AI Integrated E-Voting Hub: An Online Secure Voting System

Anshu Singh[*1], Anupama Upadhyay[*2], Deepanshu Jaiswal[*3] ,Dr. Umesh Dwivedi[*4], Ishika Singh [*5] , Mamta Singh[*6]

[*1,2,3,5,6] Students (Computer Science And Engineering), Babu Banarasi Das Northern India Institute Of Technology, Lucknow, Uttar Pradesh, India.

[*4]Associate Professor, Department Of Computer Science, Babu Banarasi Das Northern India Institute Of Technology, Lucknow, Uttar Pradesh, India.

ABSTRACT

The emergence of technology has changed the way we operate with our governing bodies and democratic structures. Traditional voting, involving paper ballots and physical polling locations, increasingly occurs alongside online voting systems (e-voting) that allow remote participation. The paper presents the advantages and disadvantages of the implementation of Internet voting with an emphasis on security issues, accessibility for voters and the increase of turnout. The study purports to determine the suitability and future of online voting systems through an appraisal of available literature, a proposed architecture of the conceptual online voting system, as well as, data flow diagram. It ends with the conclusion that although online voting is a promising prospect for increasing democratic engagement, it is vital that security and privacy as well as the proper technology are taken into account before the nationwide implementation of such a system.

Keywords: : AI, Architecture, Blockchain Database, Cybersecurity, Online, Transaction

I. INTRODUCTION

Electronic voting, or online voting, is when people use electronic methods to cast and count votes in elections. With new technology, traditional voting systems, which rely on paper ballots and physical voting stations, have been criticized for being expensive, not very accessible and inefficient. Online voting has been introduced as a possible solution as it promises to make elections more efficient, increase voter participation and reduce costs [13].

Online voting uses digital platforms that allow voters to cast their votes securely and easily from anywhere, so there is no need to go to a physical voting station. This is great for people who can't cast their ballots for some reason because they can vote using their smartphone or computer. This makes voting much more accessible because it ensures that all eligible voters can participate, regardless of where they are or what their personal circumstances are.

Such electronic systems can utilize various ways to facilitate and secure voting. Voters don’t have to be tech-savvy to navigate the system with simple web interfaces. The systems have become advanced enough, that now even fingerprints, and facial recognition is being used to verify that a person is a valid voter, who can return an honest answer in the voting process. Moreover, encryption technologies, including end-to-end encryption, are used to protect votes while they are sent, which makes it almost impossible for anyone to intercept or modify the data.

Few countries that are already using online voting in some regions[26]. Estonia [12][18][19][20][21][22] was one of the earliest; it began in 2005. (I-Voting)—a digital voting system that enables citizens to vote in national elections remotely with secure digital ID. Estonia's success has given other countries ideas about trying similar systems, as the evidence has shown that online voting can increase voter turnout whilst lowering the prices of conventional elections with paper ballots.

In Switzerland [11], residents in some regions also can vote online in local and federal elections. It has not yet been implemented across the country, but these tests have allowed Swiss authorities to strengthen the system, troubleshoot problems and win public support for digital voting. While, the system worked , they were cautious enough to test the working and implementation of the system on small scale before applying it to the whole nation.

Canada [6][9] has tested online voting in municipal elections, especially for people living abroad or in the military who have difficulty voting in person. Although it has not been used in federal elections, tests in local elections have shown that it can make voting easier and increase turnout in the future.

These examples offer a snapshot of a global trend: the introduction of digital technologies to elections. Although the countries have different systems in place, the overarching goal remains the same: boost turnout, eliminate barriers to voting and streamline the polling process." But challenges have remained, especially when it comes to security, voter privacy and public trust[13]. However, its potential benefits — increased convenience, better accessibility and cost savings — show that online voting should be considered in future elections.

That's a complicated transition that will have many challenges, especially with respect to security, since moving standard voting with paper ballots to digital systems involves many issues. Cyberattacks — like hacking, data breaches or vote tampering — are huge concerns. If there is a breach in that data, it could expose voters' personal information, which could result in identity theft or fraud, and that could lower trust in that system. Secure authentication based on strong encryption is determinant to reduce risks.

Then, there is voter fraud, in which voters might cast more than one ballot, or someone might cast a ballot in someone else name. BIOMETRIC [5][14] or GOVERNMENT ISSUED DIGITAL IDS and verified systems which restrict voters only eligible to vote.

It's about voter privacy, as well. It's important that the votes be secret through encryption and that the privacy of each voter be protected, so no one gets retaliated against or discriminated against.

Access is challenge. Not everyone has the requisite technology or skills to work within online voting systems. These systems also need to work across devices and be made available to persons with disabilities and others to ensure that everyone can vote. Then there's the issue of the "digital divide": some people — particularly in rural or developing areas — may lack access to the technology needed to vote online. Fixing these challenges is important to ensuring that online voting serves everyone.

II.RESEARCH METHODOLOGY

2.1 Literature Review

In "Blockchain Meets Database" [3] they cover the combination of a blockchain technology with relational databases forming a decentralized replicated relational database called blockchain relational database. They discuss the differences between blockchain platforms and replicated relational databases, with a primary focus on their respective trust models. The paper describes two approaches to transaction commit order — one where the order is determined before execution, the other parallel ordering. They use serializable snapshot isolation (SSI) to keep nodes consistent and provide a new variant of SSI in regards to block height. For performance analysis of the system detailed experiments are performed on PostgreSQL. Through this work, you'll learn about bridging the gap between the world of blockchain and that of traditional databases, bringing more optimizations and features, as well as enhanced security.

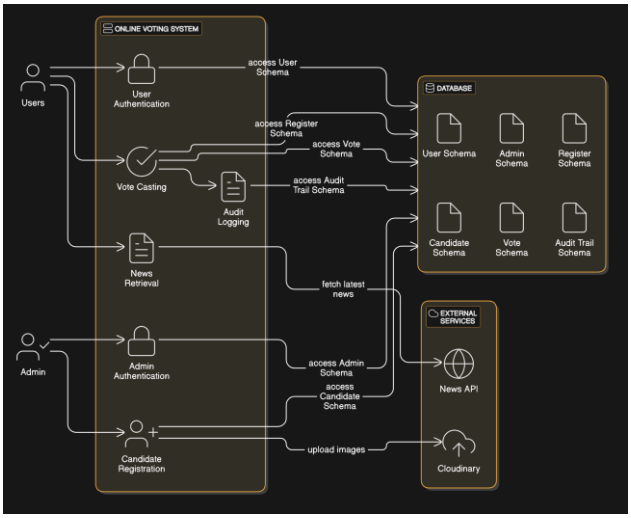
In 'Smart Online voting system' [1] the authors propose a novel online voting system that addresses problems made to voter ID and data security. They hope to use biometric scans, facial recognition and encryption to keep voting secure and private. They have also implemented live monitoring of their systems to enhance accountability and prevent cheating. They also want the system to be simple enough for all voters to use, no matter their tech skills. The authors believe their system would enable online voting The authors believe that their system could render online voting. They point out that using biometric security and Blockchain [29] tech can really boost security and trust, making it easier to accept online voting.

Sedky and Hamed (2015) A Secure e-Government's e-Voting System [2] : Suppose we are struggling with the issue in keeping the voting process secure and transparent in an online environment. Their system guarantees secure transmission, storage and tallying of votes, through strong encryption, multi-factor authentication and thus the generation of audit trails. They also think it's important to build the system to get along with different styles of government. Sedky and Hamed concluded that a secure e-voting system is key for e-government projects to succeed. They urged governments to create strong security and verification methods to keep voter trust and ensure fair elections online.

They demonstrated biometric identification with the help of "Biometric Identification" [5] which they cover biometric identification methods, and their importance in identification as well as security systems. The paper covers several biometric modalities including but not limited to fingerprints, face, iris and voice recognition and tackles their advantages and disadvantages. They also discuss the underlying technology that could help make biometric systems more reliable and cost-effective. Other papers cover new applications of biometrics to different fields, describe major challenges that need to be addressed and highlight opportunities for cross-disciplinary collaborations to solve these challenges, and provide a state-of-the-art overview of the field enabling to move forward for more robust algorithms and standards for secure and effective biometrics in various applications.

Finally, From, "Internet Voting and Turnout: Evidence from Switzerland" [11] authors study the effect of Internet voting on voter turnout in Switzerland. From trials in Geneva and Zurich, they show that i-voting (internet voting) does not increase turnout much and adding it to postal voting does not do so either. Using a natural experiment design, this study exploits federal legislation that enabled a subset of municipalities to participate in i-voting trials, while the rest did not. The research is at odds with optimistic claims that i-voting could increase voter participation.

II.2 Architecture



Architecture Components-

- User Authentication: Everytime a user tries to access the system, credentials are validated with respect to the User Schema in the Blockchain database [3]. This guarantees that user data is unchanged and secure.
- Casting a Vote: After authentication, users are able to submit their votes. Then, it is possible to register the Vote in the Vote Schema on the Blockchain [4][7], ensuring that each user can vote only once, there is a tamper-proof record of all votes.
- News Retrieval: Viewers can find recent news on voting or candidates. Now, this information is being fetched from an external News API and is showing on the user interface.
- Authentication for Admin: Admins with higher-level access, like a user schema, the credentials are checked in the admin schema of the Blockchain database [3] which leads to secure and immutable storage of admin data.
- Candidate Registration — Whether it is admins can register candidates for election. Specifically, this means entering candidate information in the Candidate Schema and uploading their images to a cloud-based [15] image storage service called Cloudinary. Transparent and secure storage of candidate Data on the Blockchain [24][17]
- User Authentication Module: Responsible for user login and access control, where the authentication details are stored on the Blockchain [25] to avoid tampering.
- Vote Casting Module: It is responsible for the process of collecting and securely storing votes on the Blockchain.
- Audit Logging Module: Logs all activity in the Audit Trail Schema on the Blockchain [23][25].
- News retrieval module: connects to the external News API to fetch and display news updates.
- Admin Auth module: It authenticates the admin with the help of login credentials and access controls stored on the Blockchain for security.
- Candidate Registration Module : Responsible for data entry and storage of candidate information, interacts with Cloudinary for image upload, the upload will be saved on Blockchain, so also the data for secure storage [15][17][24][25].
- User Schema: User credentials, profile information, and authentication data are stored on the Blockchain, providing immutability and security.
- Admin Schema : Saves admin credentials as well as access privileges securely in the Blockchain.
- Register Schema: This schema holds the registration information in order to monitor the voter eligibility which is stored on the Blockchain ensuring integrity and transparency.
- Candidate Schema: Signed data point that contains information about candidates participating in the election like profiles and pictures secured on the Blockchain.
- Vote Schema: Maintains all votes" and ensures that there is no multi-voting by a user, all of them will go into the Blockchain[23]
- Audit Trail Schema: This component logs all the activities done on the systems which will be used for audit purposes, the logs make it transparent and secure as they are stored [16][27][30] on the Blockchain.
- News API Provides real-time news of the election candidates.
- Cloudinary: Used for storing and managing candidate images uploaded during their registration securely

Flow of Actions-

1. User Action:

- If votes are directly stored and authenticated on the Blockchain, they ensure cheating and fraud will not be possible, because all details on a Blockchain are unrecoverable.
- Cast Vote: After the user authenticates, he/she will be able to cast a vote. In Blockchain, the voting is recorded in the Vote Schema, rendering a transparent and immutable record.
- View News: User can view news, fetched from News API, on user interface.

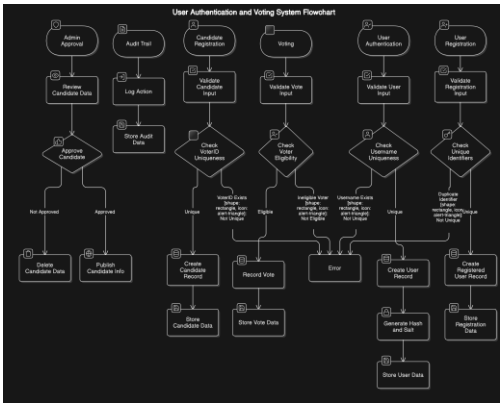
2. Admin Action:

- Admin Authentication: The Admin logs in and authenticates on the Blockchain Admin Schema (stores all of the admin data) to manage admin access control.
- Admin Registers Candidates: The admin now registers the candidates by providing the candidate information in the candidate schema and uploading their images in cloudinary. The secure and transparent blockchain technology keeps the client data.
- Admin Actions And Audit Trail: Audit logging - All admin actions are transferred to the Audit Trail Schema on the Blockchain.

3. System Interactions:

- Module Processing: As the user and admin acts, all actions are processed by corresponding modules within the core (User Authentication Module, Vote Casting Module, Admin Authentication Module, etc.).
- Data Storage and Retrieval: (Data is storing/retrieving from the Blockchain database, maintaining data integrity and durability). User credentials, votes, candidate information, audit logs, etc.
- Integrating External Services: News API and Cloudinary are handle to receive realtime news updates and candidate images, keep data secure

II.3 Data Flow Diagram (DFD)



User Registration

- Validate Registration Input: This step validates whether user's registration details (such as name, email, etc.) are complete and accurate.
- Verify Unique Identifiers: If you ask users for a unique identifier, ensure it is unique and unused, such as email or voter ID

If Unique:

- Create a New Registered User Record in the
- Immutable and integrity maintained using Blockchain database
- Blockchain allows Secure Storage of Registration Data: User registration data is securely stored on the Blockchain.

If Not Unique:

- Failed with error (Duplicate Identifier)

User Authentication

- Validate User Input: Verifies the user's login credentials.
- Username Uniqueness Check: Ensures the username is unique.

If Unique:

- Creates User Record: A new user record is created.
- Password Hashing : Those will generate Hash and Salt for you.
- Store User Data: The user has their own data stored on the Blockchain securely, and it cannot be tampered with.

If not Unique:

- Error (Username Exists): THIS USER NAME IS ALREADY IN USE

Candidate Registration

- Validate Candidate Input: Validates candidate data.
- Verify VoterID Uniqueness: Validates that the VoterID is unique and hasn't been used by another candidate.

If Unique:

- Candidate Record Creation: The Blockchain database creates a new record for the candidate in a way that ensures data integrity and transparency.
- Save Candidate Data: Candidate's data is stored on the Blockchain securely.

If Not Unique:

- (Non-Empty) Error: Here it shows a message that the VoterID has already been registered.

Admin Approval

- Review Candidate Data: Candidate submitted information is reviewed by admin
- Approve Candidate : Is Used to Approve or Reject Candidate

If Not Approved:

- Remove Candidate Data: Candidate data is deleted.

If Approved:

- Candidate Information Publishing: The candidate data is published for the users to view, with records saved on the Blockchain for transparency.

Voting

- Validate Vote Input: Validates the entered vote data.
- Verify Voter Eligibility: Validates that the voter is eligible to vote.

If Eligible:

- Cast vote: The vote is stored in the Blockchain database, in a transparent and tamper-proof way.
- Store Vote Data: We store the voting data on the Blockchain that makes sure about the integrity of the whole voting process.

If Not Eligible:

- Error (Ineligible Voter): An error message is displayed, user not eligible.

Audit Trail

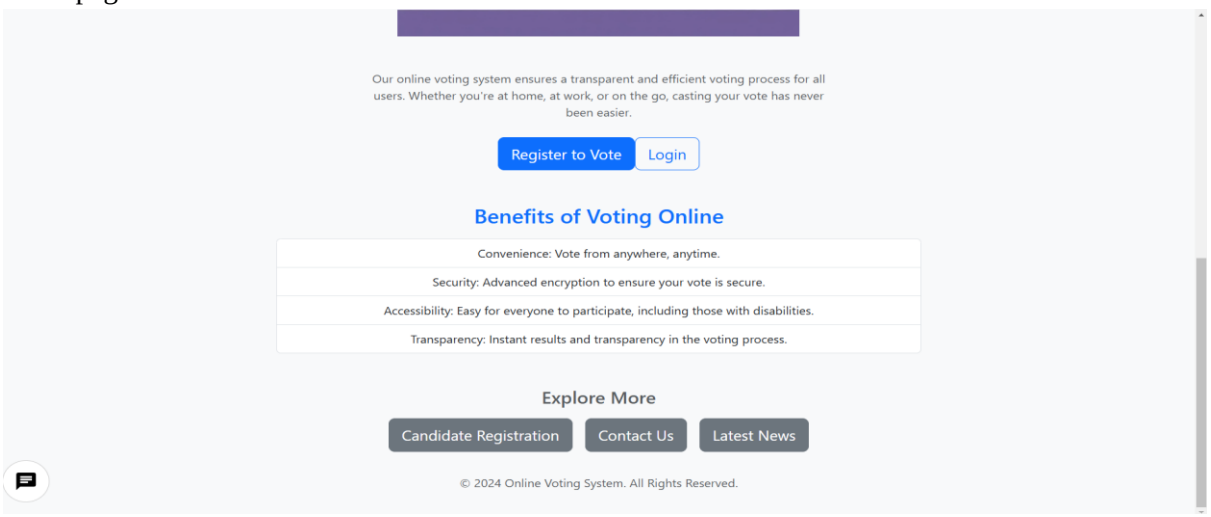
- Audit All Actions: All actions in the system are logged.
- Store Audit Data: Logged data is stored immutably in a Blockchain-based [28] audit trail, providing a secure and transparent record of all activities within the system

III.MODELING AND ANALYSIS

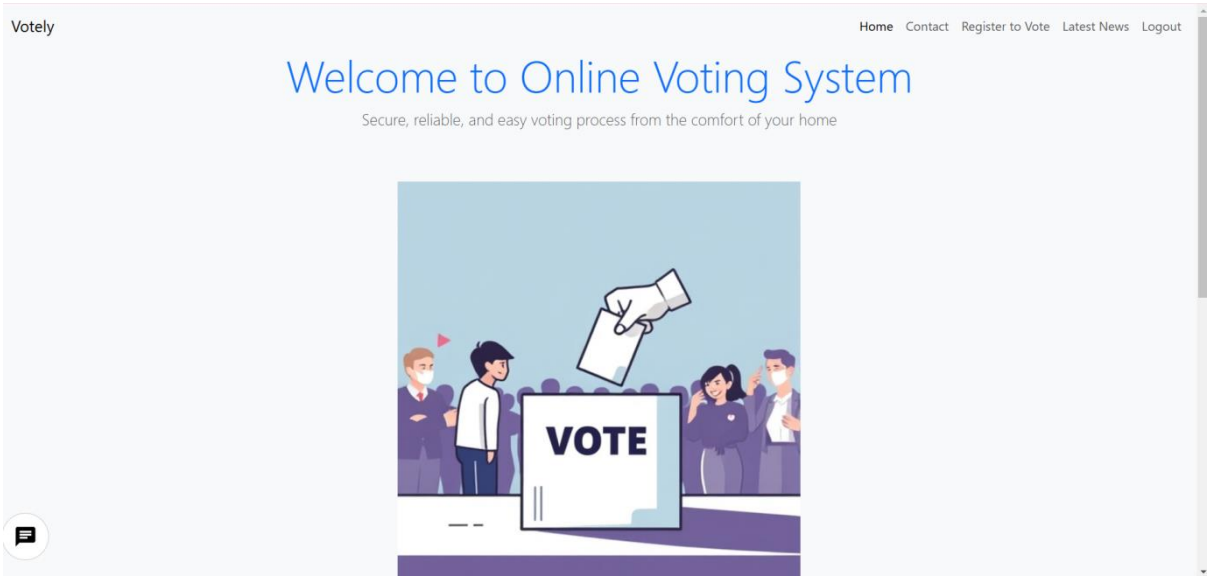
3.1 Proposed Work

The system should be designed to be user-friendly within the context of each voting system, helping Voters with varying degrees of technical expertise or income to engage in the voting process with ease and confidence.

Homepages:

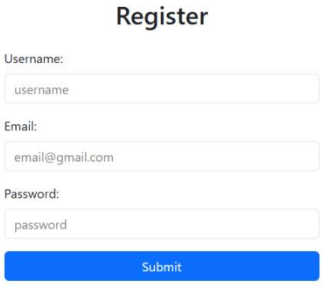


The Guest Homepage is the page non-registered users see when they first open the application, which gives the user general information about the election process. It typically includes an overview of the voting system, its features, such as Registering as a Candidate, Voter, Contact Us and News Page. However, certain sections, such as voting itself, are restricted until the user registers and authenticates their account. The guest homepage is designed to engage and inform, encouraging participation and registration.

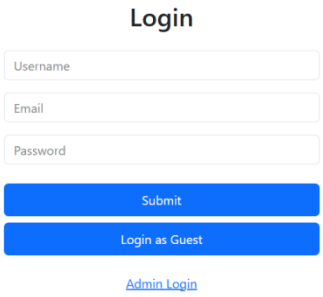


Once the User has created an account they will be lead to the member homepage of the website where they can further, register to vote, register as a candidate and more.

Registration and Login**:**



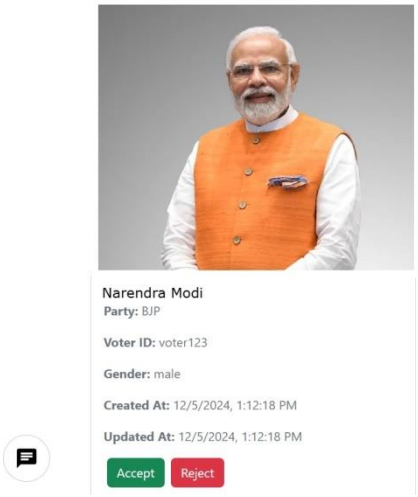
Here is the step through which people will have to register to get access to the members only features of the site. First of all, when a user registered, he shows the username, the email and the password. While the user experience can be personalized based on the user profile, the next step in this process is creating a user profile on the website.



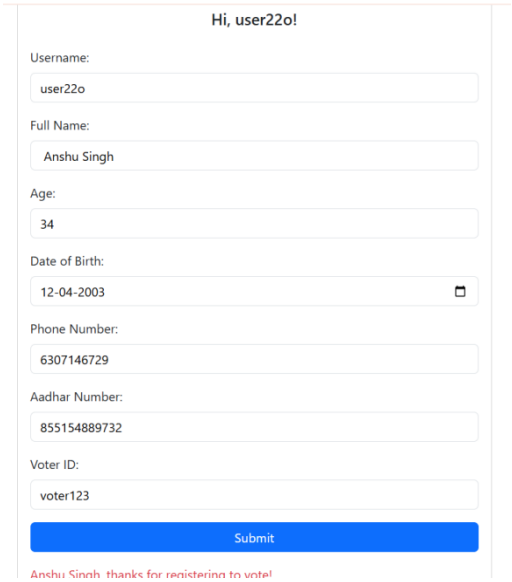
Users simply need to log in to their account by entering their credentials after completing the registration process. As a result, they can use features and content reserved for registered users. These sealed features can comprise customized preferences, polling methods, or various other unique capabilities.

Candidate Registration and Voting Registration:

Candidate Registration Page: This page on website lets people register to contest for elections.
When candidates visit the registration page, they typically fill in an online form with personal information, then receive a prompt to wait for approval of their candidacy.

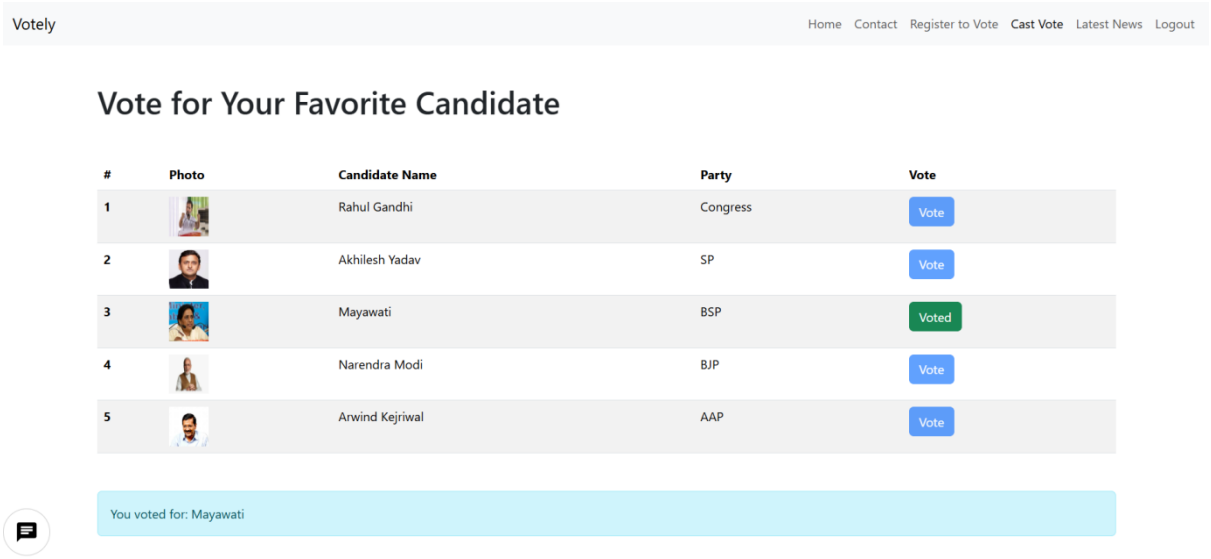


To the admin, this is how the candidate approval page looks. The card gives all the details of the candidate and accordingly admin can either Accept/Reject the candidature of the user.



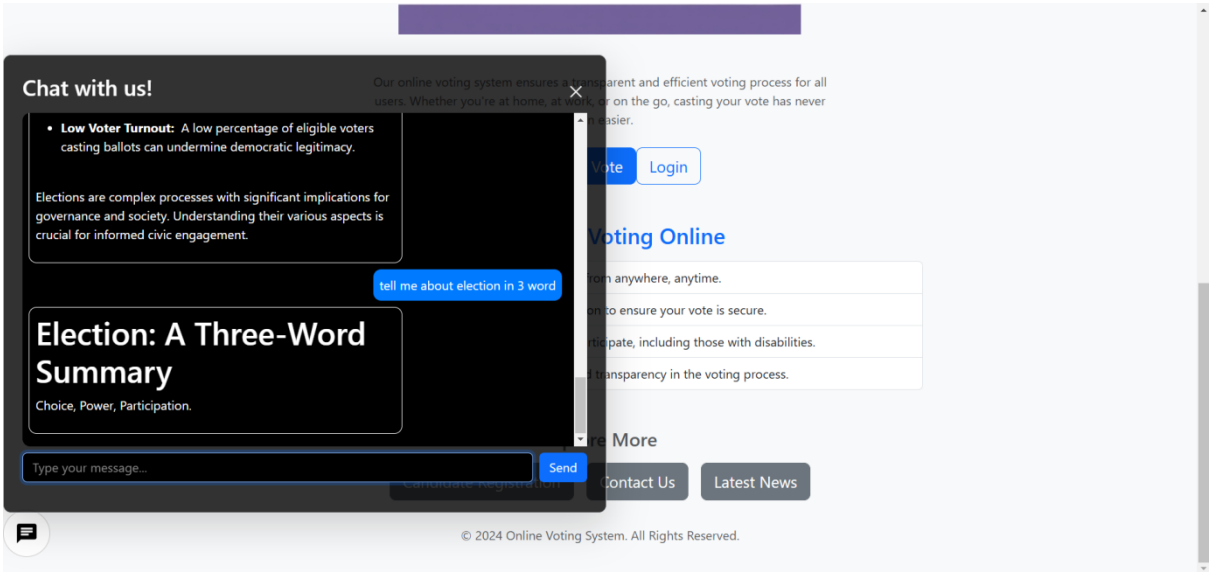
Here, users will independently register to vote in the elections. Users given a form to fill and a username that cannot be changed will help make tracking users a bit easier. Once submitted the user is officially registered to vote.

Voting Page:



This is the heart of the platform, where registered voters go to vote, with protections in place to ensure a voter can only vote once. After logging in with secure credentials (commonly a single sign-on), voters see a list of candidates or options to vote on. On each poll station, the system checks to identify the person has not voted yet, usually by checking their unique registration ID. Before casting the vote, voters can double-check their selections.
Once confirmed, the system records the vote and sends confirmation message to reassure the voter.

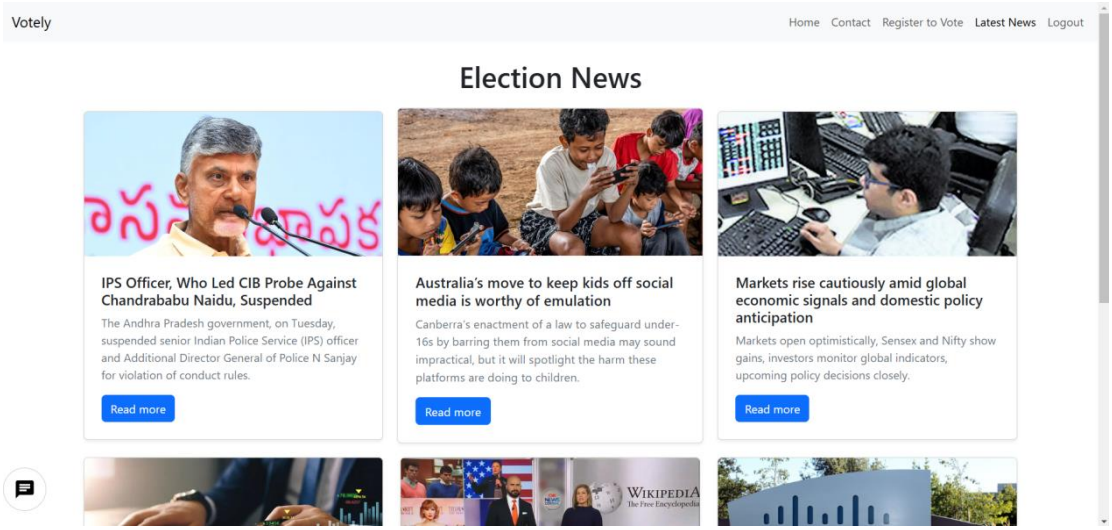
Integrated AI Chat Assistant:



Integrated AI Chat [8][10] has a critical role to improve user experience, help accessibility and ensure the voting process is being very transparent.

This could assist voters as a virtual guide navigating the online voting platform. It can help guide users step by step on how to register, vote and check election results. The chat assistant answers instantly, reducing ambiguity and freeing human support staff in many situations. Also, the AI chatbot can prove to be a great way to make predictions of results of the upcoming elections, learn more about the history of each candidate, learn about voting trends and more.

News Section:

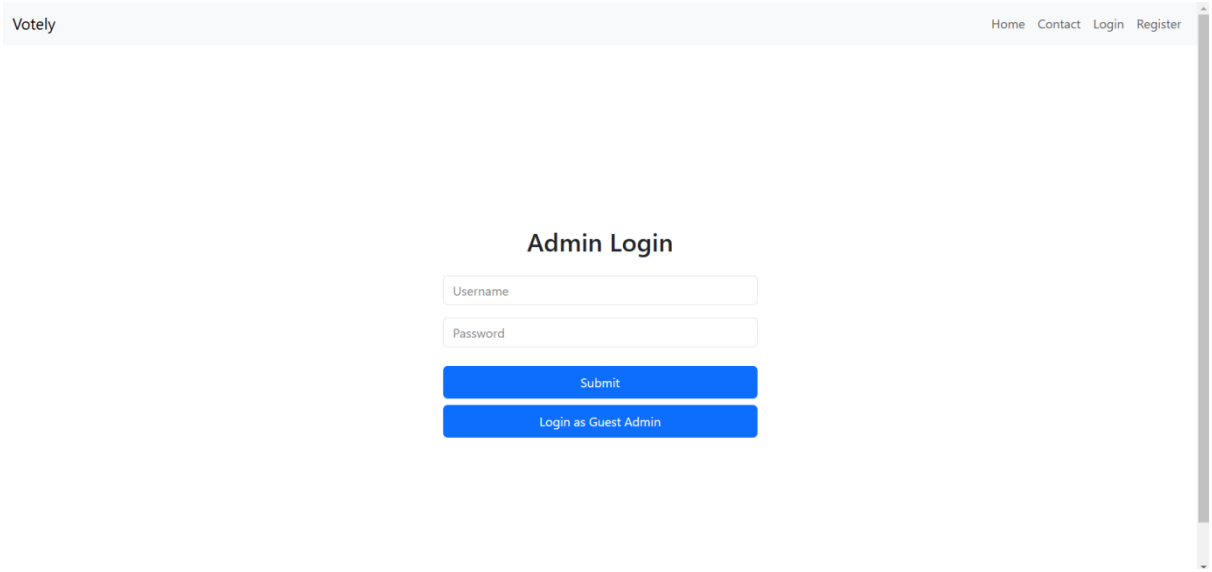


The News Section is a trusted and quick access hub in order to provide real time updates and key information around the election cycle. It also keeps voters updated on important dates and events like when voting ends, when and where to vote early, and when official results will be announced.

For instance, on the News Section, you might prominently display countdowns to the election day (the final day to vote, be it over online or otherwise).

This provides an opportunity for voters who have not participated to either call or fill out their ballots — to clarify any confusion surrounding what is on the ballot — before the election closes. Likewise, it can spotlight early voting stretches, enabling voters to vote before the actual Election Day. For all those who cannot vote on Election Day, early voting is an invaluable opportunity to cast a ballot, which is why we detail when early voting starts and when it ends in the News Section.

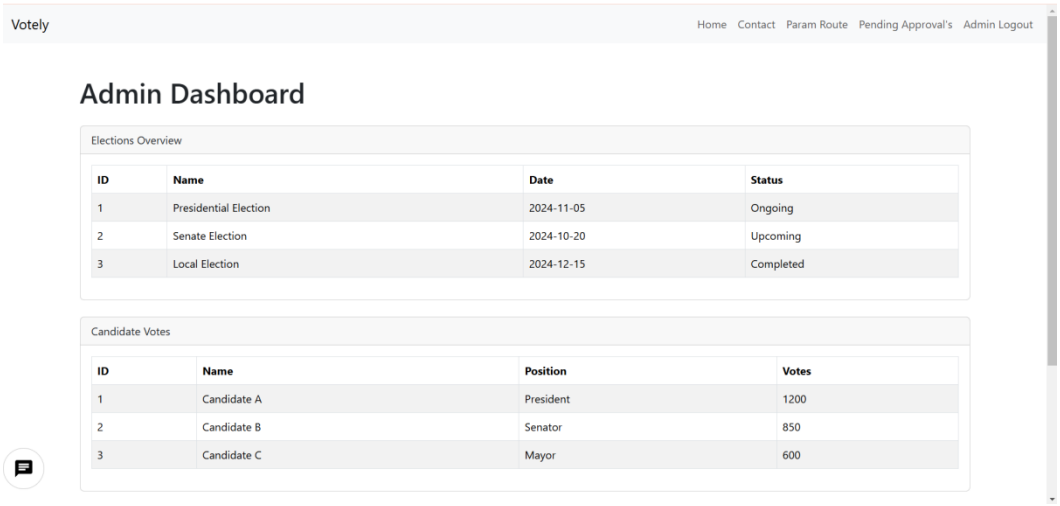
Admin Panel:



Admin is an important backend interface that has everything necessary for election administrator keeping an eye on and controlling the full election process efficiently. It acts as the administrative center for tracking voter registration, conducting the vote, managing candidates, ensuring security, and creating reports.

The Admin Login is an authentication process that grants election administrators access to the backend of the voting system. This is one of the most important factors in keeping the election secure and in good condition. The

login page requires administrators to enter a username and password, which are securely validated against the system's database.



It offers a dashboard that shows at-a-glance how the election is going, from the total number of registered voters to how many votes have been cast in real time and other deadlines. Once custom fields are included in the software, administrators can set election parameters, including the start and end dates for voting, candidate profiles, and methods. This panel also provides functionalities for the user management so admin can approve/reject the voter registrations and monitor if the candidates are eligible, manage users to ensure they're complying to the rules of the election. Real-time monitoring tools help ensure the system runs smoothly, and automated alerts inform administrators of any irregularities or technical issues.

IV.CONCLUSION

Compared to paper-based voting systems, an electronic or online voting system offers greater accessibility, faster processing times, and lower overall costs. However, ensuring security and transparency is still the largest hurdle. The architecture of a Secure and Transparent online voting system was proposed in this paper by implementing new security techniques such as biometric identification [14], Blockchain, and end to end encryption [7].

Optimisms for online voting persist despite the challenges it faces. Successful online voting (Estonia is already doing this) puts us on the right path for adoption while wider implementation of digital technologies continues to lay the ground for what is to come. The e-voting is highly promising, but its implementation will depend on overcoming issues associated with cybersecurity, privacy and security of voters.

V.FUTURE SCOPE

With the help of tech advances and a growing demand for a more convenient and useful electoral process, we are now capable of online voting that will have a broad scope long run. One area of opportunity so is security. Now with the focus on advanced encryption and the widespread use of multi-factor authentication voters will not only have their data safely stowed, but their votes accessed securely. Such systems are utilized to help avoid cyberattacks, data breaches, and voter fraud through advanced security protocols. This may be implemented through multiple technologies that guarantee absolute safe online voting

User accessibility will be another important aspect of future online voting systems. Also, these systems will become more inclusive because technologies will be used to reach more groups of voters so that disabled and disenfranchised populations will not be left behind in future versions of these systems as they become more and more widespread. Which leads to voice commands, simplified users' interfaces and multi-language support that can improve accessibility and as a result, make online voting systems more inclusive. Individual voting is done over mobile platforms through which voters can vote anytime and from anywhere eliminating a lot of barriers that arise due to logistics and making the process far more smooth.

Machine learning and AI can also play a key role in ensuring online voting systems in the future. Machine learning or artificial intelligence could, for example, be leveraged to simplify voter verification procedures, pinpoint possible fraud or irregularities within voting patterns, and smoothing the user experience by offering live assistance or leading users through the procedure. Such systems, powered by AI, could for instance monitor voting patterns and detect any anomalies before they make a difference in a race.

With use-cases for online voting increasing around the world, future systems could certainly benefit from just that — global collaboration — and even inter-country standardisation. Lack of common policies and guidelines for online voting systems in the areas lead to the incompetent and unreliable, secure, and transparent voting. If it works, this would provide confidence in online voting systems so they could be used in more elections.

VI.REFERENCES

[1] Ganesh Prabhu, S, et al. “Smart Online Voting System.” IEEE Xplore, 1 Mar. 2021, ieeexplore.ieee.org/abstract/document/9441818.
[2] Mohammad Hosam Sedky, and M Ramzy. A Secure E-Government’s E-Voting System. 1 July 2015, https://doi.org/10.1109/sai.2015.7237320. Accessed 11 Oct. 2023.
[3] Nathan, Senthil, et al. “Blockchain Meets Database.” Proceedings of the VLDB Endowment, vol. 12, no. 11, 1 July 2019, pp. 1539–1552, https://doi.org/10.14778/3342263.3342632.
[4] Golosova, Julija, and Andrejs Romanovs. “The Advantages and Disadvantages of the Blockchain Technology.” 2018 IEEE 6th Workshop on Advances in Information, Electronic and Electrical Engineering (AIEEE), vol. 1, no. 1, Nov. 2018, ieeexplore.ieee.org/abstract/document/8592253, https://doi.org/10.1109/aieee.2018.8592253.
[5] Jain, Anil, et al. “Biometric Identification.” Communications of the ACM, vol. 43, no. 2, 1 Feb. 2000, pp. 90–98, https://doi.org/10.1145/328236.328110.
[6] Brunet, James, and Aleksander Essex. “Online Voting in Ontario Municipalities: A Standards-Based Review.” Lecture Notes in Computer Science, 1 Jan. 2023, pp. 52–68, https://doi.org/10.1007/978-3-031-43756-4_4.
[7] Uddin, Mohammed Nasir, et al. “An Blockchain-Based E-Voting System Applying Time Lock Encryption.” IEEE Xplore, 1 June 2021, ieeexplore.ieee.org/document/9498566.
[8] Cheema, Muhammad Asaad, et al. “Machine Learning with Blockchain for Secure E-Voting System.” IEEE Xplore, 1 Nov. 2020, ieeexplore.ieee.org/document/9283806.
[9] Goodman, Nicole J. “Internet Voting in a Local Election in Canada.” The Internet and Democracy in Global Perspective, 2014, pp. 7–24, nicolejgoodman.com/wp-content/uploads/2017/03/Internet-Voting-in-a-Local-Election.pdf, https://doi.org/10.1007/978-3-319-04352-4_2. Accessed 28 Mar. 2022.
[10] Pawlak, Michał, et al. “Towards the Intelligent Agents for Blockchain E-Voting System.” Procedia Computer Science, vol. 141, 2018, pp. 239–246, https://doi.org/10.1016/j.procs.2018.10.177.
[11] Germann, Micha, and Uwe Serdült. “Internet Voting and Turnout: Evidence from Switzerland.” Electoral Studies, vol. 47, June 2017, pp. 1–12, www.sciencedirect.com/science/article/pii/S026137941630453X, https://doi.org/10.1016/j.electstud.2017.03.001.

[12] Vassil, Kristjan, et al. "The Diffusion of Internet Voting. Usage Patterns of Internet Voting in Estonia between 2005 and 2015." Government Information Quarterly, vol. 33, no. 3, July 2016, pp. 453–459, https://doi.org/10.1016/j.giq.2016.06.007.

[13] Warkentin, Merrill, et al. "Social Identity and Trust in Internet-Based Voting Adoption." Government Information Quarterly, vol. 35, no. 2, Apr. 2018, pp. 195–209, https://doi.org/10.1016/j.giq.2018.03.007.

[14] Agarwal, Samarth, et al. "Biometric Based Secured Remote Electronic Voting System." IEEE Xplore, 1 July 2020, ieeexplore.ieee.org/document/9202212.

[15] Jayakumari, Beulah, et al. "E-Voting System Using Cloud-Based Hybrid Blockchain Technology." Journal of Safety Science and Resilience, vol. 5, no. 1, 1 Mar. 2024, pp. 102–109, www.sciencedirect.com/science/article/pii/S2666449624000069, https://doi.org/10.1016/j.jnlssr.2024.01.002.

[16] Panja, Somnath, et al. "A Smart Contract System for Decentralized Borda Count Voting." IEEE Transactions on Engineering Management, vol. 67, no. 4, Nov. 2020, pp. 1323–1339, https://doi.org/10.1109/tem.2020.2986371. Accessed 6 May 2021.

[17] Monrat, Ahmed Afif, et al. "A Survey of Blockchain from the Perspectives of Applications, Challenges, and Opportunities." IEEE Access, vol. 7, no. 7, 19 Aug. 2019, pp. 117134–117151, ieeexplore.ieee.org/abstract/document/8805074, https://doi.org/10.1109/access.2019.2936094.

[18] Alvarez, R. Michael, et al. "Internet Voting in Comparative Perspective: The Case of Estonia." PS: Political Science & Politics, vol. 42, no. 03, 26 June 2009, pp. 497–505, https://doi.org/10.1017/s1049096509090787.

[19] Berg, Eiki. "Ethnic Mobilisation in Flux: Revisiting Peripherality and Minority Discontent in Estonia." Space and Polity, vol. 5, no. 1, Apr. 2001, pp. 5–26, https://doi.org/10.1080/13562570120049636. Accessed 18 Oct. 2021.

[20] Brady, Henry E., and Cynthia S. Kaplan. "Subjects to Citizens: From Non-Voting, to Protesting, to Voting in Estonia during the Transition to Democracy." Journal of Baltic Studies, vol. 32, no. 4, Dec. 2001, pp. 347–378, https://doi.org/10.1080/01629770100000151. Accessed 3 Dec. 2020.

[21] Drechsler, Wolfgang, and Ülle Madise. "Electronic Voting in Estonia." Electronic Voting and Democracy, 2004, pp. 97–108, https://doi.org/10.1057/9780230523531_6. Accessed 27 Nov. 2021.

[22] Ehin, Piret, et al. "Internet Voting in Estonia 2005–2019: Evidence from Eleven Elections." Government Information Quarterly, vol. 39, no. 4, June 2022, p. 101718, https://doi.org/10.1016/j.giq.2022.101718.

[23] Polepaka Sanjeeva, et al. " Decentralized and Automated Online Voting System Using Blockchain Technology." E3S Web of Conferences, vol. 430, 1 Jan. 2023, pp. 01046–01046, https://doi.org/10.1051/e3sconf/202343001046. Accessed 2 June 2024.

[24] Huang, Jun, et al. "The Application of the Blockchain Technology in Voting Systems." ACM Computing Surveys, vol. 54, no. 3, June 2021, pp. 1–28, https://doi.org/10.1145/3439725.

[25] "Towards Blockchain-Based E-Voting System | IEEE Conference Publication | IEEE Xplore." Ieeexplore.ieee.org, ieeexplore.ieee.org/abstract/document/8745613.

[26] Rathee, Geetanjali, et al. "On the Design and Implementation of a Blockchain Enabled E-Voting Application within IoT-Oriented Smart Cities." IEEE Access, vol. 9, 2021, pp. 34165–34176, https://doi.org/10.1109/access.2021.3061411.

[27] Desai, Shreya, et al. Untampered Electronic Voting in Entertainment Industry. 26 Sept. 2019, https://doi.org/10.1145/3349266.3351386. Accessed 19 Dec. 2024.

[28] Ali Syed, Toqeer, et al. "A Comparative Analysis of Blockchain Architecture and Its Applications: Problems and Recommendations." IEEE Access, vol. 7, 2019, pp. 176838–176869, https://doi.org/10.1109/access.2019.2957660.

[29] Gao, W., et al. "A Survey of Blockchain: Techniques, Applications, and Challenges." IEEE Xplore, 1 July 2018, ieeexplore.ieee.org/abstract/document/8487348/.

[30] Hao, Feng, et al. "Every Vote Counts: Ensuring Integrity in {Large-Scale} Electronic Voting." Usenix.org, 2014, www.usenix.org/conference/evtwote14/workshop-program/presentation/hao. Accessed 19 Dec. 2024.