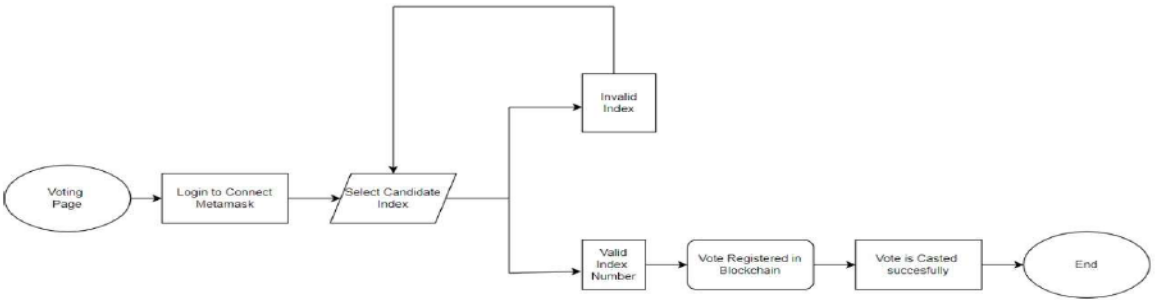

Figure 2: Flowchart of Blockchain Based E-Voting System

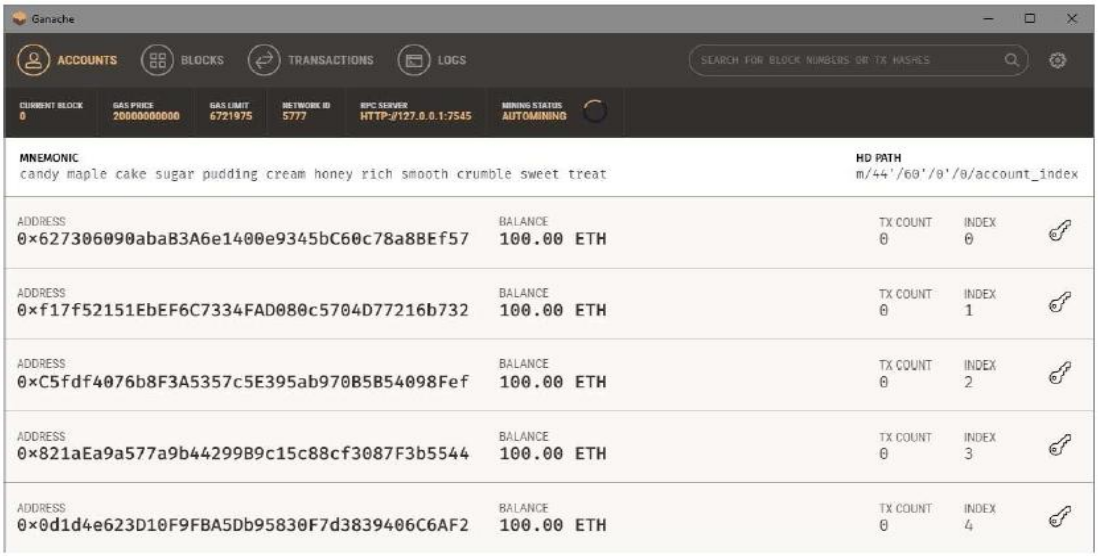

Figure 3: Ganache Test Accounts for a Local Server

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Ganache is a popular tool used in blockchain development to simulate a local Ethereum blockchain for testing purposes. It provides a personal blockchain that developers can use to deploy contracts, develop applications, and run tests without the need for a real Ethereum network.

Ganache Overview:

Ganache offers both a graphical user interface (GUI) and a command-line interface (CLI), making it flexible for various development workflows. It creates a local blockchain instance with a set of pre-configured accounts, which developers can use to interact with their smart contracts and decentralized applications (dApps).

Test Accounts: When you start Ganache on your local host, it automatically generates a set of test accounts. Here are the key features of these test accounts:

Pre-Funded Accounts: Ganache provides a default set of 10 accounts, each pre-funded with a significant amount of ethers (ETH).

Private Keys: Each test account comes with a corresponding private key, allowing developers to sign transactions and interact with the blockchain. These keys are displayed in Ganache's GUI or CLI, making it easy to copy and use them in development environments.

Fixed Addresses: The test accounts have fixed Ethereum addresses, which remain consistent across Ganache sessions unless the instance is reset. This stability helps in running repeatable tests and developing contracts that interact with known addresses.

Account Management: Ganache's GUI provides an easy way to view and manage these accounts. Developers can see the account balance, transaction history, and other details. The CLI version offers similar functionalities through command line commands.

Custom Accounts: While Ganache starts with a default set of accounts, it also allows customization. Developers can configure the number of accounts, their initial balance, and other parameters through Ganache's settings.

Interaction with Truffle: A development framework for Ethereum that integrates seamlessly with Ganache. It provides tools for compiling, deploying, and testing smart contracts.

Ganache test accounts on a local host provide a powerful and convenient way for blockchain developers to simulate and test their applications in a controlled environment. With pre-funded accounts, fixed addresses, and easy integration with development tools, Ganache streamlines the development and testing process, making it an essential tool in the Ethereum development ecosystem.

IV. RESULTS & DISCUSSIONS

4.1 Web Page Development

We created a web page using React.js for our Voting Dapp application because it is useful for single page applications. React.js allows us to build a dynamic and responsive user interface, ensuring a seamless user experience. By leveraging React's component-based architecture, we can efficiently manage the state of our application, making the voting process intuitive and engaging for users.

Our Voting Dapp leverages the power of blockchain technology to provide a secure, transparent, and tamper-proof voting system. Integrating this with a React front-end ensures that users can interact with the blockchain in a straightforward manner. The single-page application (SPA) nature of React means that users can navigate through the voting process without needing to reload the page, enhancing performance and user experience.

Figure 4: VS Code commands for starting React App

4.2 MetaMask Network Configuration

Now for proper functioning of our Voting DApp we need to set up a MetaMask custom network for our Voting DApp, to do that you first need to install MetaMask, a browser extension that serves as a cryptocurrency wallet and gateway to blockchain applications. Once installed, create a new wallet or import an existing one if you already have it. Next, access the MetaMask settings by clicking on the account icon in the top right corner and selecting "Settings" from the dropdown menu. Navigate to the "Networks" section, where you can see the list of default networks. To add a new custom network, click on the "Add Network" button.

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You will need to fill in the details of your specific blockchain network. This includes the network name, the RPC URL provided by your blockchain network, the chain ID unique to your network, and the currency symbol, such as ETH for Ethereum or another symbol for different networks. By entering these details correctly, MetaMask will connect to the custom network, enabling users to interact with the blockchain where your Voting Dapp is deployed. This setup ensures that transactions and interactions within the Dapp are directed to the correct network, providing a seamless user experience.

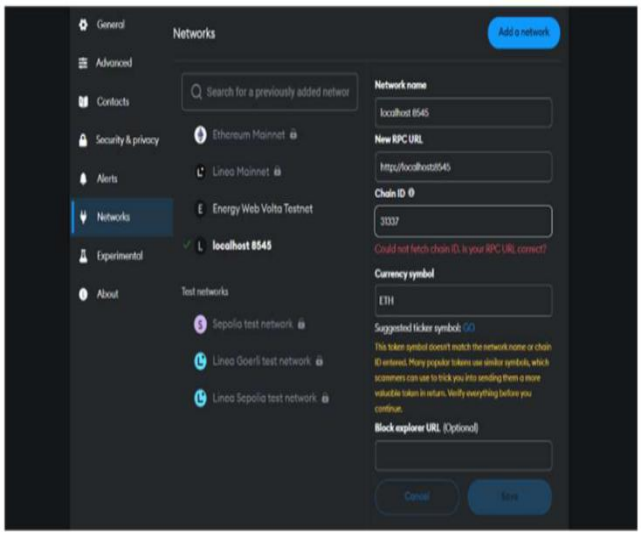

Figure 5: Setting up network on MetaMask

4.3 Web Page UI Design

The blockchain voting DApp (Decentralized Application) comprises several crucial components designed to ensure a secure, transparent, and efficient voting process. The "Home" page serves as the landing interface, providing users with easy access to various functionalities. "Candidate Registration" allows potential candidates to register their details and be listed on the platform. The "No Candidate" and "No Voter" indicators display the current number of registered candidates and voters, respectively, ensuring users are informed about participation levels in real-time.

The "Voter Registration" component enables eligible voters to register securely on the blockchain, ensuring their identity and eligibility are verified. The "Voter List" feature provides a comprehensive list of registered voters, which can be accessed for transparency and verification purposes. Additionally, the DApp can generate reports, offering insights into voter turnout, candidate participation, and overall election metrics. By leveraging blockchain technology, the voting DApp ensures immutability, security, and transparency, significantly enhancing the integrity and trustworthiness of the electoral process.

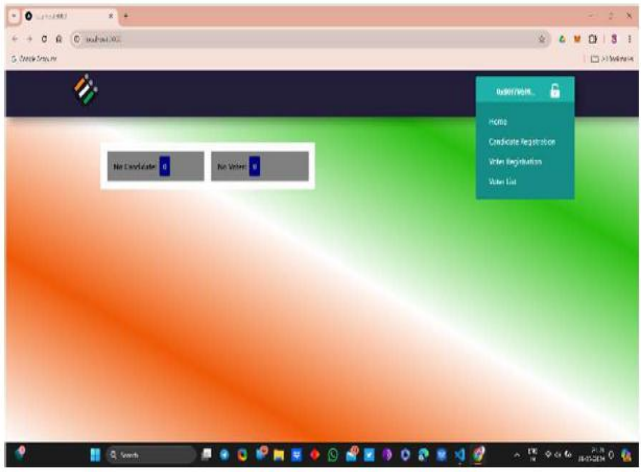

Figure 6: UI Home Page of Voting DApp

4.4 User Navigation and Voter Registration

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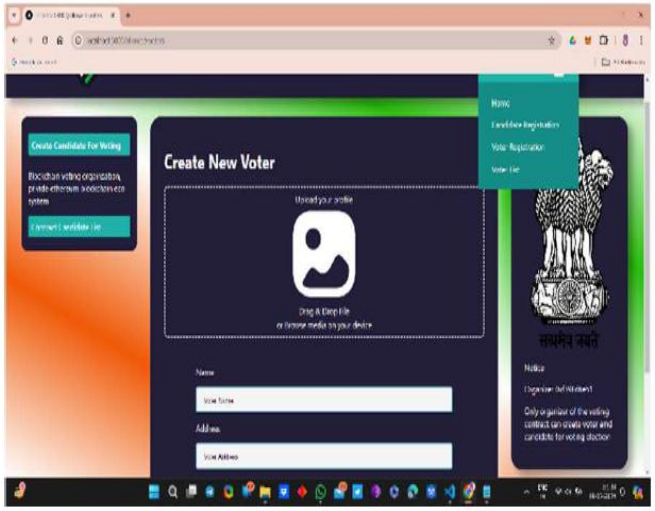

Figure 7: Uploading Candidates for Voting

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Figure 8: Authorizing Transaction to Register Vote

A user interacts with our Voting Dapp to cast a vote. The process begins with the user selecting their candidate of choice within the Dapp's user interface. Upon selection, the Dapp generates a transaction request, encapsulating the voting data, which is then forwarded to MetaMask for user confirmation.

When the transaction request appears in MetaMask, the user is prompted to review the transaction details, including the destination address, the gas fee, and the data payload representing their vote. The user then authorizes the transaction by clicking the "Confirm" button within MetaMask. This action digitally signs the transaction using the user's private key and submits it to the blockchain network.

V. CONCLUSION & FUTURE SCOPE

A Blockchain-Based E-Voting System has the potential to revolutionize elections by addressing key issues in traditional voting methods. Its primary advantage lies in enhanced security, as blockchain's decentralized and immutable nature ensures each vote is recorded as a tamper-proof transaction, making manipulation nearly impossible. Cryptographic techniques further secure voter privacy and ballot integrity. The system ensures transparency and auditability, which are crucial for maintaining trust in democratic processes. While challenges such as identity verification, scalability, and user adoption remain, the system promises to enhance security, transparency, accessibility, and efficiency, thereby strengthening the foundations of democracy in the digital age.

The future of voting systems based on blockchain technology is highly promising due to its potential for enhancing security, transparency, and efficiency. Blockchain's decentralized ledger ensures that votes are immutably recorded, reducing fraud and manipulation risks. It also provides real-time verification for all stakeholders, boosting trust in the electoral process while maintaining voter anonymity. By streamlining the voting process and eliminating manual counting and intermediaries, blockchain can deliver faster results and lower election costs. Moreover, it increases accessibility, allowing secure remote voting and potentially boosting voter participation. Overall, blockchain can transform electoral systems, strengthening democratic practices globally.

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