Smart Glasses for the Visually Challenged: A New Approach to Assistive Vision Technology

Pravin M. Dhanrao [1*]

[1] Department of Computer Engineering, Sanjivani College of Engineering, Kopargaon

Abstract

This paper introduces an innovative assistive device — smart glasses specially designed for people with visual impairments**.** These smart glasses use a Raspberry Pi camera module to capture images of printed materials like newspapers, books, and everyday objects. The captured images are then processed using optical character recognition (OCR)**,** which converts the visual content into text. This text is then converted into speech using text-to-speech (TTS) technology, allowing the user to hear the information through a connected headset.

The main goal of this project is to help visually challenged individuals access printed information in real time, giving them greater independence in their daily activities. In addition to reading printed text, the smart glasses also include a second feature that can recognize and read currency notes, helping users manage money with confidence and accuracy.

By combining text reading and currency identification, these smart glasses aim to improve the quality of life and self-reliance of visually impaired individuals. This project is a step toward bridging the information gap faced by this community, offering them a practical tool to better interact with the world around them.

Keywords:

Envisioning, Revolutionizing, Raspberry Pi, Camera Module, OCR, TTS, Currency.

A) Introduction

In today's fast-paced digital world, most information is shared visually — through screens, signs, books, and printed content. While this works well for many, it creates a serious barrier for people who are visually impaired. Everyday tasks such as reading a newspaper, understanding public signs, or identifying currency notes become challenging and often require external help. These challenges can limit their independence and affect their confidence and overall quality of life. [3, 6]

To address this issue, the research presented in this paper focuses on the development of smart glasses that are specially designed to assist people with visual impairments. These smart glasses aim to support users in reading printed materials and identifying currency, two critical tasks in daily living.

The core of this system lies in a camera module integrated into the glasses, which captures images of items like books, newspapers, or signboards. [4] What makes these glasses powerful is the use of Optical Character Recognition (OCR) technology, which converts these captured images into readable text. That text is then converted into spoken words using a Text-to-Speech (TTS) system, allowing users to listen to the content through a headset. This gives them real-time access to information that would otherwise be inaccessible.

In addition to helping with reading, these glasses have a second feature dedicated to identifying currency notes [10]. By scanning the notes and recognizing different denominations, the glasses help users handle money with accuracy and confidence — an essential part of leading an independent life.

This multi-functionality is designed to bridge the information and accessibility gap that people with visual impairments often face [12]. It promotes a sense of freedom by enabling them to perform everyday activities with less reliance on others. The development of these smart glasses is not just a technical achievement — it's a step toward creating a more inclusive and accessible society [9]. By combining simple hardware with intelligent software, this system shows great potential to transform assistive technology and improve the lives of those who are visually challenged.

This paper explores the design, features, and future potential of these visionary smart glasses and discusses how they can reshape assistive tools for better accessibility and independence [16].

B) Literature Survey

Our work focuses on text recognition that is text extraction from image and cash identification. Our work focuses on two different fields. Following is the discussion on these points.

1) Text Recognition:

The proposed method [1] is inspired by the way a normal reader reads the book. For this reason, they used a human-centric approach, in order to achieve the highest degree of the same natural experience between a normal reader and a VI (visually Impaired) person. As per it [1], the blind person needs to hold the book open (two pages) with his hands stretched straight at the level of his eyes. The system continuously captures the image and tries to find the best position. It guides users to the best position using voice commands. But this system needs a book open with two pages. The system is not able to read text from images other than books. It can't read labels of products or text from other images. [2] The referenced paper introduces an innovative system using OCR technology and smartphone cameras to convert English text into speech for visually impaired users, emphasizing improved accessibility. This technology aligns with a growing body of research highlighting the importance of OCR and text-to-speech solutions in enhancing accessibility for the visually impaired. But, it [2] uses our smartphones which can be difficult to handle for Visually Impaired persons.

There is also a system that uses a device that can be wearable as a ring [11]. It is an index-finger wearable device that supports the VI in reading printed text by scanning with the finger. As we are trying to design a system for blind people this system is not suitable.

2) Cash Identification:

Handling money in day-to-day life is easy for a normal person but difficult for a Blind person. By identifying this problem some of the work is done previously. As per the paper [6], a basic Indian currency identification system has been proposed. Straight – forward image processing KNN is used for classification after that to find the ROI in the dataset images. The system has been composed Design and Development of a Real-Time Paper Currency Recognition System of Demonetization of New Indian Notes by Using Raspberry Pi for the Visually Challenged. [6]

C) System Architecture

a) Hardware System

The hardware part of this assistive smart glasses system is built around a few key components that work together to make the entire setup functional and user-friendly for visually challenged individuals. At the heart of this system is the Raspberry Pi, which connects to a Pi Camera module and a Bluetooth headset. These three devices together form the basic flow of the system — from capturing the image to delivering the spoken output to the user.

1. Raspberry Pi

The Raspberry Pi plays the most important role in this system. It acts like the "brain" of the smart glasses. All the major tasks such as processing the images, recognizing the text, and converting that text into speech are handled by this compact computer. When the camera captures an image of printed material, the Raspberry Pi uses software tools to analyse the image and extract the text using Optical Character Recognition (OCR) technology. After that, it turns the text into speech through Text-to-Speech (TTS) processing so the user can listen to it.

What makes the Raspberry Pi ideal for this project is its small size, low cost, and flexibility. Even though it's small, it is powerful enough to run all the software needed for this application. This makes it a perfect choice for developing helpful devices like smart glasses, especially for people who are visually impaired and need a compact, wearable, and reliable system. Its adaptability allows developers to build and customize it to suit the specific needs of users, making the device both affordable and practical.

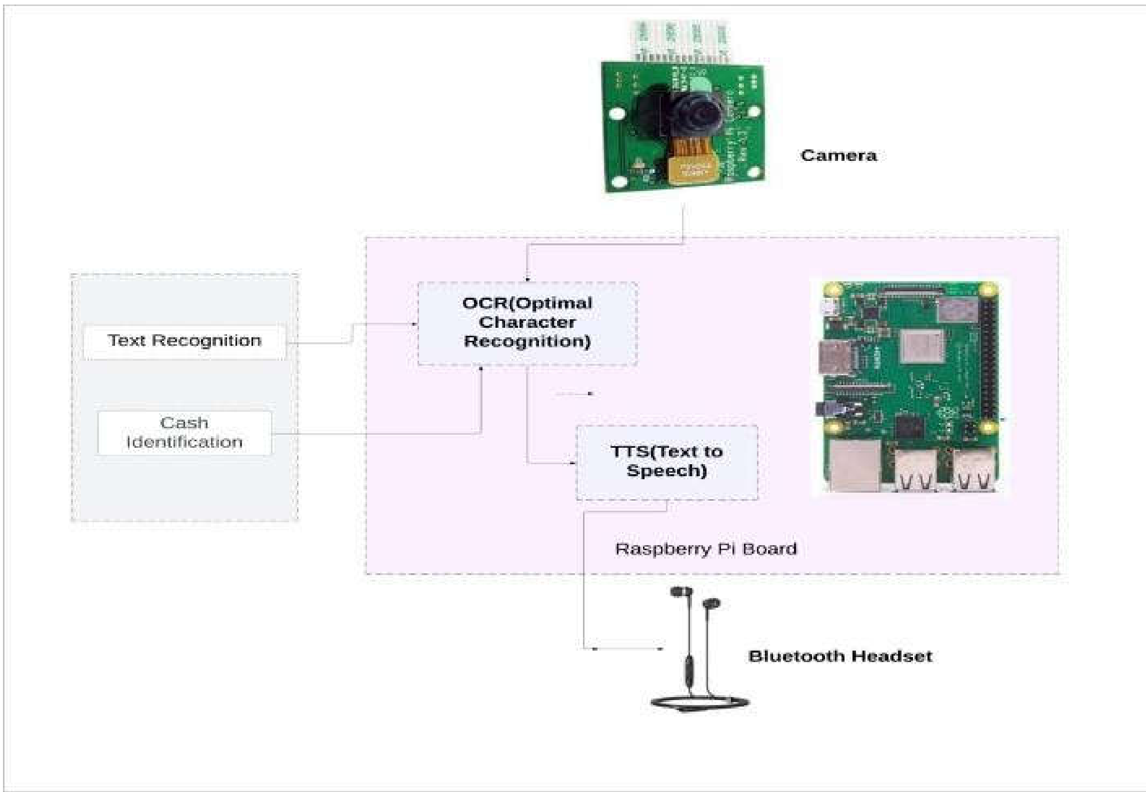

Figure 1. System Architecture

2. **Camera Module**

The system's camera is a Pi 5mp camera, which the Raspberry Pi can easily integrate with. The role of the camera is to capture the image and send it to the Raspberry Pi for processing. In the current work, 5mp is used as it is enough to capture a clear image.

3. **Bluetooth Headset**

The user uses the Bluetooth headset to signal their desire to be extracted.

D) Methodology

a) Image Recognition

1. OCR (optical Character Recognition)

In this system, we are mainly using an OCR (Optical Character Recognition) module to help convert images into readable text. When the camera captures an image—such as a page from a book or a newspaper—the OCR software steps in to scan and recognize the letters and words in that image. It then pulls out the text from the image so that it can be used for further processing.

For this purpose, we are using Tesseract OCR, which is a well-known and reliable open-source OCR library that works smoothly with the Raspberry Pi. It's popular because it is lightweight, easy to use, and gives good results when it comes to recognizing printed text. This allows the smart glasses to understand the content in the image and later convert it into speech for the user to hear.

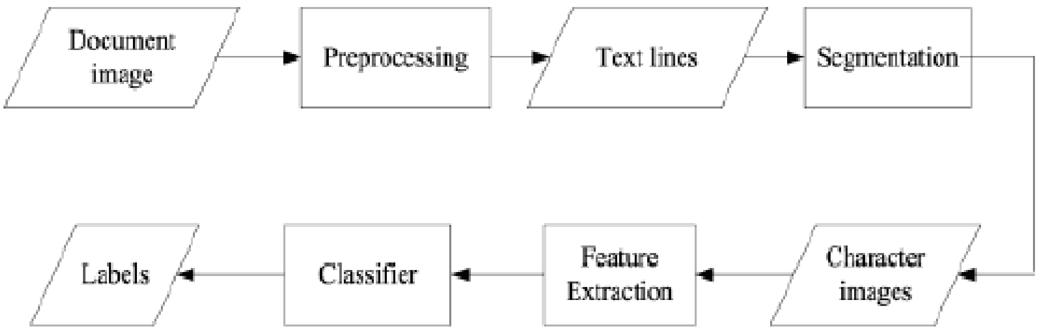

Figure 2. OCR Architecture

2. TTS(Text to Speech)

After text extraction the Raspberry Pi receives the extracted text and uses a text-to-speech module to convert it into audio. In this module, the TTS module processes the incoming text and turns it into realistic audio. The user can hear the generated audio output thanks to the Bluetooth headset that is connected. The system makes sure that speech understanding and clarity are prioritized in the audio output.

b) Cash Identification

One of the most helpful features of the smart glasses is their ability to identify currency notes, which plays a big role in helping visually impaired individuals handle money safely and independently. To make this possible, the system goes through a training phase where many images of different currency notes are collected. These images are taken from different angles, lighting conditions, and note positions to make the system more accurate and reliable in real-life situations.

1. Image Acquisition

The first step in identifying the currency is to capture a clear image of the note**.** For this, the system uses a high-resolution 5 Megapixel (5MP) Pi Camera. This camera is built to work well with the Raspberry Pi and is capable of capturing detailed images quickly. Once the image is taken, it is converted into a grayscale format. Grayscale images make it easier for the computer to focus on important details like numbers, patterns, and note designs by removing colour information. This makes the next steps—like image recognition and classification — more efficient and accurate.

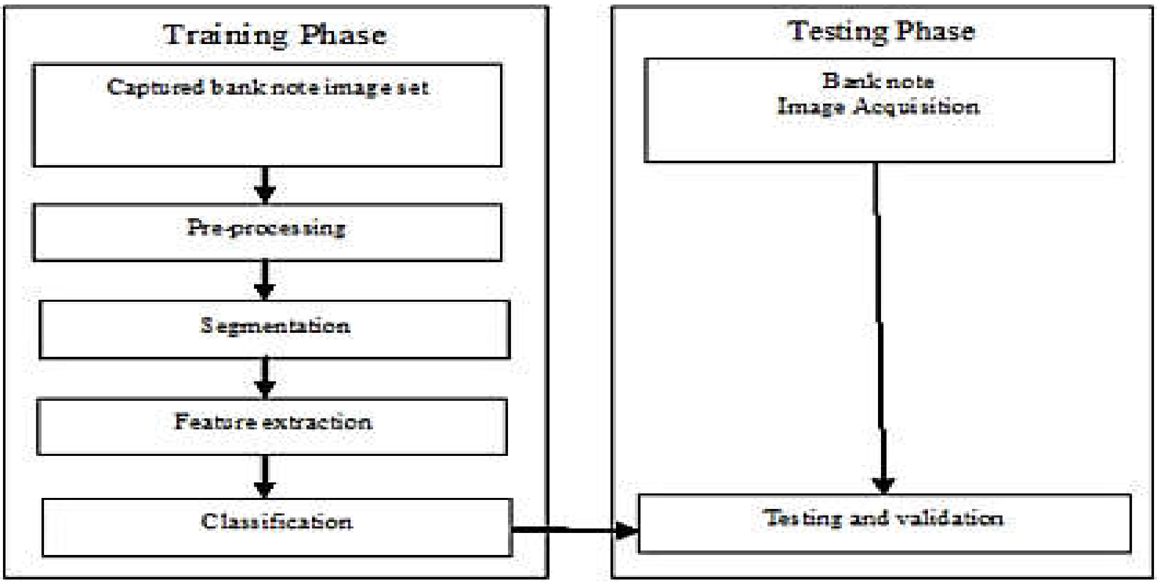

Figure 3. Cash Identification Architecture

2. Segmentation

After capturing the image of the currency note, the next important step is called segmentation**.** This process helps the system separate the currency note from the background, like a table or someone's hand. To do this, the image is first converted into a binary format — which means it's changed into just two colours: black and white. This makes it easier to clearly spot the edges of the note.

To find and highlight the boundaries or edges of the currency note, we use well-known edge detection methods like the Canny edge detector and Sobel operator**.** These methods help the system recognize the shape and outline of the note.

The Sobel operator is especially useful because it helps detect how the brightness (or intensity) of the image changes from one point to another. This change is called the intensity gradient**.** The Sobel method looks at the image in two directions — side to side (horizontal) and up and down (vertical). This is done using something called a Sobel kernel, which is a small matrix used to scan across the image.

By applying the Sobel method in both directions, we can find out where the strong edges are, and also which direction the edges are pointing. This is important because it helps the system understand the shape and position of the currency note more accurately.

$$Edge\ Gradient(G) = \sqrt{G_x^2 + G_y^2}$$

$$Angle(\theta) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

3. Feature Extraction

The specific kind of dimensionality reduction method is feature extraction. It is a method for capturing a picture's visual content for recovery and indexing. When the contribution to the calculation is too great to go on and there is enough information but not more, at that point. At that point, the input data will be converted into a trimmed-down highlight set. The amount of resources needed to represent the complex arrangement of information can be easily determined through feature extraction.

4. Classification

The notes are classified using the non-parametric k- nearest neighbor's algorithm (k-NN). The data consists of the feature space's k closest training cases. Whether k-NN is used for classification or recurrence establishes the success rate. With the goal of assisting the client with simple comprehension and coordination between the client and the application, text-to-speech (TTS) (TTS) is used to inform the client by the estimation of the paper note/Money.

E) Results and Discussions

The smart glasses developed in this project have shown very encouraging results**.** By using two main technologies — Optical Character Recognition (OCR) and Text-to-Speech (TTS) — these glasses are able to read printed or handwritten text from the user's surroundings and then speak it out loud**.**
This feature is especially helpful for people with visual impairments, as it allows them to understand printed content like books, newspapers, signs, or labels without needing help from others. The glasses capture the text using a camera, convert it into readable form using OCR, and then turn it into speech that the user can hear through a headset.

Besides helping visually impaired individuals, these glasses can also be useful for translating foreign languages, reading instructions in real-time, or accessing written information quickly in busy environments — like offices, libraries, or while travelling.
Overall, the smart glasses create a strong connection between the physical and digital worlds, improving accessibility, independence, and ease of use for many types of users. This shows great potential for use in daily life, education, and even professional settings.

F) Conclusion

The visionary smart glasses developed in this project mark a big step forward in the field of assistive technology for people with visual impairments. These glasses are built with a small camera and use Optical Character Recognition (OCR) to capture and understand printed text—like newspapers, books, or signs—and then convert that text into speech so the user can listen to it instantly. The main goal of this device is to help visually impaired individuals become more independent by giving them quick and easy access to written information in their surroundings. In addition to reading text, the glasses also have a special feature for identifying currency notes, which makes it easier and safer for users to handle money on their own. Together, these features help users understand written content and manage daily tasks with more confidence. They not only make life easier but also support greater financial freedom and personal safety. This project shows how smart, affordable technology can make a real difference in people's lives. With ongoing improvements and more development, these smart glasses have the potential to create a more inclusive world—where people with visual challenges can live more independent, informed, and dignified lives.

References

[1] Crosswalk Guidance System for the Blind Hojun Son;Divya Krishnagiri;V. Swetha Jeganathan; James Weiland

[2] P. Kunekar *et al.*, "Camera Detection for Blind People Using OCR," *2023 5th Biennial International Conference on Nascent Technologies in Engineering (ICNTE)*, Navi Mumbai, India, 2023, pp. 1-6, doi: 10.1109/ICNTE56631.2023.10146654.

[3] Kurlekar, S.; Deshpande, O.A.; Kamble, A.V.; Omanna, A.A.; Patil, D.B. Reading Device for Blind People using Python, OCR and GTTS. *Int. J. Sci. Eng. Appl.* 2020, *9*, 049–052, https://doi.org/10.7753/ijsea0904.1003.

[4] Aditya Rajbongshi, Md. Ibadul Islam, Al Amin Biswas, Md. Mahbubur Rahman, Anup Majumder and Md. Ezharul Islam, "Bangla Optical Character Recognition and Text-to-Speech Conversion using Raspberry Pi" International Journal of Advanced Computer Science and Applications(IJACSA), 11(6), 2020.

http://dx.doi.org/10.14569/IJACSA.2020.0110636

[5] Anilkumar B and KRJ Srikanth, Design and Development of Real Time Paper Currency Recognition System of Demonetization New Indian Notes by Using Raspberry Pi for Visually Challenged, International Journal of Mechanical Engineering and Technology, 9(3), 2018, pp. 884–891. http://iaeme.com/Home/issue/IJMET?Volume=9&Issue=3

[6] Nayyar, Anand & Puri, Vikram. Raspberry Pi-A Small, Powerful, Cost Effective and Efficient Form Factor Computer: A Review. International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE). 5, 2015, pp 720-737.

[7] Vinaya Phutak, Richa Kamble, Sharmila Gore, Minal Alave, R.R.Kulkarni Text to Speech Conversion using Raspberry - PI. International Journal of Innovative Science and Research TechnologyISSN No:-2456-2165

[8] Khaldoon Ibrahim Khaleel, Dr. Ku Nurul Fazira Binti Ku Azir. AN ENHANCEMENT OF TEXT TO SPEECH (TTS) SYSTEM USING RASPBERRY PI. Turkish Journal of Computer and Mathematics Education Vol.12, No.13, 2021, pp 6310-6321

[9] J. G. Linvill and J. C. Bliss, "A direct translation reading aid for the blind," in *Proceedings of the IEEE*, vol. 54, no. 1, pp. 40-51, Jan. 1966, doi: 10.1109/PROC.1966.4572.

[10] R. Shilkrot, J. Huber, C. Liu, P. Maes and N. S. Chandima, "FingerReader: A Wearable Device to Support Text Reading on the Go", *CHI ‘14 Ext. Abstr. Hum. Factors Comput. Syst.*, no. VI, pp. 2359-2364, 2014.

[11] Roberto Neto, Nuno Fonseca,Camera Reading for Blind People, Procedia Technology, Volume 16, 2014, Pages 1200-1209, ISSN 2212- 0173,

[12] Rajkumar N Anand M.G Barathiraja N, Portable Camera-Based Product Label Reading For Blind People. International Journal of Engineering Trends and Technology (IJETT) – Volume 10 Number 11, Apr 2014

[13] M. Sravan Kumar, B. Jyothi Priya, "An Automatic Recognition of Fake Currency Note Using Raspberry Pi", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 3, Issue 1, pp.356-360, January-February-2018.

[14] R. Smith, "An Overview of the Tesseract OCR Engine," *Ninth International*

Conference on Document Analysis and Recognition (ICDAR 2007), Curitiba, Brazil, 2007, pp. 629-633, doi: 10.1109/ICDAR.2007.4376991.

[15] V. Mohane and C. Gode, "Object recognition for blind people using portable camera," *2016 World Conference on Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave)*, Coimbatore, India, 2016, pp. 1-4, doi: 10.1109/STARTUP.2016.7583932.

[16] M. Acharya, P. Chouhan and A. Deshmukh, "Scan.it - Text Recognition, Translation and Conversion," *2019 International Conference on Advances in Computing, Communication and Control (ICAC3)*, Mumbai, India, 2019, pp. 1-5, doi: 10.1109/ICAC347590.2019.9036849.

[17] H R, P. S., & Revathi, D. (2022). OCR Oriented Reading System for Blind People. *Asian Journal for Convergence In Technology (AJCT) ISSN -2350-1146*, *8*(2), pp 5-8.