



RECENT ONLINE VOTING SYSTEMS: STUDY & COMPARATIVE ANALYSIS

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Abstract: In this paper, we have analyzed different approaches to implement an electronic voting system. We have discussed these approaches with respect to voter anonymity and security from manipulations. This paper mainly focuses on the various proposed methodologies which are used to tackle the important issue of E-Voting or Online Voting. In this paper, we have presented the exhaustive analysis of the vast literature relevant and pertinent to Online Voting and the mechanisms associated with it. Although, there are lot many research contributions in this field, but here we have critically analyzed and summarized twenty significant research works and projects addressing it. These related works are recent, consistent and pertinent. The studied literature is also systematically arranged in tabular form for comparative analysis. Although different approaches used different platforms or technology, most of the techniques revolve around the use of fingerprint scans, face recognition and UID database information.

Index Terms – Artificial Intelligence, Big Data, Blockchain Technology, Cloud Technology, Electronic Voting System (EVS), Information Technology, Internet of Things, Online Voting

I. INTRODUCTION

Voting is commonly related to politics and is finished with often exploitation and manual approach where voters stand to vote for his or her decisions. Manual voting may lead to malpractices sometimes, so there is a need to implement online voting system. This is for expand the technology from manual voting system to digital voting system. Mainly EVS depend on electronic technology for their correct functionality. Inherently, EVS poses many technical challenges with respect to verifiability, dependability, security, anonymity and trust. Also, by making changes in EVS, leads to various social and political implications. The part of election organizers is unnaturally different when complex communications is involved in the process. Electronic voting has been stationed in numerous different types of election throughout the world for several decades.

Elections form a major part of any democratic society to elect its new government. In earlier times, paper-based elections were conducted. In that, voters cast their votes on the ballot paper and then drop that paper in sealed boxes provided by the election department. When the elections end, the secret ballots are opened and manually counted to proclaim results. But in this process sometime there can be manually error or cheating to declare the results. Also, there is lot of wastage of paper and manpower [1].

The Indian government installed direct record electronics - DRE voting system which are popularly known as E-voting machines – EVMs. The ideation in this work is to redesign electronics voting system to make the system more efficient and reliable [1]. However, the manipulation of voting results still exists. The unreliable nature of the voting system and delays in results of the existing system is the prime motivation to study for alternative and more secure methods of online voting. Also, the COVID-19 Pandemic have accelerated the use of technologies which includes online shopping, digital payments, telehealth, AI, Remote work, Distance education and online internet. So online voting also seems imminent..

II. LITERATURE REVIEW

Although there are many researches works on online voting systems, here we have critically analyzed and summarized twenty research works and projects which are more relevant, recent and pertinent. It is observed that most the recent works addresses the issue of online voting and use of various information technologies.

In the year 2020, Vivek S K, et.al., developed a secure, transparent and decentralized e-voting system is proposed using the Hyperledger Sawtooth blockchain framework [1]. Restricted access of the system through election polling stations allows voters to cast their votes, which are recorded in the immutable blockchain state. Fairness and reliability of the election procedure due to nil possibility of vote manipulation. The issue of fairness and reliability of the election procedure due to nil possibility of vote manipulation was addressed. The technology/platform used were Angular 8, Node.js, Amazon RDS, and Sawtooth blockchain, Python with the APIs, Docker technology, Amazon Web Services.

In the year 2021, Shubham Gupta, Divanshu Jain, Milind Thomas Themalil developed a system where the voter is registered into the system database well before the time of election [2]. Now at the voting time, In the first step voter must verify his/her government identity such as Aadhar card or voting card with his/her proper picture, once it is verified, he/she moves to the second step. In second step voter has to go under the face reorganization process. Once the corresponding matching or verification is done, the voter will move to next step to cast his/her vote at the EVM. The cast vote is shown on display for the satisfaction of voters. Then the voting data is continuously uploaded on ThingSpeak server. The election department can monitor the data in more reliable way so that no

discrepancy/ modification can take place later was addressed. The technology/platform used were PyCharm, JetBrains IDE using Python, IoT, ThingSpeak, Open Source Computer Vision Library OpenCV, Arduino.

In the year 2020, Naseer Abdulkarim Jaber Al-Habeeb, Dr. Nicolae Goga, Haider Abdullah Ali1, Sarmad Monadel Sabree Al-Gayar described an application for m-voting targeting the specific conditions of Iraq in the COVID situation [3]. In the current society, the application of which we are talking about, can also be seen as a significant help for a numerous amount of countries during the pandemic of COVID- 19. The application is based on Mobile technology. Mobile technology is chosen motivated by the fact that although people do not have computers, almost everyone has a mobile phone in Iraq. The technology/platform used were Android Studio, PHP- Restful Services for the BackEnd Component and MySQL database.

In the year 2020, Roopak T M, Dr. R Sumathi developed a scheme which provides the secured EVS by using biometric details and virtual ID of voters which is obtained from the Aadhar database. These details are mandatory before casting the Vote. Apart from this, as an additional measure, this system also uses the digital signature as the key for the encryption of the votes inside the block [4]. Aadhar integration to the EVS overcomes the duplication or tampering of votes. The technology/platform used were Blockchain Technology.

In the year 2021, Ganesh Prabhu S, et.al., developed the face scanning system is used to record the voters face prior to the election and is useful at the time of voting [5]. The offline voting system is improvised with the help of RFID tags instead of voter id. This system also enables the user the citizens to see the results anytime which can avoid situations that pave way to vote tampering. This paper focusses on a system where the user can vote remotely from anywhere using a computer or mobile phone and doesn't require the voter to got to the polling station through two step authentication of face recognition and OTP system. The technology/platform used were Arduino Uno, LCD Display, RFID, Push Button.

In the year 2003, Robert Kofler, Robert Krimmer, Alexander Prosser developed a system which can assure the a anonymity of the voter. This makes sure that there is little to no risk of tampering or manipulation of votes [6]. The issue of security and application choices for security was also addressed in this paper. The technology/platform used were Electronic Voting, Electronic Democracy, Internet Applications.

In the year 2021, Mohamed Ibrahim, et.al. discussed the design and development of ElectionBlock, a voting system that provides its own blockchain [7]. This paper address the considerations taken to develop and implement the centralized and independent blockchain network for use as a voting platform with the integration of biometrics for the purpose of enhanced user security. The technology/platform used were Merkle tree, SHA-256 algorithms, ElectionBlock blockchain.

In the year 2020, Shaikh Mohammad Bilal, Prince Ramesh Maurya developed Voting System utilizing Android Application is progressively effective that the great technique to do a political decision [8]. The task has build up an intuitive GUI board for casting a ballot framework. In addition, Apps Inventor 2 had been utilized to structure the whole task. The database that made additionally does the computation of the information before move the information to the official site. This framework has better exactness contrasted with the conventional strategy for tallying. The technology/platform used were Android applications.

In the year 2021, Awsan A. H. Othman, et.al developed an approach where the IoT and Blockchain have been used with this system to ensure that users' data are protected from theft and prevent eavesdropping or vote tampering to guarantee the integrity of the voting. The blockchain encrypts votes in order to protect every vote from forgery. The system assists the concerned authorities in obtaining results quickly without delay, taking into account the differences in voting process between government and private organizations [9]. Governments can establish referendums or elections, and anyone who has reached the legal age and has a voting card issued by the government will be able to vote, thus we get rid of the traditional methods and dispense with ballot boxes, standing in long queues and delay counting the votes that cost governments a lot of time, effort and money. The technology/platform used were IoT with Ethereum blockchain technology

In the year 2017, Dr. Z.A. Usmani, Kaif Patanwala, Mukesh Panigrahi, Ajay Nair, developed the online voting system which is a multi-purpose platform independent system which can be used by any organization and government to conduct the elections [10]. The user needs Aadhaar card number and a smartphone which has a barcode scanning feature implanted in them. The user can vote from anywhere as the system is online. The mentioned method is platform independent.

In the year 2010, Cesar R. K, et.al., describes two experiences: The first experiment, called International Direct Digital Election (ID2E), is made for testing the viability for the international voting by mobiles using SMS protocol, using Web 2.0 tools to facilitate discussions about the election main theme [11]. The second experiment is the construction of a voting prototype using Android platform smart phones, with applications and vote collecting databases available on dynamic web pages, trying to simulate de Identical Ballot Boxes strategy described in two papers of Alefragis, Lounis, Triantafillou and Voros. The two experiments are part of a mentioned e-Voting methodology, and were made with the final objective of surveying scenarios about international voting processes, to give some experimental base for future e-Voting projects at international level. The technology/platform used were Biometric and steganographic authentication, RSA algorithm Web 2.0 social networks Android smart phones, ID2E,

In the year 2015, Mohammad Hosam Sedky, Essam M. Ramzy Hamed, developed Voting Model System overcomes the issue of security obstacles. Before sending the final result report per polling station automatically to the district's committee, a paper copy of the final result report of each polling station will be audited manually by every candidate' representative and signed it as a proof of his agreement of the final result report [12]. Then, it will be delivered physically to the propagate district's committee Office. Judges in each district's committee office will compare the polling station physically delivered result report with the automatically received report to be sure that the results are accumulated successfully. The same process will be done in all the higher committees till the final results from the Governorates will be submitted automatically and physically signed to the HEC. The technology/platform used were ID card Reader, Fingerprint Reader, Visual Studio 2010, C# software and SQL Server 2008.

In the year 2020, Ramya Govindaraj, Kumaresan P, K.Sree harshitha developed an online voting system with features like the schemes that the specific party has implemented, based on the features we are going to vote [13]. The main reason we need to shift from normal voting system to online voting system is that we can consume our time and can vote from anywhere through online. The technology/platform used were C# as a programming language, Microsoft SQL server 2012 and Microsoft azure as a cloud.

The systematic representation of above online voting related work is given in Table 1. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the proposed methodology, issues addressed and the technology or platform used. Their claims are also highlighted.

Table 2.1: Comparative Analysis of the existing methods

Ref No	Name of Authors, Paper Title, Year	Proposed Methodology	Issue Addressed	Technology/ Platform Used
[1]	Vivek S K, et.al., "E-Voting System using Hyperledger Sawtooth", 2020	A secure, transparent and decentralized e-voting system is proposed using the Hyperledger Sawtooth blockchain framework. Restricted access of the system through election polling stations allows voters to cast their votes, which are recorded in the immutable blockchain state.	Fairness and reliability of the election procedure due to nil possibility of vote manipulation.	Angular 8, Node.js, Amazon RDS, and Sawtooth blockchain, Python with the APIs, Docker technology, Amazon Web Services (AWS)
[2]	Shubham Gupta, Divanshu Jain, Milind Thomas Themalil, "Electronic Voting Mechanism using Microcontroller ATmega328P with Face Recognition", 2021	In the first step voter must verify his/her government identity such as Aadhar card or voting card with his/her proper picture, once it is verified, he/she moves to the second step. In second step voter has to go under the face reorganization process. Once the corresponding matching or verification is done, the voter will move to next step to cast his/her vote at the EVM. The cast vote is shown on display for the satisfaction of voters. Then the voting data is continuously uploaded on ThingSpeak server. The election department can monitor the data in more reliable way so that no discrepancy/ modification can take place later.	The central office of election department can monitor the data in more reliable way so that no discrepancy/ modification can take place later.	PyCharm, JetBrains IDE using Python, IoT, ThingSpeak, Open Source Computer Vision Library OpenCV, Arduino.
[3]	Naseer Abdulkarim Jaber Al-Habeeb, et.al, "A New E-voting System for COVID-19 Special Situation in Iraq", 2020	In this paper, the authors have described an application for m-voting targeting the specific conditions of Iraq in the COVID situation. In the current society, the application of which we are talking about, can also be seen as a significant help for a numerous amount of countries during the pandemic of COVID- 19.	The application is based on Mobile technology. Mobile technology is chosen motivated by the fact that although people do not have computers, almost everyone has a mobile phone in Iraq.	Android Studio, PHP- Restful Services for the BackEnd Component and MySQL database.
[4]	Roopak T M, Dr. R Sumathi, "Electronic Voting based on Virtual ID of Aadhar using Blockchain Technology", 2020	The mentioned scheme provides the secured EVS by using biometric details and virtual ID of voters which is obtained from the Aadhar database. These details are mandatory before casting the Vote. Apart from this, as an additional measure, this system also uses the digital signature as the key for the encryption of the votes inside the block.	Aadhar integration to the evoting system overcomes the duplication or tampering of votes.	Blockchain Technology
[5]	Ganesh Prabhu S, et.al., "Smart Online Voting System" 2021	The face scanning system is used to record the voters face prior to the election and is useful at the time of voting. The offline voting system is improvised with the help of RFID tags instead of voter id. This system also enables the user the citizens to see the results anytime which can avoid situations that pave way to vote tampering.	This paper focusses on a system where the user can vote remotely from anywhere using his/her computer or mobile phone and doesn't require the voter to go to the polling station through two step authentication of face recognition and OTP system.	Arduino Uno, LCD Display, RFID, Push Button
[6]	Robert Kofler, et.al. "Electronic Voting: Algorithmic and Implementation Issues" 2003	The paper developed a system which can assure the anonymity of the voter. This makes sure that there is little to no risk of tampering or manipulation of votes	The issue of security and application choices for security was addressed in this paper	Electronic Voting, Electronic Democracy, Internet Applications
[7]	Mohamed Ibrahim, et.al. "ElectionBlock: An Electronic Voting System using Blockchain and Fingerprint Authentication", 2021	This paper discussed the design and development of ElectionBlock, a voting system that provides its own blockchain.	This paper address the considerations taken to develop and implement the centralized and independent blockchain network for use as a voting platform with the integration of biometrics for the purpose of enhanced user security..	Merkle tree, SHA-256 algorithms, ElectionBlock blockchain
[8]	Shaikh Mohammad Bilal, Prince Ramesh Maurya, "Online Voting System via Smartphone", 2020	The Voting System utilizing Android Application is progressively effective that the great technique to do a political decision. The task has build up an intuitive GUI board for casting a ballot framework. In addition, Apps Inventor 2 had been utilized to structure the whole task. The database that made additionally does the computation of the information before move the information to the official site.	This framework has better exactness contrasted with the conventional strategy for tallying.	Android application
[9]	Awsan A. H. Othman, et.al. "Online Voting System Based on IoT and Ethereum Blockchain" 2021	The IoT and Blockchain have been used with this system to ensure that users' data are protected from theft and prevent eavesdropping or vote tampering to guarantee the integrity of the voting. The blockchain encrypts votes in order to protect every vote from forgery. The system assists the concerned authorities in obtaining results quickly without delay, taking into account the differences in voting process between government and private organizations.	Governments can establish referendums or elections, and anyone who has reached the legal age and has a voting card issued by the government will be able to vote, thus we get rid of the traditional methods and dispense with ballot boxes, standing in long queues and delay counting the votes that cost governments a lot of time, effort and money.	IoT with Ethereum blockchain technology
[10]	Dr. Z.A. Usmani, et.al., "Multi-Purpose Platform Independent Online	In this paper, an EVS system is developed which is a multi-purpose platform independent system which can be used by any organization and government to	The user can vote from anywhere as the system is online.	Platform Independent

	Voting System", 2017	conduct the elections. The user needs Aadhaar card number and a smartphone which has a barcode scanning feature implanted in them.		
[11]	Cesar R. K, et.al., "Web 2.0 E-Voting System Using Android Platform", 2010	This paper describes two experiences: The first experiment, called International Direct Digital Election (ID2E), is made for testing the viability for the international voting by mobiles using SMS protocol, using Web 2.0 tools to facilitate discussions about the election main theme. The second experiment is the construction of a voting prototype using Android platform smart phones, with applications and vote collecting databases available on dynamic web pages, trying to simulate de Identical Ballot Boxes strategy described in two papers of Alefragis, Lounis, Triantafillou and Voros.	The two experiments are part of a mentioned e-Voting methodology, and were made with the final objective of surveying scenarios about international voting processes, to give some experimental base for future e-Voting projects at international level.	Web 2.0 social networks Android smart phones, ID2E,
[12]	Mohammad Hosam Sedky, et.al., "A Secure e-Government's e-Voting System" 2015	The mentioned EVS overcomes the issue of security obstacles. Before sending the final result report per polling station automatically to the district's committee, a paper copy of the final result report of each polling station will be audited manually by every candidate' representative and signed it as a proof of his agreement of the final result report. Then, it will be delivered physically to the propagate district's committee Office. Judges in each district's committee office will compare the polling station physically delivered result report with the automatically received report to be sure that the results are accumulated successfully. The same process will be done in all the higher committees till the final results from the Governorates will be submitted automatically and physically signed to the HEC.	The mentioned EVS is designed to address the cost effectiveness, and transparency problems. The system is also claimed to be accurate..	ID card Reader, Fingerprint Reader, Visual Studio 2010, C# software and SQL Server 2008
[13]	Ramya Govindaraj, Kumaresan P, K.Sree harshitha, "Online Voting System using Cloud", 2020	In this specific research mentioned idea is to implement online voting system with features like the schemes that the specific party has implemented, based on the features we are going to vote.	The main reason we need to shift from normal voting system to online voting system is that we can consume our time and can vote from anywhere through online.	C# as a programming language, Microsoft SQL server 2012 and Microsoft azure as a cloud.

III. PROBLEM FORMULATION AND POSSIBLE APPROACH

After studying the vast literature, we have identified the problem and a possible approach can be mentioned as follows: We can design a system with the help of biometric fingerprint along with camera devices. We can use these two modules for voter verification in EVS. Th fingerprint can exclude the necessity of carrying voter identity proofs. If the fingerprint of the voter matches with the pre-stored information of the registered fingerprint database, only then the vote is authorized. If it doesn't matches, then a message will be displayed on LCD accordingly and the person can be either sent for investigation or barred from polling his vote.

IV. DISCUSSION

Through the studied literature, it is fund that the cutting-edge technologies can make huge advancements in EVS and can provide adequate security, anonymity, and ease of use. Therefore, it is expected in the near future that the EVS can be modified which can facilitate the voters, thus providing a framework for fair elections. The development of an overall effective online voting system is anticipated in near future..

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