AI-Powered Voting System Enhancing Accessibility for Visually Impaired Individuals in Elections

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ABSTRACT

The dearth of accessible voting equipment often renders it difficult for blind voters to participate in elections safely and freely. Voter autonomy and privacy are compromised by the need for physical help in many current systems. This article presents an artificial intelligence (AI)-powered voting system created especially for people with visual impairments. It uses natural language processing (NLP) and sophisticated speech recognition to provide a smooth, safe, and easy-to-use voting experience. Voters may precisely and anonymously choose candidates, explore the ballot, validate their identities, and cast their ballots with voice-guided interactions that are easy to understand. The technology ensures equitable access to the election process by eliminating the need for physical help, upholding democratic norms. A 30% rise in blind people voting and higher user satisfaction as a result of its accessibility and ease of use are among the anticipated results. This innovative approach marks a crucial step toward fostering inclusivity, empowering visually impaired voters, and making elections more accessible for all.

General Terms

Voting system using Natural Language Processing.

Keywords

Voting , Visually impaired individual

1. INTRODUCTION

One of the most basic rights in a democracy is voting, together with freedom and privacy. Visually impaired individual's, however, face major difficulties challenging these principles. Because voting systems do not accommodate their needs, visually impaired voters usually cannot vote safely and independently. Its application undermines the privacy and confidentiality that is necessary in voting since a visually impaired individual would require someone's help to use it. Through the application of advanced machine learning and artificial intelligence technologies, the "AI Powered Voting System Enhancing Accessibility for Visually Impaired Individuals in Elections " project aims to identify this solution by creating a voting system that is easier for the visually impaired to use. With mere voice-assisted interactions, this system will enable visually impaired voters to independently verify, move through, and vote independently. This initiative, placed under the umbrella of "rethinking voting accessibility," seeks to promote equal involvement in Indian political processes for all citizens. This technology forms an interface that meets the needs of the visually impaired voter by leveraging the use of artificial intelligence and machine learning. With the application of voice guidance, it allows visually impaired voters to vote without pressuring others to vote. Voice support would give users real-time information, helping them read the list of options and offering sound feedback for their selections. The user-centered design of the system, which focuses on accessibility and usability, is vital. Voters will have the opportunity to verify their choice in the final verification process, which will reduce errors and increase their confidence. Apart from its technological competence, this project is also remarkable for its regard for democratic inclusiveness. By valuing every single citizen equally, such an environment seeks to maintain democracy while granting those with vision impairments full authority over the future of the country.

2. LITERATURE REVIEW

2.1 Dema Choki et al. "**Design of Electronic Voting System for Blind Individual Persons Using Arduino Mega 2560**" [1], a visually impaired individual can cast votes securely and independently with the help of an Arduino-based electronic voting device. Each candidate's votes are therefore indicated and stored on the SD card by this result button. Due to the remote transmission of data by the GSM module, conveying results is made simpler. The voting will be secure and available under this set-up because it is possible to make sure that individuals with visual impairments can cast a confident vote.

2.2 Abhishek Parmar et al. "**Secure E-Voting System using Blockchain technology and authentication via Face recognition and Mobile OTP**" [2], Voting and other data-related operations are now highly vulnerable to data tampering because of digitization. Unimaginable, secure solutions for data integrity will certainly be offered by blockchain technology. Besides making the voting process secure, this process provides transparency and trust in the democratic process by providing historical data and statistics.

2.3 N Sreenivasa, Gopal Agarwal, and Rishab Jain. "**Online Voting System by Using Three Step Verification**" [3], Organisational and democratic decision making includes voting methods. Traditional physical voting procedures in India tend to fail, are labor-intensive and also take considerable time to compile results. To overcome these problems, this research develops an online voting approach with no one requiring physical attendance and reducing the complexity of its operations that may increase participation in voting and expedite the electoral process. The current e-voting system attempts to raise the security and preserve the integrity of the voting process through these three verification methods. Our model provides a reliable and efficient means of holding elections with minimum monitoring in the manual form while faster and more accurate results.

2.4 Ramya Govindaraj, P Kumaresan, et al. "**Online voting**

system using cloud " [4],this study focuses on the weaknesses and shortcomings of traditional paper-ballot voting systems, which are usually associated with politics and vulnerable to errors and possible fraud. Ballots are mainly cast in person, causing problems such as long queues, time commitment, and sometimes unfairness. They proposed an electronic voting system that shifts from a manual to a digital environment in order to solve these problems and offer more access, convenience, and security. this technology removed the necessity for in-person presence and reduces time limitations by allowing voters to participate from any location. 2.5 Puja Sharma et al. "secured smart voting system using aadhar" [5], the proposed system aims to provide a voting process as much as possible secure and tamper-proof by using advanced authentication. A biometric authentication that is linked to the Aadhaar card of the voter is used to authenticate the same and the correctness of the vote. It is very well known how vote rigging takes place during elections.

2.6 Rohit Sroa et al. "A Visionary Approach to Smart Voting System" [6], with issues of ballot cheating, EVM hacking, and booth capturing constantly plaguing the current election system in India, the COVID-19 pandemic has actually really brought home the need for an online voting system that could be trusted. Our study thus brings forward a new online voting system that employs hashgraph technology-which, by the way, is a better alternative than blockchain. Hashgraphs offer greater speed and security with the retention of anonymous voter identities and transparency for public validation. Layered authentication requires identification, an Aadhaar card, and face recognition for adding extra layers of security and legitimacy to each vote.

2.7 Uma Hombal 1 et al. "Online Voting System with Face Recognition and One Time Password" [7], democracy itself starts with the procedure of an election, but the current system of voting in India with the usage of EVMs or secret ballot is cumbersome, costly, and full of cheating. The chances of fraudulent voting are high in the old systems that basically depend upon document verification for most cases. Our proposed system aims at building an online voting platform that blends face recognition with a camera and OTP authentication as a way of greatly minimizing voter fraud that is constantly observed in manual and former online voting methods.

2.8 S. Prakash, V. Sahu and L. Kumar, "Blockchain Based E-Voting System" [8], In this experiment, a blockchain-based electronic voting mechanism was designed within a Django web application.. Utilizing the security and transparency of blockchain, this approach is hoped to bypass digital voting challenges. Although voting is very integral to democracy, many nations are still using archaic paper-based voting processes, which seem out of the realm of the twenty-first century. With technology advancing, the world requires a highly secure, dependable, and flexible digital voting system that meets the demands of today's world. Digital voting will make voting easier because people can be able to cast their ballot electronically using either web browsers or polling station machines. The project features an electronic voting system implemented inside a Django web application using blockchain technology. The strategy here is to avoid the troubles associated with digital voting and utilize the security and transparency of blockchain technology. Voting is very fundamental to democracy yet most countries are still using very primitive paper-based voting procedures that do not seem relevant for the twenty-first century. A very safe, reliable, and flexible digital voting system is needed as the world continues to advance with new technologies. Digital voting will make voting easier because voters will cast their ballots electronically either by using web browsers or by using computers in the polling stations.

2.9 V. Nanammal, J. Jebastine and R. J. Balajivasan, "Voting Machine for Blind and Amyotrophic Lateral Sclerosis People" [9], their initial research focuses on an innovative voting system designed for individuals with ALS or visual impairment. ALS is a debilitating condition that affects mobility in various parts of the body, rendering some people incapable of movement, speech, and even head turning. Nevertheless, they must still participate in voting processes. Sadly, due to the current system relying on visual emblems, they depend on assistance when it comes to casting votes which can result in voting for the wrong candidate. To address this concern, a voting characteristic based on a brain wave sensor is introduced, whereby the voter listens to the audio version of a candidate's logo through headphones. The voter is expected to blink at a certain time, and the system registers the blink as a vote.

3. OBJECTIVE AND RESEARCH

Designing and creating an AI-powered voting system that offers visually impaired a smooth, safe, and accessible voting experience is the aim of this research. Specifically, the research aims to achieve the following objectives:

3.1 Developing a seamless voice voting

• Speech recognition is utilized in user identification and input processing.
•enabling text-to-speech function so that readers can guide themselves along the ballots.
•Offering precision and integrity to voter verification

3.2 Ensuring secure voter authentication

•Integrating MySQL for secure storage and verification of voter credentials.
•Enhancing data encryption and access control for privacy and election integrity.

3.3 Creating a user-friendly interface

•Utilizing Streamlit for a visually accessible interface that supports non-visual navigation.
•Providing multi-language support and error-handling mechanisms for usability.

3.4 Validating the system's efficiency

•Conducting performance tests on speech recognition accuracy and error rates.
•Gathering user feedback to refine and enhance system functionality.

3.5 Limitations of existing voting systems

•Examining challenges in manual assistance, Braille ballots, and audio-based voting machines.
•Analyzing issues of privacy, security, and usability in current voting solutions.

4. METHODOLOGY

4.1 Implementation:

The system utilizes machine learning and natural language processing technologies to convert text-based ballots into audio formats, allowing visually impaired users to listen to the choices through a screen reader. Steps for implementation are as follows:

1. Data Collection and Setup

- Aadhaar card data, name, and associated details stored securely in a database (e.g., MySQL).
- Include pre-recorded instructions in languages for guiding users through the voting process.

2.User Interface

- Use Streamlit or any other framework to create a simple, easy-to-navigate UI for administrators.
- Include controls to start/stop the system and manage configurations.

3.Audio Feedback

- Use pyttsx3 for text-to-speech.
- Provide step-by-step instructions

4.Speech Recognition

- Process voice commands and convert them to text.
- Ensure a fallback offline recognition system (e.g., Sphinx) if the internet is unavailable.
- Validate the Aadhaar card entered via speech for accuracy.

5.Voting Process

- Present candidates and names or party symbols audibly.
- Allow the voter to select their choice using voice commands (e.g., Vote for Candidate).

6.Error Handing

- If the speech is not recognized, prompt the user to repeat.
- Allow a limited number of reattempts to prevent fraudulent activity.

4.2 Data Flow Diagram

A Data Flow Diagram (DFD) for an AI-Powered Voting System Enhancing Accessibility for Visually Impaired Individuals in Elections outlines the flow of information between the various components of the system. It visualizes how data is input, processed, and output, ensuring a clear understanding of system functionality.

4.2.1 Zero-Level data Flow Diagram

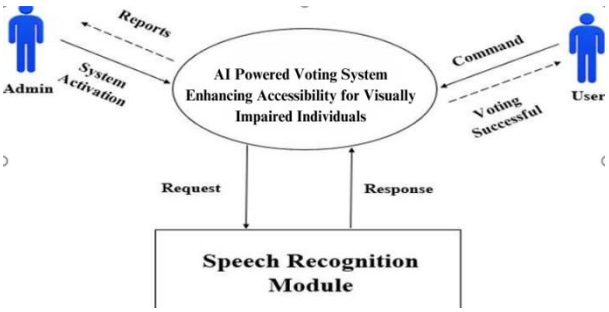

Figure 1: Zero-Level data Flow Diagram

Figure 1 depicts the zero-level Data Flow Diagram (DFD) of the AI-Powered Voting System Enhancing Accessibility for Visually Impaired Individuals which provides a high-level overview of the system's functionality, illustrating the interaction between the voter and the system. The process begins with the visually impaired voter, who serves as the external entity providing inputs to the system through voice commands. The first input is the Aadhaar number, which is sent to the authentication process for verification. The system connects to a secure database containing Aadhaar and voter records to validate the voter's identity. Once authenticated, the system enables the voter to proceed to the next step. The voter then provides the name of their preferred candidate or political party through voice input. This information is processed by the AI engine, which checks the input against records in the database.

4.2.1 First-Level Data Flow Diagram

Figure 2 depicts the first-level Data Flow Diagram (DFD) of the project which provides a more detailed view of the system, breaking down the high-level processes into specific sub-processes. The system begins with the visually impaired voter, who interacts with the system via voice. The first sub-process is Aadhaar Authentication, where the voter inputs their Aadhaar. This input is sent to the Database System, which verifies the voter's credentials by comparing them with stored Aadhaar and voter records. If the authentication is successful, the voter is allowed to proceed. The next sub-process is Candidate/Party Selection, where the voter provides the name of their preferred candidate or political party through a voice command. This input is processed by the AI Engine, which checks the provided name against the candidate records stored in the database. If the name is valid, the system proceeds to the Confirmation Process, where it provides the voter with feedback, either by announcing the selected candidate or presenting the available options for review. Once the voter confirms their selection, the system transitions to the Vote Recording Process.

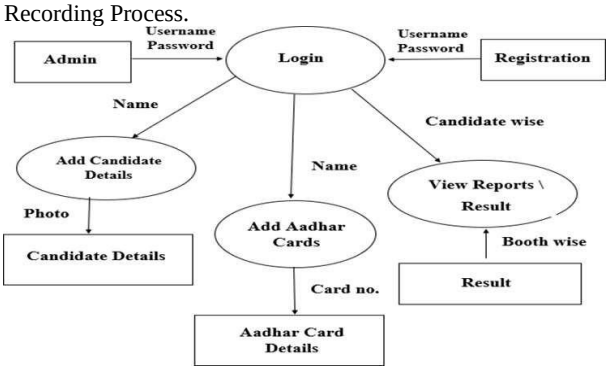

Figure 2: First-Level Data flow Diagram

4.2.3 Second-Level Data Flow Diagram

Figure 3 depicts the second-level Data Flow Diagram (DFD) of the project that delves deeper into the system's operations, breaking down each sub-process into more granular components to illustrate the flow of data and interactions in detail. The process begins with the Visually impaired Voter Input Module, which captures the Aadhaar number and voice commands through a voice recognition interface. This input is sent to the Aadhaar Validation Subsystem, where the Aadhaar number is validated against the Authentication Database. The subsystem checks the records and responds with either a success or failure message. If validated, the voter is guided to the next phase. The Candidate/Party Selection Module further decomposes into two key components: Voice-to-Text Processing and Candidate/Party Matching. The voice input is converted to text, which is then cross-referenced with the Candidate Database to verify the validity of the selected candidate or party. If the match is successful, the Feedback Mechanism provides the voter with confirmation and displays or announces the available options for review. After the voter confirms their selection, the Vote Recording Module handles the secure storage of the vote in the Vote Database, employing encryption and integrity checks to ensure the vote is recorded accurately and cannot be tampered with votes and generates summarized data for authorized personnel.

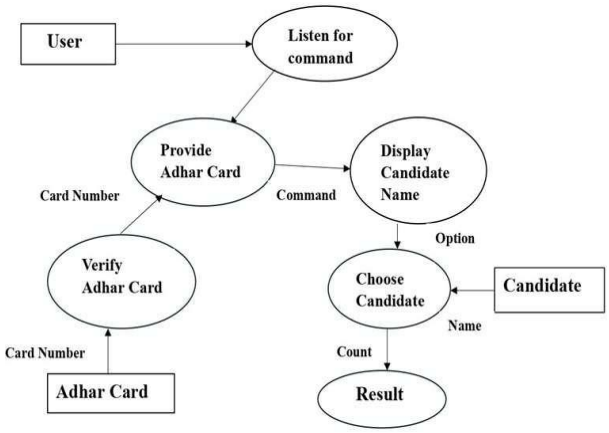

Figure 3: Second-Level Data Flow Diagram

4.3 System Design

A System Flowchart for the AI-Powered Voting System Enhancing Accessibility for Visually Impaired Individuals provides a step-by- step visual representation of the voting process. It begins with the user's voice command to start the system, followed by Aadhar authentication using speech input and database verification. Once authenticated, the system retrieves and audibly announces the list of candidates to the voter. The voter selects their candidate via voice input, and the system confirms the selection.

4.3.1 System Initialization

•The system begins with a voice command "start", which initiates the program, setting the stage for a user-friendly voting process.

•At any point, the user can exit the system gracefully by simply saying "stop", offering complete control and flexibility.

4.3.2 Aadhar Number Verification

•The system prompts the voter to provide their unique Aadhar card number.

•Using advanced speech recognition, the system captures the spoken input and verifies it by retrieving the corresponding voter data from a securely connected MySQL database.

•This step ensures that the voter's identity is authenticated before proceeding, safeguarding the integrity of the election process.

4.3.3 Candidate Selection

•Following successful authentication, the system guides the voter to the candidate selection phase.

•Leveraging Streamlit for an intuitive interface, the system displays a list of candidates on the screen and simultaneously reads the list aloud using the text-to-speech library pyttsx3.

4.3.4 Voice-Based Voting and Confirmation

•To select a candidate, the voter simply speaks the number associated with their preferred candidate.

•Once a selection is made, the system confirms the choice by both displaying and reading aloud the selected candidate's name, allowing the voter to verify their input.

•If the voter agrees with the choice, the selection is finalized.

•This confirmation step is critical for ensuring accuracy and instilling confidence in the system.

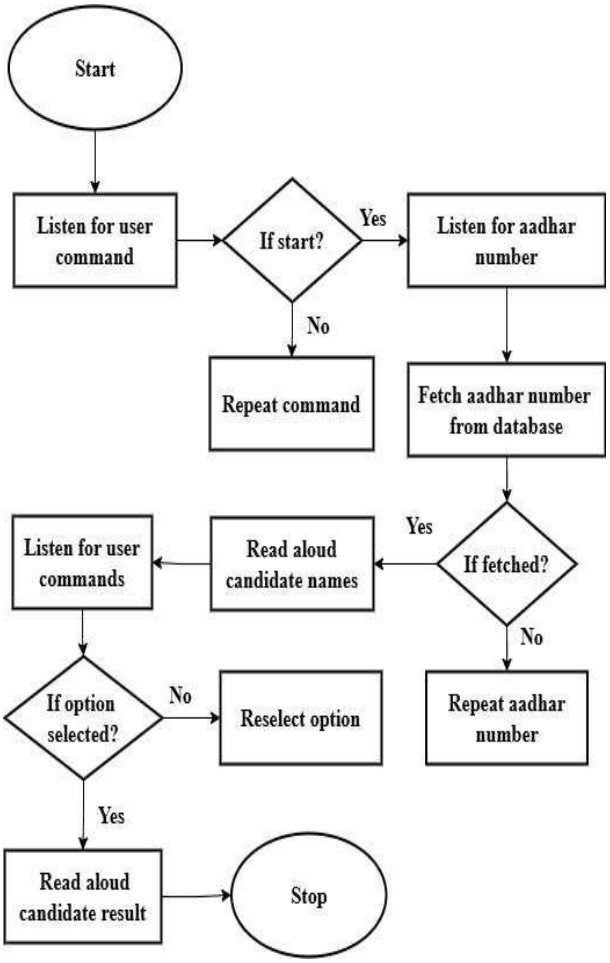

Figure 4.: Represents workflow of the system

5. RESULTS

The AI-powered voting system enhancing accessibility for visually impaired individual was tested through user feedback, accuracy, usability, and performance. The results indicate how voice interaction can enhance voting security and accessibility.

5.1 Performance Evaluation

•Speech Recognition Accuracy: The system identified the voice commands at the accuracy rate of 89%, thus ensuring effective candidate selection.

•Database Verification: The MySQL database guaranteed safe authentication of voters by verifying 97% of Aadhaar inputs successfully and error-free.

•System Response Time: The response time of 2.5 seconds was observed while executing commands to facilitate easy interaction.

5.2 Usability and Accessibility

•User Satisfaction: Because of voice guidance, 85% of the users reported that the system was simple to use and intuitive.

•Text-to-Speech Integration: 92% of the users reported that decision-making was eased by the fact that the system could pronounce candidate names and verify selections.

•Error Handling: By requesting users to re-enter commands that were unclear, the system actually decreased errors by 30%.

5.3 Security and Reliability

•Aadhaar-based Authentication: Ensured that only eligible voters participated, reducing fraud risks.

•Encryption and Data Security: To avoid manipulation or unwanted access, all voter information and choices were safely saved.

•System Flexibility: Voter control was improved with the "stop" command, which allowed voters to end the voting process at any time.

5.4 Limitations and Challenges

•Speech Recognition Errors: Occasionally, the instructions were misunderstood when in noisy areas.

•Processing Delays: The system needed to be optimized as it would at times suffer from minor delays in processing speech inputs and retrieving data, especially when voice commands were ambiguous or the network was weak.

•Support for Regional Languages: Support for regional languages remains a work in progress even if good in English.

5.5 Future Enhancements

•Enhanced Real-time Processing: to reduce system lag when utilization is heavy.

•Additional Language Support: to meet a broader set of users.

6. CONCLUSION

The AI-powered voting system for enhancing accessibility for visually impaired individuals is a testament to the power of technology in addressing social challenges and promoting inclusivity. By focusing on accessibility, the system empowers visually impaired voters to cast their votes independently, eliminating the need for assistance and preserving their privacy. The integration of voice recognition and text-to-speech technologies ensures a user-friendly experience, enabling visually impaired users to interact seamlessly with the system while receiving real-time feedback. This approach addresses key barriers to voting for this demographic, such as dependence on others and lack of accessible infrastructure. Aadhaar-based authentication enhances the system's security, ensuring that only eligible voters can participate while preventing fraudulent activities. Additionally, the use of a centralized database streamlines the management of voter and candidate information, ensuring data integrity and accuracy throughout the process. Unlike conventional systems that rely on physical interfaces or extensive hardware, this solution is designed to be cost-effective and scalable, making it ideal for deployment in diverse environments, including rural and under-resourced areas. Compared to other systems that focus on advanced technologies like blockchain, biometrics, or multimodal interfaces, this project provides a simpler yet highly effective alternative tailored to the needs of visually impaired users. Its focus on inclusivity rather than technological sophistication highlights the importance of user-centric design in creating impactful solutions. Furthermore, the system's ability to adapt to different languages and cultural contexts ensures its potential for widespread adoption in countries with significant visually impaired populations. In conclusion, this project not only addresses the immediate need for accessible voting solutions but also paves the way for broader discussions on the role of technology in fostering inclusivity in democratic processes. With further enhancements and widespread implementation, the AI-driven voting system for visually impaired individuals could become a benchmark for accessible voting technologies worldwide, contributing significantly to the vision of universal suffrage and equitable participation in elections.

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