Decentralized E-Voting System

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***Abstract*—Using blockchain technology to record votes immutably on a decentralized network, decentralized voting on the Ethereum blockchain offers an online election system that is safe, transparent, and impenetrable. With smart contracts automating and safeguarding the voting process, this solution does away with middlemen, guards against fraud, and guarantees data integrity. Blockchain's decentralized structure makes it more resistant to manipulation and hacking, providing a dependable and affordable option for credible and equitable elections. All things considered, this method greatly enhances voting security, integrity, and transparency, which makes it perfect for free and fair elections.**

***Index Terms*—Decentralized voting, Ethereum, blockchain, smart contracts, transparency, security,online elections, tamper-proof, fair elections, authentication, duplicate votes prevention.**

I. Introduction

Blockchain technology is revolutionary because it makes transactions safe and transparent and does away with the need for middlemen. Data tampering is extremely difficult since it makes use of a decentralized network of computers to guarantee system integrity and security. Since Bitcoin initially gained widespread recognition, blockchain has been used in a variety of industries, such as voting, finance, supply chain management, and healthcare. Fundamentally, it works by building data blocks joined by a chain, with a unique code, or hash, generated from the block's contents for each block. Once put to the blockchain, data is immutable and provides transparent, secure storage. When all is said and done, blockchain's ability to increase accessibility, security, and transparency might drastically change how data is shared and stored.

A decentralized voting system ensures that votes are unchangeable and tamper-proof by assigning each voter a distinct digital identity and recording them on the blockchain. This increases election process efficiency and reduces its vulnerability to manipulation or corruption by doing away with the requirement for middlemen, like government organizations, to supervise it.Furthermore, because decentralized voting systems enable voters to cast their ballots from any location with an internet connection, they can boost voter turnout. Increased voter participation and turnout may result from this, making the electoral process more inclusive and democratic. The electoral process can thus benefit greatly from decentralized voting via the Ethereum blockchain, which can make it more transparent, safe, and open to all.

II. Related Work

Implementing a successful worldwide internet voting system requires sophisticated security measures. Due to their frequent reliance on centralized management by a single entity, which can result in problems like database manipulation and lack of transparency, traditional election systems offer serious risks to security and transparency. In the study "Online Voting System Using Blockchain," a number of older voting systems that are still in use by various countries and organizations are investigated. This emphasizes the need for more secure, transparent alternatives to existing methods as well as their inherent flaws.

As a distributed, decentralized public ledger operating within a peer-to-peer network, blockchain technology has attracted a lot of interest. Blockchain has potential for a variety of applications, such as supply chain management, voting, and the Internet of Things, by establishing a tamper-proof digital platform for data sharing and storage through a linked block structure and trusted consensus process. The study "A Survey of Blockchain Based on E-voting Systems" examines current developments in blockchain-based electronic voting while addressing security and privacy issues. A comparison of current blockchain-based electronic voting systems' security and privacy requirements comes at the end of this survey.

India, the largest democracy in the world, with more than 668 million voters and over one billion citizens. As such, it confronts many obstacles in its efforts to provide safe and transparent voting. Significant security holes exist in the current electronic voting systems, which also have trouble authenticating users and guarding against fraud using voting

machines. The suggested approach, described in the paper "A Smart Electronic Voting System Using Blockchain Technology," proposes to create a high-security voting system that is coupled with blockchain technology to improve user security and transparency. By addressing the serious security flaws in the current voting process, this strategy aims to lower election expenses and increase voter turnout.

III. Problem with Existing System

Voting on paper ballots in the current voting systems usually requires going in person to specified polling locations, where the ballots are manually counted. In many nations, voting can also be done electronically using devices or the internet. However, due to security concerns, these systems have come under fire. The drawbacks of traditional voting systems include their high operating costs, centralization that raises the possibility of power abuse, lack of transparency in the vote-counting process, susceptibility to fraud in both paper and electronic systems, labor-intensive paper ballot counting, delayed result announcements, and limited accessibility for voters with disabilities or mobility issues, which may result in some voters losing their right to vote.

IV. Proposed Methodology

To improve election security and transparency, a decentralized voting mechanism is being implemented on the Ethereum blockchain by a user. The system consists of an Administrator module for managing the voting procedure and a Voter module enabling qualified users to safely cast ballots. The system uses blockchain technology to guarantee the voting process's immutability and integrity, offering a transparent platform for democratic elections.

A. System Architecture

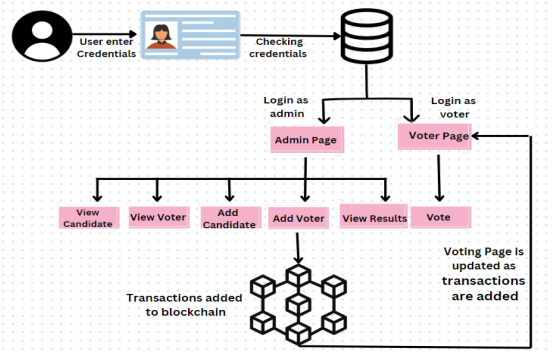

Fig. 1. System Architecture

The decentralized voting platform's system design incorporates smart contracts that are implemented on the Ethereum blockchain, user authentication methods, and customized user interfaces for both administrators and voters. Admin users are granted access to an administration dashboard that includes features such as managing candidates and voters, tracking votes, and visualizing results, after their authentication is successful. Administered activities are safely documented on the blockchain through interactions with smart contracts, guaranteeing data integrity and openness during the election process. However, voters are given a straightforward interface via which they can safely cast their ballots. Through communication with smart contracts, this interaction reduces the possibility of fraud and manipulation by permanently recording votes on the blockchain. Only approved actions are carried out by corresponding user roles thanks to role-based access control systems.

B. System Modules

The system consists of two primary modules: the Voter module and the Admin module.

1) Voter Module: Qualified voters can cast ballots, check their choices on the blockchain, view candidate information, and safely validate their identities with the voter module. Every vote is tracked and updated in real time, guaranteeing all candidates a secure, equitable, and open voting process.

For security purposes, users must check in to the Voter module using their unique voter ID. They can vote for candidates after logging in. By verifying each voter's identification, the system makes sure they can only cast one vote. Before choosing a candidate, voters can view the list of contenders and the parties associated with them. Voters receive a confirmation notice after casting their ballot to make sure it was recorded correctly. The method ensures the voters' choices remain anonymous while maintaining the

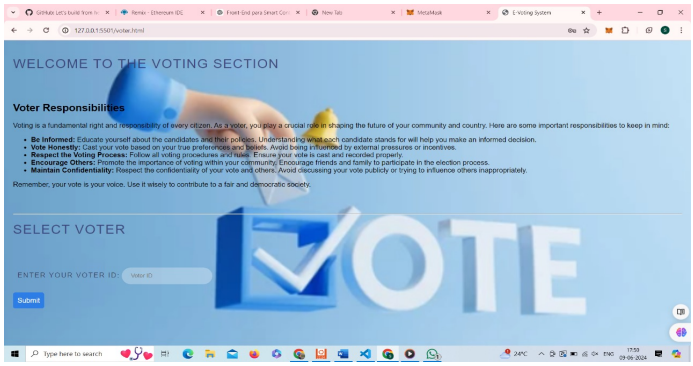

Fig. 2. Login as voter

2) Admin Module: The Administrator module serves as the main hub for controlling all voting-related activities. This module is used by administrators to set up and oversee the election, such as election officials or appointed individuals. In order to keep the voter database current, they can add new voters to the system by inputting their names and email addresses. In order for the election to go smoothly, administrators must also register candidates by obtaining their names and party affiliations.

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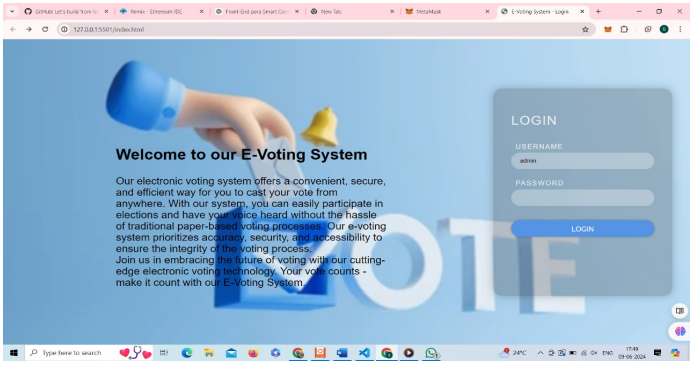

Fig. 3. Login as admin

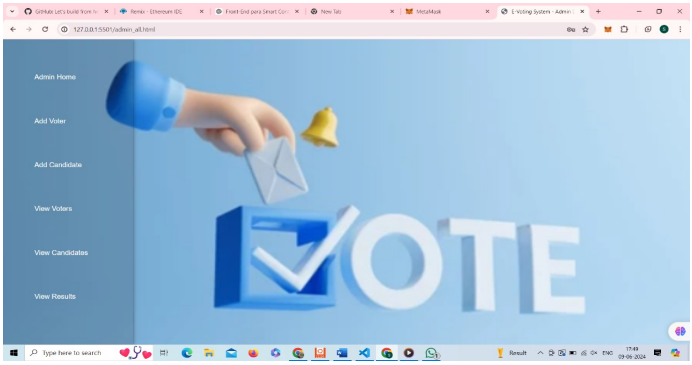

Fig. 4. Admin Page

V. Implementation

To guarantee security, transparency, accessibility, efficiency, and trust, a number of crucial processes are involved in the proposed decentralized voting system that makes use of the Ethereum blockchain. First, voting procedures, including voter registration and vote tallying, would be managed by smart contracts. The election procedures would be automated by these smart contracts, guaranteeing that votes are cast safely and counted correctly without the need for human intervention. In order to ensure voter privacy and voting data integrity, each voter would be given a unique identification that would allow them to cast an anonymous ballot. Because of the immutability of the blockchain, votes cannot be changed once they are recorded, which guards against tampering. Furthermore, since the blockchain is decentralized, there isn't a single point of failure, which improves system security. By providing voters with a secure internet connection, the system became more accessible and might even increase voter turnout from any location. Because of the blockchain's openness, all participants can keep an eye on the election process in real time, including vote counting and results, which increases confidence in the results of the vote. The technology also offers major increases in efficiency, decreasing the time and expenses generally associated with traditional voting techniques by automating the voting process and eliminating the need for physical infrastructure and intermediaries. The overall goal of implementing this blockchain-based voting system is to transform elections by increasing its security, transparency, accessibility, efficiency, and reliability.

1) Truffle: Decentralized application (dApp) development is made easier using Truffle, an Ethereum development environment and testing framework. Testing and deployment functionalities are among the tools it provides for developing smart contracts. Truffle is well-suited to create the smart contracts required for a decentralized voting system, assuring their confidentiality and integrity on the blockchain because of its asset pipeline and network management features.

2) Solidity: For the purpose of creating and implementing smart contracts on the Ethereum blockchain, Solidity is a high-level programming language. Developers can design self-executing contracts with established rules and circumstances using Solidity, which is statically typed. The Ethereum Virtual Machine (EVM) is responsible for carrying out these smart contracts, making sure that everything goes according to plan and no middlemen are required. Complex, modular, and reusable code development is made easier by Solidity's support for features like inheritance, libraries, and event logging. By guaranteeing that votes are permanently recorded on the blockchain, Solidity enhances the integrity and reliability of the electoral process in the context of decentralized voting, allowing the development of safe and transparent voting systems.

3) MetaMask: A popular cryptocurrency wallet and entry point to blockchain apps made exclusively for the Ethereum network is MetaMask. It functions as a mobile app and browser extension that lets users securely store, send, and receive Ethereum and ERC-20 tokens in addition to managing their Ethereum private keys. Using MetaMask, users can directly connect with the Ethereum blockchain without requiring a full Ethereum node, making it easier to access decentralized apps (dApps).By enabling safe, anonymous voting transactions and verifying voters in the context of decentralized voting, MetaMask can improve the security and transparency of the election process by guaranteeing that votes are permanently recorded on the blockchain.

4) Geth: Developed in the Go programming language, Geth, often known as Go Ethereum, is one of the most popular Ethereum clients. Users can engage with the blockchain, carry out smart contracts, and mine ether using it as a full node on the Ethereum network. Geth is a platform that offers a command-line interface (CLI) for developers and network users to carry out a range of tasks, including account creation and management, smart contract deployment and interaction, and the operation of decentralized apps (dApps). By providing access to a local Ethereum network, it also facilitates the creation and testing of Ethereum-based apps. In order to ensure the safe execution of voting smart contracts and the

correct recording of votes on the blockchain, Geth can be used to set up and manage the Ethereum infrastructure. thereby contributing to the overall integrity and transparency of the voting process.

VI. Results

Users of the voting system project authenticate themselves by logging in with their username and password. To guarantee that only people with permission, like administrators and voters, may access their particular modules, the login procedure is essential. Administrators can handle the election process by logging in and accessing the admin control panel. In contrast, voters must log in in order to safely cast their ballots. The voting system's security and integrity are preserved in part by the username and password authentication process.

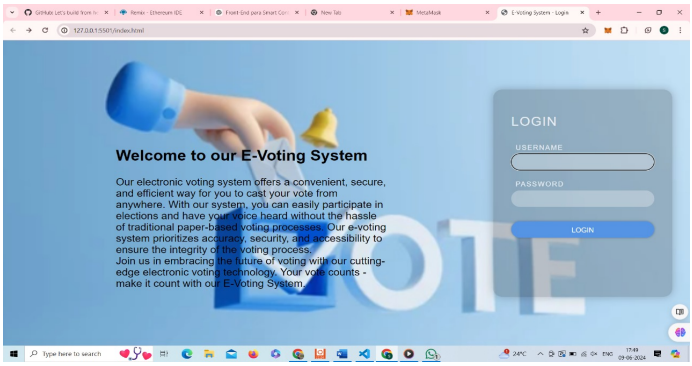

Fig. 5. Login Page

Administrators must log in to the admin control panel and go to the "Add Candidate" area in order to add a candidate to the voting system. Here, they include the name of the candidate and, if relevant, the name of their political party. The candidate gets added to the system and their details show up in the list of registered candidates as soon as the information is provided. Through this procedure, administrators can maintain an accurate and up-to-date list of candidates taking part in the election.

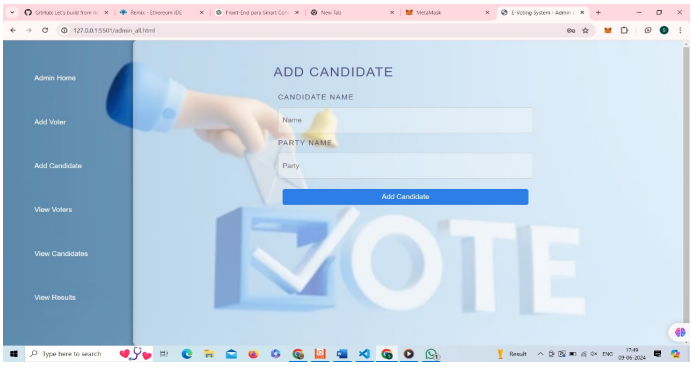

Fig. 6. Add Candidate

Administrators must log in to the admin control panel and navigate to the "Add Voter" area in order to add a voter to the voting system. The voter's email address and name are entered here. The voter is added to the system and their details appear on the list of registered voters as soon as the information is provided. By using this procedure, administrators can keep an eye on the voter database and make sure that everyone who is eligible to vote can.

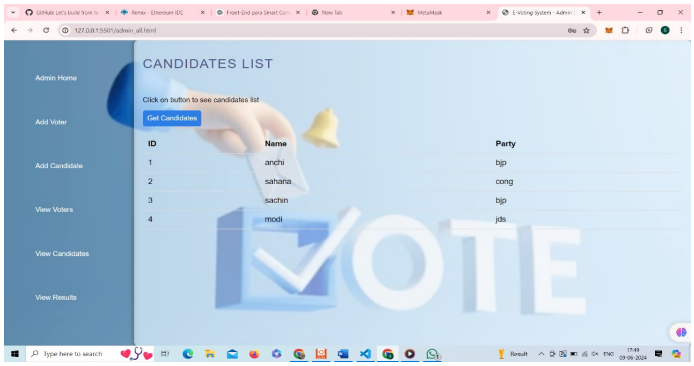

Fig. 7. View Candidate

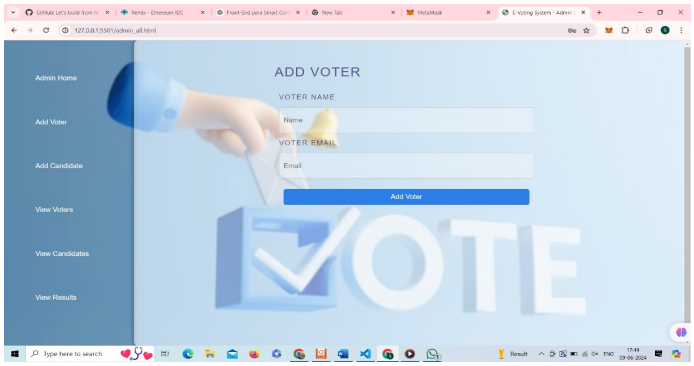

Fig. 8. Add Voter

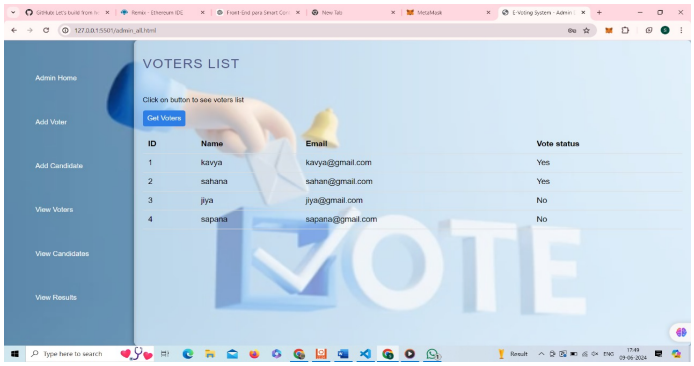

Fig. 9. Voters List

In order to cast a ballot for a candidate, voters who have registered must log in using their specific voter ID for security reasons. After logging in, people can choose the candidate of their choice from the list of candidates who have registered. Voters then submit their ballots, which the system records when they have made their choices. In addition to helping

to preserve the voting process's integrity and security, this procedure guarantees that each voter may only cast one vote.

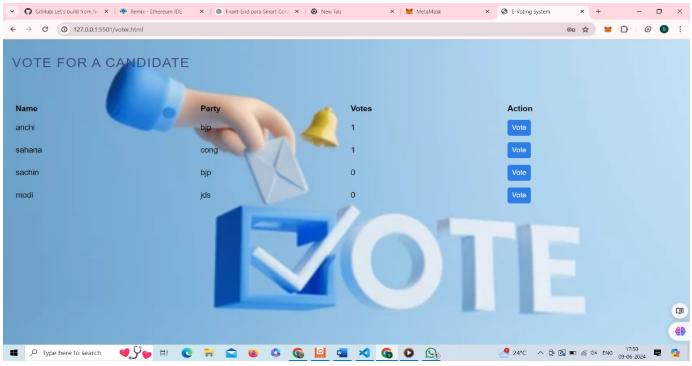

Fig. 10. Vote for candidate

The votes cast by voters who are registered to vote are used by the voting system to tabulate the results. Administrators can view the results by going to the "View Results" area of the admin control panel after the voting session has ended. The technology determines how many votes each contender earned and presents the results in an understandable and transparent way. This function gives administrators the ability to declare the victors and provide a summary of the results of the election.

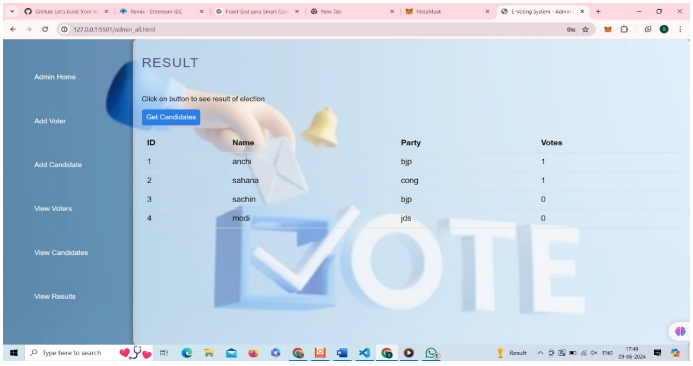

Fig. 11. Results of the vote

VII. Conclusion

Conclusively, the Ethereum blockchain-based decentralized voting system project offers a novel approach to democratizing and modernizing electoral procedures. The project boosts security, transparency, and accessibility by putting smart contracts to use to automate important voting procedures and guarantee their integrity. The system is made more dependable and efficient by the incorporation of tools like Truffle, Solidity, MetaMask, and Geth, which also provides a good substitute for conventional voting techniques. All in all, this project has the power to transform elections by encouraging increased confidence in democratic procedures and enabling more inclusive and equitable electoral outcomes.

Furthermore, the project's emphasis on efficiency, security, and transparency fits with the expanding need for cutting-edge and easily accessible voting technologies. Using blockchain technology not only lowers expenses and simplifies the administrative work involved in traditional voting procedures, but it also enhances the electoral process's integrity. The initiative establishes a standard for upcoming achievements in the areas of decentralized governance and democratic participation by utilizing these technology breakthroughs.

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