Blockchain Based Secure Voting System

Election integrity depends on trust: voters must believe every ballot was counted exactly once and that results cannot be altered after the fact. Conventional electronic voting systems centralize this trust in a database and an administrator, creating single points of failure that are difficult to audit. This project presents VoteChain, a decentralized voting system built on an Ethereum-style blockchain, in which each vote is recorded as an immutable on-chain transaction enforced by a smart contract.

The system architecture separates concerns across three layers. The smart-contract layer, written in Solidity, encodes the entire election rule set: voter eligibility, a one-vote-per-registered-voter constraint, voting-window enforcement, and final tally computation. Because these rules execute on-chain, they cannot be bypassed by the application server or an administrator. The application layer, built with Web3.js and a Node/Flask backend, provides the VoteChain voter registration flow, ballot interface, and admin election management. The presentation layer renders a real-time tally dashboard that any observer can cross-check against the ledger, giving voters a transaction-hash receipt to verify inclusion of their ballot.

Key design decisions address the classic tensions of blockchain voting. Voter identity is registered off the critical path while the ballot itself carries no identity linkage on-chain, preserving ballot secrecy. Gas costs are eliminated by operating on a private Ganache/Hardhat chain, making the system free to deploy and demo. Double-vote attempts are rejected deterministically by contract state, and any post-election modification of chain data triggers a tamper alert.

Evaluation covers contract-level unit tests, double-vote and replay attack rejection, and end-to-end election simulations. Limitations include reliance on a private chain rather than a public network, admin-mediated voter identity verification, and the absence of zero-knowledge proof constructions, which are discussed as future work. The project demonstrates how blockchain properties — immutability, transparency, and deterministic execution — map directly onto the requirements of trustworthy electronic voting.