E-Voting Made Simple and Secure using Blockchain
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Abstract:
Electronic Voting System has been implemented in the form of Electronic Voting Machine since last few decades with benefits over paper-based systems for their increased efficiency and reduced error rate. However, there remains challenges to achieve wide spread adoption of such systems especially with respect to improving their resilience against attacks such as malicious attacks, EVM hack which leads to loss of data and vote count tampering. Blockchain is a disruptive technology of current era that promises to improve the overall resilience of e-voting systems and allows voter to vote from any constituency. Several researches done on blockchain have proved that its properties such as immutability of information, decentralization and high scalability can overcome the downsides of current electoral systems. The project work attempts to implement blockchain technology concepts to leverage the benefits of both for the better implementation of a digital voting system.

Keywords: Blockchain, Immutability, Decentralization, Smart Contract, Rinkeby Test Network

I. INTRODUCTION
An election is a formal group decision-making process by which a population chooses an individual to hold public office. Elections have been the usual mechanism by which modern representative democracy has operated since 17th century. The first Indian election was held in the year 1951-1952 for Lok Sabha. The election took place in the form of ballot box, wherein at the polling booth, each candidate’s name and symbol was written and votes were cast on piece of paper. The paper ballots method was widely criticized because of fraudulent voting and booth capturing, where party loyalists captured booths and stuffed them with pre-filled fake ballots. The printed paper ballots were also more expensive, requiring substantial post-voting resources to count hundreds of millions of individual ballots. Nearly after 50 years came a new standard means of conducting elections using Electronic Voting Machines (EVMs). They were introduced in Indian elections between 1998 and 2001, in a phased manner. The electronic voting machines have been used in all general and state assembly elections of India since 2004. Even after constant upgradation of EVMs, there still remain electoral frauds and discrepancies. Another issue with current voting system in India is that it does not allow for a citizen to vote from any pooling booth in the country. Thereasons stated serve as the main motivation for a need of a voting system that uses latest technologies to overcome all the previously existing drawbacks and set a new standard in the area of digital voting through its immutability of information, high scalability, high resilience and minimal flaws.

II. RELATED WORK
According to Fridrik P Hjalmarsson et al. [1], electronic voting systems which are implemented to reduce the cost of running elections focus to ensure election integrity by fulfilling the security, privacy and compliance requirements. The paper describes the implementation of blockchain as a service for e-voting, providing the details about the blockchain setup and smart contract. The evaluation of the blockchain implementation is also discussed highlighting the security it provides. According to Francesco Fusco et al. [2], it is possible to guarantee the security for e-voting using block-chain technology. This paper demonstrates a new voting system called crypto-voting which is implemented using blockchain to integrate procedures and events of an election. According to Clement Chan Zheng Wei et.al [3], blockchain technology provides a decentralized mechanism for e-voting system. This paper states that incorporation of blockchain technology into e-voting protocol can instill data integrity, data authenticity and data confidentiality.

III. EXISTING SYSTEM
Electronic voting has been an area of research focus for many years by using computing machines and equipment for casting votes and producing high quality and precise results in accordance with the sentiments of the participating voters. Various attempts have been adopted in practice to support election process. Initially counting system allowed the voter to cast vote on papers. Later on, those cards went through the process of scanning and tallying at every polling cell on a central server. Electronic Voting Machines (EVM) were put in place later on which were admired and acknowledged greatly by the voters.

The steps involved in casting a vote using EVM are:
1. The voter has to go to the polling booth in his constituency.
2. The polling officer verifies that the voter is a valid voter and belongs to the same constituency using the electoral roll that is generated well before the election.
3. Once verified the polling officer presses a button on the control unit (CU) which allows the voter to cast his vote.
4. The voter then moves to the ballot unit and presses the button against his choice of the candidate.
5. There is a beep sound after the vote has been registered and the VVPAT prints the choice of the voter on a paper which the voter can see for a while after which the paper gets stored in the VVPAT.

The procedure after the election gets completed:
1. The whole EVM is sealed in the presence of different stakeholders and then transported to a secure location at district headquarters under military/police protection.
2. On the day of the announcement of the results, the EVMs are taken out and the count from each of the EVM is tallied and the winners are announced.
3. The government also mandates that some random EVMs should be picked and the paper votes generated by the VVPAT should be counted and compared against the electronic tally to ensure that they are same.
4. In case of ambiguity, the paper votes are considered as the source of the truth.
5. The whole process of the election is recorded for security purposes.

**Drawbacks of Existing System:**
1. A person is required to vote in the same polling booth of constituency where he/she had registered, which severely affects the voting percentage as people tend to internally migrate.
2. Existing system requires security personnel to provide 3-tier security to EVMs and VVPATs post-election.

**IV. PROPOSED SYSTEM**
The proposed blockchain implementation is a web application which includes computer nodes (machines kept at polling booths) which are voting terminals, that have the list of voters of the nation with their identities in a public blockchain network such as Ethereum. Since the dataset is spread across the nation, it permits voters to cast their votes to candidate of appropriate constituency from any polling booth. As soon as a person casts vote, it would be reflected in the total votes casted, thereby giving almost real-time results. Decentralized networks are robust, as in, if one of the polling booths (system at polling booth) becomes corrupt, then remaining nodes of the network corrects the corrupted node. As the entire voting data will be on all the computer nodes, even if one of the nodes fail, there is no threat of losing data of all the votes which were cast on the computer system. The project attempts to leverage these properties of blockchain to achieve an efficient digital voting system.

**Advantages of proposed system:**
- Anonymity, privacy protection, robustness.
- Does not allow multiple voting
- No single point of failure as blockchain contains distributed ledger.
- Blockchain provides immutability which prevents tampering of votes.
- Proposed voting system reduces involvement of electoral duty personnel.
- Distributed dataset ensures voters can vote from any polling booth in the country provided his VoterId is in the database provided by the ECI which increases the voting participation in the election.

**V. SYSTEM IMPLEMENTATION**
The front end of the proposed system is implemented using HTML5, CSS3, React.js and Node.js as server side scripting language. Smart Contract is written using Solidity. Smart Contract is written and deployed in Remix IDE.

**System Architecture**

**The system can be divided into three parts:**

a) **The Frontend**
- The interface validates the voter and loads the candidate list of constituencies on to the screen based on the voter’s details if the voter has not voted.

b) **The Backend**
- This part of the system manages and controls all the different components.
- It sends the data of the candidates list to the frontend by fetching it from a remote database.
- It accepts the request from the frontend to cast a vote and then it is added as transaction to the blockchain network.

c) **The Blockchain network**
- Smart contract is deployed which contains the code that runs whenever a transaction is made.

**System Processes:**
- The contract is deployed on Rinkeby test network by the Election Head. (The Metamask account of Election Head).
- Adding of constituencies, citizens, candidates and polling booth.
- Election Head starts the election process.
- The voter id is validated at the time of voting at polling booth and later allowed to vote.
- Citizens cast the vote for the candidate of their choice at the polling booth.
- Election Head ends the election.
- Votes for each of candidates is calculated and rank is assigned for each of them.

**Testing and Results:**
Unit testing was performed on the system and the following results were obtained:
Table 5.1, compares decentralized e-voting and normal voting based on different criteria and gives an overview of both the voting process.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Feature</th>
<th>Existing Voting</th>
<th>Proposed Voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verification</td>
<td>Vote cannot be tampered</td>
<td>Vote can be tampered</td>
</tr>
<tr>
<td>2</td>
<td>Result Calculation</td>
<td>Time required</td>
<td>Time required</td>
</tr>
<tr>
<td>3</td>
<td>User Update</td>
<td>Flexible</td>
<td>Immutable</td>
</tr>
<tr>
<td>4</td>
<td>Technology Used</td>
<td>Smart Contract</td>
<td>Logical Contract</td>
</tr>
<tr>
<td>5</td>
<td>Cost</td>
<td>One time setup cost</td>
<td>Cost varies on several factor</td>
</tr>
</tbody>
</table>

Table 5.2, shows the functions of the contracts being executed and time taken to execute each function individually.
Table 5.2. Contract Execution Time

<table>
<thead>
<tr>
<th>Sn.</th>
<th>Contract</th>
<th>Avg time(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Add Voter</td>
<td>9.99</td>
</tr>
<tr>
<td>2.</td>
<td>Add Polling Booth</td>
<td>5.54</td>
</tr>
<tr>
<td>3.</td>
<td>Add Voting Booth</td>
<td>5.47</td>
</tr>
<tr>
<td>4.</td>
<td>Add Candidate</td>
<td>12.37</td>
</tr>
<tr>
<td>5.</td>
<td>Cancel vote</td>
<td>8.17</td>
</tr>
</tbody>
</table>

Table 5.3, evaluates average time taken and cost that is gas used to deploy the contracts. Each time a contract is deployed, its execution time and cost of deployment that is gas used is noted. Five observations are taken and average of these values are calculated. Execution time varies at each deployment but the gas used for deployment always remains the same.

Table 5.3. Contract Deployment Time

<table>
<thead>
<tr>
<th>Contract</th>
<th>Time(s)</th>
<th>Cost(gas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.62</td>
<td>35992728</td>
</tr>
<tr>
<td>2</td>
<td>15.55</td>
<td>35992728</td>
</tr>
<tr>
<td>3</td>
<td>15.59</td>
<td>35992728</td>
</tr>
<tr>
<td>4</td>
<td>15.20</td>
<td>35992728</td>
</tr>
<tr>
<td>5</td>
<td>15.62</td>
<td>35992728</td>
</tr>
</tbody>
</table>

VI. CONCLUSION AND FUTURE WORK

The proposed electronic voting system is based on the Blockchain technology. Any registered voter will have the ability to vote in any polling booth in the country. The Blockchain-based system will be secure, reliable, anonymous and will help increase the number of voters as well as the trust of people in their governments. The current existing system is shown to have large number of issues which can lead to widespread political unrest in a country. Hence, it is vital for a democracy to have a transparent voting system that must have the least number of obstacles for a voter to vote. The proposed system is shown to be highly cost efficient and can be implemented with existing infrastructure owned by a nation. Considering all these factors, the proposed system would be a comprehensive solution that satisfies all the requirements. In the future, this system can be improved for better accuracy and authentication using biometric identification technique.

VII. REFERENCES

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[2]. Francesco Fusco, Maria Ilaria Lunesu, Filippo Eros Pani, Andrea Pinna, “Crypto-voting, A blockchain based e-voting system”, in 10th International Conference on Knowledge Management and Information Sharing, JAN 2018
