Decentralize Based E-Voting System Using Blockchain Technology

[1]Poonam Tiware, [2]sushant Patil, [3]Jagruti Raut, [4]Sakshi Shelar, [5]Amol Mali

Computer engineering AMRIT
University Of Mumbai, India.

Abstract-

Building an electronic voting system that satisfies the legal requirements of legislators has been a challenge for a long time. Recently, the Electronic Voting Machines (EVMs) used for casting the vote. They are prone to tampering and electoral frauds. This project attempts to solve the above problems by storing the vote data shared among all the devices in the network and peer-to-peer verification is done to verify the authenticity of the vote data. In order to successfully tamper with the system, the data stored in all the nodes must be changed. This makes the proposed system more efficient and reliable. The idea in blockchain enabled balloting scheme isto integrate Aadhaar card and Mobile number of the people using which the OTP is generated and then the voter is allowed to cast their vote. The user can cast their votes from anywhere. They should provide a valid reason for not voting within a period of 6 months, if the reason is invalid then the government will take necessary action. The implementation of this system addresses most of the issues faced in the balloting scheme and is used to avoid proxy casting and recasting and is also used to achieve above 95% of the vote.

Keywords -Blockchain, Smart Contracts, Electronic voting, Privacy, Ethereum.

Published in IJIRMPS (E-ISSN: 2349-7300), Volume 12, Issue 2, March- April 2024

I. INTRODUCTION

The heart of democracy is voting. In order to ensure a fair and credible electionprocess, security and reliability must be guaranteed in every stage of the process. The success of a democracy depends on the degree of fairness and reliability of its elections. At first, elections in India were conducted using paper ballots. In the paper ballot-voting scheme, voters marked their choice of candidates in a piece of paper known as the ballot paper and placed them in the ballot box. Mostly, these ballots were manually counted and this led to a considerable delay in the election process. In addition, there was no guarantee of vote secrecy. In some constituencies there were allegations of booth capture and 'ballot stuffing' by party loyalists.

In order to overcome the problems in paper ballots, the Election Commission of India introduced Electronic Voting Machines (EVMs) in the 1990s. Electronic Voting Systems greatly reduce the time taken for the election process; there is still some degree of manual counting involved. Each EVM displays the total vote count for each candidate in a particular region of a constituency. In order to obtain the final consolidated vote count, the EVMs from all the regions in the constituency are taken to a secure location and the total votes in each EVM are tallied in front of the representatives of all political parties.

Blockchain is the robust, immutable and the most trusted technology that contains a block of data linked using cryptography, which is based on a peer-to-peer(P2P) network. Blockchain was first developed to support Bitcoin, which is a peer-to-peer electronic cash system. Few years after bitcoin, emerged a new cryptocurrency named "Ethereum". Ethereum is a decentralized platform that enables developers to form/develop smart contracts using a tuning-complete Ethereum virtual machine and allows anyone to

run decentralized applications(DApps).
The main contribution of this solution is to keep the voting data confidential by encrypting the data and storing it in the blockchain as blocks and to avoid duplicate votes polled during the election process. Thus, it aims at data integrity and data immutability and tries to achieve maximum number (above 95%) of votes through an online voting web-based application using Ethereum Blockchain.

II. BLOCKCHAIN OVERVIEW

Blockchain is essentially an open, distributed database of records or a public ledger of all transactions or digital events that have been occurred and shared among participating parties connected within a network. A blockchain is a chain of blocks where blocks are connected to form a chain of blocks that holds data or information regarding any event. Each transaction or activity within the blockchain is verified by consensus of a majority of the participants i.e. without the approval of the majority network; an activity cannot be taken into consideration. Once some datahas been inserted into a blockchain, it becomes very difficult to change it due to having immutability configuration. In order to rewrite any data, dishonest miners must re-write the previously broadcasted block, sand the changes have to be agreed by the other miners in the network.
The structure of a block in blockchain is described below:
Data- The data can be the type of information is
stored in the block.
Hash- The hash is a kind of fingerprint that uniquely identifies a block and is deter-mined by its contents.
Hash of previous block- Points the previous block to form the chain, a change in a single hash causes the after created blocks to change their hash.

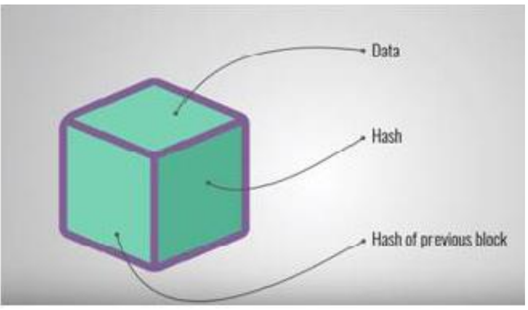


Figure.1 Block Representation

Every block has data, hash of the block and hash of previous block. When new block is created then hash of previous block is store in this block and then hash of new block is calculate and store in it. In this way, blockchain is created.

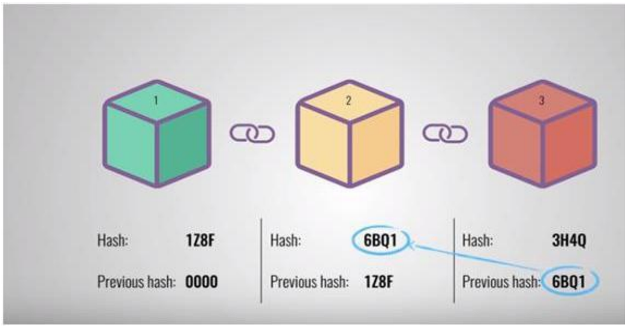


Fig.2 Blockchain Creation

Let us consider an example; here we have a chain of three blocks. As you can see, each block has hash and hash of the previous block. Therefore, block3 points to block2 and block2 points to block1. The first block is bitspecial; it cannot point to the previousblock because it is the first one. We call this block as Genesis block.
Now let us say, you tamper with the second block, this causes the hash of the block to change as well.

In turn, it will make block3 and follow block invalid because they no longer store a valid hash of the previous block. So, changing a single block will make all following block invalid. Since they are a limited set of the candidate, you can change the value of theblock and make the block valid such that every further block from the tampered block become valid. This is how transparency, accuracy, and security of the voting system are achieved.

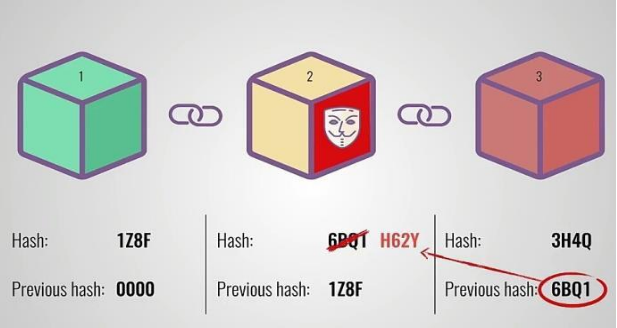


Fig.3 Tamper with the Block

A. *How Blockchain Works?*

When a block stores new data, it is added to the blockchain. Blockchain, as its name suggests, consists of multiple blocks strung together. In order for a block to be added to the blockchain, however, four things must happen:

i. A transaction must occur.
ii. That transaction must be verified.
iii. That transaction must be stored in a block.
iv. That block must be given a hash.

B. *Is Blockchain Fully Secure?*

Always new blocks were stored linearly and chronological order. That is, new blocks always added at the end of Blockchain.Once a block added to the Blockchain, it is very difficult (not impossible) to alter the contents of the block. Each block has a unique hash, connected with the previous block hash. Hash codes are created by a math function that converts all information into a string of numbers and letters. If anything is changed in the information, the hash value changed and blockchain rejects the block.

If a hacker wants to change your data or any information on the blockchain, he/she need to change theentire blockchain network, which requires a lot of computational power and time-consuming.

When a hacker tries to edit any information of the transaction, the block hash will be changed and every block contains the hash of the previous block. Therefore, what happens here is the next block contains the hash of the block hacker wants to change or edit the transaction information, so if the hacker wants to clear blockchain he needs to change the hash of the next block also will accept his tracks and the block. This process goes on until the hacker changes the hash of all blocks; this will take a lot of computational power and energy (money).

C. *Types of Blockchain*

Depending on the scope of theapplication, blockchains may be of the following types:

1) Public: It is a permission less blockchain in which any user can join by creating a personal address. All users have both read and write permissions. Additionally, a user is allowed to choose whether to become a miner or simply run a node on the system. A miner is a node, which verifies the transactions of other nodes and is paid in cryptocurrency for its work.

2) Private: It is a permissioned blockchain, whichis controlled by a central authority. It allows only authorized or trusted participants to join the network, validate and view transactions. The user details are also concealed from third parties.

3) Consortium: It is also a type of permissioned blockchain. It is like private blockchain except that permissions are controlled by a group of individuals or organizations known as a consortium, rather than by a central authority.

4) ***Hybrid:*** It is a combination of permissioned and permission less blockchain.

D. *Ethereum*

Ethereum is a public decentralized blockchain network. Ethereum is platform that allows programmers to build decentralized applications using blockchain technology. It is a permission-less blockchain network.Ethereum has two account types.

i. External Accounts

ii. Contract Accounts

An externally owned account is a user- controlledaccount. It represents an external agent of network likeusers, miners etc. These accounts are regulated with apublic-private key cryptography like RSA algorithms. Users use mainly external accounts as a means tointeract with the Ethereum blockchain.

A contract account is a smart contract, which is acollection of code that regulates blockchain. These arestored at a specific address, hence considered as accounts.Contract accounts are always either invoked by someexternal accounts or by other contract accounts. Thesecontracts are written in high level scripting languages suchas Solidity and Serpent.Both of these accounts can store Ether. Ether is thecrypto currency of Ethereum, denoted by “ETH” in cryptocurrency exchanges. It is used for transactions fee andservices in the Ethereum network. These are used to payGas or transactions done. Gas is an intermediary token usedto make payment for computational work done forexecuting a smart contract or for some transactions.

E. *Smart Contracts*

Smart contracts are self-executable code written insideblockchains. These are similar to conventional businesscontracts that are used for code of conduct agreementbetween two parties. The smart contracts executeautomatically when the defined conditions are met. Smartcontracts help to carry out agreements and transactions in atrusted manner among the untrusted or unknown partieswithout the requirement of central authority.

Smart contracts are written using Solidity language. It isan object-oriented language, and its syntax are similar toJavaScript or Python. Smart contracts have several benefitsover conventional contracts like cost saving, and improvedefficiency. Smart contracts are popular as they are easilyverifiable by all users and ensure trust among parties.

In this implementation, smart contracts are used as ballots to enforce the election agreement. Specifically, we want the contract to contain a voting function that can only be called once per valid voter and that is executed as a transaction in the blockchain.

III. RELATED WORK

This paper evaluates the use of blockchain as a service to implement an electronic voting (e-voting) system [1]. It felicitates the legal and technological limitations of using block chain as a service for realizing such systems. They defining a smart contract includes identifying the roles that are involved in the agreement and the different components and transactions in the agreement process. The process of an election and implementing a block-chain based application, which improves the security and decreases the cost of hosting a nationwide election. It is immutable and self- executed.

In thepaper [2], the android app is developed for blockchain based e-voting. In this, a PIN based authentication scheme is used to verify the voters and enable them to check their votes after the election process is over. Two separate blockchains are used to store the votes and the voter IDs of the voters who had cast their vote.

It is based on Ethereum network and uses decentralized applications (dapps) for user interface [3]. The authors propose three dapps. One is the Admin dapp, which is for management to set policies etc. Another dapp is Voter dapp used by individual users to register and vote. Then the Tally dapp is used to tally and declare election results.

In the paper [4], the open source blockchain based technology that uses both private blockchain and remix.

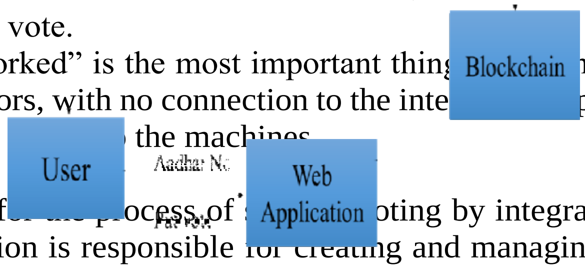
IV. EXISTING SYSTEM

Electronic Voting Machines ("EVM") are being used in Indian General and state elections to implement electronic voting in part from 1999 elections and recently in 2019 Vidhan Sabha Elections. Before EVM, vote counting was done by paper ballot but with the advancement in technology, electronic voting machines appeared. EVMs have replaced paper ballots in local, state and general elections in India.

There are two units in EVM: the control unit and the balloting unit. These units are joined together with the help of cable. The control unit of the EVM is kept with the presiding officer or the polling officer. The balloting unit is kept within the voting compartment for electors to casttheir votes. This application, where the voter is allowed to cast their vote from anywhere and poll their vote. The server will authenticate each user by Aadhar number. In order for the user to login into the application corresponding OTP will be generated for the registered mobile number. The user must enter the Aadhar number and the OTP based on which the corresponding contestant are notified to the user.

Blockchain technology can be one solution to solve the problems that often occur in the electoral system. The use of hash values in recording the voting results of each polling station linked to each other makes this recording system more secure and the use of digital signatures makes the system more reliable. The use of the sequence proposed in the blockchain creation process in this system considers that in an electoral system not required for mining as in the Bit coin system because the voter data and numbers are clear and are not helps polling officer to verify your identity. With the EVM, allowed to select more than once, the proposed sequence instead of issuing a ballot paper, the polling officer will press the Ballot Button, which enables the voter to cast their vote. A list of candidate's names and/or symbols will be available on the machine with a blue button next to it. The voter can press the button next to the candidate's name they wish to vote.

No part of the EVM is "networked" is the most important thin achines are extremely simple machines, like pocket calculators, with no connection to the inte perating system and no way of being altered without physical the machines.



V. Proposed work

We present various solutions for the process of oting by integrating e-voting and Blockchain technology. The web application is responsible for creating and managing the new voting events. The Admin stores the information such as Aadhar number, constituency and the details necessary for both the candidate and the user through a web application. These details are then carried out to the server and maintained.

platform and it acts as a tool in storing the data. The user can ensures that all nodes Which is legally connected and can avoid collision in transportation.

The main contribution of this solution is to keep the voting data confidential by encrypting the data and storing it in the blockchain as blocks and to avoid duplicate votes polled during the election process. Thus, it aims at data integrity and

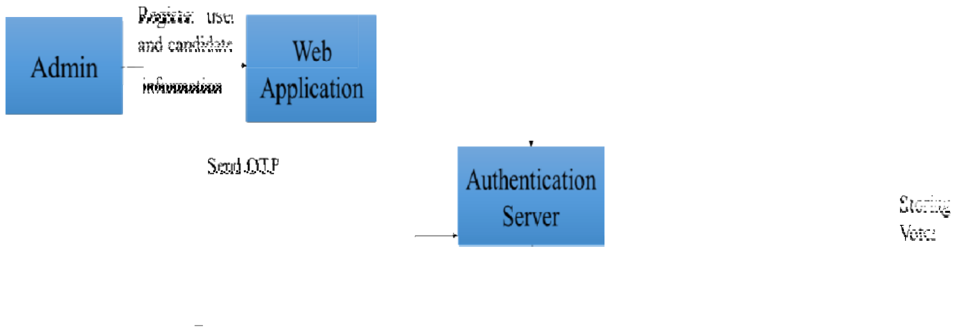


Fig.4 Electronic voting system

The voting event takes place through a web cast their votes from anywhere (nearby booth) and the corresponding contestant are notified to the users based on their constituency and candidate.

A. Disadvantges

1. Vulnerability to hacking.
2. Susceptibility to fraud.
3. Malicious programming.
4. The time gap between the voting and counting of votes is large which leads to tampering.
5. Due to the physical accessibility to the EVM, the third party can interrupt and change the count of votes.

data immutability and tries to achieve maximum number (above 95%) of votes through an online voting web-based application using Ethereum Blockchain.

Fig. 4 System Architecture

VI. IMPLEMENTATION AND RESULTS

Our system consists of features for the ability of the user to verify their vote. The data are double encrypted before they are sent to the blockchain. The votes are counted based on the constituency of the candidate for the results.

A. *Ballot Creation*

Registration process of voters and candidates is to be done in advance. Identity verification should be done before creating accounts. After identity verification, authorized person should authenticate eligible users by proving a coin or token. Using this coin or token each user can vote only once. Blockchain's verification process will ensure that double spending of this token is not possible. So, any user cannot virtual node. Ganache can be connected with wallets for transactions.

For this implementation, Meta-mask is used. Meta- mask is a chrome extension, which connects to Ethereum nodes and reads user wallets. Meta-mask uses RPC to connect

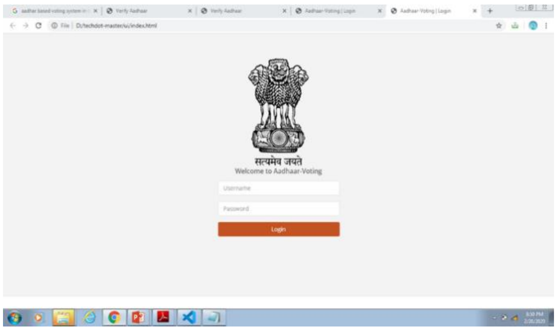


Fig. 5 Admin Login

with Ethereum nodes.

In this implementation, smart contracts are used as ballots to enforce the election agreement. Specifically, we want the contract to contain a voting function that can only be

vote multiple times. The e-voting system based on blockchain called once per valid voter and that is executed as a is decentralized. There is no central authority to conduct the

elections.

The e-voting decentralized application, or dApp, is built on the Ethereum blockchain. Ethereum smart contract is written in Solidity for casting votes. A client-side user transaction in the blockchain. Moreover, in order to facilitate the vote count process, we want our contract to provide functionality for checking the total number of votes that a specific candidate has. However, since voters should not have access to partial vote counts before casting their votes, only interface is built to use Ethereum accounts to cast votes.the administrators of the election should be able to call these

Truffle Framework is used in this implementation to test the smart contracts and deploy them to the blockchain. Truffle framework facilitates to develop, test and deploy decentralized applications. It provides a development environment for blockchain network. Truffle development framework can be used to build smart contracts, compile built-in contracts; link and deploy those contracts.

Ganache is part of Truffle ecosystem. It provides a private blockchain for Ethereum development. It can be seen as an Ethereum client. It can be used to test the decentralized application built on truffle. It can be used to deploy contracts while developing decentralized applications. It also facilitates functions.

B. Voting Process

We now describe a typical interaction of a user with the proposed scheme based on our current implementation of the system. Typically, a voter logs into the system by providing his/her Aadhar number and OTP. If the match is found, the voter is then presented with a list of available candidates with the option to cast vote against them. On the contrary, if the match were unsuccessful, any further access would be denied. This function is achieved using appropriate implementation of the authentication mechanism and

to run tests on blockchain and smart contracts. Once the predefined role-based access control management.

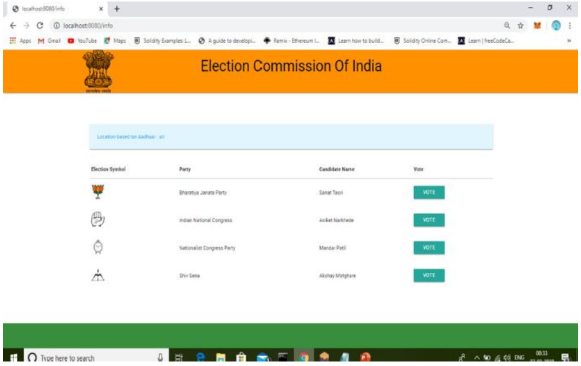
application is tested on ganache, it can be deployed on Furthermore, it is also envisioned that a voter is assigned to Ethereum client like Geth. Ganache provides a local and virtual blockchain for testing. It provides ten external user their specific constituency and this develop the list ofcandidates that information is used to a voter can vote. The accounts. Each account in Ganache has been assigned a

unique Ethereum address and a private key associated with it. All the accounts come preloaded with 100 ‘fake’ ethers.

Ganache comes in two versions, CLI and UI. This implementation has used UI version for simplicity. Running ganache is similar to running an Ethereum node. It is like an assignment of voter to a constituency is rendered an offline process and therefore out of scope of this research.

After a successful vote-cast, multiple miners for validation following which valid and verified votes are added into public ledger mine it. The security considerations of the votes are based on blockchain technology using cryptographic hashes to secure end-to-end verification. To this end, a successful vote cast is considered as a transaction within the blockchain of the voting application. Therefore, a vote cast is added as a new block (after successful mining) in the blockchain as well as being recorded in data tables at the backend of the database. The system ensures only one-person, one-vote (democracy) property of voting systems. This is achieved by using the voter's unique thumbprint, which is matched at the beginning of every voting attempt to prevent double voting. A transaction is generated as soon as the miners mine the vote, which is unique for each vote. If the vote is foundmalicious,miners reject it.

After validation process, a notification is immediately sent to the voter through message or an email providing the above-defined transaction id by which user can track his/her vote into the ledger. Although this functions as a notification to the voter, however it does not enable any user to extract the information about how a specific voter voted thereby achieving privacy of a voter.

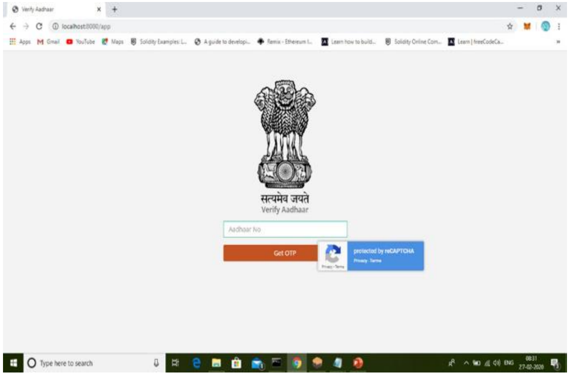


Election Commission Of India

Location based on Aadhaar : a1

Election Symbol	Party	Candidate Name	Vote
	Bharatiya Janata Party	Sanat Taori	VOTE
	Indian National Congress	Aniket Narkhede	VOTE
	Nationalist Congress Party	Mandar Patil	VOTE
	Shiv Sena	Akshay Motghare	VOTE

Fig. 6 Aadhar Verification

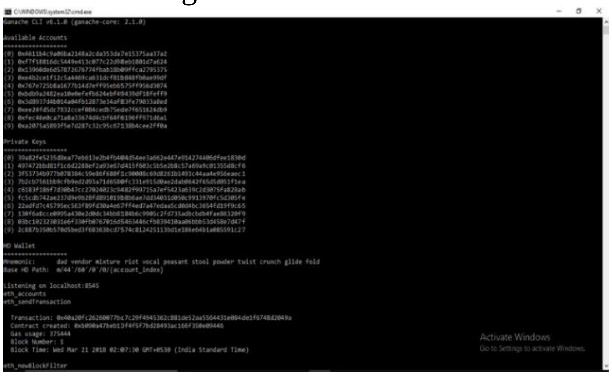


Verify Aadhaar

Aadhaar No

Get OTP

Fig. 7 OTP Verification



C:\WINDOWS\system32\cmd.exe
Activate Windows
Go to Settings to activate Windows.

```
Ganache CLI v6.1.0 (ganache-core: 2.1.0)

Available Accounts
==================
(0) 0x4611b4c9a06ba2148a2cda353da7e15375aa37a2
(1) 0xf7f18816dc5449e413c077c22d98eb1801d7a624
(2) 0x13960de6d57872676774fbab18b09ffca2795375
(3) 0xe4b2ce1f12c5a4469ca611dcf81b848fb0ae99df
(4) 0x767e725b8a1677b14d7eff95eb6575ff956d3074
(5) 0xbdb9a2482ea10e0efefb624ebf49439df18feff9
(6) 0x3d8937d4b014a04fb12873e34af83fe79033a8ed
(7) 0xee24fd5dc7832ccef084cedb75ede7f651624db9
(8) 0xfec46e0ca71a8a33674d4cbf64f0196ff971d6a1
(9) 0xa2075a5893f5e7d287c32c95c67138b4cee2ff0a

Private Keys
==================
(0) 39a82fe5235d8ea77eb613e2b4fb404d54ee3a662e447e914274406dfee1830d
(1) 497472bbd81f1c6d2288ef2a93e67d415f603c5b5e2b8c57a69a9c01355d8cf6
(2) 3f53734b977b078384c59e86f680f1c90008c69d8261b1493c44aa4e956eaec1
(3) 7b2cb7561bb9cfb9ed2d93a71d6580fc331e915d0ae2dab0642f65d5d051f1ea
(4) c6183f186f7d30b47cc27024023c9482f99715a7ef5423a639c2d3075fa828ab
(5) fc5cdb742ae237d9e9b28fd891019b8b6ae7dd34031d050c9913970fc5d305fe
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(7) 130f6a8cce0995a430e2d0dc34bb8184b6c9905c2fd735adbcbdb4fae86320f9
(8) 03bc102323031e6f330fb0767016d5463446cfb839410aa06bbb53d458e7d47f
(9) 2c887b350b570d5bed3f683638cd7574c812425113bd1e188e64b1a085591c27

HD Wallet
==================
Mnemonic:      dad vendor mixture riot vocal peasant stool powder twist crunch glide fold
Base HD Path:  m/44'/60'/0'/0/{account_index}

Listening on localhost:8545
eth_accounts
eth_sendTransaction

  Transaction: 0x40a20fc26260077bc7c29f4945362c881de52aa5564431e084de1f6748d2049a
  Contract created: 0xb090a47beb13f4f5f7bd28493ac166f350e09446
  Gas usage: 375444
  Block Number: 1
  Block Time: Wed Mar 21 2018 02:07:30 GMT+0530 (India Standard Time)

eth_newBlockFilter
```

Fig. 8 Candidate details

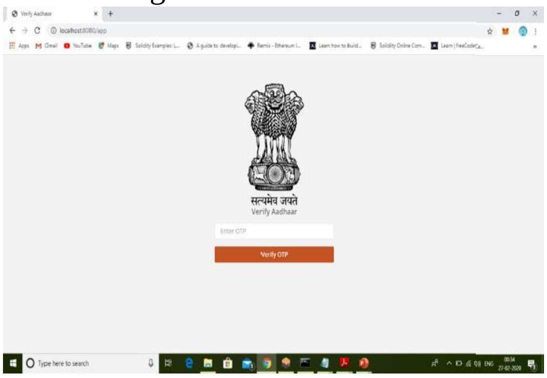
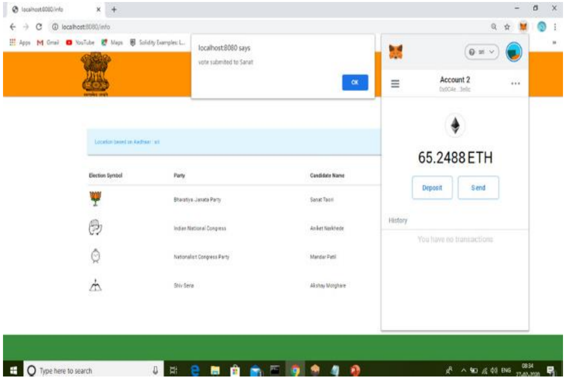


Fig. 9After Votings



localhost:8080 says

vote submitted to Sanat

Election Symbol	Party	Candidate Name
	Bharatiya Janata Party	Sanat Taori
	Indian National Congress	Aniket Narkhede
	Nationalist Congress Party	Mandar Patil
	Shiv Sena	Akshay Morghare

Fig. 10 Storing in Blockchain

C. *Storing Votes in Blockchain*

Once the vote is polled, the vote log is taken for the candidate, these details are double encrypted using AES and RSA algorithms, and the key is sent to the block of blockchain. Blockchain runs in the port 8545. Then it returns the hash code, block number etc.,the block number is retrieved and are stored in the database. A vote is considereda transaction. Thus, the vote is verified using arbitration server. Remix is a powerful, open source tool, whichis used to write solidity contracts from the browser. It is a browser-based compiler and IDE, whichis used to build ethereum contracts and debug transactions.

Each vote is appended onto the blockchain by its corresponding ballot smart contract, if and only if all corresponding district nodes agree on the verification of the vote data. The vote is considered as valid, only when it match with the smart contract. These transactions are broadcast over the blockchain network.

The process of counting the votes of the candidate is a simple process. The block number is given as input to the blockchain, then the data is double decrypted and maximum count of the parties are calculated.If any of the citizen fails to vote then a warning SMS will be sentto justify their reason. If the reason is invalid then the government will take necessary action.

VII. ADVANTAGES

1. The e-voting system should not allow access to invalid candidates.
2. Any voter should get only a single chance to vote.
3. It should provide complete privacy to voters and the votes should not be traceable.
4. It should not allow tampering with the votes casted by anyone.
5. The system should not allow single authority control on counting.
6. Reduce the cost.
7. The proposed system also increasing the number voters.

VIII. CONCLUSION

In this paper, we introduce a unique, blockchain- based electronic voting system that utilizes smart contracts to enable secure and cost-efficient election while guaranteeing voters privacy. 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. Our election scheme allows individual voter to vote at a voting district of their choosing while guaranteeing each individual voter vote is counted from the correct district, which could potentially increase voter turnout.

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