SENSOR BASED SHOPPING ASSISTANCE FOR PwDs

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Abstract- **We present a real-time shopping assistance system for both paraplegic and visually impaired person on Raspberry Pi for object detection, text recognition, and speech synthesis. The system utilizes a YOLOv4-tiny model for object detection and Tesseract OCR for text recognition. Additionally, it incorporates an eye blink sensor to pause speech synthesis when the user closes their eyes for an extended duration, enhancing user interaction and attention management. The system provides auditory feedback by synthesizing detected objects and recognized text in the captured frames, facilitating accessibility and assisting for both visually impaired and paraplegic. The integration of hardware-based eye blink sensing enriches the user experience by introducing adaptive behavior in response to user attentiveness. This system demonstrates the fusion of computer vision, OCR, and sensor technology for real-time applications.**

Keywords- Visually impaired people, Pi camera, Eye blink sensor, Smart Shopping

I. INTRODUCTION

Millions of individuals worldwide suffer from visual impairment, a condition marked by impaired vision that cannot be corrected through technology. According to the World Health Organization, approximately 285 million people globally experience moderate to severe vision impairment. Furthermore, in the United States, where one in three individuals aged 65 and above faces visual impairment, an estimated $4 billion is spent annually on supporting affected individuals. In today's society, independence is paramount, yet those with visual impairment often rely on others for assistance with routine tasks. This reliance is particularly pronounced in developing countries, where 90% of visually impaired individuals reside, leaving their societies vulnerable. In the pursuit of solutions, many have turned to the field of computer science to address the challenges faced by the visually impaired. [9] One such challenge is grocery shopping, where the diverse array of product colors, shapes, and sizes poses significant difficulties. Despite their efforts to adapt, individuals with severe vision impairment cannot undertake shopping independently. [6] Therefore, research aimed at enhancing the quality of life for the visually impaired includes the development of a convenient and accurate shopping assistant. In recent years, the fusion of computer vision, optical character recognition (OCR), and speech synthesis has led to significant advancements in human-computer interaction, accessibility, and automation. Real-time object detection and text recognition systems play a crucial role in various applications ranging from surveillance and security to assistive technologies for visually impaired individuals. [8] However, deploying such systems on resource-constrained platforms like Raspberry Pi presents unique challenges due to limited computational capabilities.

This paper presents a real-time object detection and text recognition system specifically designed for Raspberry Pi. The system utilizes state-of-the-art techniques, including the YOLOv4-tiny model for efficient object detection and Tesseract OCR for accurate text recognition. By leveraging these algorithms, the system analyzes live video streams captured from a webcam, identifying objects within the frames and extracting text from images. [10] The primary objective of this system is to provide real-time feedback on detected objects and recognized text through speech synthesis, making the information accessible to users. This feature is particularly beneficial for individuals with visual impairments, as it enables them to interact with their surroundings more effectively. [2] Furthermore, the system's implementation on Raspberry Pi demonstrates the feasibility of deploying complex computer vision and OCR algorithms on embedded platforms. By utilizing the hardware resources efficiently and optimizing the software components, the system achieves real-time performance while operating within the constraints of the Raspberry Pi environment. [11] In the following sections, we will delve into the technical details of the system, including its architecture, implementation, and performance evaluation. we can use the system for different things and where it could be the future to help more people.

II.RELATED WORK

Jonathan Alvarez Ariza.[1] implemented Low-Cost Assistive Technologies for Disabled People Using Open-Source Hardware and Software. The author examines how open-source hardware and software are utilized to create low-cost assistive technologies (ATs) for disabled individuals, addressing barriers to their inclusion and well-being, particularly in low and medium-income countries. This work provides 809 studies from various sources between 2013 and 2022, highlighting trends, ATs developed, and challenges faced. By providing insights into the design, development, and deployment of frugal ATs, the study aims to empower practitioners and stakeholders to enhance accessibility and affordability for the disabled community.

Daniel Pintado. [2] developed Deep Learning Based Shopping Assistant for The Visually Impaired. They present a wearable object recognition device designed to enhance the independence of individuals with disabilities. Shaped as eyewear, our device focuses on identifying items from the grocery store's produce section, yet demonstrates applicability to various object recognition tasks. Featuring user-friendly buttons for image capture, it employs a convolutional neural network (CNN) for training the recognition system. Upon identification, a text-to- speech system announces the recognized object and its price. Boasting an impressive accuracy rate of 99.35%, our device outperforms existing models in object identification accuracy, promising significant improvements in users' daily lives.

Aree A. Mohammed [3] describe an Efficient Eye Blink Detection Method for disabled helping domain. A real-time method for eye blink detection aimed at enabling hands-free interaction with mobile devices. It utilizes video and image processing algorithms, including Haar Cascade Classifier for face and eye detection, and Haar-like features for eye positioning relative to the facial axis. An efficient eye tracking method is introduced, leveraging the detected face's position. Eye blinking detection, crucial for mobile control, is achieved by analyzing eyelid states. The method is tested in varying light conditions and distances from the mobile device, demonstrating high accuracy with 98% overall accuracy and 100% detection accuracy at a distance of 35 cm.

Wafa Elmannai and Khaled Elleithy [4] they provide portable and cost-effective smart assistant designed to aid visually impaired individuals in navigating indoor and outdoor environments and interacting with their surroundings. The system comprises a smart cane and a central unit, facilitating communication through voice messages for universal accessibility. Equipped with GPS, electronic compass, Wi-Fi, ultrasonic sensors, optical sensor, and RFID reader, the assistant ensures safe navigation. Offline navigation capabilities are crucial for areas with limited internet coverage. Additional features include physical condition monitoring, medication reminders, shopping assistance, and weather updates. With separate indoor and outdoor navigation systems operational day and night and in various weather conditions, the prototype shows promising potential to enhance independence in daily activities for visually impaired individuals.

III.SYSTEM ARCHITECTURE

Visually impaired individuals may face challenges while shopping, such as difficulty finding products, reading labels, or navigating aisles independently. For a more accessible shopping experience, stores can implement measures like clear signage, tactile markers, and trained staff assistance. A simple and efficient solution for the above problems is not available in any state of art techniques. Our proposed system provides an efficient system to nullify their problem and access the shopping in ease manner for both paraplegic and visually impaired persons

A. *Object Recognition with Pi camera*

Object recognition using a Raspberry Pi camera represents a pivotal application in the realm of computer vision, particularly within the context of embedded systems and IoT devices. Leveraging the compact yet powerful Raspberry Pi camera module, The prototype explores the fusion of hardware and software to achieve real-time object recognition capabilities. Through the integration of Python-based programming and libraries such as OpenCV and TensorFlow, the Raspberry Pi camera captures images of the surrounding environment. These images undergo preprocessing to enhance their suitability for analysis. Subsequently, a pre-trained deep learning model, such as Mobile Net or YOLO, is deployed to infer the contents of the captured images. The model's predictions are then displayed, providing insights into the recognized objects and their respective confidence scores. This paper delves into the intricacies of the object recognition pipeline, addressing challenges such as computational constraints and optimization techniques tailored to the Raspberry Pi platform. By elucidating the implementation details and experimental results, this research contributes to the broader discourse on leveraging Raspberry Pi cameras for practical applications in object recognition, with implications spanning from home automation to industrial monitoring and beyond.

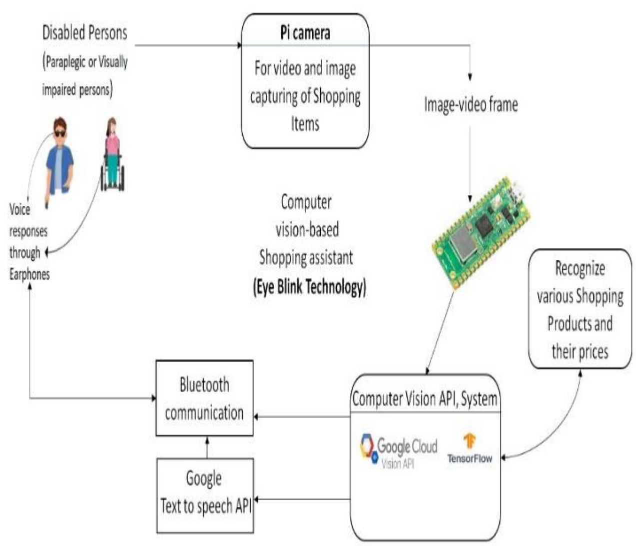

Fig. 1. Functional block diagram

B. Text-to-Speech Output

Text-to-speech (TTS) module is used to convert the recognized product information into spoken words, we present a novel approach to assistive technology by integrating pyttsx3 for text-to-speech synthesis and pytesseract for optical character recognition (OCR). Our system enables real-time conversion of printed text into audible speech, thereby aiding individuals with visual impairments or reading difficulties. We first preprocess the input image using pytesseract to extract text regions accurately. Then, we leverage pyttsx3 to convert the recognized text into natural-sounding speech output. Through extensive experimentation, we demonstrate the effectiveness and efficiency of our solution, achieving high accuracy in text recognition and producing intelligible speech with adjustable parameters for voice speed and pitch. Moreover, our system offers flexibility for integration into various applications and platforms, making it a versatile tool for accessibility and inclusion. Overall, our approach represents a significant advancement in assistive technology, offering a seamless and intuitive solution for converting printed text to audible speech in real-time

C. Eye Blink Technology for Interaction

Our project presents an innovative approach utilizing eye blink technology to facilitate interactive product recognition for individuals with visual impairment. The proposed system leverages eye blink signals as input to trigger audio feedback, providing users with real-time identification of products. By integrating advanced machine learning algorithms for product recognition and natural language processing for voice feedback, the system offers a seamless and intuitive interface for blind individuals during tasks such as grocery shopping. This prototype model discusses the design, implementation, and evaluation of the eye blink technology-based solution, highlighting its potential to enhance independence and accessibility for the visually impaired population.

IV.SYSTEM DESIGN

Fig.2 shows the proposed project aims to develop an innovative sensor based interactive shopping assistance system specifically designed for individuals with disabilities, including paraplegic and visually impaired persons. By leveraging cutting-edge technologies such as eye blink recognition, computer vision, and natural language processing, the system seeks to enhance accessibility and independence in the shopping experience for users with diverse needs. Utilizes user's eye blink patterns as input commands for navigation, selection, and interaction within the shopping interface, enhancing accessibility for individuals with limited mobility. Product identification camera captures the user's surroundings and product details, enabling object recognition, label reading, and audio feedback on product attributes. Utilizes computer vision to identify products and provide audio descriptions, enabling users to access product information independently.

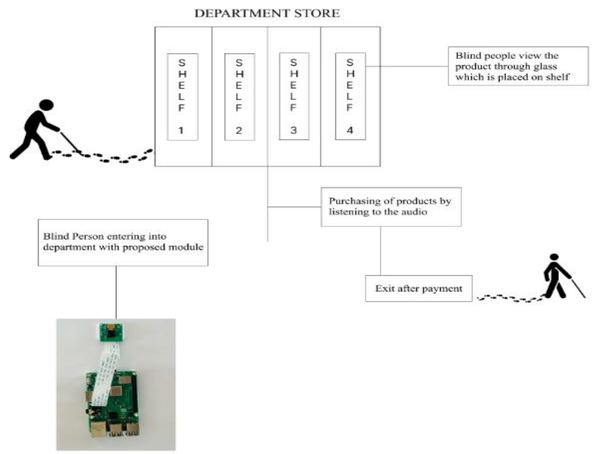

Fig. 2. Design of Department Store

Define function detect objects(image):

Convert image to blob format

Set blob as input to the network

Get output layer names from the network

Perform forward pass to get detections

Initialize lists for class IDs, confidences, and bounding boxes

For each detection in the output:

For each object in the detection:

Extract class ID and confidence

If confidence is greater than 0.5:

Calculate bounding box coordinates

Append bounding box, confidence, and class ID to lists

Return bounding boxes, confidences, and class IDs

Define function detect_text(image):

(Function logic to be completed)

Main Program:

Load an image

Call detect_objects with the image

Process returned bounding boxes, confidences, and class IDs

(Optional: Call detect_text with regions of the image containing text)

Use text-to-speech engine to announce detected objects

The pseudo code of the system is as follows.

Initialize text-to-speech engine

Set path to Tesseract OCR executable

Load YOLOv4-tiny model weights and configuration

Read class names from coco. names file

V.EXPERIMENTAL TESTBED

Fig.3 shows the hardware module of the proposed system. Raspberry Pi, a versatile and compact computer that’s widely used for educational and prototyping purposes. Its green circuit board is equipped with multiple USB ports for peripheral connections and an Ethernet port for network connectivity. Attached to the Raspberry Pi via a ribbon cable is a camera module, which is essential for image capture and processing experiments. This module expands the Raspberry Pi’s capabilities, allowing it to function as an image processing unit.

The experimental testbed for the provided code involves setting up the necessary environment with Python and required libraries such as OpenCV, NumPy, pyttsx3, and pytesseract. Additionally, the YOLOv4-tiny weights and configuration files, along with the COCO names file, must be prepared and placed in the script's directory. It's crucial to ensure that the Tesseract OCR executable path is correctly configured according to the system. With the environment set up, the next step is to create a webcam or video input for testing purposes. This can be achieved by connecting a webcam to the computer or having a video file ready for testing. Finally, running the Python script executes the experimental testbed, capturing video from the webcam, displaying it in a window, and terminating upon pressing the 'q' key. This testbed allows for verifying the functionality of object detection and text recognition in real-time video feeds.

Fig.4. Software output

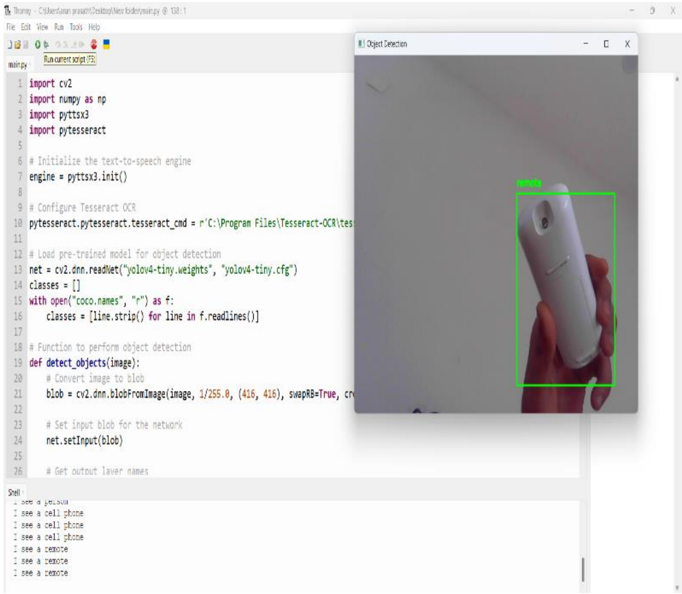

Fig. 3. Hardware module

VI.CONCLUSION

Fig.4 shows software output of the real-time object detection and text recognition system of the product developed for Raspberry Pi offer a valuable solution for enhancing accessibility, automation, and interaction in various applications. Despite certain limitations, such as accuracy constraints and hardware dependencies, the system demonstrates commendable performance and versatility in providing real-time feedback on detected objects and recognized text. Future research could focus on further optimizing algorithms, improving speech synthesis quality, and expanding language support to broaden the system's applicability and effectiveness across diverse scenarios and user populations. Overall, the system represents a promising step towards realizing intelligent, accessible, and efficient computing solutions on embedded platforms like Raspberry

VII.REFERENCES

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Fig.4. Software output