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# E-Smart Voting System Using Blockchain Technology

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**ABSTRACT:** Elections have a great importance in determining who will rule a nation, it can be said as it is an event that decides the fate of any nation. Traditional voting systems are affected by concerns such as security vulnerabilities and lack of transparency, which weakens public confidence. In response, our proposed system leverages blockchain's inherent features of decentralization, immutability, and transparency to ensure a secure and trustworthy voting environment. Through the use of smart contracts, each vote is recorded on the blockchain in a tamper-proof manner, safeguarding the integrity of the electoral process. Authentication mechanisms guarantee the anonymity and legitimacy of voters, fostering trust in the system. The transparency afforded by blockchain technology enables voters to independently verify election results, thereby enhancing the credibility and integrity of democratic outcomes.

**KEYWORDS:** Blockchain Technology, Voting System, Transparency, Security, Decentralization.

## I. INTRODUCTION

The significance of elections in democratic nations is crucial, as they determine the future leadership. E-voting systems present a mixed landscape of strengths, weaknesses, and vulnerabilities. One aspect is the unparalleled convenience and accessibility they offer, enabling voters to participate in elections from remote locations via internet-enabled devices. This flexibility fosters higher voter turnout and broader democratic engagement. However, existing voting systems face challenges like booth capturing, manipulation, rigging, and EVM hacking.

Blockchain technology emerges as a potent solution to mitigate the challenges plaguing existing voting systems. By leveraging the immutable and decentralized nature of blockchain, e-voting systems can ensure transparency, auditability, and tamper resistance throughout the voting process. The proposed voting system utilizes a permissioned blockchain network, where each participating node represents a trusted entity, such as a government agency or an electoral body.

Smart contracts are employed to encode the voting rules and automate the execution of the voting process, ensuring its integrity and fairness. Each vote is securely recorded as a transaction on the blockchain, providing an immutable and transparent audit trail. Overall, the integration of blockchain technology into e-voting systems offers a secure, transparent, and efficient solution to modernize electoral processes. By ensuring the integrity and trustworthiness of the voting process, blockchain-based e-voting systems have the potential to enhance democracy and foster greater participation among citizens.

## II. RELATED WORK

Electronic voting (e-voting) [1] systems have gained prominence in modern democratic processes, offering convenience, accessibility, and efficiency. However, these systems face various challenges, including security vulnerabilities, transparency concerns, and accessibility issues. In response to these challenges, researchers and practitioners have proposed new technologies and methodologies to enhance the integrity and reliability of e-voting

systems. This literature survey explores the latest advancements in e-voting technologies and methodologies, focusing on their potential to address existing limitations and improve the overall effectiveness of e-voting systems.

### 2.1 MetaMask Wallet

MetaMask [2] wallet stands out as a widely adopted tool for interacting with the Ethereum blockchain, offering users a secure and user-friendly interface for managing cryptocurrencies and decentralized applications. Leveraging MetaMask within the context of e-voting systems allows for seamless integration with blockchain-based voting platforms. By providing users with a familiar and intuitive interface for interacting with e-voting applications, MetaMask enhances accessibility and usability while ensuring the security and privacy of voting transactions.

### 2.2 Ganache

Ganache, part of the Truffle Suite, is a local Ethereum [3] blockchain emulator designed for testing and development purposes. By simulating a local blockchain environment, Ganache enables developers to deploy and interact with smart contracts and DApps [4] in a controlled and isolated environment. In the context of e-voting systems, Ganache serves as a valuable tool for testing and debugging smart contracts, verifying their functionality and security before deployment on the main net. Through its lightweight and user-friendly interface, Ganache streamlines the development and deployment process, facilitating the implementation of secure and reliable e-voting solutions.

### 2.3 Ethers

Ethers [5] is a JavaScript library for interacting with the Ethereum blockchain, providing developers with a robust set of tools and utilities for building decentralized applications. With its comprehensive API and support for both synchronous and asynchronous operations, Ethers simplifies the integration of Ethereum functionality into e-voting systems. Developers can utilize Ethers to interact with smart contracts, send transactions, and retrieve data from the blockchain, enabling seamless integration of blockchain technology into the backend infrastructure of e-voting applications.

### 2.4 Web3.js

Web3.js [6] is a JavaScript library that provides an interface for interacting with the Ethereum blockchain, enabling developers to build decentralized applications and integrate blockchain functionality into web applications. With its comprehensive API and extensive capabilities, Web3.js serves as a foundational tool for developing e-voting systems that leverage the Ethereum blockchain. One of the key features of Web3.js is its ability to facilitate communication between web applications and the Ethereum network. Developers can utilize Web3.js to connect their e-voting applications to the Ethereum blockchain, enabling functions such as sending transactions, deploying smart contracts, and querying blockchain data.

### 2.5 Smart Contracts

Smart contracts [7] are self-executing contracts with predefined rules and conditions encoded on the blockchain [8], facilitating trustless and transparent transactions without the need for intermediaries. In the context of e-voting systems, smart contracts play a crucial role in governing various aspects of the electoral process, including ballot casting, tallying, and result declaration. One of the key advantages of smart contracts in e-voting systems is their ability to enforce predefined rules and ensure the integrity of the voting process. By deploying smart contracts on the blockchain, e-voting systems can eliminate the risk of manipulation, fraud, and tampering associated with traditional voting systems.

### 2.6 Truffle

Truffle [9] simplifies Ethereum development with tools for contract compilation, migration, and testing. Developers can quickly initialize projects and deploy contracts across networks using migration scripts. Its integrated testing framework ensures contract reliability, while debugging aids in troubleshooting. Truffle seamlessly integrates

with tools like Ganache for local testing and Remix IDE for contract development. With a user-friendly interface and support for multiple network configurations, Truffle streamlines dApp deployment and contract interactions, making it a preferred choice for Ethereum developers.

### 2.7 Solidity

Solidity [10] is a high-level programming language for writing smart contracts on platforms like Ethereum. It supports inheritance, libraries, and user-defined types, compiling into bytecode for execution on the Ethereum Virtual Machine (EVM). Its syntax resembles JavaScript, making it accessible to developers familiar with object-oriented programming. However, due to the immutable nature of smart contracts, careful attention to security is essential. Solidity is widely used for building decentralized applications, including DeFi, NFTs, and DAOs.

## III. METHODOLOGY

The methodology for designing and implementing a blockchain-based e-voting system involves a systematic approach to ensure the integrity, security, and reliability of the electoral process. This section outlines the key steps involved in the methodology, including system design, development, testing, and deployment.

### 3.1 DESIGN

#### 3.1.1 Architecture

The image depicts the architecture of an online voting system that utilizes blockchain technology. It includes components such as Candidate Registration, Voter Registration, Admin Database, Smart Contract & Mining Node, Blockchain, Casted votes display, and Voting Interface. The system involves processes like voter and candidate verification, list generation, audit votes, and displaying results.

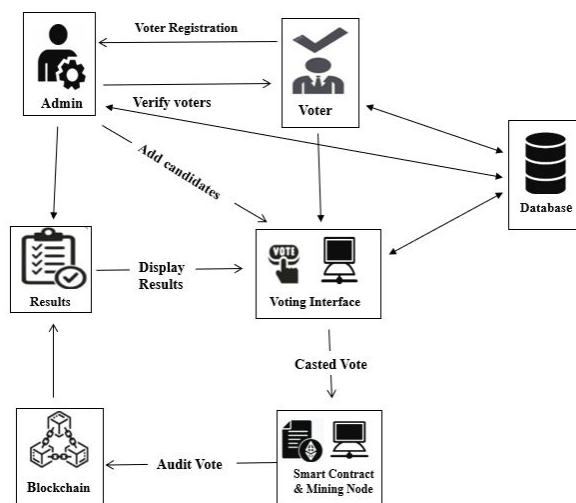


Fig 1: Architecture

The election process starts with the candidate registration. The candidates register themselves in the traditional way. After that the rest of electoral process will be done through our website. The election commission will play the admin role in our voting website and has a separate admin login. The voters have to sign up for the website. These login credentials will be saved securely in a MySQL database.

The election process is divided into 3 phases namely –



1. Registration Phase
2. Voting Phase
3. Results Phase

### Registration Phase

The admin will be the only entity who can add the registered candidates for the polling in the admin dashboard. The voters can register themselves with the help of voter registration tab in the voter/user dashboard. The admin has to approve the voter registration in admin dashboard. The admin has the only rights to change the phases of the elections.

### Voting Phase

After the admin changed the election phase from registration to voting, the candidates participating in the elections will be displayed in the vote area tab of the voter dashboard. The voters can cast their vote. After a certain period of time the admin will change the election phase from voting to results.

### Results Phase

The voters can see the results of the elections in the results tab of the voter dashboard.

## 3.2 DEVELOP

In the endeavor to construct an online voting system using blockchain technology, the development process mirrors the creation of a prototype tailored specifically for facilitating secure and transparent voting procedures. This prototype serves as a practical manifestation of the comprehensive research findings, implemented as a web-based application to engage stakeholders actively in the electoral process, ensuring transparency and integrity.

To ensure the smooth development and operation of the online voting system, several prerequisites are crucial. Node.js version v20.11.0 or higher acts as the foundational runtime environment, empowering developers to execute JavaScript code efficiently beyond web browsers. Truffle version v2.7.1 plays an indispensable role, offering a robust development framework for Ethereum that streamlines the creation, deployment, and testing of smart contracts. Solidity version v0.5.16 emerges as the preferred programming language for crafting smart contracts on the Ethereum platform, facilitating the establishment of rules and logic governing interactions within the blockchain network. Ganache serves as a pivotal component, acting as a personal blockchain emulator. It provides a simulated environment for local development and testing, allowing developers to deploy contracts and execute transactions without interacting with the live Ethereum network. These prerequisites lay the foundation for the seamless implementation and functionality of the online voting system, ensuring efficiency and reliability throughout the development process.

Smart contracts play a pivotal role in the online voting system, acting as autonomous, self-executing agreements that uphold transparency, efficiency, and trust among all stakeholders. These contracts, written in Solidity, automate and enforce various processes, ranging from voter registration to ballot casting and result tabulation. Deployed on decentralized networks such as Ethereum, smart contracts operate on the Ethereum Virtual Machine (EVM), ensuring immutability and integrity of the agreements they represent. By leveraging smart contracts, the online voting system eliminates intermediaries, enhancing transparency and streamlining processes.

The development process revolves around three core components: frontend interface, smart contracts, and their seamless integration. React.js is employed for the frontend aspect, prioritizing user interaction and visual presentation. Smart contracts, constituting the backbone of the system, govern its logic and operations, meticulously crafted to cater to administrative and user functionalities. Integration between frontend and smart contracts is facilitated through the Application Binary Interface (ABI), ensuring seamless interaction between the user interface and the underlying blockchain infrastructure. Node.js plays a crucial role in this integration process, providing a robust environment for executing JavaScript code.

MySQL v8.0.36 databases store voters' details and login credentials, while votes and candidates' details are stored in the blockchain. Thorough testing is conducted post-integration to validate the functionality and integrity of the online voting system, ensuring adherence to desired standards and requirements before deployment. By embodying principles of transparency, security, and trust, the system paves the way for a more democratic and inclusive electoral process, fostering civic engagement and participation.

### 3.3 TESTING

We conducted comprehensive testing of the e-voting system to verify functionality, security, and performance. And performed unit tests, integration tests, and end-to-end tests to identify and address any bugs or vulnerabilities. Tried our best to ensure compliance with industry standards and best practices for software development and blockchain implementation.

Validations included while testing –

- Legitimate/ registered users can only get access to this voting website.
- A voter can only register once in the website.
- Voters can only register in the registration phase.
- Admin only has the rights to add a candidate, change the election phases, approve the voter registration.
- A voter can only cast their vote once with an account in the voting phase.
- The results will be displayed only after the end of voting phase.

### 3.4 DEPLOY

We integrated the Web3.js library and MetaMask wallet to enable interaction with the Ethereum blockchain (Ganache test net). We imported the accounts from Ganache to the MetaMask wallet to implement the functionalities for account management, transaction signing, and smart contract interaction to facilitate secure and seamless voting experiences for users.

Deployed the blockchain-based e-voting system on a Ganache network for initial testing and validation. If all the stake holders and government validate, we can deploy the e-voting system on the main net or public blockchain network for live elections. A transaction will be generated whenever the admin adds a candidate, approves the voter registration, change the election phases, voter casting their votes. These transactions will be completed only if the respective user confirms the transaction.

## IV. EXPERIMENTAL RESULTS

We have explored using blockchain in online voting systems to make them more secure and trustworthy. Blockchain's unique features like decentralization and transparency could help address issues with current systems. Our findings suggest that integrating blockchain has the potential to improve online voting, making it safer and more reliable. A blockchain is a disseminated, unchanging, undeniable, open record. This modern innovation works through three fundamental features The record exists in numerous distinctive areas, No single point of disappointment in the support of the dispersed record.

- There is dispersed control over who can add unused exchanges to the record.
- Any proposed “new block” to the record must reference the past form of the record, making an unchanging chain from where the blockchain gets its title, and in this way avoiding altering with the keenness of past sections.

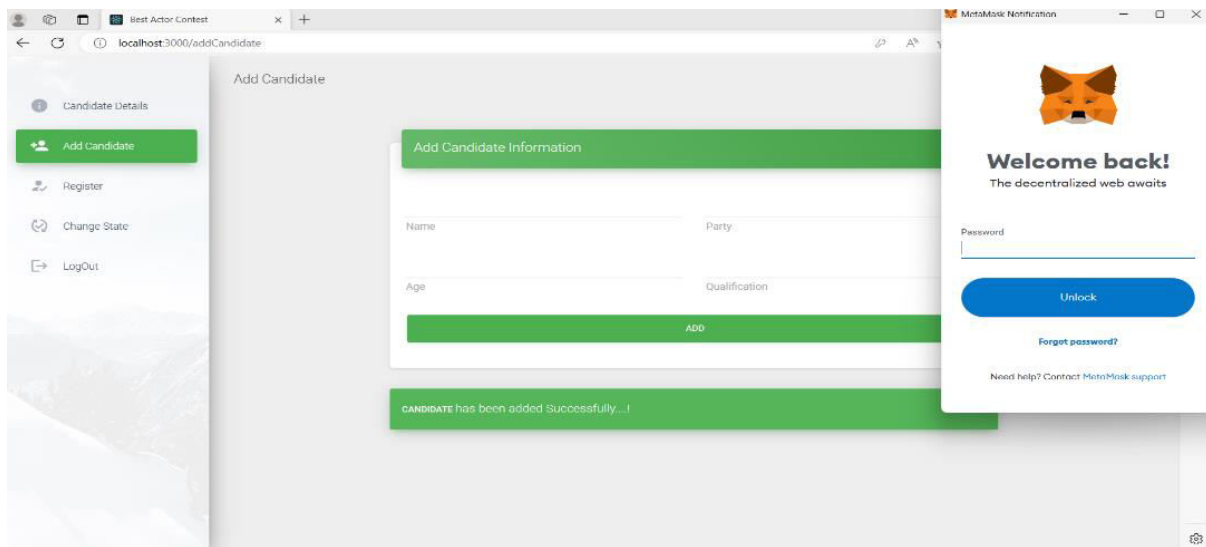


Fig 2: Add Candidate Page

The admin has the all rights to add a candidate in the elections. Firstly, the admin needs to enter the candidate details on the form displayed in the website's add candidate tab in the admin dashboard. When admin completed entering these details, a metamask popup will be displayed asking the admin's confirmation for the transaction. The candidate will be added successfully if the admin confirmed the transaction.

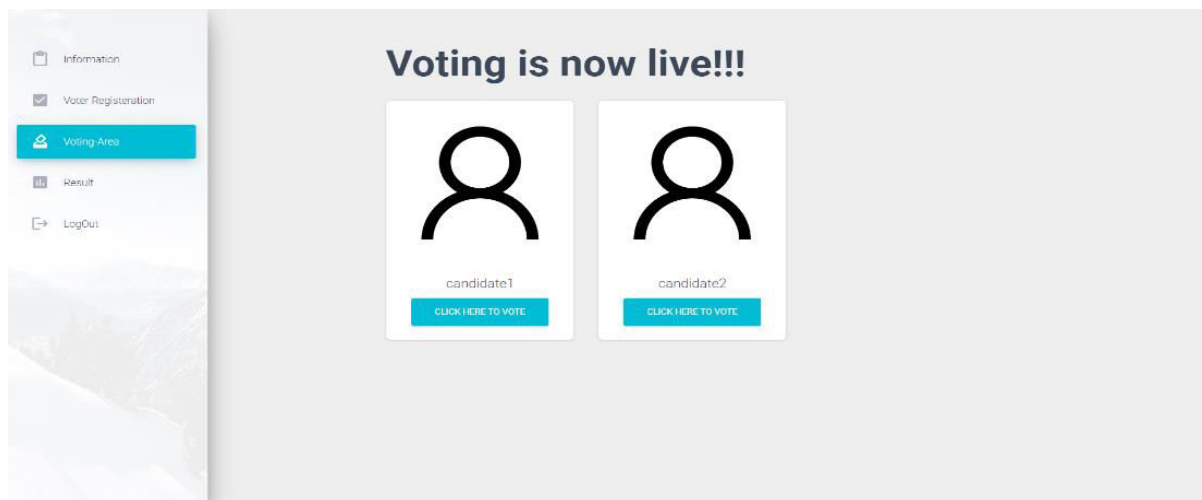


Fig 3: Voting Area Page

The voter can see all the candidates participating in the elections in the voting area in voter dashboard. When the voter selects a candidate there will be 2 buttons where the first one i.e., vote button allows the voter to vote that candidate and the second button closes the candidate card leaving the voter selecting a candidate again. When the voter clicks vote button, a metamask popup will be displayed asking the voter to confirm their transaction. Their vote will be casted successfully if the voter confirms that transaction.

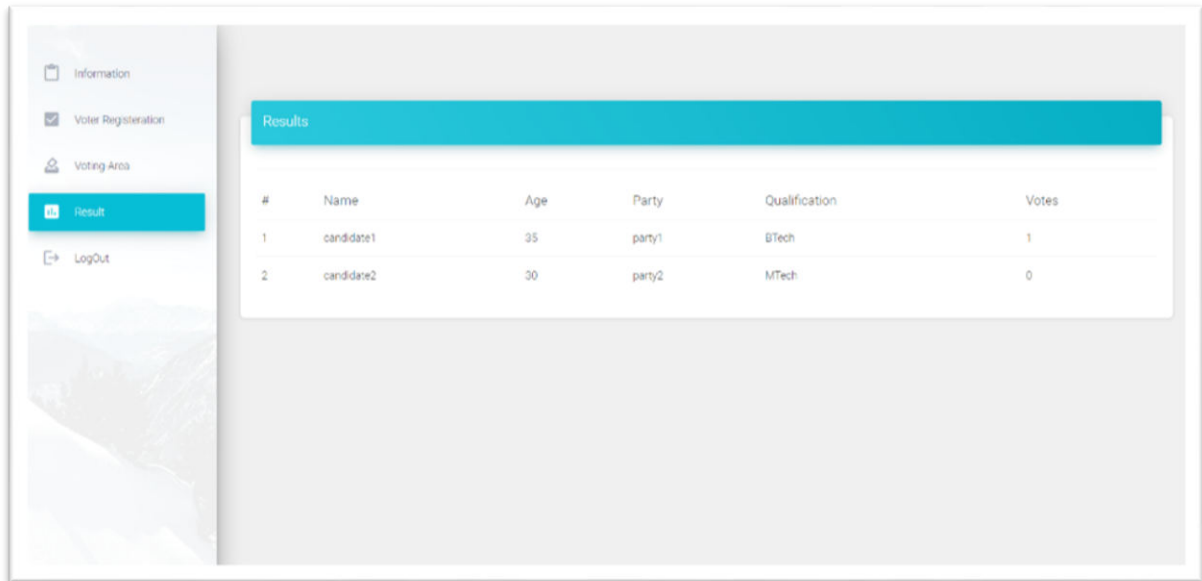


Fig 4: Result Page

The voters can see the results of the elections in this page. In this page, the results are rendered dynamically based on the phase of election decided by the admin.

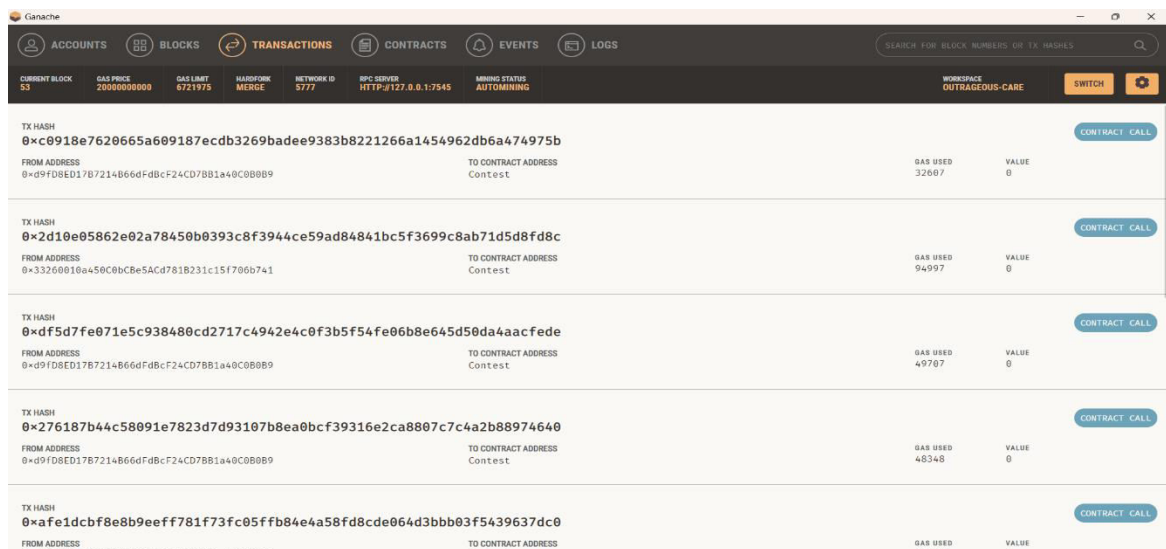


Fig 5: Transactions in Ganache

The changes made on the admin and voter sides, such as adding candidates and casting votes, are recorded in the local blockchain (Ganache). This is the primary purpose of integrating blockchain into e-voting, so that everyone can observe what is happening in the voting process. This enhances the system's trustworthiness by ensuring security and transparency.

### V. CONCLUSION

In conclusion, a comprehensive investigation of the prerequisites and goals of an e-voting framework is fundamental for its compelling plan and usage. By considering variables such as client availability, security





conventions, and administrative compliance, partners can guarantee that the framework meets the needs of voters, keeps up the astuteness of the appointive prepare, and complies with lawful measures. Characterized improvement, testing and conveying steps give a clear guide for engineers, directing the creation of a comprehensive, secure, and straightforward e-voting framework. Eventually, prioritizing these steps lays the foundation for a strong and dependable appointive foundation, reinforcing certainty in law-based forms and guaranteeing the authenticity of decision results.

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