



ECHOLENS: Smart Glasses for Real-time speech display for deaf individuals

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Abstract: Communication is a fundamental human need, and for deaf individuals, the barriers posed by auditory impairments can be particularly isolating. Smart glasses, equipped with cutting-edge technology, have emerged as a promising solution to bridge the communication gap for the deaf community. This abstract explores the concept and implications of smart glasses designed to display spoken words in real-time during conversations, enabling deaf individuals to engage seamlessly in verbal interactions. Smart glasses for real-time speech display leverage advanced speech recognition algorithms, microphones, and augmented reality (AR) technology to transcribe spoken words into text and project them onto the glasses' heads-up display. This innovation not only empowers deaf individuals by providing access to conversations that were previously inaccessible but also enhances their social integration, autonomy, and overall quality of life. Additionally, it discusses the potential impact on education, employment, and social interactions, emphasizing the transformative nature of this technology in empowering the deaf community. Furthermore, the abstract touches upon the ethical considerations surrounding privacy, consent, and the need for inclusive design principles in the development of such devices. It also acknowledges ongoing research and development efforts aimed at improving accuracy, accessibility, and affordability. In conclusion, smart glasses that display words spoken by others in real-time hold immense promise in breaking down communication barriers for the deaf. This abstract highlights the potential of this technology to revolutionize the lives of deaf individuals, foster inclusive societies, and promote a more accessible and equitable future.

Index Terms: Smart glasses, Augmented Reality, Dynamic spectrograms

I. INTRODUCTION

In a world where communication is fundamental to human connection, individuals with auditory impairments often face significant barriers to engaging fully in verbal interactions. The inability to hear spoken words can lead to feelings of isolation and hinder participation in various aspects of daily life. To address this challenge, the project aims to develop an innovative solution: smart glasses tailored specifically for the deaf community.

These glasses will utilize advanced technology to instantly convert spoken words into text, offering real-time access to verbal communication. Equipped with microphones and augmented reality, they prioritize privacy, security, and accessibility. By integrating emerging technologies and adopting a user-centric design, our project aims to empower the deaf community, enhancing social integration and quality of life. With applications in education and employment, these glasses promise to foster inclusivity and accessibility. Through collaboration, research, and ethical principles, we aspire to create a transformative solution that bridges communication gaps for the deaf, promoting greater connection and understanding in society.

II. OBJECTIVE AND SCOPE

The project aims to create smart glasses for the deaf, instantly converting spoken words into text. These glasses, equipped with advanced microphones and augmented reality, provides customizable text display. Prioritizing privacy, security, and accessibility, the project explores educational and employment applications, contributing to ongoing research for continuous improvement. Ultimately it seeks to empower the deaf community enhancing social integration overall quality of life.

The scope of this project encompasses the development of innovative smart glasses designed specifically to address the communication needs of the deaf community. This include:

Development of Smart Glasses: Design and manufacture of smart glasses equipped with advanced microphone technology and augmented reality capabilities.



Speech-to-Text Conversion: Implementation packages and plugins for real-time conversion of spoken words into text, ensuring accuracy and reliability.

Customizable Text Display: Creation of a user-friendly interface for displaying converted text on the smartphone, allowing customization according to user preferences.

Privacy and Security: Integration of privacy and security measures to safeguard user data and ensure confidentiality during communication.

Applications in Education and Employment: Exploration of potential applications in education and employment sectors, aiming to facilitate communication and integration for deaf individuals in academic and professional settings.

Continuous Improvement: Commitment to ongoing research and development to enhance the functionality, accuracy, and accessibility of the smart glasses, ensuring continuous improvement and adaptation to user needs.

Social Impact: Evaluation of the social impact of the smart glasses on the deaf community, focusing on improvements in social integration, autonomy, and overall quality of life.

Inclusivity and Accessibility: Emphasis on fostering inclusivity and accessibility in various aspects of daily life for the deaf community through the provision of a transformative communication solution.

Collaboration and Stakeholder Engagement: Collaboration with stakeholders, including deaf individuals, organizations, and researchers, to gather feedback, ensure relevance, and maximize the project's impact.

Ethical Considerations: Adherence to ethical principles, including privacy, consent, and inclusive design, throughout the project development process to promote ethical and responsible use of the technology.

III. LITERATURE REVIEW

A. INTRODUCTION

In this literature review, a total of 6 papers were studied to understand the current state of the technology and its potential applications. These papers underscore a common theme: the utilization of technology to address challenges faced by individuals with hearing impairments, particularly the deaf and hard-of-hearing (DHH) community. Across these papers, innovative solutions are proposed, ranging from augmented reality (AR) systems to voice activity detection (VAD) algorithms, all aimed at improving communication, sound perception, and overall quality of life for individuals with hearing disabilities.

The papers delve into various aspects of technology-enabled assistance. Some focus on converting household sounds into visual information using machine learning and dynamic spectrograms, offering DHH individuals a way to perceive their environment in real-time. Others introduce augmented reality glasses equipped with speech-to-text conversion capabilities, bridging the communication gap by making speech visible to those with auditory loss. Additionally, there are discussions on smart glasses designed to enhance awareness of important sounds and their directions, utilizing advanced technologies like active noise cancellation and speech recognition.

Furthermore, the papers explore the technical aspects of these solutions, including hardware design, algorithm development, and experimental evaluations. They highlight the effectiveness and potential applications of these technologies in healthcare, education, and everyday interactions. Moreover, considerations such as affordability, integration with existing systems, and future advancements are also addressed, underscoring the broader impact and sustainability of these solutions. In essence, these papers collectively represent a concerted effort to leverage technology for the empowerment and inclusion of individuals with hearing disabilities. By providing innovative tools and systems that enhance communication, perception, and interaction, these advancements pave the way for a more accessible and equitable society for all.

B. ADVANTAGES

There were many real-life and existing applications discussed in the papers. Some of these are :

Augmented Reality (AR) System: These systems could find applications in public spaces such as libraries, transportation hubs, and government offices, where real-time visualization of environmental sounds can enhance accessibility and safety for individuals with hearing impairments.



Augmented Reality Glasses: In public healthcare settings, AR glasses with speech-to-text conversion capabilities can facilitate communication between healthcare providers and patients with hearing impairments, ensuring effective delivery of medical information and services.

Smart Glasses for Sound Awareness: Public safety agencies could utilize smart glasses equipped with sound awareness features to alert individuals with hearing disabilities to important environmental sounds, enhancing their awareness and safety in public spaces.

Voice Activity Detection (VAD) Algorithms: Public transportation systems and emergency response services could benefit from VAD algorithms to detect speech in noisy environments, ensuring clear communication and timely assistance for individuals with hearing impairments during emergencies or while using public transportation.

C. CHALLENGES

While the applications discussed in the papers offer promising solutions for individuals with hearing impairments, several challenges may arise in their implementation and adoption. Some of these challenges include:

Accuracy and Reliability: Ensuring the accuracy and reliability of sound classification, speech recognition, and other algorithms is crucial for the effectiveness of these applications. Variability in environmental conditions, background noise, and individual speech patterns can pose challenges to achieving high accuracy rates.

Technical Limitations: The hardware and software components used in these applications may have technical limitations such as processing power, battery life, and compatibility issues. Overcoming these limitations while maintaining functionality and usability is essential for widespread adoption.

User Acceptance and Usability: The acceptance and usability of these technologies among users, particularly individuals with hearing impairments, can be influenced by factors such as ease of use, comfort, and perceived benefits. Designing intuitive interfaces and considering user feedback are critical for ensuring user acceptance.

Privacy and Security: Speech-to-text conversion and other features may involve the processing and transmission of sensitive information, raising concerns about privacy and security. Implementing robust security measures and ensuring compliance with privacy regulations are essential to address these concerns.

Cost and Accessibility: The affordability and accessibility of these technologies can be barriers to adoption, especially for individuals with limited financial resources or access to specialized devices. Addressing cost barriers and ensuring equal access to technology are important considerations.

Integration and Interoperability: Integrating these applications with existing systems and technologies, such as smart glasses, smartphones, and IoT devices, may pose interoperability challenges. Ensuring seamless integration and compatibility across platforms is essential for maximizing utility and usability.

Ethical and Social Implications: Consideration of ethical and social implications, such as potential biases in speech recognition algorithms, stigmatization of individuals with hearing impairments, and equitable access to technology, is important for responsible development and deployment of these applications.

IV. CONCLUSION

The development of the Speech-to-Text Conversion System for smart glasses represents a significant leap forward in communication technology for individuals with hearing impairments. This system addresses critical limitations of existing solutions, such as the lack of portability, real-time transcription, and user-friendliness. By incorporating a compact design and leveraging advanced technologies like the ESP32 microcontroller and OLED display, the system provides accurate, on-the-fly transcription of spoken words into text, displayed directly on the glasses' heads-up display. This innovation ensures that users can engage in conversations and access spoken information effortlessly, regardless of their environment. The integration of a user-friendly interface further enhances the system's accessibility, allowing users to navigate and interact with the device seamlessly. The successful implementation of this project underscores its potential to significantly improve the quality of life for individuals with hearing challenges. The portable nature of the smart glasses, combined with the real-time speech-to-text conversion, fosters greater social integration and autonomy for users. Moreover, this technology serves as a foundation for future advancements in assistive devices, paving the way for enhanced functionality and broader applications.



The project highlights the importance of inclusivity in technological development, demonstrating how innovative solutions can bridge communication gaps and promote accessibility. This research not only contributes to the field of assistive technology but also sets a precedent for future endeavors aimed at improving communication accessibility for all.

V. FUTURE SCOPE

Smart glasses are a rapidly evolving technology with a wide range of potential applications. Some possible future developments and scopes for smart glasses include:

Enhanced Speech Recognition: Continuous refinement and improvement of speech recognition algorithms to increase accuracy and effectiveness, even in noisy environments.

Expanded Language Support: Integration of additional languages and dialects to cater to a broader user base and improve accessibility for individuals from diverse linguistic backgrounds.

Gesture Recognition: Exploration of gesture recognition technology to enable users to interact with the smart glasses through intuitive hand movements, offering an alternative input method for individuals with mobility impairments or in situations where verbal communication is challenging.

Integration with Wearable Devices: Collaboration with wearable technology manufacturers to seamlessly integrate the system with other wearable devices, enhancing functionality and providing users with a unified experience across different platforms.

Community Engagement: Establishment of online communities and forums where users can share their experiences, provide feedback, and collaborate on further enhancements and developments of the system, fostering a sense of community and support among users.

Ethical Considerations: Ongoing assessment of ethical implications, including privacy protection, data security, and algorithm biases, to ensure that the system upholds ethical standards and respects users' rights and dignity. Regular audits and reviews will be conducted to address any emerging ethical concerns and uphold user trust and confidence in the system.

VI. PROPOSED METHOD

The proposed system, Echo Lens is a combination of a smart glass and mobile application that has 3 modules working together to provide a seamless experience. The system integrates smart glasses equipped with advanced speech recognition and augmented reality technology. These smart glasses can convert spoken words into text in real time, displaying them on the glasses' heads-up display. The system includes a user-friendly UI that allows users to easily navigate and interact with the device. Additionally, the system allows users to transcribe speech directly on their mobile phones using a dedicated app. This feature provides users with flexibility and convenience, as they can choose between using the smart glasses or their mobile phones for transcription. The system also offers functionality to save transcribed text from lectures or conversations on both the smart glasses and the mobile app, allowing users to review and reference information later. Overall, this system significantly improves social integration, autonomy, and overall quality of life for users with auditory impairments, while also enhancing their learning experience and information retention. The 3 modules present in the device are: Speech Recognition Module, Display control Module and Power management Module

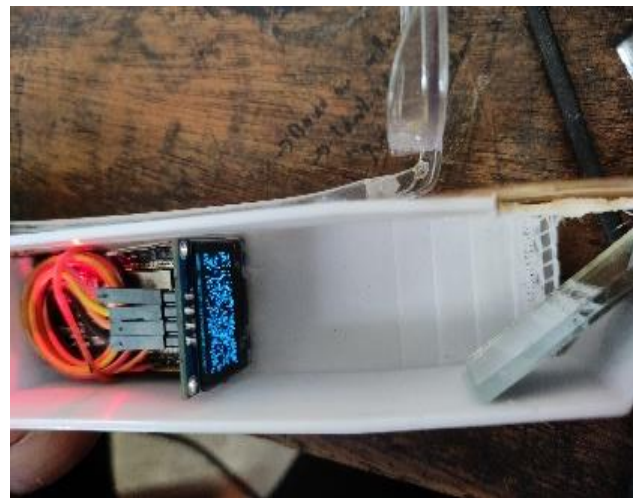
A. *Speech Recognition Module*

The Speech Recognition module plays a pivotal role in the system, responsible for capturing audio data from a microphone and processing it for speech recognition using the "speech to text" Flutter plugin. Once the speech is recognized, the module converts it into text format. Additionally, it manages wireless communication with the ESP32 for sending the recognized text. Comprising components such as a microphone and audio processing logic, the module ensures efficient and accurate recognition of speech, enhancing the overall functionality of the smart glasses system. The Wi-Fi or Bluetooth connectivity further enables seamless communication, allowing for real-time data exchange between the mobile application(ECHOLENS) and ESP 32



B. *Display Control Module*

The Display Control Module is integral to the system, tasked with managing the OLED display and rendering the received text data for visualization. It oversees the control of the display, ensuring optimal presentation of the text information. Additionally, the module processes the received text data, including decoding if necessary, and prepares it for display. This involves formatting and organizing the text to ensure clarity and readability on the OLED screen. The key components of the module include the OLED Display and ESP32.



itself, the Display Control Logic responsible for interfacing with the display hardware, and the ESP32 microcontroller, which coordinates the overall functioning of the module within the smart glasses system. Together, these components work in tandem to deliver a seamless and effective display of text information, enhancing the user experience and usability of the smart glasses.

C. *Power management Module*

The Power Management Module is a critical component of the smart glasses system, responsible for overseeing all aspects related to power distribution and utilization. Its primary role is to ensure the efficient management of power-related components to support uninterrupted functionality. This involves integrating a rechargeable battery with an optimal capacity to sustain the device's operation for extended periods. Additionally, the module may feature supplementary circuits like battery protection and charging circuits to safeguard the battery against potential risks such as overcharging or over-discharging. Key components within this module include the rechargeable battery itself, alongside essential circuits such as the battery protection and charging circuits.

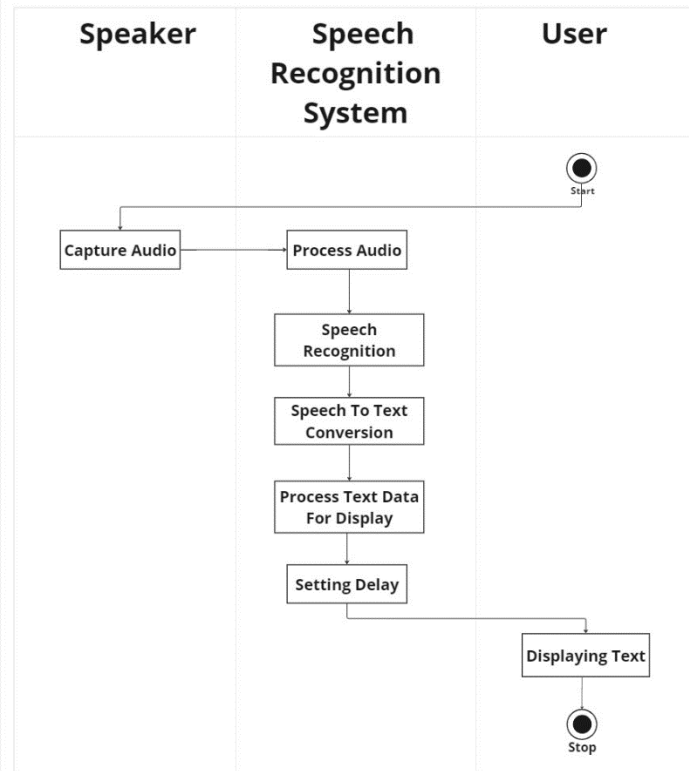


fig 1. Activity diagram of proposed system

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