Voice-based E-mail for the Visually Impaired

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ABSTRACT

Voice-Based E-Mail for the Blinds is an innovative and transformative email system designed specifically to empower individuals with visual impairments. By leveraging advanced technologies such as natural language processing (NLP), speech recognition, and text-to-speech synthesis, the system allows users to interact with their emails using voice commands, significantly enhancing accessibility, and improving the overall user experience.

This paper presents a comprehensive analysis of the development, implementation, and evaluation of the Voice-Based Mail system. It delves into the technical aspects of the system architecture, including the seamless integration of speech recognition engines, NLP algorithms, and email server APIs. This integration facilitates the effortless retrieval, organization, and composition of mail through voice commands.

Furthermore, the paper highlights the distinctive features that distinguish this Mailing technology from traditional email platforms. These features encompass customizable voice settings that enable users to personalize speech characteristics and pacing, as well as multi-language support to cater to a diverse user base. Robust error-handling mechanisms ensure accurate recognition of user commands and provide informative audio feedback in cases of ambiguity.

To evaluate system performance and user satisfaction, extensive user testing sessions were conducted with visually impaired individuals. The feedback received emphasized the system's user-friendliness, efficient navigation, and significant positive impact on daily email communication tasks. The implications of the system in terms of productivity, independence, and inclusivity for visually impaired users are also discussed.

Keywords

Voice-based Email, visually impaired, Speech-to-text, text-to-speech, Speech recognition, NLP (Natural Language Processing), Libraries, APIs

1. INTRODUCTION

Mail services are an integral part of our daily lives, but visually impaired individuals face challenges in accessing and utilizing these systems. Existing technologies such as screen readers, automatic speech recognizers, and braille keyboards have attempted to address this issue. However, these solutions often fall short of providing a seamless and efficient user experience.

The goal of the Voice Based Email for Visually Impaired project is to enhance accessibility for visually challenged individuals by leveraging advanced technologies. This application leverages speech-to-text and text-to-speech converters to enable users to control their email accounts using their voice alone. Users can effortlessly read, send, and perform various tasks within their mail accounts through voice commands.

The system employs the .NET framework, utilizing Speech-to-Text technology to convert spoken speech into text for composing emails. This simplifies the process of creating and composing emails. Additionally, the Text-to-Speech module generates audio output that reads out the mail's key details, including the sender, subject, and body of the email.

In addition to email functionality, the system aims to assist visually impaired individuals in using fundamental applications like My Computer, Word, Notepad, and more. By providing comprehensive support across various applications, the Voice Based Email system ensures a more inclusive and user-friendly experience for visually challenged individuals.

The rest of the paper is structured as follows: Section 2 presents a literature survey, examining existing solutions and their limitations. In Section 3, we propose our system designed specifically for visually impaired users. Section 4 provides implementation details, outlining the technologies and tools utilized. Finally, Section 5 concludes the paper, highlighting the significance and potential impact of this voice-based email solution for visually impaired individuals.

2. LITERATURE SURVEY

In this section, we present a comprehensive review of the existing literature on similar techniques.

Paper [2] proposes a voice-based email architecture aimed at assisting visually impaired individuals in accessing their emails. The current system lacks user-friendliness for blind users, as it lacks audio feedback for content reading. The proposed solution utilizes Speech Recognition, Interactive Voice Response, and Mouse Click events. Additionally, voice recognition is employed for user verification. The system consists of two modules: Registration, which collects user information through voice prompts, and login, where users provide their username and password using voice commands. Voice verification is required before being redirected to the inbox page. Once logged in, users can perform various email operations such as composing, managing the inbox, sending mail, and trash folders, all through voice commands.

Paper [3] introduces a voice command-based system as an alternative to the existing mail systems. This system primarily relies on speech-to-text commands. The application prompts users to speak specific commands for accessing desired services. The system utilizes the Internet Message Access Protocol (IMAP) for retrieving email messages from the mail server over a TCP/IP connection. The main activity screen, displayed at the app's start, awaits user input through a full-sized button anywhere on the

screen. Users can then use voice commands to send and read emails.

In paper [4], a system is proposed that incorporates three main technologies: speech-to-text, text-to-speech, and interactive voice response. Upon the first visit, users are required to register using voice commands, and their voice samples are recorded and stored for additional security. After login, users gain access to the mail option. The system's user interface is designed using Adobe Dreamweaver CS3, focusing on enhancing understanding and efficiency. A "contact us" page is also available for user suggestions or assistance.

Paper [5] presents an email system designed for easy access by blind individuals. The system utilizes speech-to-text and text-to-speech converters, along with the Viterbi Algorithm. The algorithm detects the most appropriate word based on the user's spelling and matches it with the pronounced word. Users need to register on the website during their initial visit. This system addresses some drawbacks of existing solutions, although the efficiency of the Viterbi algorithm decreases with increased errors and requires more space.

In a paper [6], Saurabh Sawant et al. proposes a system specifically tailored for visually impaired and illiterate individuals, aiming to improve their interaction with email systems. This system eliminates the use of IVR technology, which involves screen readers and Braille keyboards. Instead, it relies on speech-to-text and text-to-speech conversion, as well as voice commands for other operations. Registration involves providing an email ID and password. The system incorporates a PHP mailer, a library used for sending emails, and employs the Knuth-Morris-Pratt Algorithm for searching emails in inboxes. Overall, the system offers a purely voice-based environment with feedback at each stage. However, it is limited to using Gmail as the host server and does not support other email services like Yahoo.

In their paper [7], Payal Dudhbale et al. propose a voice-based system for desktop and mobile devices, targeting blind users. The proposed system includes components such as a G-mail system for reading messages, RSS for news syndication, a song-listening feature, a book reader for reading books, and a drive browser for searching drives and folders. The architecture allows blind individuals to access email and multimedia functions of the operating system through voice commands and mouse clicks, eliminating the need for a keyboard. Additionally, the system includes an RSS feature for distributing headlines and update notices. A mobile application has also been developed, enabling voice-based access to various applications, including email.

In the paper [8], the authors propose Tetra Mail, an email client specifically designed for blind users to address accessibility and usability challenges on smartphones. The proposed email client, Tetra Mail, is evaluated through an empirical study involving 38 blind participants performing 14 email activities. The solution aims to assist blind individuals in sending, receiving, organizing, and managing emails. Usability and accessibility parameters based on the Human-Computer Interaction (HCI) model are used to evaluate the design. The performance of Tetra Mail is compared to other email clients like Gmail and Thunderbird.
The framework for the Tetra Mail client is developed based on the HCI model, focusing on creating an email client that blind users can easily navigate without extensive knowledge of touchscreen interfaces. The user interface of Tetra Mail is designed to provide a consistent and blind-friendly experience.
The results of the empirical study demonstrate that Tetra Mail offers a better alternative for blind users, thanks to its consistent and blind-friendly interface design. The prototype implementation showcases improved user experience, accuracy in task completion, and better control over touchscreen interfaces for basic email management activities. Tetra Mail proves to be an accessibility-inclusive email client, enabling blind users to have a more user-friendly interaction experience and reducing cognitive overload when managing emails.
The empirical study confirms that Tetra Mail assists blind users in comfortably sending and receiving emails with ease. It proves to be a reliable solution that enhances the user experience and accessibility of email-related activities for blind individuals [8].

Advantages of the above-surveyed techniques

The majority of the papers highlight the benefits of utilizing speech-to-text and text-to-speech conversion, which enhances interactivity and ease of use for visually impaired individuals. These techniques contribute to a more inclusive system, allowing disabled users to feel like normal participants. Moreover, a voice-based approach proves beneficial for individuals with disabilities and those who are illiterate. One major advantage is the use of automatic speech recognition, which facilitates convenient interaction without the need for visually impaired users to remember and type characters on a keyboard. Overall, the voice-based email systems discussed are designed to be user-friendly and accessible.

Disadvantages/Limitations of the above-surveyed techniques

A common limitation observed in most of the papers is the reliance on mouse clicks for various tasks, which poses challenges for visually impaired individuals who cannot rely on visual cues. Additionally, the applicability of these techniques is primarily focused on the English language, thus limiting their effectiveness in regions like the Indian subcontinent with diverse languages. Speech recognizers are primarily designed to recognize English, which hinders their usability for other languages. This poses a significant drawback for users who prefer or require non-English languages.

The following section presents the proposed system specifically designed for the visually impaired.

3. PROPOSED SYSTEM

The proposed solution entails developing a desktop application designed to facilitate easy and efficient email access for individuals with visual impairments. Unlike existing voice-based email systems that offer their custom email services, this application aims to incorporate Google's Gmail client, providing users with an additional advantage.

Module Description

1. Multilingual Speech Recognition:

Technology: Deep Learning and Automatic Speech Recognition (ASR)

Libraries/Frameworks: TensorFlow, Keras, PyTorch

Language: Python

Implementation Details: Collect diverse language datasets that cover languages spoken in the Indian subcontinent. Train deep learning models using ASR techniques, employing libraries such as TensorFlow, Keras, or PyTorch. Develop language-specific acoustic models and dictionaries for each targeted language. Ensure the system can handle multiple languages seamlessly, recognizing and transcribing speech accurately.

2. Gesture-based Navigation:

Technology: Motion Sensing or Touch-based Input
Libraries/Frameworks: Leap Motion, OpenCV
Language: Python, C++
Implementation Details: Utilize motion sensing devices like Leap Motion or cameras with computer vision capabilities provided by libraries like OpenCV. Develop algorithms to track hand gestures or touch-based input and map them to specific application functions. Enable intuitive navigation through email functions without relying on visual cues.

3. Natural Language Processing (NLP):

Technology: Natural Language Processing
Libraries/Frameworks: NLTK, SpaCy, TensorFlow
Language: Python
Implementation Details: Apply NLP techniques to perform advanced language processing tasks. Utilize libraries such as NLTK, SpaCy, or TensorFlow for tasks like sentiment analysis, text summarization, and language translation. Enhance the system's ability to understand and interpret the content and context of emails, providing visually impaired users with a comprehensive understanding of their messages.

4. Accessibility Standards Compliance:

Technology: Web Accessibility
Libraries/Frameworks: None specific, but adherence to Web Content Accessibility Guidelines (WCAG)
Language: HTML, CSS, JavaScript
Implementation Details: Design the application's user interface and user experience with accessibility in mind. Follow WCAG guidelines, ensuring proper text alternatives for non-text content, semantic markup, and keyboard accessibility. Use HTML, CSS, and JavaScript to create an accessible and inclusive email application compatible with assistive technologies like screen readers and braille devices.

5. Integration with Voice Assistants:

Technology: Voice Assistant APIs (e.g., SiriKit, Google Assistant SDK)
Libraries/Frameworks: None specific, but APIs provided by voice assistant platforms
Language: Depends on the voice assistant platform (e.g., Swift for SiriKit, Python for Google Assistant SDK)
Implementation Details: Integrate the email application with popular voice assistants like Siri, Google Assistant, or Amazon Alexa. Utilize the provided APIs to enable voice-based interaction with emails. Implement voice command recognition and response handling, allowing visually impaired users to manage their emails hands-free using voice commands.

Hardware Requirements

1 GB RAM.

200 GB HDD.

Intel 1.66 GHz Processor Pentium4

Software Requirements

1. Windows 10
2. Visual Studio 2013
3. Windows Operating System
4. ASP.net: A web development platform that facilitates the creation of enterprise-class web applications.
5. Microsoft SQL Server: A Relational Database Management System (RDBMS) used to store user registration and other relevant details.

Flowchart of the Proposed System

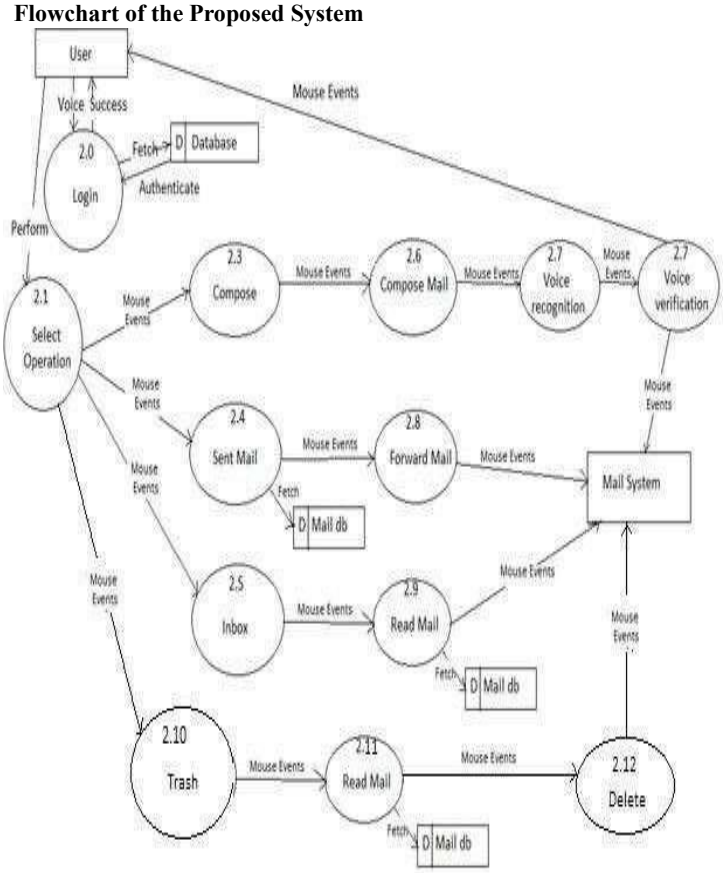

Figure 2: Flowchart of the Proposed System

Fig. 2 explains the flow of the application:

User Registration:

1. Users need to create their accounts by providing their email ID and password.
2. The system prompts for authentication, verifying the entered credentials.
3. Upon successful authentication, the user's registration process is completed.

Email Access and Composition:

1. Users can log into their mail systems, check received emails, and compose new emails.
2. The speech-to-text and text-to-speech modules play a crucial role in facilitating these actions.
3. The system reads out the details of received emails, including sender's name, subject, and main body.
4. Users can compose emails using the speech recognition module or directly send audio attachments via the application's provided recorder.

The next section delves into the implementation details.

4. IMPLEMENTATION DETAILS

This section provides an overview of the implementation details of the proposed system. The registration process necessitates specific credentials, including the Email ID and Password.

- **Requirements Gathering:**
  Identify the specific requirements and needs of visually impaired users. Determine the desired functionalities and features of the email system. Consider the target languages and accessibility standards to be supported.

- **Data Collection and Preparation:**

  Gather diverse language datasets that cover languages spoken in the Indian subcontinent. Clean and preprocess the collected data to ensure its quality and suitability for training.

- **Multilingual Speech Recognition:**

  Train deep learning models using Automatic Speech Recognition(ASR) techniques. Use libraries/frameworks like TensorFlow, Keras, or PyTorch to implement the ASR models. Develop language-specific acoustic models and dictionaries for each targeted language. Test and evaluate the accuracy and performance of the speech recognition system.

- **Gesture-based Navigation:**

  Choose motion sensing devices (e.g., Leap Motion) or utilize cameras with computer vision capabilities (e.g., OpenCV). Develop algorithms to track hand gestures or touch-based input for navigation purposes. Map the detected gestures or touch events to specific application functions. Test and refine the gesture-based navigation system for optimal user experience.

- **Natural Language Processing (NLP):**
  Implement NLP techniques using libraries/frameworks such as NLTK, SpaCy, or TensorFlow. Apply sentiment analysis, text summarization, and language translation to enhance email understanding. Develop algorithms to interpret the content and context of emails for comprehensive comprehension. Evaluate and refine the NLP components to improve accuracy and performance.
- **Accessibility Standards Compliance:**

  Design the user interface and user experience with accessibility in mind. Follow Web Content Accessibility Guidelines (WCAG) for proper text alternatives, semantic markup, and keyboard accessibility. Implement HTML, CSS, and JavaScript to create an accessible and inclusive email application. Test the application's compatibility with assistive technologies like screen readers and braille devices.

- **Integration with Voice Assistants:**

  Choose the desired voice assistant platform (e.g., Siri, Google Assistant, Amazon Alexa). Utilize the provided APIs (e.g., SiriKit, Google Assistant SDK) for seamless integration. Implement voice command recognition and response handling within the email application. Test and ensure proper functionality of voice-based interaction with emails.

- **System Integration and Testing:**

  Integrate the developed components into a cohesive email-based system. Conduct rigorous testing to ensure the system's functionality, accuracy, and usability. Address any bugs or issues encountered during testing and make necessary refinements.

- **Deployment and User Training:**

  Deploy the email-based system on the desired platform (e.g., desktop, mobile). Provide user training and documentation for visually impaired individuals to navigate and utilize the system effectively. Gather feedback from users to further enhance the system's usability and accessibility.

- **Continuous Improvement and Maintenance:**

  Regularly update and maintain the email system to address any emerging issues or advancements in technology. Stay updated with new techniques and technologies to continually improve the system's performance and user experience.

By developing a desktop application that integrates Speech-to-text and Text-to-speech converters, we have successfully addressed the challenges faced by visually impaired individuals in checking and composing emails. Furthermore, we have overcome the limitations of relying on a user-based mailing system by integrating Gmail's SMTP and POP3 clients into our application. This approach not only ensures the security of users' data but also instills a sense of confidence in their mailing experience.

5. CONCLUSIONS

The following paper proposes a Voice-based Email system specifically designed for visually impaired individuals. This innovative application enables blind and handicapped users to effortlessly access and manage their emails. Providing a voice-based mailing service empowers visually impaired individuals to independently read and send emails without relying on others. The system eliminates the need for keyboard shortcuts and addresses the challenges faced by the visually impaired community. It incorporates a speech recognition application that offers an efficient voice input method for email communication, catering not only to the visually impaired but also to individuals with disabilities and low literacy levels.

Looking ahead, our future endeavors involve making the system keyboard-free and fully voice-based, ensuring seamless accessibility for visually impaired users. While the current implementation focuses on desktop platforms, the ever-growing usage of mobile phones presents an opportunity to extend this functionality as a dedicated mobile application. Additionally, we recognize the importance of enhancing security measures during the login phase to ensure the utmost safety and privacy for users.

By continually refining and expanding upon these aspects, we aim to provide a comprehensive and inclusive email system that meets the evolving needs of visually impaired individuals, fostering independence and equal participation in the digital world.

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