Decentralized Voting System Using Solana Blockchain

A report submitted in partial fulfillment of the requirements for the award of the Degree of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE ENGINEERING

by

Farman Shaik (N200788)

Mulleti Lohith(N200357)

Ishaan Kondapalli (N200570)

Suhana Shaik(N200694)

Poojitha Thota (N200296)

Under the guidance of

Mr. Kumar Anurupam Sir
Assistant Professor
Department of Computer Science Engineering

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES

NUZVID, INDIA

April, 2025

RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES
(A.P. Government Act 18 of 2008) RGUKT-NUZVID, Krishna Dist - 521202
Tel: 08656-235557 / 235150

CERTIFICATE OF COMPLETION

This is to certify that the work entitled **"Decentralized Voting System Using Solana Blockchain"** is the bonafide work of **Farman Shaik (N200788), Mulleti Lohith (N200357), Ishaan Kondapalli (N200570), Suhana Shaik (N200694), Poojitha Thota (N200296)**, carried out under my guidance and supervision for the Minor Project of the Bachelor of Technology in the Department of Computer Science and Engineering under RGUKT Nuzvid. This work was done during the academic session December 2024 - April 2025 under our guidance.

Mr. Kumar Anurupam	**Mrs. S. Bhavani**
Assistant Professor,	Head of Department,
Department of CSE,	Department of CSE,
RGUKT Nuzvid.	RGUKT Nuzvid.

RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES
(A.P. Government Act 18 of 2008) RGUKT-NUZVID, Krishna Dist - 521202
Tel: 08656-235557 / 235150

CERTIFICATE OF EXAMINATION

This is to certify that the work entitled **"Decentralized Voting System Using Solana Blockchain"** is the bonafide work of **Farman Shaik (N200788), Mulleti Lohith (N200357), Ishaan Kondapalli (N200570), Suhana Shaik (N200694), Poojitha Thota (N200296)**, and hereby accord our approval of it as a study carried out and presented in a manner required for its acceptance in Minor Project of Bachelor of Technology for which it has been submitted. This approval does not necessarily endorse or accept swervy statement made, opinion expressed or conclusion drawn, as recorded in this thesis. It only signifies the acceptance of this thesis for the purpose for which it has been submitted.

Mr. Kumar Anurupam	**Mr. Siva Narayana**
Assistant Professor,	Assistant Professor,
Department of CSE,	Department of CSE,
RGUKT Nuzvid.	RGUKT Nuzvid.

RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES
(A.P. Government Act 18 of 2008) RGUKT-NUZVID, Krishna Dist - 521202
Tel: 08656-235557 / 235150

DECLARATION

We **Farman Shaik (N200788), Mulleti Lohith (N200357), Ishaan Kondapalli (N200570), Suhana Shaik (N200694), Poojitha Thota (N200296)**, hereby declare that the project report is submitted for partial fulfillment of the requirements for the award of the Bachelor of Technology degree in Computer Science Engineering of the **Rajiv Gandhi University of Knowledge Technologies, Nuzvid** is a bonafide work done by us under the guidance of **Mr. Kumar Anurupam Sir**. This submission represents our ideas in our own words, and where ideas or words of others have been included, We have adequately and accurately cited and referenced the original sources. We also declare that we have adhered to the ethics of academic honesty and integrity and have not misrepresented or fabricated any data, idea, fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the university and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not previously been formed as the basis for the award of any degree, diploma, or similar title from any other university.

Date: ______________
Place: ______________

Farman Shaik (N200788)
Mulleti Lohith (N200357)
Ishaan Kondapalli (N200570)
Suhana Shaik (N200694)
Poojitha Thota (N200296)

ACKNOWLEDGMENT

We take this opportunity to express our sincere gratitude to our guide, **Mr. Kumar Anurupam**, Assistant Professor, for his valuable guidance, support and encouragement throughout our mini project work titled **“Decentralized Voting System Using Solana Blockchain”**. His insightful feedback and technical expertise helped us navigate the complex concepts and contributed immensely to our learning.

We also would like to thank **Mrs. Samineni Bhavani**, Head of the Department of Computer Science and Engineering, for her constant motivation and for providing us with the opportunity to carry out this project under the direction of the department.

We are grateful to all faculty members of the Department of CSE, RGUKT Nuzvid, for their valuable suggestions and cooperation during various stages of the project.

Lastly, we express our heartfelt thanks to our parents, friends, and the Almighty for their support and encouragement, without which the successful completion of this project would not have been possible.

ABSTRACT

Voting is a fundamental democratic right, yet traditional systems often face challenges such as accessibility barriers and vulnerabilities to vote tampering. To address these issues, we propose a **Decentralized Voting System using the Solana Blockchain**. The system is implemented across two websites: the **verification website**, under admin control, and the **voting website**, integrated with the Solana blockchain.

During the **verification process**, voters submit their email and wallet address. The admin validates the voter's details and, if verification is successful, the tokens are sent to the voter's wallet, granting them the right to vote. If the admin rejects the verification request, the voter does not receive the tokens, and a **verification failure** message is displayed. On the **voting website**, the voter uses the token to cast their one-time vote. Once the vote is cast, the token is consumed, ensuring the **one-vote-per-user** policy and preventing duplicate voting.

The **Solana blockchain** plays a key role in recording the entire voting process securely, ensuring transparency, immutability, and tamper-proof data. With Solana's high throughput and low transaction fees, the system offers a fast, cost-effective, and secure alternative to traditional voting systems. This innovative approach ensures a modern, trustworthy and efficient electoral process.

TABLE OF CONTENTS

Chapter 1: Introduction

1.1 Problem Statement

Traditional voting systems rely on centralized databases and processes, which are vulnerable to manipulation, fraud, and errors. Blockchain technology offers a promising solution by providing a decentralized, tamper-proof ledger for voting records. However, existing blockchain-based voting systems often struggle with scalability, high transaction fees, and slow processing times, which limit their effectiveness in large-scale elections. This project aims to address these issues by utilizing the Solana blockchain, known for its high throughput and low transaction fees, to create a scalable and cost-effective decentralized voting system that ensures transparency, security, and efficiency in the electoral process.

1.2 Objectives

- **Develop a Secure Decentralized Voting dApp**: Build a decentralized application (dApp) on the **Solana blockchain** to enable secure, transparent, and scalable elections, ensuring that all votes are immutably recorded and tamperproof.
- **Implement Voter Verification**: Design and integrate a separate **voter verification portal** to authenticate and authorize eligible users, ensuring that only legitimate voters can participate in the election process.
- **Enforce One-Person-One-Vote Mechanism**: Bind each verified voter's identity with a **blockchain wallet interaction** to enforce a strict one-person-one-vote policy, preventing duplicate or fraudulent voting.
- **Ensure Security and Privacy**: Enhance the security, scalability, and transparency of the voting process while safeguarding voter privacy, utilizing cryptographic methods and Solana's blockchain capabilities to maintain the confidentiality and integrity of election data.
- **Optimize for Scalability and Efficiency**: Leverage Solana's high throughput and low transaction fees to ensure that the voting system can handle large-scale elections efficiently without compromising speed or cost.

1.3 Motivation

Traditional voting systems have long been burdened by security vulnerabilities, lack of transparency, and inefficiencies, which undermine the integrity of the electoral process. These systems are often centralized, making them prone to manipulation, data breaches, and human error. In addition, with the growing complexity of modern elections and the increase in voter populations, traditional systems struggle to scale, leaving many elections susceptible to delays, inaccuracies, and fraud.

In addition, the ongoing trend toward digitalization and the increasing reliance on online services have increased the demand for modern, secure, and efficient voting mechanisms. Existing blockchain-based solutions have made strides in offering decentralized alternatives, but many still grapple with issues like high transaction fees, slow processing times, and limited scalability, making them less feasible for large-scale elections.

External pressures, including increasing concerns about election security and the increasing sophistication of cyber threats, further highlight the need for more robust and transparent voting systems. In light of these challenges, the Solana blockchain, with its high throughput, low transaction costs, and secure architecture, emerges as an ideal candidate to address these problems.

Using Solana's strengths along with secure voter verification methods, we can design a system that not only overcomes the flaws of traditional voting, but also offers a decentralized, scalable, and tamper-proof solution. This motivates the need for a next-generation voting system that enhances security, ensures transparency, and restores trust in the democratic process, empowering citizens with the confidence that their vote is protected and counted accurately.

Chapter 2: Related Works

2.1 Studies on E-Voting Systems

Research conducted by Susanto [5] emphasizes the application of the Solidity programming language for integrating with the Ethereum blockchain in an e-voting system. The study demonstrates that smart contracts can generate unique codes for each new election, effectively preventing the manipulation of election outcomes. The findings underscore the significant potential of blockchain technology to enhance the security and integrity of electoral systems.

Similarly, Song et al. [6] developed a prototype voting system based on Ethereum blockchain technology. The trial results indicated that users found the system user-friendly and effective in presenting comprehensive information.

Limitation: The study also revealed certain limitations, such as an average transaction execution time of around 30 seconds, which may impact the system's overall efficiency.

Barbu et al. (2022) [7] presented a critical analysis of the challenges and benefits inherent in blockchain-based voting systems. Through prototype implementations and stakeholder surveys in Romania, they found that decentralized ledgers can increase trust and reduce central points of failure, with voters appreciating the transparency dashboard and immutable audit trail.

Limitation: The authors also note significant challenges, including scalability issues (such as network congestion under heavy load), high energy consumption from certain consensus protocols, and a general lack of public understanding—factors that could impede the widespread acceptance and deployment of blockchain-based voting systems.

Gandhi et al. (2022) [8] performed a comprehensive security requirements analysis by mapping e-voting threat models onto blockchain properties, demonstrating how immutability and distributed consensus can effectively thwart tampering and DDoS attacks, and proposing cryptographic enhancements—such as zero-knowledge proofs—to preserve voter anonymity.

Limitation: Despite these safeguards, they recognize unresolved tensions between full transparency (necessary for public audit) and voter privacy, and emphasize that coercion resistance remains an open research problem.

Prashanth et al. (2023) [9] surveyed recent end-to-end blockchain e-voting prototypes, focusing on secure authentication, encrypted ballot storage, and verifiable vote tallying. Their proposed system integrates biometric identity checks and off-chain vote aggregation to reduce on-chain costs.

Limitation: The authors point out that the architecture faces challenges in legal and regulatory interoperability, as most electoral laws are not yet designed for immutable ledgers, and the hybrid on/off-chain design could complicate implementation for election officials and auditors.

2.2 Solana Blockchain

Solana is a high-performance, permissionless blockchain platform designed to support scalable decentralized applications (dApps) and smart contracts [1]. Proposed by Anatoly Yakovenko in 2017 and officially launched in March 2020, Solana aims to address the scalability limitations of earlier blockchains through a novel consensus mechanism known as Proof of History (PoH), combined with Proof of Stake (PoS). This hybrid approach enables Solana to achieve exceptionally high throughput, with the capability to process thousands of transactions per second while maintaining low latency and minimal transaction costs [2].

The platform features the Sealevel parallel smart contract runtime, allowing for concurrent execution of thousands of contracts, significantly improving performance over traditional single-threaded environments. Solana's native cryptocurrency, SOL, is used to pay for transaction fees and to participate in the staking process, contributing to network security and decentralization.

Solana also plays a vital role in the decentralized finance (DeFi) ecosystem by enabling fast and cost-efficient financial transactions. Additionally, it has gained popularity for hosting non-fungible token (NFT) marketplaces and gaming dApps, further expanding its adoption and use cases [3].

Solana CLI and Solana Validator software are the primary tools used for interacting with the Solana network. The CLI provides commands for wallet management, deploying smart contracts (known as programs), and querying blockchain data, making it a powerful utility for developers and network participants. Validators, on the other hand, are nodes that maintain a copy of the ledger, validate transactions, and participate in consensus. Validators must stake SOL tokens to be eligible for selection, ensuring alignment between incentives and network integrity.

In addition to its PoH-based consensus model, Solana utilizes Tower BFT, a Byzantine fault-tolerant algorithm that leverages the synchronized clock provided by PoH to reduce latency and improve consensus efficiency [4]. This architecture makes Solana a strong candidate for applications that require high-speed and cost-effective execution, including DeFi platforms, real-time data markets, and blockchain-based games.

Chapter 3: Methodology

3.1 System Overview

The proposed decentralized voting system leverages the **Solana blockchain** to ensure secure, transparent, and scalable elections. The system includes a **voter verification portal** to authenticate and authorize voters, while utilizing Solana's blockchain for immutability and low transaction fees. By binding verified identities with blockchain wallet interactions, the system enforces a **one-person-one-vote** policy. This design ensures data integrity, prevents fraud, and provides a user-friendly interface for seamless participation, offering an efficient and secure alternative to traditional voting systems. .

3.2 Implementation Steps

3.2.1 User Registration and Authentication

User Registration

New users access the application and register using their unique wallet addresses (e.g., Phantom Wallet).

Identity Verification

Wallet ownership is verified through cryptographic signature validation.

Authentication

Once verified, users are authenticated and logged into the voting platform through decentralized identity management methods.

Outcome

Successfully authenticated users are redirected to the voting dashboard.

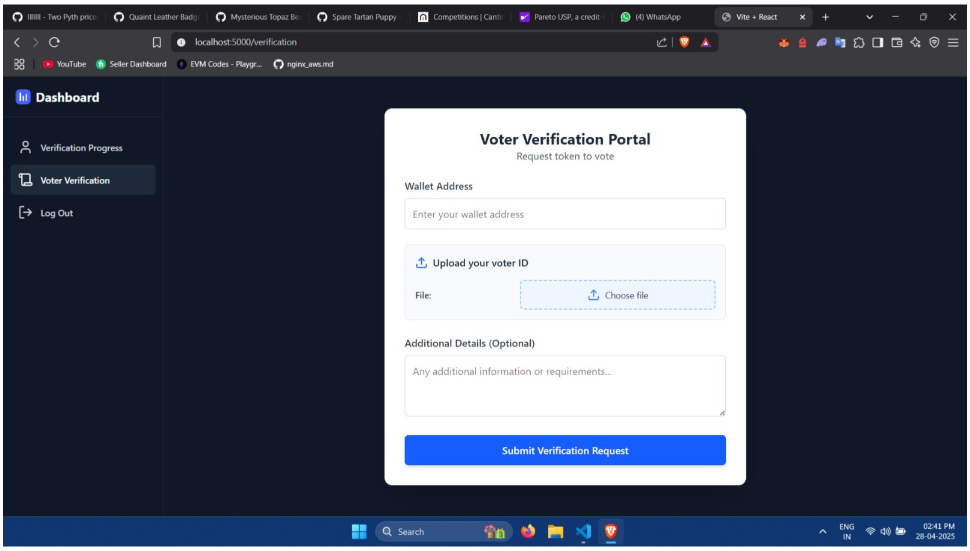

Figure 1: Identity Upload

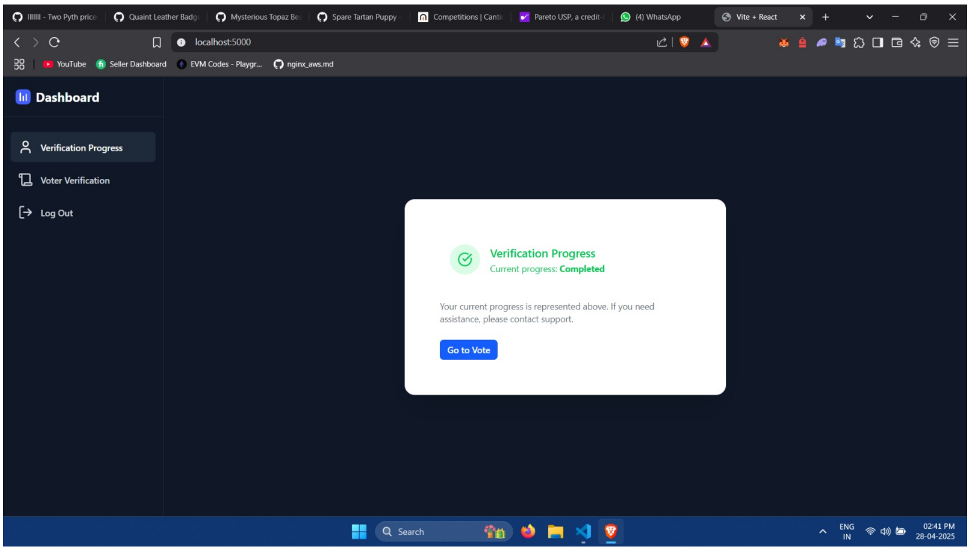

Figure 2: Verification Progress

3.2.2 Poll Creation by Admin

Admin Login

The administrator accesses a secure portal for election management.

Create Poll

Admin defines:

- Election title
- Start and end times
- List of candidates or voting options

Poll Account Creation

An account representing the election is created in the Solana blockchain, ensuring immutability and decentralization.

Outcome

The newly created election becomes visible to eligible users for participation.

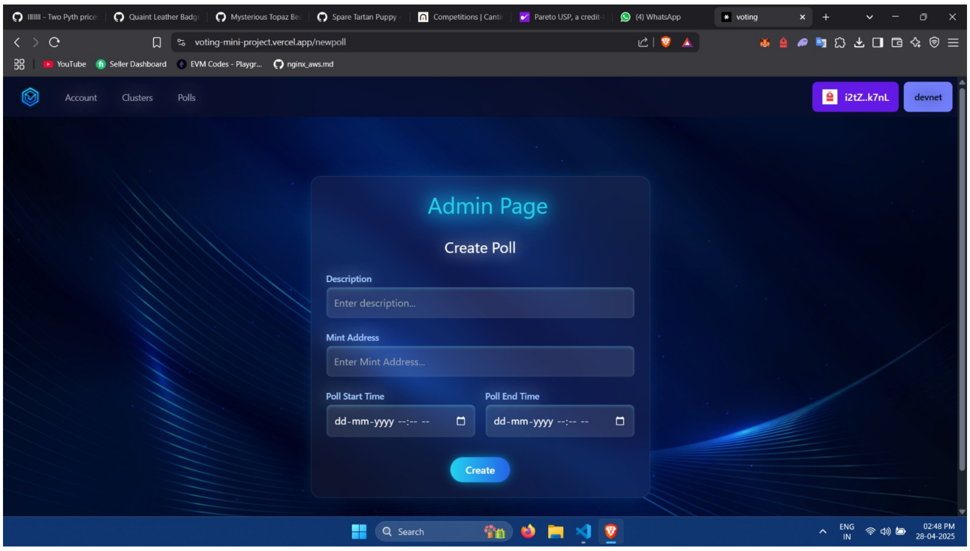

Figure 3: Poll Creation by Admin

3.2.3 Candidate Creation

User Login

The user accesses the participation page and defines:

- Candidate and Party Name
- Candidate and Part Symbol Image
- Poll ID

Candidate Account Creation

An account representing the candidate is created in the Solana blockchain, ensuring immutability and decentralization.

Outcome

The newly created candidate becomes visible to users for the voting process.

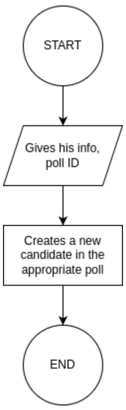

Figure 4: Candidate Creation Flowchart

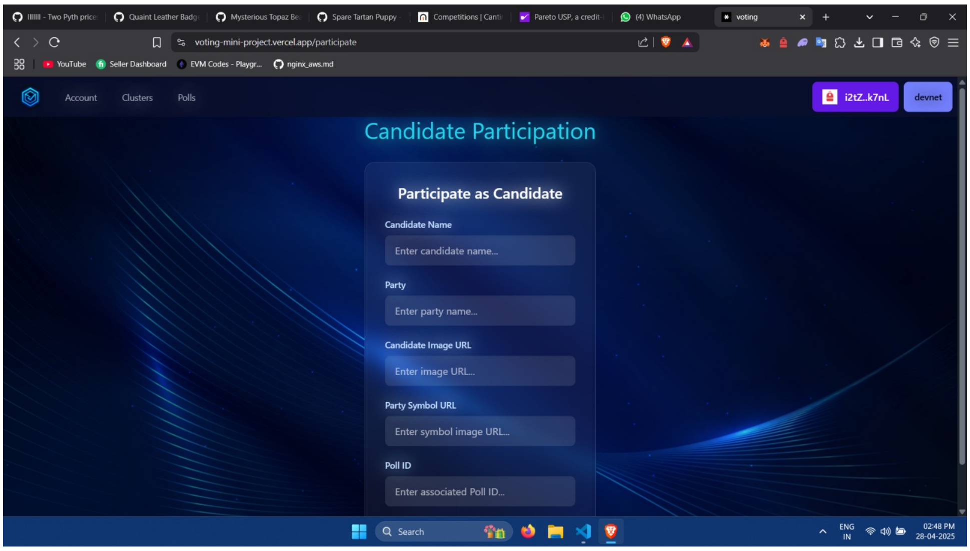

Figure 5: Candidate Creation by User

3.2.4 Voting Process by Users

Display Active Elections

Authenticated users can view the ongoing elections available for voting.

Cast Vote

- Users select their preferred candidate.
- Each vote is cryptographically signed by the user's wallet private key.
- The signed transaction is submitted to the Solana blockchain.

Transaction Confirmation

Solana network validates and confirms the transaction, permanently recording the vote.

Outcome

The user's vote is securely and immutably stored on-chain.

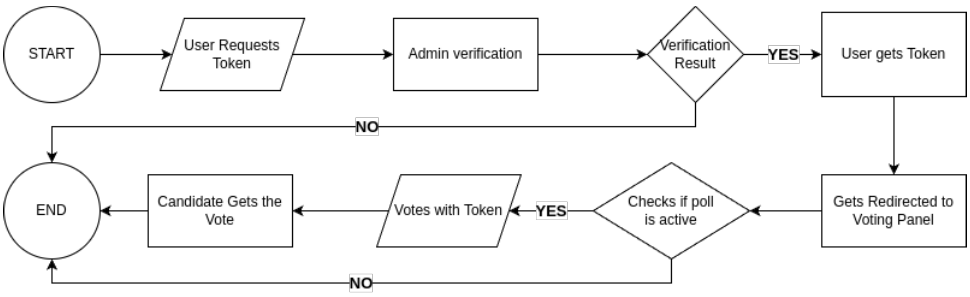

Figure 6: Process Flowchart

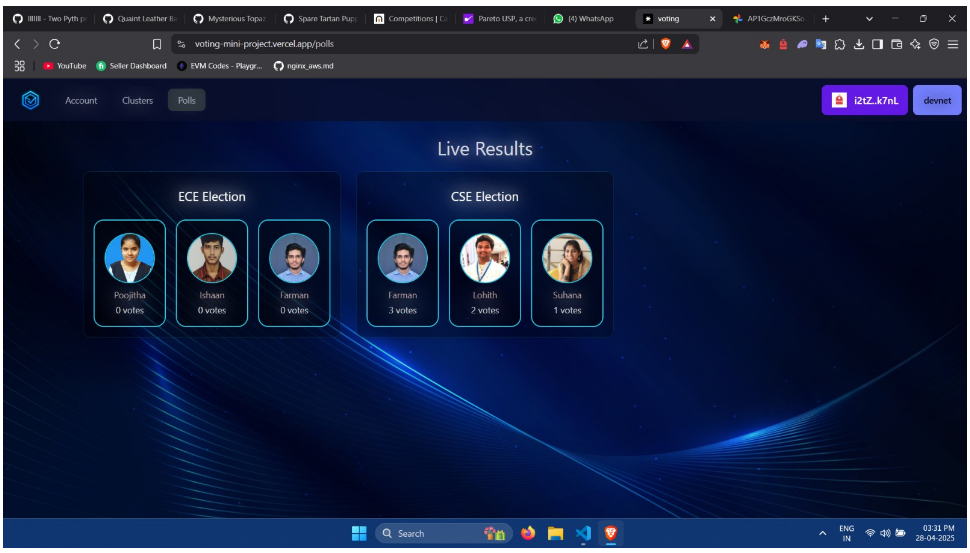

Figure 7: Currently Active Polls

3.2.5 Vote Tallying and Result Generation

Election End Check

At the end of the election period, voting is automatically disabled.

Vote Retrieval

Votes are retrieved from the blockchain using smart contract queries.

Vote Counting

The smart contract tallies votes transparently without manual intervention.

Result Display

The final results of the election are displayed on the user interface for all participants to view.

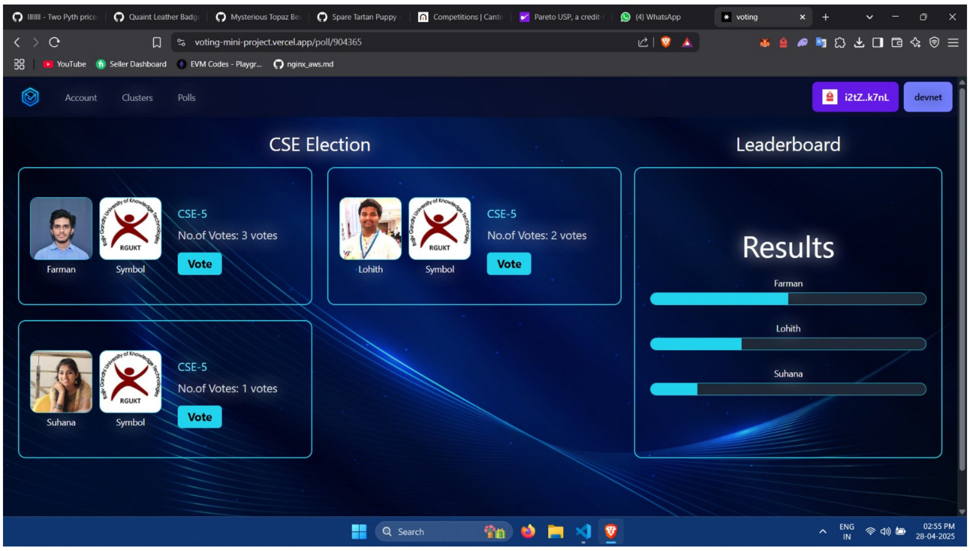

Figure 8: Live Results

3.2.6 Security, Privacy, and Integrity Checks

Blockchain Immutability

The Solana blockchain guarantees that once a vote is recorded, it cannot be altered or deleted.

Voter Anonymity

Voter identities remain private; only wallet addresses are associated with votes, preserving anonymity.

Auditing

Election data is publicly verifiable through blockchain queries, allowing independent auditing without centralized trust.

Outcome

Ensures a fully decentralized, secure, transparent, and tamper-proof voting experience.

Chapter 4: Technical Details

4.1 Blockchain and Smart Contract Integration

4.1.1 Solana Blockchain

The voting system is built on the Solana blockchain, chosen for its high throughput (6̃5,000 TPS), low transaction costs, and near-instant transaction finality (400ms block times). Solana's Proof-of-History (PoH) and Proof-of-Stake (PoS) hybrid consensus ensures immutability and decentralized security.

4.1.2 Smart Contracts (Anchor Framework)

Smart contracts written using the Anchor framework (Rust) handle critical voting logic:

- **Token Generation and Distribution**: Each verified voter is issued a non-reusable voting token.
- **Vote Casting and Validation**: Smart contracts validate votes, burn tokens post-voting to prevent double voting, and permanently store results on-chain.
- **Error Handling Techniques**: Smart contracts use custom error codes and event logging to track failures or invalid operations safely.

4.2 Voter Authentication and Token Management

4.2.1 Voter Verification Technique

A two-phase model ensures voter authenticity:

- **Centralized Verification**: Users register by submitting email, wallet address, and KYC documents.
- **Admin Approval**: Upon approval, users receive a voting token associated with their wallet address.

This token acts as both an identity proof and access control for voting.

4.2.2 Token-Based Authentication

Instead of using off-chain session management, the project uses blockchain-native token authentication:

- Voters are identified via their wallet address and issued voting tokens (SPL tokens on Solana).
- Once the vote is cast, the token is burned or locked, preventing reuse.

4.3 Frontend Techniques

4.3.1 User Interface Design

The frontend (developed in Next.js, React, Tailwind CSS) follows these techniques:

- **Wallet Adapter Integration**: Solana Wallet Adapter library is used to securely connect Phantom wallets for login and voting.
- **Transaction Feedback Mechanism**: Frontend listens to transaction signatures to immediately show success/failure status.
- **Lazy Loading and Dynamic Imports**: Only necessary components are loaded on demand to optimize loading speed.
- **Error Boundary Handling**: React error boundaries are used to catch frontend failures and guide the user properly.

4.4 Security Techniques

4.4.1 Blockchain-Level Security

- **Cryptographic Signatures**: Every transaction must be signed by the voter's private key, ensuring non-repudiation.
- **Immutable Ledger**: Once a vote is recorded, it cannot be changed or deleted, ensuring election integrity.
- **Token Consumption**: Tokens are invalidated immediately after use, preventing duplicate voting.

4.4.2 Frontend and Backend Security

- **HTTPS Encryption**: All API calls and data transmissions between the frontend and the admin verification server are secured via SSL.
- **KYC Document Storage**: Sensitive user data (for verification) is securely stored and deleted post-verification wherever applicable.

4.5 Optimization Techniques

4.5.1 Transaction Optimization

- **Minimal Gas Fees**: Smart contracts are designed with minimal computation to reduce gas fees on Solana.
- **Parallel Transaction Processing**: Solana's architecture allows handling thousands of simultaneous votes without bottlenecking.

4.5.2 Frontend Optimization

- **Static Site Generation (SSG)** and **Server-Side Rendering (SSR)** (optional in Next.js) are leveraged for faster page load and SEO optimization.
- **Caching and Pre-Fetching**: Prefetching of static assets improves voting app responsiveness.

4.6 System Architecture

4.6.1 Architectural Pattern

The system follows a hybrid architecture:

- **Centralized Phase**: Voter registration and admin verification.
- **Decentralized Phase**: Actual voting, token burning, and result recording via smart contracts.

4.6.2 Data Flow

User Registration → Admin Approval → Token Allocation → Wallet Authentication → Vote Casting → Token Burn → Vote Storage

Chapter 5: Results and Conclusion

5.1 Results

The experimental results of the decentralized voting system demonstrate its effectiveness, security, and user-centric design. By utilizing Solana blockchain technology, the system ensures that votes are securely recorded, tamper-proof, and transparent. A user-friendly front-end interface guarantees smooth participation for voters, even under real-world conditions involving high transaction volumes and network fluctuations.

Key performance indicators (KPIs) such as transaction speed, system scalability, and user accessibility were evaluated. The system showed excellent performance in handling multiple concurrent votes with minimal latency and ensured that all votes were securely recorded without compromise.

5.1.1 Transaction Speed and Stability

The voting system displayed outstanding stability and responsiveness. Even under simulated high-load conditions, Solana's high throughput ensured that vote transactions were confirmed within a few seconds.

This high-speed performance is critical for scaling elections to large voter populations.

5.1.2 Security and Integrity

The system's security was assessed based on its resistance to common blockchain and network threats, such as transaction tampering, unauthorized access, and double voting. The use of Solana's cryptographic transaction signatures and programmatic smart contracts ensured:

- **Immutable Vote Records**: Once a vote was cast, it was permanently stored on the blockchain without the possibility of alteration.
- **Voter Authenticity**: Each vote was tied to a verified wallet address, ensuring legitimate participation.
- **Tamper Resistance**: The decentralized nature of Solana and its Proof-of-History mechanism safeguarded the election process from centralized attacks.

5.2 Conclusion

This project successfully demonstrates the potential of a decentralized voting system using the Solana blockchain, smart contracts, and secure web technologies. By leveraging Solana's high throughput and low-cost transactions, the system ensures that voting is transparent, tamper-proof, and scalable. Smart contracts were utilized to automate election processes securely without the need for centralized authorities, while web technologies such as React.js and Solana Web3.js enabled a user-friendly and responsive interface for voters.

Furthermore, features like real-time notifications, revoting before deadlines, multi-language support, and audio guidance significantly enhance the platform's accessibility and user experience. AI integration for administrative assistance further streamlines backend operations, making the system efficient and scalable for larger elections.

Overall, the system provides a practical, transparent, and secure solution for modern elections, addressing major concerns of traditional voting systems such as security, trust, accessibility, and administrative complexity.

5.3 Future Scope

The decentralized voting system can be further enhanced with additional features to improve user experience, accessibility, and administrative efficiency. Key areas for future development include:

5.3.1 Notifications and Alerts

A notification system can keep users informed about key election events, including:

- **Poll Openings**: Alerts users when voting starts.
- **Deadline Reminders**: Notifies users as the poll deadline approaches.
- **Result Announcements**: Informs users when the election results are available.

These alerts will ensure users stay updated and engaged throughout the voting process.

5.3.2 Revoting Before Deadline

Allowing users to modify their vote before the poll closes provides flexibility, ensuring they can correct any errors or make more informed choices. The system would track only the latest vote, preserving vote integrity while increasing user satisfaction.

5.3.3 Multi-Language Support

Integrating multi-language support would make the system more accessible to users from different linguistic backgrounds. This would enhance the platform's inclusivity, allowing global participation and improving the user experience across regions.

5.3.4 Audio Guidelines

To improve accessibility for users with limited literacy or disabilities, adding **audio guidelines** will guide users through the voting process. This feature ensures that even users with low literacy can easily understand and participate in elections.

5.3.5 AI Integration for Admin Support

AI can assist in simplifying administrative tasks such as:

- **Automated Election Setup**: Streamlining the creation of elections.
- **Data Analysis**: Monitoring voting trends and detecting anomalies.
- **Voter Support**: AI-powered chatbots can answer voter queries and assist with issues.

This will reduce administrative workload and improve system efficiency, especially for large-scale elections, and also proposed features aim to improve the decentralized voting system's accessibility, flexibility, and efficiency. By integrating notifications, multi-language support, revoting capabilities, audio guidelines, and AI, the system can cater to a broader audience, streamline operations, and enhance the user experience.

Chapter 6: References

[1] A. Yakovenko, "Solana: A new architecture for a high performance blockchain," 2017. [Online]. Available: https://solana.com/solana-whitepaper

[2] Solana Foundation, "What is Solana?," Solana Documentation, 2023. [Online]. Available: https://docs.solana.com/

[3] A. Yakovenko and G. Fitzgerald, "Sealevel: Solana's Parallel Smart Contracts," 2021. [Online]. Available: https://solana.com/news/sealevel-solanas-parallel-smart-contracts

[4] Solana Labs, "Tower BFT: Solana's Byzantine Fault Tolerance Mechanism," Technical Report, 2021. [Online]. Available: https://docs.solana.com/cluster/overview

[5] A. Susanto, "Smart contract blockchain pada e-voting," Jurnal Informatika Upgris, vol. 5, 2019. https://www.academia.edu/57473875/Smart_Contract_Blockchain_pada_E_Voting

[6] J. G. Song, S. J. Moon, and J. W. Jang, "A scalable implementation of anonymous voting over ethereum blockchain," Sensors, vol. 21, 2021. https://www.mdpi.com/1424-8220/21/12/3958

[7] D.-C. Barbu, G. Dobrița (Ene), S.-V. Oprea, A. Bâra, and V. Diaconița, "Challenges and Benefits of Blockchain-Based Electronic Voting System," *Romanian Journal of Information Technology and Automatic Control*, vol. 32, no. 4, pp. 117–128, 2022. [Online]. Available: https://rria.ici.ro/en/vol-32-no-4-2022/challenges-and-benefits-of-blockchain-based-electronic-voting-system/

[8] S. S. Gandhi, A. W. Kiwelekar, L. D. Netak, and H. S. Wankhede, "Security Requirement Analysis of Blockchain-Based E-Voting Systems," *arXiv preprint arXiv:2208.01277*, 2022. [Online]. Available: https://arxiv.org/abs/2208.01277

[9] U. Prashanth, M. Muneeruddin, T. Bhanuprakash, R. V. Reddy, and S. Kartania, "A Review of a Blockchain E-Voting System for Secure Voting," *International Journal of Engineering Research and Technology*

(IJERT), vol. 12, no. 8, 2023. [Online]. Available: https://www.ijert.org/a-review-of-a-blockchain-e-voting-system-for-secure-voting