Secure Online Voting System UsingBlockchain Technology

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Abstract **- In any democratic country, Voting is a fundamental part of democratic systems; it gives individuals in a community the facility to voice their opinion. In recent years, voter turnout has diminished while concerns regarding integrity, security, and accessibility of current voting systems have escalated. They are plagued by issues of security vulnerabilities, voter fraud, and lack of transparency, undermining the integrity of elections and eroding public trust.E-voting was introduced to address those concerns; however, it is not cost-effective and still requires full supervision by a central authority. The blockchain is an emerging, decentralized, and distributed technology that promises to enhance different aspects of many industries. Expanding e-voting into blockchain technology could be the solution to alleviate present concerns in e-voting. In this paper, we propose a blockchain-based voting system, named BC Vote thatpreserves voter privacy and increases accessibility, while keeping the voting system transparent, secure, and cost- effective. It represents a paradigm shift in democratic governance, leveraging blockchain technology to revolutionize electoral process. BC Vote implements a voting framework that utilizes Ethereum's blockchain and smart contracts deployed on blockchain, govern rules of elections, ensuring fairness and transparency throughout voting cycle. Our implementation was deployed on Ethereum's test network to demonstrate usability and scalability.**

Keywords – Ethereum, smart contracts, blockchain, decentralized, paradigm.

I. INTRODUCTION

The fundamental pillar of any democratic society is the ability of its citizens to exercise their right to vote freely and securely. Over the years, traditional voting systems have faced numerous challenges such as concerns about transparency, security vulnerabilities, and the need for centralized authorities. However, recent advancements in blockchain technology have opened new possibilities for transforming the way we conduct elections. By leveraging the decentralized and immutable nature of blockchain, e- voting systems have emerged as a promising solution to address these challenges and enhance the integrity and transparency of the voting process.

Blockchain, is a distributed ledger that records and verifies the transactions across multiple computers or nodes. It operates on the principle of decentralization, where no single entity has complete control over the network, ensuring that decision-making power is distributed among participants.

Each transaction or vote recorded on the blockchain is time-stamped, cryptographically secured, and linked to the previous transaction, creating an unalterable chain ofinformation. The connection between each block is created by incorporating the previous block's hash into the current block. When someone tries to alter the data, the hash valueis altered, the link is broken, and the hash value is altered. The attacker must modify and recalculate the hashes of succeeding blocks in order for the attack to succeed. Consequently, security, immutability, and transparency are provided by blockchains.

The integration of blockchain technology into e-voting systems offers several advantages. Firstly, it eliminates the need for a centralized authority to oversee the voting process, reducing the risk of manipulation or tampering.Secondly, blockchain-based e-voting systems enhance transparency by providing all participants with the ability to

independently verify the accuracy of the recorded votes. Moreover, blockchain technology provides robust security measures to protect the privacy and anonymity of voters. The integration of blockchain technology into e-voting systems offers a transformative solution to address the limitations of traditional voting methods.

II. PROBLEM STATEMENT & OBJECTIVES

Traditional voting systems and the current electoral process face various challenges such as voter fraud, vote manipulation, and other forms of malpractice that compromise the integrity and erode public trust in democratic systems. These challenges include Lack of transparency, Voter fraud and tampering, Inefficiency and delays, Accessibility.

Electronic voting (e-voting) was proposed as a solution to overcome these issues and challenges by providing a more efficient and convenient voting process system. However, existing e-voting systems have their own set of vulnerabilities, including hacking, tampering, and other forms of cyber-attacks that can compromise the integrity and accuracy of the election results after the election process. To address these concerns, Blockchain technology has been proposed as a possible and efficient solution to create a more secure and transparent e- voting system. Since the election process takes place in predetermined election booths the possibility of coercion of votes is extremely high in rural areas. There is absolutely no transparency while the votes are counted and ballot boxes relocated for the same.

Since voter identification and verification is done manually there is high possibility of duplication of ID proofs and votes. Duplication of votes is highly possible. Since most work is done manually there are high chances of corruption and error. Voters have to travel and cast their votes only in the allotted poll booths making it difficult for many, eventually the voter turnout percentage falls very low.

To deal with all the problems faced, we propose an online voting system based on blockchain and smart contracts for a safe and efficient election process. The main objective of this project is to understand and approach the problems and difficulties faced by both the voters and administrators during an election in the current system and rectifying them to build an efficient electronic voting system. Our objective here is to solve issues of digital voting (e-voting) by using blockchain technology. Blockchain enabled voting system could reduce voter fraud and increase voter access. The objective of this voting system using blockchain technology project is to develop a secure, transparent, and efficient platform that leverages blockchain's inherent properties to enhance the integrity and accessibility of electoral process. By achieving these objectives, this voting system aims to revolutionize the electoral process, overcoming the limitations of traditionalvoting systems and instilling confidence in the integrity, transparency, and accessibility of democratic election.

III. EXISTING SYSTEM

Integrity of the election process will determine the integrity ofdemocracy itself. So, the election system must be secure and robust against a variety of fraudulent behaviours, should be transparent and comprehensible that voters and candidates canaccept the results of an election. But in history, there are examples of elections being manipulated in order to influence their outcome. In a voting system, whether electronic or using traditional paper ballots, the system should meet the followingcriteria: Anonymity, Tamper resistant, Human factors.

There are already several existing systems that exists in the real world such as:

A. Traditional Paper Ballot System :

This is voters make a queue and one by one enter the voting booth where using papers they select their preferred candidates. Some of the limitations in this systems were it takes a long time as voters have to make very long queues andthe voting process is slow. It is expensive as a lot of personnelare required to oversee the voting process and purchase of the voting materials.

B. Direct-Recording Electronic (DRE) Voting System :

A Direct-Recording Electronic (DRE) voting machine recordsvotes by means of a ballot display provided with mechanical or electro-optical components that can be activated by the voter (typically buttons or a touchscreen); that processes data with computer software; and that records voting data and ballot

images in memory components. After the election it produces atabulation of the voting data stored in a removable memory component and as a printed copy. They typically tabulateballots as they are cast and print the results after the close of polling. The main limitation is that the system overcomes the problem of queues however its main weakness is that it can be hacked and the results manipulated.

IV. PROPOSED SYSTEM

The system overcomes the problem of queues however its mainweakness is that it can be hacked and the results manipulated. The proposed system has two major objectives for the public i.e. voters and for the election commission organising the elections. The objective of our project is to conduct safe and sustainable elections, where we aim to eradicate certain existingproblems such as coercion of votes, possibility of tampering votes, not enough transparency, collection, and safe storage of data. Funds required to conduct elections are cut down tremendously, and can be used for various other beneficialnational projects. This paper is to cater to the future needs of thenationwide elections.

The proposed system is broadly classified into four categories such as collection of data, verifying the identity and authenticity of voters, addition of new data into blocks, and the release of results. Using blockchain and smart contracts this system is much more efficient and safer than the existing system. Some ofthe advantages of our Proposed System would be the Usage of Blockchain prevents access to the votes cast and other data, by whom so ever. This also prevents trace back of voter information, maintaining voter's privacy.

No possibility to add, alter or delete votes once entered, which makes Blockchain a truly safe technology to use. Votes entered by the voters can be verified by them proving transparency. Once updated at any single system or node, the data is instantly reflected all the authorised nodes preventing corruption. Manual or human intervention is almost negligible as smart contracts are used at all election processes, saving human resources, and preventing error. Coercion of votes is technically impossible as voters can cast their votes from any preferred location at any time during the election process.

V. SYSTEM DESIGN ARCHITECTURE & FLOW

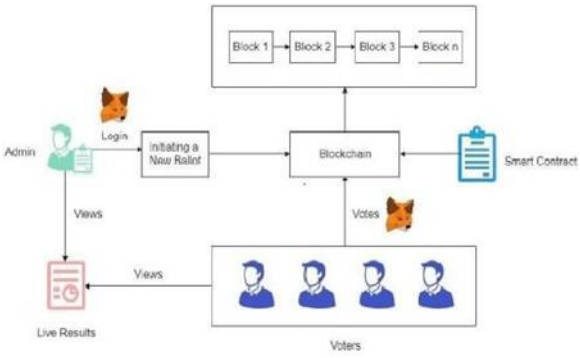

Figure 1. Transparent Voting System Architecture

The above system architecture illustrates the various entities that have been integrated into the system. It briefly outlines howthe proposed system's complete voting process will work, from the administrator initiating a fresh ballot for election through numerous voters casting their votes. It also depicts their interrelationships and includes a series of decision-making procedures and steps. This graphic also explains functionalcorrespondences.

The proposed system comprises two modules:

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.

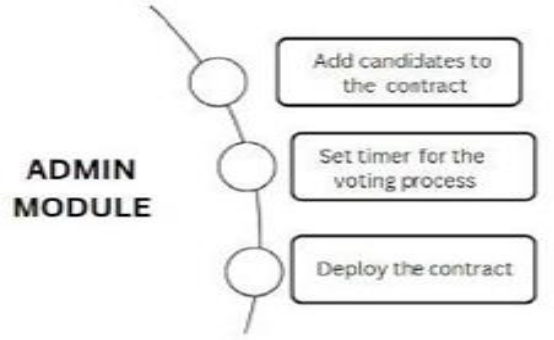

Figure 2. Admin Module

B. Voter Module: Voters are 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. Voting process ensures the anonymity of voters, keeping their identity & chosen candidate secret.

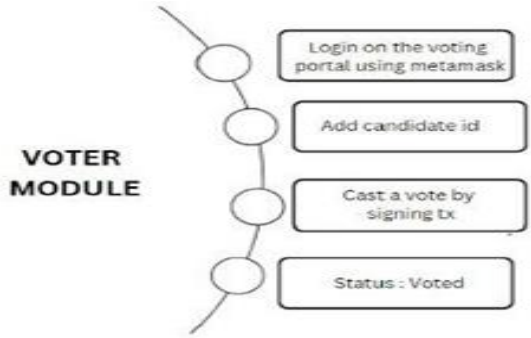

Figure 3. Voter Module

Our proposed Blockchain voting mechanism also involves three phases namely,

A. 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 thenecessary gas fees.

B. 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 theirvote by signing the transaction on MetaMask.

C. Voting End Phase:

This phase marks the end of the voting period. When the remaining time reaches zero, no more voters can participate orcast their votes.

VI. SYSTEM IMPLEMENTATION

The system implementation was divided into the two mainphases namely.

A. GANACHE BLOCKCHAIN DEPLOYMENT (BACKEND)

Ganache was installed at the backend of the application tointeract with an Ethereum blockchain network. With the installation comes 10 free accounts preloaded with 100 Ethers (ETH) as shown in the below Figure 4. Each user has a unique address and a private key. Each account address will serve as a unique identifier for each voter in the election process. The smart contracts were built and saved into a directory designatedto store the smart contracts. All the business logic of the application resided in the smart contracts, which were in chargeof modifying the Ethereum blockchain network. They allowed the registration and listing of candidates that participated in the election. They also kept track of all electoral results and their voters. All the rules of the election were governed by the smart contracts, by enforcing accounts to vote only once per election. The system ensured that once a voter casts a vote, he or she is denied access to cast another vote, thus making the system resistant to a double vote count.

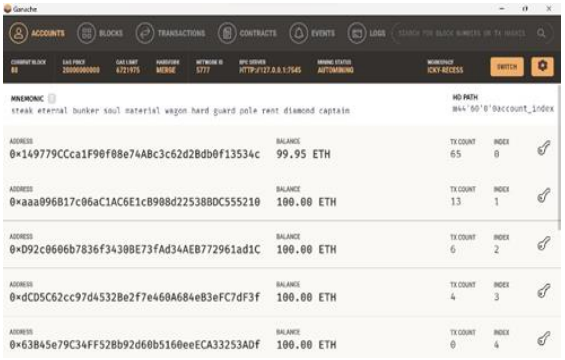

Figure 4. Blockchain users on Ethereum Blockchain Network The highlighted address of index 2 in the Ganache network is used in the simulation network. The private key to the address was opened on the Ganache network to copy the address of the private key as shown in Figure 5. This address was then imported into MetaMask, the wallet system that interacts with the Ethereum blockchain, which was used to register the user for vote casting. Once in MetaMask, the user was then connected to voting site where he/she was able to cast a vote for preferred candidate.

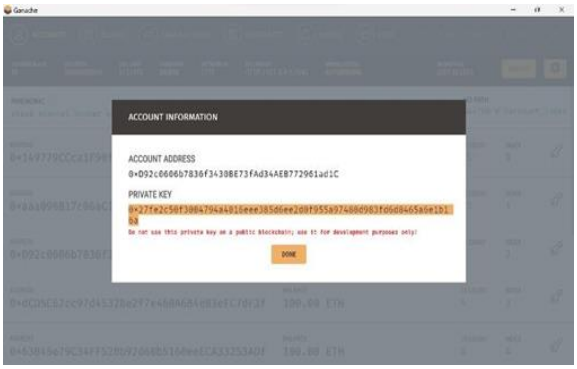

Figure 5. Private Key Address on Ethereum Blockchain

Then, the transaction list will be available publicly to provide the user with convenience to tally their votes respectively. Theusers can check their votes given by them by looking into the transaction list.

B. ELECTRONIC VOTING SYSTEM (FRONTEND)

A client-side application was designed using HTML, CSS, andJavaScript to communicate with the smart contract at the backend. The client-side application was designed so that it displayed a list of the candidates that were to be voted for and each user of the system was able to view the number of votes each candidate had received in real-time.

As already established, the moment a vote was cast on the network by a user, the user lost the ability to cast another vote for the same election, and could only view the progress of the electoral results. To do so, we used truffle framework to transfer the smart contract to the blockchain by giving command on the command line. We have also used NPM directory by cmd. After migrating the smart contract, we start the project using NPM directory by cmd.

VII. RESULTS

We now present the snapshots of the system, where Userinterface(UI) is through which users can interact with thevoting system based on blockchain. Figure 6 here represents theHome page of the d-App named "BC-VOTE" illustrating the Blockchain-Vote with no active election going on. Hence, the admin is first required to start the election process & only thenusers will be able to vote.

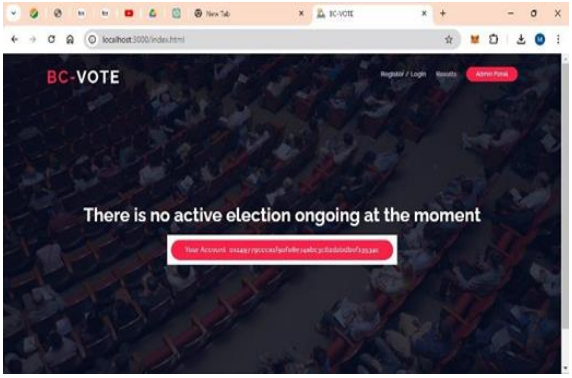

Figure 6. Home Page

After logging in through the MetaMask, the Account 2 is considered as the Admin's account where the admin will perform its respective transactions. Once the user is connected,the admin can now set up the election that is to add candidatesand start and end the election using the admin panel.

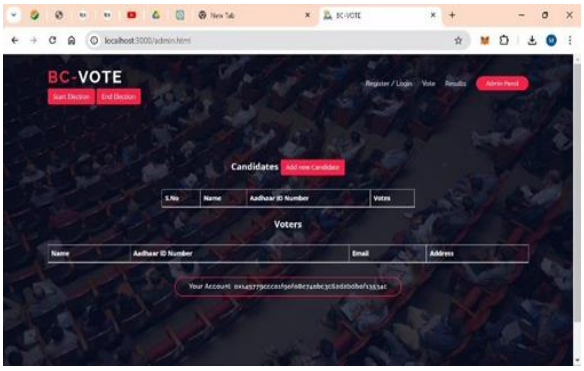

Figure 7. Admin Panel

The admin when he adds candidate in the list, he confirms a transaction by paying a small fee as gas price from preloaded 100 Ethers (ETM). Admin has successfully added all the participating candidates to the list and starts the election by the clicking the button on the Admin Panel.

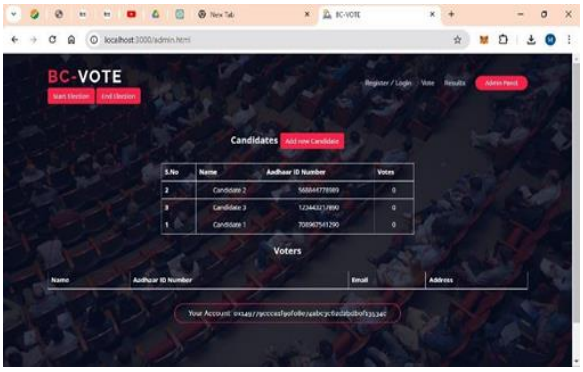

Figure 8. Candidates List in the Admin Panel

Once the voting process is deployed, voters can now register for voting process by creating an account through MetaMask using the Accounts 3, 4, 5, 6, 7…..11 respectively assigned for the voters. After that, main screen comes up with zero vote, theuser cannot vote until they import their account by entering private key. The private key is given in advance to tuser.

The voters imports their account by entering the private key. Then, Voters will cast their vote by choosing their preferred candidate from the list. The below page shows the voters' ability to vote for a selected candidate.

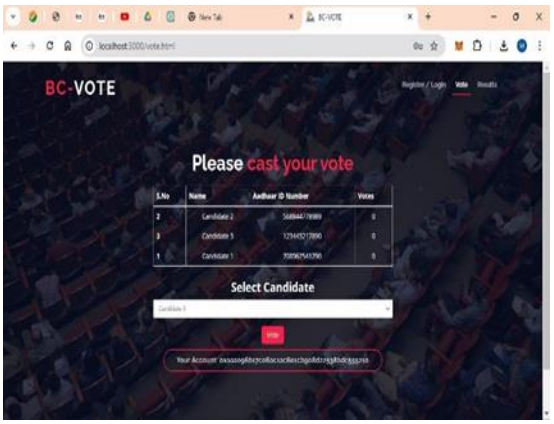

Figure 9. Voting Page for the voters

When the voters choose candidate of their choice, the MetaMask pop-up gets open when clicked on vote to confirm the transaction. Once confirmation is done, the voter gets redirected to the main page where only results are visible but now you cannot vote. In the similar manner, others can also vote by importing their account.

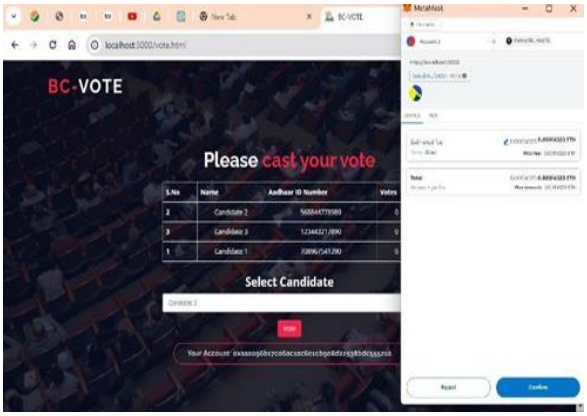

Figure 10. Voter Casts a vote by signing

The admin can also view the election details such as the vote tally and the voters' details such as their names, Aadhaar ID Numbers, emails, and their hash address in the blockchain on the admin panel. Once all the voters have casted their votes successfully to their preferred candidates over a specified time,the admin then the ends the election by clicking the button present on the admin panel.

Once the admin has ended the election, the Results page displays the electoral result in real-time with receipt of voter'stransaction as Aadhaar ID. The Final Results page consists of the total final votes tally indicating the total number of votes for each individual candidates participated in the election.

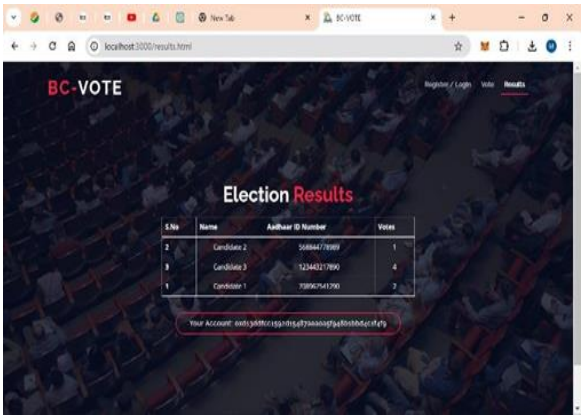

Figure 11. Results Page

At last, Considering the scenario as when the user attempts to vote after the admin has ended the election, a screen will bedisplayed as before, clearing indicating that the election process has been ended with the votes tally summary.

VIII. CONCLUSION

In this project, we introduced a blockchain-based voting system that utilizes smart contracts to enable secure and cost- efficient election while guaranteeing voters privacy. We have shown that the blockchain technology offers a new possibility to overcome the limitations and adoption barriers of electronicvoting systems which ensures the election security, integrity and lays the ground for transparency. Using an Ethereum private blockchain, it is possible to send hundreds of transactions per second onto the blockchain, utilizing every aspect of the smart contract to ease the load on the blockchain.

The transparency of the block-chain enables more auditing and understanding of elections. The blockchain will be publicly verifiable and distributed in a way that no one will beable to corrupt it. The utilization of blockchain in e-voting systems offers several advantages over traditional methods.

In conclusion, an e-voting system using blockchain technology has the potential to revolutionize the way we conduct elections by providing transparency, immutability, andsecurity. By leveraging the power of blockchain, we can create a tamper-proof voting system that ensures each vote is countedaccurately and fairly. It can provide greater accessibility, especially for voters who may have difficulty physically attending polling stations. There are also substantial social benefits to using the system as well such an

easier and quickervoting process which will lead to higher voter turnout. Overall,a Voting system using blockchain technology represents amajor step forward in the evolution of democratic systems, andit has the potential to transform the way elections are held.

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