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Smart Wearable Glass for Visually Impaired

N.Sathiyanathan¹, A.Arun¹, S.V.Janani², N.Kamatchi², A.Kanipriya²

Assistant Professor, Department of Electronics and Communication Engineering, Sethu Institute of Technology,

(Autonomous), Virudhunagar, Tamil Nadu, India¹

UG Student, Department of Electronics and Communication Engineering, Sethu Institute of Technology,

(Autonomous), Virudhunagar, Tamil Nadu, India²

ABSTRACT: The dearth of accessible resources and technologies makes it extremely difficult for people with visual impairments to access school and career possibilities. This study suggests creating a smart spectacle that transforms printed text into audible output in order to empower visually challenged persons and overcome these challenges. The eyewear, which has a built-in camera, takes pictures of text from printed materials. Tesseract OCR(Optical Character Recognition) is used to process these images in order to extract text, which is then transformed into voice using a text-to-speech(TTS) engine. This model's implementation combines OpenCV libraries for effective image processing and acquisition with an ESP32 Node MCU acting as the core processing interface. Real time text recognition and audio feedback are provided by an embedded technology, allowing visually impaired more benefiting in their real-time usages.

KEYWORDS: OCR; TTS; Open CV;

I. INTODUCTION

Modern engineering solutions have seamlessly integrated into our daily lives, improving the quality of life in countless ways, often without our notice. Among these advancements, one of the most transformative impacts has been in the realm of disability assistance, enabling individuals to overcome challenges and adapt to dynamic environments. Visual impairment, characterized by a significant reduction in vision that cannot be corrected by traditional glasses or contact lenses, continues to affect millions globally. This condition encompasses classifications like low vision acuity, legal blindness, and moderate visual impairment. Over recent decades, the number of visually impaired individuals has grown across various age groups, amplifying the need for innovative solutions.

As reported by the world health organization WHO at August 2014, 285 million people worldwide are estimated to be visually impaired, 39 million of them are blind and 246 million have low vision. Losing the sight or vision means a lot of difficulties communicating with others as well as developing the level of knowledge and experience. This innovative system demonstrates the potential to revolutionize accessibility for visually impaired individuals by providing a practical, cost-effective, and scalable solution. With its ability to convert printed text into audible speech seamlessly, it stands as a testament to the power of engineering in creating inclusive and equitable opportunities for all.

II. RELATED WORK

The concept of the text conversion was first introduced by [1] Gupta, R.K., & Sharma, R : In their research in Optical Character Recognition (OCR) explores the development of systems to help blind users read printed text by converting images of text into speech or Braille. Author[2] Shiri Azenkot's research focused on how blind users interact with touchscreen devices, such as smartphones, and how to improve this interaction to make the devices more accessible.

In [3] the authors work focuses on making digital libraries and archives more accessible to blind and visually impaired individuals through the development of specialized software and interfaces. Dr. T.V. Raman developed Emac speak, a speech interface for the Emacs text editor that converts on-screen text into speech, making it accessible for blind individuals who use computers presented in [4]. In [5] authors work depicts ariq and Ahmed's work investigates the combination of OCR and speech synthesis technologies to create practical reading aids for blind individuals. Their work has contributed to systems such as OrCam My Eye and KNFB Reader, which provide real-time reading assistance to blind users by converting text into speech. Dr. Michele LaPorte's research in tactile and auditory systems has





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contributed to the development of tools to assist blind students in their education, including interactive Braille books and auditory learning aids. LaPorte's work helps ensure that blind students have access to learning materials in ways that are just as effective as for sighted students was depicted in[7].

III. METHODOLOGY

Phase1: Microcontroller Integration

The ESP32 microcontroller serves as the heart of the smart reader system, coordinating all tasks and ensuring smooth operation. The ESP32 is responsible for overseeing the input and output tasks of the system. It interacts with the connected peripherals, including the camera module and the speaker, to manage data flow and processing. With its integrated Wi-Fi and Bluetooth capabilities, the ESP32 can wirelessly transmit data to cloud-based services, such as the OCR service, ensuring quick and efficient processing of captured images. The ESP32 powers the connected components, including the camera module, through its 3.3V pin, making it a self-sufficient unit capable of running the entire system.

Phase2: Image Capture – Camera Module

The camera module captures images of physical documents, signage, books, or any printed text. It provides the raw data (image) necessary for the OCR process. The camera communicates with the ESP32 microcontroller via dedicated GPIO pins. The ESP32 provides power to the camera and handles the transmission of captured data. The camera is powered directly from the 3.3V pin of the ESP32, ensuring an efficient power usage system without the need for additional power sources.

Phase3: Optical Character Recognition (OCR) Service

The captured image is transmitted wirelessly from the ESP32 to the cloud-based OCR service via the ESP32's Wi-Fi capabilities. This ensures seamless communication and fast processing. The OCR service processes the image data and converts the visual information intomachine-readable text. This process involves image preprocessing, text recognition, and formatting the output for further use.

Phase4: Text-to-Speech (TTS) Conversion

Upon receiving the text from the OCR service, the ESP32 processes it using a Text-to- Speech (TTS) algorithm. The ESP32 either directly processes the recognized text with an integrated TTS engine or communicates with an external TTS service to generate speech output. The TTS engine converts the text into audio signals. These audio signals are then sent to a connected speaker, enabling the system to vocalize the captured text.

Phase5: Audio Output – Speaker Integration

The system is equipped with a speaker that receives the audio signals from the ESP32 and reproduces the speech output. The speaker is an essential component for delivering real- time auditory feedback to the user. The audio output is produced in real-time as the system processes and converts the captured text. This ensures an immediate response, offering a fluid and efficient user experience.

Phase6: Workflow and System Integration

The process begins with the camera module capturing an image of printed text. The ESP32 then transmits the image data to the OCR service via its wireless connection. The OCR service processes the image data and returns the extracted text to the ESP32, which then sends the text to the TTS system for conversion into speech. The final text is converted into audio and played through the connected speaker, allowing the user to hear the content of the printed text in real-time.





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IV. SYSTEM ARCHITECTURE AND KEY TECHNOLOGIES ESP32 CAM MODULE

In this project, the ESP32-CAM serves as the primary component for capturing images of text. Equipped with a 2MP OV2640 camera module, it allows for high-quality image capture, which is essential for the Optical Character Recognition (OCR) process. Once an image is captured, the ESP32-CAM transmits it wirelessly via Wi-Fi to the ESP32 Node MCU, which processes the image and converts the extracted text into speech. This makes the ESP32-CAM an essential part of the system, enabling the capture and transfer of text images that will be transformed into speech for users in need, such as those with visual impairments.

ESP32 NODE MCU MODULE:

In this project, the ESP32 Node MCU serves as the central processing unit responsible for receiving, processing, and outputting the captured text. Once the ESP32-CAM captures an image of the text, the Node MCU receives the image data via Wi-Fi or Bluetooth, and performs Optical Character Recognition (OCR) to extract the text. It then uses a Text-to-Speech (TTS) engine to convert the recognized text into audio, which is output through headphones or speakers connected to the Node MCU.

Open CV: OpenCV is a Python open-source library, which is used for computer vision in Artificial intelligence, Machine Learning, face recognition, etc. In OpenCV, the CV is an abbreviation form of a computer vision, which is defined as a field of study that helps computers to understand the content of the digital images such as photographs and videos.

TESSERACT: Tesseract OCR is used as the core engine for Optical Character Recognition (OCR), enabling the conversion of text images captured by the ESP32-CAM into machine readable text. Tesseract is an open-source OCR engine known for its accuracy and flexibility, supporting multiple languages and various text formats.

V. HARDWARE IMPLEMENTATION

Figure (a) shows the ESP32 node mcu to control the entire process. (b) shows the ESP32 cam for the text image capture. (c) shows the two of the components get integrated.



Figure(a)



Figure(b)



Figure(c)





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VI. EXPERIMENTAL RESULTS

Figures shows the results of text detection from an text material and then using libraries to convert that into speech. Fig (a) shows the original text image. (b) shows that text capturing through some installed libraries. (c) shows Showed Text converted To image . (d) Text is Extracted from Image using OCR technique. And converted into its speech.



Figure(a)

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<pre>Nelping Article : https://stackoverflow.com/questions/50051055/pytesseract-tesseractmotfound-error-tesseract-is-net-installed-or-its-net-i</pre>			
https://pypl.org/project/opency-python/			
Figure(b)			
rigure(b)			



Figure(c)



Figure(d)





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VII. CONCLUSION

By leveraging Optical Character Recognition (OCR) and Text-to-Speech (TTS) technologies, it offers a valuable tool for individuals with visual impairments or reading disabilities, enabling them to capture printed text and have it read aloud instantly. The system is designed to be portable, affordable, and user- friendly, making it accessible to a wide range of users, from students and the elderly to individuals in need of assistive technology. With Wi-Fi and Bluetooth integration, the system can be controlled remotely, adding convenience and flexibility. The project's use of open-source software and low-cost components ensuresscalability and the potential for future improvements or customizations. Overall, this project holds great promise in enhancing accessibility and independence for individuals facing challenges with reading printed material, making it a practical and valuable tool in the growing assistive technology

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