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Blockchain-Based Autonomous Voting System Ethereum

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Abstract: The default voting procedure has many inefficiencies such as issues with effectiveness, security, and transparency. These problems erode the confidence and credibility in the electoral frameworks which fosters conflict and skepticism towards the legitimacy of governance. A solution for voting problems is Secure Sphere, a decentralized ballot system that employs the Ethereum blockchain. Through block technology, Secure Sphere guarantees that its voting process is utterly transparent, secure, and un hackable. Votes are protected against unauthorized additions by casting them on the Ethereum blockchain. This approach mitigates most problems associated with traditional voting systems such as vote tampering and recounting, misrepresentation, and cyber threats. Moreover, the voting process is further secured by the application of cryptographic techniques. The principal feature of Secure Sphere is smart contracts which are vital in automating the voting process. Each vote is verifiable and counted, therefore, once cast, a vote becomes irrevocable. Because of these contracts the system is enhanced to enable real time vote verification, thus rendering the votes straightforwardly auditable. Therefore, both voters and election officials are able to independently confirm the outcomes.

Keywords: Blockchain, Autonomous, Ethereum, secure-Sphere

I. INTRODUCTION

The conventional method for casting votes in democratic elections is through in-person voting with paper ballots, as it allows citizens to participate in the electoral process. However, this method continues to face challenges such as fraud, security risks, mismanagement, and a lack of accountability. People's trust is further eroded by demographic and identity-related vote manipulation: vote alteration, impersonation, vote duplication, and result tampering. Furthermore, dependence on centralized election systems subject voters to cybersecurity risks, potential mistakes by election staff, and political bias. These gaps reveal the need for an electoral system that is dependable, secure, and maintains the integrity of elections. Secure- Sphere solves these problems with an autonomous voting framework based on the Ethereum blockchain. Secure Sphere offers an effective, transparent, and secure voting solution by implementing blockchain technology. Voting systems based on blockchain technology allow separation from authorities, intermediaries, and centralized control, which minimizes manipulation. Elections are also more reliable as votes occur in a tamper-proof system of records; ledgers are kept as such and cannot be edited or erased. Secure Sphere has incorporated intelligent agreements through which the voting criteria and procedures are simplified.

Votes are safeguarded from any misconduct by smart contracts that ensure every single voice is heard and counted. Cryptography integrated within the blockchain enables protected privacy verification of votes being submitted. Unlike prior systems of electronic voting, this particular system design allows elections to be safeguarded against cyber threats with results that can be verified without external interference. Additional objectives of Secure Sphere include enhancing the efficiency and accessibility of the system to voters. With remote voting capabilities, all eligible citizens can securely cast their votes from anywhere around the globe. Such features resolve the logistical problems associated with electronic voting machines (EVMs) and paper ballot voting. Besides, the automation in counting and declaring votes accelerates the time taken to announce the election results which improves overall effectiveness, and reduces mistakes.

II. LITERATURE SURVEY

Both printed ballots and electronic voting machines (EVMs) have significant drawbacks. According to Sharma et al. (2018), cyberattacks usually lead to fraud in elections that do not have an authoritative monitoring system; they often attack security features. The compilation of ballot stuffing, dual voting, and vote casting all render elections untrustworthy. Besides this, dependency on a central organization raises the risk of data manipulation or alteration and unwanted influence.

According to Rehman et al. (2019), the manual methods of counting, providing evidence, and announcing results do not guarantee the confidentiality or authentication of results which leads to inefficiencies like undue delays or additional errors. The use of manual techniques increases the probability of bias due to human interference. These challenges foster the need for a voting system that is simple to verify and anonymous while preserving confidentiality for voters and honesty for elections. Blockchain technology enables the use of Ethereum as a distributed ledger which augments voting applications since it executes smart contracts. Kiayias et al. (2015) advanced the proposition of an Ethereum-based voting system where smart contracts designed for elections automate the entire voting process, ensuring validation of votes, and prevention of multiple voting.

The Ethereum blockchain secures the voting process such that every vote is cast, and no changes can be made after the voting process is complete. An audit is performed by all parties. As explained in the presentation, Secure Sphere utilizes Ether smart contracts for enhanced political accountability and governance. SecureS phere applies cryptography, decentralized identity management for vote registration, and communications technology to make the system accessible to voters. Through these technologies, Secure Sphere has developed a sophisticated and streamlined voting process that exceeds current systems. Though applying blockchain technology in voting systems is advantageous, it becomes logistically difficult due to scalability issues, privacy, and voter identification. Kiayias et al. (2015) highlighted that there's a significant constraint to how much activity blockchain networks can support during busy periods, such as elections, because of congestion and high fees. In order to maintain anonymity, while not compromising the verifiability of the vote, sophisticated methods like homomorphic encryption and zero-knowledge proofs need to be utilized. Further work is needed on policy governance regarding the use of blockchain technology in voting, enhancing biometric voter verification, and increasing blockchain adaptability through layer two solutions.

To attain a safe and globally embraced voting framework on the blockchain, aligned action from governments, scholars, and clean tech visionaries in blockchain is essential.

III. PROPOSED SYSTEM AND FEATURES

A. System Overview

Voting procedure has been automated with the use of smart contracts that integrate with the Secure Sphere system which works on the Ethereum blockchain. A vote can now be encrypted and recorded on the blockchain eliminating interference from malicious third parties. Centralized authorities can no longer manipulate the voting system because these votes can now be tampered with.

The following is part of the Secured Block from Ethereum:

With Ethereum Blockchain as the foundation of Secure Sphere, the system offers an open access ledger where votes can be staked. This guarantees secure and decentralized casting of votes which prevents manipulation of elections by any single party.

Vote control, contract execution, process automation and enforcement are achieved with the help of smart contracts. Automated voting is done filing, dealing with voters and tallying the results.

In cases of unwanted shifting of votes or tampering, SecureSphere makes use of different cryptographic techniques. Anonymity of the voter is preserved as evidence is gathered for every encrypted vote.

With respect to anonymity and sensitive data, the non-central identity management system guarantees protection for Authentication of the voter. By employing identity control systems on the blockchain, SecureSphere blocks unauthorized and duplicate votes.

User Convenience: Voters can easily use a web interface to cast their votes. Election authorities have access to an admin portal where they can control when voting happens, manage candidates and see their votes in real time.

Immediate Election Audit: Voters and impartial auditors can audit and verify every single vote independently as it is being carved in the blockchain, thus providing the highest level of confidence towards the elections.

1) Process of registering a voter in the system:

- Blockchain based identity management system will validate voters using their unique credentials.
- A smart contract enables a registered voter to cast votes.

2) The act of voting:

- Every person votes through the Secure Sphere interface.
- Voting processes include encrypting the vote and sending it to the Ethereum blockchain.
- A smart contract guarantees the vote validation and ensures its immutability.

3) *Vote Verification and Openness:*
- Since votes are kept on the blockchain, everyone can access the public records which allows citizens to check the authenticity of the election.
- Complete voter anonymity can be maintained, and full transparency across the whole process is guaranteed.

4) *Determining the final result:*
- Once the voting process has been completed, the votes will be summed up automatically via a smart contract.
- Voting results are visible to the public but are securely locked against any modifications.
- ➢ Voter Registrations Can Not Be Removed: After a vote is recorded on the blockchain, it is immutable, meaning it cannot be changed or erased.
- ➢ Various Forms of Voting Systems: The distributed architecture averts impersonation and hacking infiltration.
- ➢ Hashing algorithms ensure the secrecy of the votes.
- ➢ Prevention Against Identity Theft: No head of system conducting provides means where an individual needs the head of system is not present and eliminates the head of the system to voting allows election bypass.

These proposed features of security systems are considered beneficial:
- Give ability to make changes and charge correcting ballots.
- Votes securely protected by blockchain.

5) *Open:*
- Voter identities are shielded by relevant security agencies while enabling verification to the audit of election results.
- Secured Accuracy Counting: Assure the accounts of the voters are verified and counted precisely.
- Boundless control of manipulation and failure preventative borders the election infrastructure. Single control point neglected the central point.

6) *Directness Efficiency:*
- Fixing and adjusting results from manual counting election flaws can be done solving set problems from counting process.
- Guarantees results to be produced instantaneously and estimates verifiable.
- Remote voting poses no threats to security ensures a hundred percent participation with users being limited to residents of the region.

7) *Voting Technology:*
- Monetonomi secure voting wallets: an administering tool for voters Identity verification also enables execution of voting.
- No block execution language denies MetaMask.
- Ethereum smart contracts are executed in their proprietary language known as “solidity.”
- Web3.js can be employed as an interface when interacting with the Ethereum blockchain.
- Again with CSS, Javascript, and HTML, npm includes the GUI

For seamless interaction with specific areas of the voting system authored in HTML, oneself can use npm.
- ➢ Interact Outcomes: The election analysis and data analysis are done using Python, version 3.9.
- ➢ Closing Privacy Gaps While blockchain ensures higher transparency, it also brings forth concerns regarding privacy for the voters. ProtectSphere guarantees that:
- ➢ Anonymity of voters: Votes are anonymized and placed in the blockchain without any identifying information. Votes ravaged and stored encrypted cannot be exposed cannot be exposed but can be authenticated. Through zero-knowledge proofs (ZKP), voters can validate that they have cast a vote without any need to show their identity.

IV. ONLINE VOTING SYSTEM

A. *Advantages of an online voting system*
As with any online voting method, this offers a host of advantages over traditional methods. Online voting offers better security as one of the main features.

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The incorporation of blockchain technology allows the votes to be securely stored, tamper proof, and unchangeable. This significantly reduces the chances of multiple voting, fraudulent elections, and unauthorized access to the vote logs.

Another important advantage is providing transparency. Anonymity is preserved using blockchain technology, which allows all voters, election authorities, and independent auditors to validate the results of elections. This transparency increases public trust in the elections since it is harder for one party to manipulate or alter the results.

When coupled with blockchain technology, decentralization becomes yet another advantage of online voting systems. Traditional voting methods require a central authority to organize and supervise the voting process, which can result in bias and other issues. A decentralized digital voting system eliminates intermediaries and guarantees that no single entity has control over the entire election process. This reduction in control helps to reduce the risk of manipulation or fraud during elections.

Online voting systems offer enhanced efficiency. An online system replaces traditional voting techniques with automated processes including intelligent contracts and encrypted algorithms for tallying and verifying results. These advanced technologies streamline the registration process, reduce the possibility of human error, and allow for immediate vote counting. With these improvements, election results can be announced in real-time rather than being delayed.

Another critical advantage is accessibility. Online voting allows voters to participate remotely and place their votes from anywhere in the world. This is especially helpful for people living in remote areas where actual polling stations may be hard to reach, expatriates, or the disabled. Online voting does away with geographic barriers, therefore enhancing inclusivity and increasing voter turnout. Cost-effectiveness is another major advantage of voting online. Traditional elections incur heavy expenses from printing ballots, hiring election workers, renting polling places, and managing logistics. An online solution reduces these costs by streamlining the entire process. Automated vote counting also saves on labor costs and eliminates the need for recounts or politically motivated disputes that typically accompany manual counts.

Scalability is another important advantage. When populations and voter counts increase, large-scale elections can be challenging to manage effectively with traditional voting techniques. Online voting systems, particularly those enhanced with blockchain technology, can securely and rapidly process millions of votes simultaneously. They are therefore ideal for large-scale referendums, corporate voting, and national elections.

Online voting eliminates wastes associated with paper ballots used in traditional voting, reducing useable space and allowing forests to remain intact. The employment of modern technologies by organizations and governments makes voting more sustainable while vastly reducing the carbon footprint associated with voting.

Safeguarding voter privacy as well as anonymity constitutes essential factors within election activities today. For voters, online voting systems provide assurance their identities will not be revealed, while election officials can validate the authenticity of the ballots. Advanced cryptographic techniques such as homomorphic encryption and zero-knowledge proofs capture maintaining the secrecy of voters while safe guarding the election making the election auditable.

Voter anonymity and privacy are imperative aspects to consider regarding voting catalyzed through the internet. Unlike out-dated systems that pose the risk of voter cloning, contemporary online systems utilize biometrics for voter verification, multi-factor verification, and digital signatures to guarantee that only genuine, authorized voters are able to cast their votes. These measures prevent the fraudulent manipulation of elections through altered ballots.

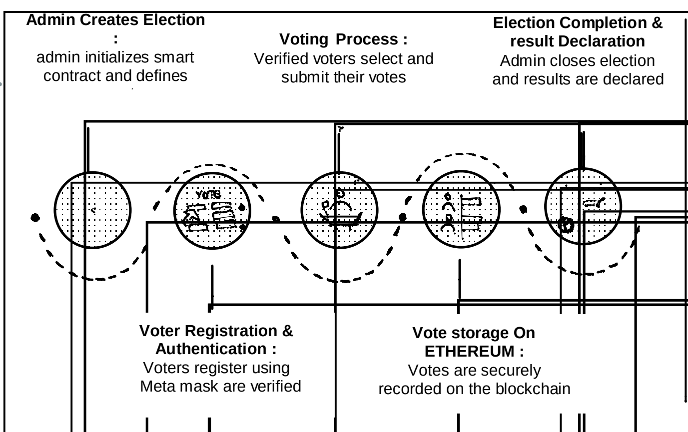

Fig. 1. Flow chart of Online voting system

B. The Benefits of an Online Voting System

An online voting system provides several benefits, but specific risks and issues are also a concern. First and foremost, there is the issue of online security. Online voting platforms can be subjected to attacks by viruses, hacking, and other Internet perils. If a hacker attains access to the voting system, they could alter votes, disrupt election processes, and threaten voter information. Detecting these attacks requires substantial protection measures. A voter authentication and identity verification system pose yet another considerable challenge. Unlike traditional voting that requires voters to physically go to voting centers, online voting requires digital verification. The privacy of citizens, however, makes it difficult to prove that each voter is who they claim to be. Although possibilities such as digital identity verification and biometrics do exist, their applicability is not universal, which hinders their implementation. Security breaches caused by system errors also pose a serious threat to online voting systems. Any technical error, server failure, or network issue could prevent voters from casting their vote during an election, which could lead to complete disenfranchisement .The dependability of the elections relies upon assuring system dependability and providing contingency measures for any failures. Other challenges also includes internet accessibility and internet literacy. Regardless of the ease provided by online voting, it presumes that every voter has access to the internet as well as the requisite technological skills. Voter suppression might stem from the challenges elderly voters, those residing in peripheral regions, or individuals without computers or mobile phones face in participating. A different concern is the skepticism surrounding electronic voting. There are many people that still question the safety and reliability of online voting due to past hacks on various digital systems. There is a likelihood that some voters will doubt the transparency of the elections if a paper ballot is not made available. In order to build public confidence towards online voting, such concerns need to be addressed through education and open auditing frameworks. Legal and regulatory policies pose some of the most critical challenges. The absence of appropriate legal provisions to support internet voting in several countries hampers its adoption. Governments need to develop specific policies for cyber elections that deal with fraud, data security, and dispute resolution in order to ensure effective control and compliance. Resistance from other stakeholders and political parties poses yet another challenge.

Some political organizations could opt out of online voting due to a lack of transparency, potential system vulnerabilities, and changes in voter demographics that could skew election outcomes. Collaboration between the government, IT specialists, and independent auditors is critical in removing the opposition towards using online voting systems, ensuring that they are neutral, secure, and free from bias. Another issue that these stakeholders should consider is the cost of implementation. Online voting is cost-effective in the long run, but creating a secure, easy-to-navigate modular digital voting platform requires substantial infrastructure, cybersecurity, and technological investments. This cost may be too much for lower-tiered governments and associations that operate on limited budgets. A different major concern is lack of a paper trail. Paper ballots are a simple yet effective way to record votes as they can be manually recounted in case of disputes. Voting systems that operate electronically are prone to data corruption, making it nearly impossible to audit electronic data. This issue can, however, be remedied by implementing blockchain-based audit trails or verifiable paper backups. In some regions, censorship and political control pose significant threats. In some countries, authoritarian regimes may block access to online voting or manipulate the entire platform to prevent fair participation from opposing political parties.

To prevent state control, the system has to remain decentralized and capable of independent verification. Another issue is the complexity of conducting international elections. Some variations in internet access, issues with cybersecurity, legal differences across countries, and non-uniformity in cyber laws may complicate participation by foreign voters if elections allow remote participation. Uniform strategies must be adopted to uphold the integrity of online voting globally. Even though there are many benefits of online voting, achieving a balance among security, convenience, transparency, and trust is a substantial challenge. Achieving these goals will require further development in voter identity verification systems, blockchain, and cryptographic security. There must be collaboration between governments and private entities to ensure that online voting platforms are secure, inclusive, and widely accepted by the electorate.

V. CONCLUSION

The implementation of blockchain technology in voting systems is transforming election management processes. SecureSphere is a fully decentralized voting system that uses the Ethereum blockchain to solve the problems of fraud, security issues, inefficiency, and transparency in conventional election systems. With the application of smart contracts, SecureSphere enhances the trust and security of the electoral system by guaranteeing the votes are kept in an unchangeable, ascertainable, and safeguarded state.One of the most prominent features of SecureSphere is the ease at which intermediaries and central authorities are removed.

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This kind of decentralization reduces the likelihood of election fraud and other outside intervention greatly. Every election's information is safeguarded from tampering because an immutable record of all the votes is stored in the blockchain, guaranteeing tamper-proof results. Moreover, the implementation of cryptographic methods enhances the system's resilience to online attacks. Other important elements of SecureSphere include identity non-disclosure during voting and transparent voter verification. Trust and dispute resolution can be improved when voters and election officials are able to independently audit the election results post-election. In addition, the smart contracts' willing participation automating the voting process further minimizes manual involvement, thus streamlining the processes associated with outdated systems. Even with the advantages that blockchain voting systems offer over traditional systems, difficulties like identity validation, adaptability, and legal compliance limit broader acceptance. In addition, the autonomous voting systems stand to gain a lot from forthcoming improvements in biometric identification, digital ID verification, and blockchain consensus algorithms. To summarize, SecureSphere has shown to increase the efficiency, security, and accessibility of electoral systems.The advancement of blockchain technology provides SecureSphere and other similar platforms the capability to transform democracy through unbiased, unrestricted, and immutable elections. Such technology can be employed globally by governments and organizations to enhance trust and reliability in electoral systems, thus marking a new age in democracy characterized by secure and transparent elections.

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