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ROBOMATE CRUISER USING ZERO UI TECHNOLOGY

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Abstract: This paper describes a Zero-UI and Raspberry Pi-based Robomate Cruiser for the visually impaired. To control the gadgets, Zero UI makes use of auditory, visual, and gestural cues. Robomate Cruiser functions in four different ways: first, it operates on voice commands; second, it can recognize text from an image using optical character recognition and speak the equivalent audio to the user through an integrated speaker or headset; third, it uses the Google Assistant API to process queries and speak information found on the Internet to the user through an integrated speaker or headset; Fourth, the robot pauses when it recognizes a barrier and groups it into specified categories like person, car, or animal. This robot serves as a replacement for communication through screens. To create this robotic companion car, we utilize a Raspberry Pi board together with two DC motors for the robot's wheels, a webcam with an integrated microphone, a headset, and a motor driver IC.

Keywords: Raspberry PI, Zero UI, OCR, Google Assistant API, Obstacle Detection.

I. INTRODUCTION

Visually impaired people face significant obstacles when navigating the world without sight, which frequently lowers their independence and quality of life. For those with visual impairments, simple things that are taken for granted by sighted people can become formidable difficulties. This condition limits movement in addition to communication and information access, which can result in feelings of dependency and loneliness.

The Robomate Cruiser with Zero UI for the Blind, however, is a ray of hope that appears in the midst of these obstacles. This revolutionary invention provides a game-changing way to improve accessibility and freedom by catering especially to the special needs of those who are blind or visually impaired. Using a zero UI (User Interface) design approach, this creative robot forgoes conventional graphical interfaces in favor of intuitive, natural means of communication.

The robot's simple voice-activated mobility technology is its main feature. With basic voice commands, users may dictate movements like left, right, forward, backward, stop, and capture, and manage their environment with ease. Users mobility and flexibility of movement are improved by this simple control system, which gives them the confidence and independence to explore their surroundings.

This assistive robot's incorporation of state-of-the-art optical character recognition (OCR) technology is essential to its operation. This feature makes it possible for the robot to convert text to speech and photos to text with ease. It also makes text-to-speech functionality possible for improved accessibility and gives real-time access to read traffic signs. This feature gives users access to written material and removes obstacles, allowing them to do everything from read labels and signs to enjoy books and documents with ease.

Its interaction with the Google Assistant API significantly enhances the user experience. Through natural language interaction, this integration gives consumers access to a multitude of information and services, improving their everyday lives and enabling them to do activities more quickly. Whether looking for information, using online tools, or making significant life enrichment efforts.

Robomate Cruiser was designed with safety and autonomy as top priorities, as seen by its cutting-edge obstacle detecting capabilities. It is able to recognize and notify users of impediments including cars, trucks, animals, and possible fire threats. By providing them with immediate feedback, users feel more secure and confident when navigating, which gives them more freedom and peace of mind.

II. RELATED WORKS:

The paper "Raspberry Pi-based voice-operated personal assistant (Neobot)" introduces the development and implementation of Neobot, a voice-operated personal assistant system built on the Raspberry Pi platform. The research focuses on creating an intuitive interface for users to interact with Neobot using voice commands. Key implementation details include utilizing Raspberry Pi for hardware control and integration with various sensors and modules, enabling voice recognition and response capabilities. The system architecture incorporates speech recognition algorithms, natural language processing techniques, and pre-trained models to interpret and respond to user commands effectively. Through experimental validation, the paper demonstrates the robustness and accuracy of Neobot in understanding and executing voice commands, showcasing its potential for enhancing user convenience and accessibility in various applications such as home automation, information retrieval, and assistance for users with disabilities [1].

The paper "Design and Implementation of Vision Module for Visually Impaired People" discusses an innovative way to creating a vision module to assist visually impaired individuals. The project is aimed at developing a system that uses computer vision techniques to assist people in navigating their surroundings and recognizing objects. The use of cameras or wearable devices to gather visual input, image processing algorithms to evaluate captured images, and machine learning models to identify items and deliver aural or tactile feedback to the user are all important implementation elements. The system architecture includes hardware components such as cameras, microcontrollers, and audio output devices, as well as software modules for image processing and machine learning inference. The research provides a potential solution for real-world applications in navigation and object identification tasks by demonstrating the usefulness of the vision module in enhancing the freedom and mobility of visually impaired people through extensive testing and validation [2].

The paper "Voice Controlled Personal Assistant Robot for Elderly People," details the development and implementation of a voice-controlled personal assistant robot designed specifically for elderly individuals. The research aims to address the needs of the elderly population by creating a robot that can assist with daily tasks, provide companionship, and respond to voice commands. Key implementation details include the integration of voice recognition technology to interpret user commands, the use of robotic hardware platforms such as motors and sensors for physical interaction, and the incorporation of AI algorithms to enable intelligent responses and behavior. The system architecture encompasses both hardware and software components, including microcontrollers, speech recognition modules, and natural language processing algorithms. Through rigorous testing and validation, the paper demonstrates the efficacy and usability of the voice-controlled personal assistant robot in supporting elderly individuals, offering a promising solution to enhance their quality of life and independence [3].

In the paper "Multi-Functional Personal Assistant Robot Using Raspberry Pi and Coral Accelerator," a flexible personal assistant robot that combines Raspberry Pi and Coral Accelerator is presented. It is intended to carry out a range of duties. The goal of the project is to develop a system that can improve the robot's performance in tasks including task execution, object identification, and natural language processing by utilizing the computational capacity of the Coral Accelerator and Raspberry Pi. The hardware configuration, which consists of a Raspberry Pi serving as the central processing unit and a Coral Accelerator for accelerating machine learning inference processes, is one of the implementation specifics. Other aspects include the integration of sensors, actuators, and communication modules for user and environmental interaction. Speech recognition algorithms, picture processing methods, and machine learning models with task-specific training are all part of the system architecture, which consists of both hardware and software elements. The study provides a potential solution for applications in home automation, healthcare, and personal support chores by demonstrating the efficacy of the multi-functional personal assistant robot in helping users in a variety of scenarios through rigorous testing and validation [4].

In the paper "Creation of a Cost-Efficient and Effective Personal Assistant Robot using Arduino & Machine Learning Algorithm," it is explained how machine learning algorithms and Arduino microcontrollers were used to create and execute an effective and economical personal assistant robot. The goal of the project is to provide accessible and reasonably priced personal assistant solutions by utilizing the machine learning techniques and the flexibility and low cost of Arduino platforms. The creation of machine learning algorithms for tasks like speech recognition, object detection, and decision-making, as well as the usage of Arduino microcontrollers for hardware control and integration with sensors, actuators, and communication modules, are examples of implementation details. The emphasis of the system architecture is on modularity, scalability, and ease of deployment, encompassing both software and hardware components. The study presents the efficacy of the affordable personal assistant robot in carrying out a range of duties through rigorous testing and validation, providing a workable solution for applications in home automation, education, and healthcare, especially in settings with limited resources [5].

III. PROPOSED METHODOLOGY:

A Raspberry Pi 3 board powers a voice-controlled robotic personal assistant vehicle, equipped with a USB webcam with microphone and headset for audio feedback. Movement is directed via voice commands utilizing Google Assistant API.

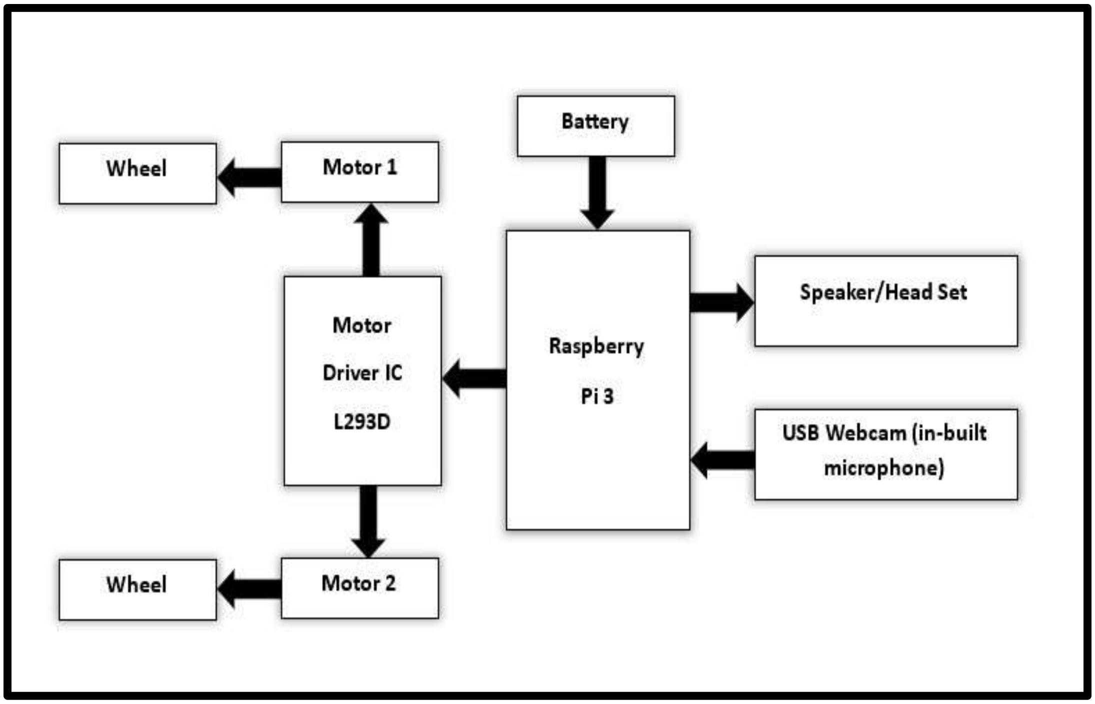

Figure 1 : Block diagram of RoboMate Cruiser

The webcam captures images for text extraction via optical character recognition, relayed to the user through the headset or loudspeaker. Specific voice commands enable Google Assistant API queries for enhanced functionality.

IV. RESULT

Robot Vehicle Movement Control

A vehicle movement-controlled robot for blind individuals, Controlled by a Raspberry Pi, the robot responds to voice commands from the user, navigating accordingly. It provides feedback through text-to-speech and optional haptic cues, enabling the user to understand its surroundings. Powered by a rechargeable battery, the robot offers independent mobility and navigation for blind individuals, enhancing their autonomy and safety. The system starts by capturing audio input from the user through a microphone. Speech recognition software processes this audio to convert spoken words into text commands. The text commands are then interpreted by the system to determine the desired movement of the robot. This involves parsing the text to identify keywords or phrases related to movement directions, such as "forward," "left," "stop," etc. Once the commands are understood, the system translates them into control signals for the robot's motors or actuators. These signals direct the robot to move according to the specified direction as needed.

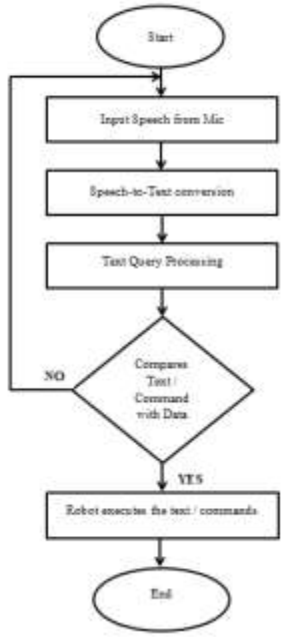

Figure 2: Flow diagram of Robot Movement

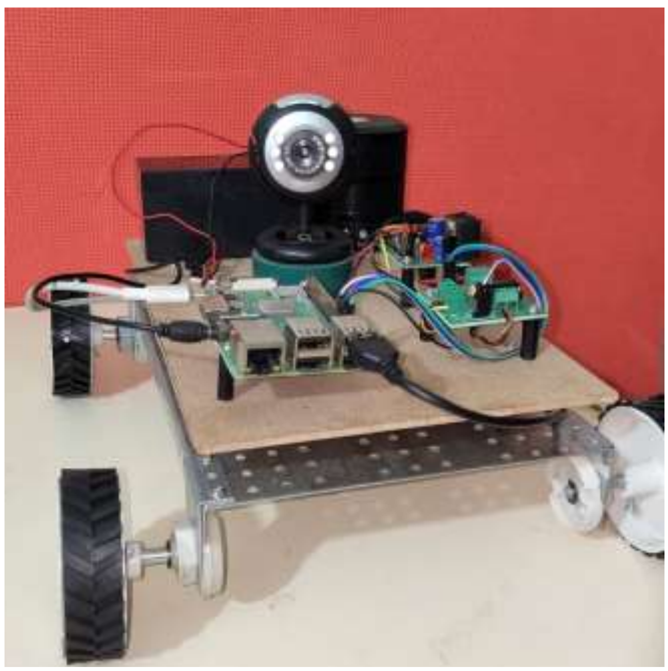

Figure 3 : Hardware Model

Image to Text and Text to Speech Conversion

Optical Character Recognition (OCR) plays a crucial role in converting image text documents into editable text. However, segmentation errors can hinder accuracy, especially in handwritten text. This paper proposes a segmentation algorithm based on projection profiles, achieving 100% line segmentation and approximately 98% character segmentation accuracy, even with overlapping text components.

Image acquisition involves capturing text images using a high-resolution web camera (5MP or higher). Pre-processing steps include color to grayscale conversion, edge detection, noise removal, warping, cropping, and thresholding to enhance text detection and remove background noise.

The pre-processed image undergoes OCR using Tesseract OCR, resulting in a .txt file. This text file is then converted into speech using the gTTS (Google Text-to-Speech) library, facilitating accessibility for visually impaired individuals.

This streamlined process ensures efficient text extraction and conversion, enhancing accessibility and usability for various applications requiring text-to-speech functionality.

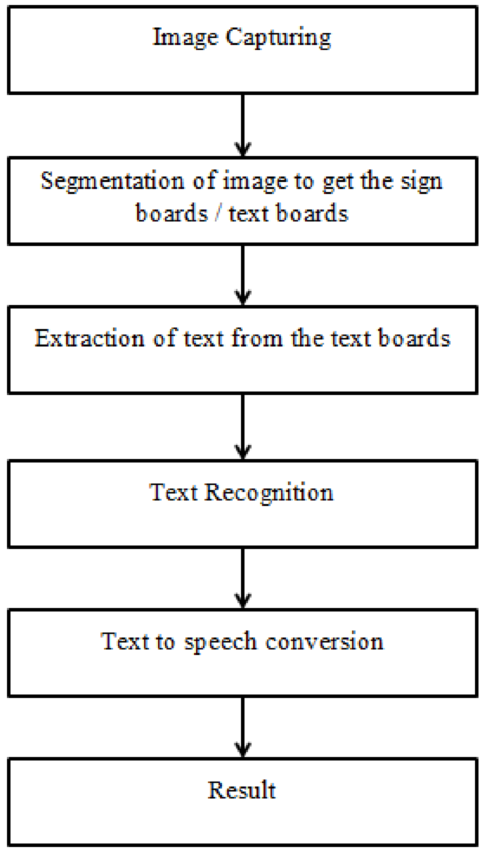

Figure 4 : Flow diagram of OCR

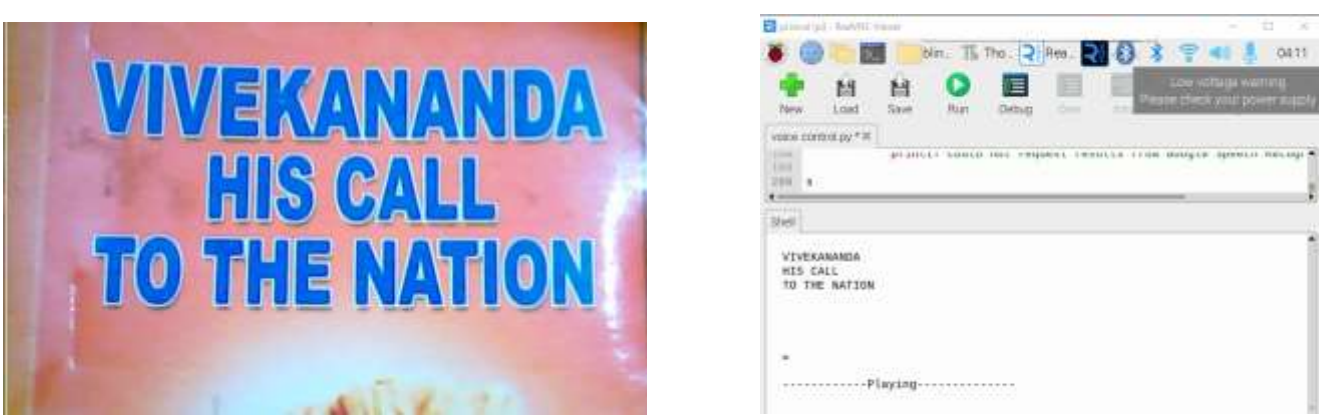

Figure 5 : Snapshot of image captured by Web Cam

GOOGLE ASSISTANT API

Google Assistant API tailored for the visually impaired, a revolutionary tool designed to provide seamless access to information and assistance. With this API, users can effortlessly navigate through a myriad of tasks, from checking the weather to accessing essential queries, Gaining knowledge and beyond.

Input / Query from User: The user speaks their query or input.

Conversion of Voice to Text: This step involves using speech-to-text technology to convert the user's spoken words into written text that the system can process.

Google Assistant API: The text input is passed to the Google Assistant API, which can understand natural language queries and perform actions based on them.

Query Processing: The Google Assistant API processes the user's query, which could involve tasks like searching for relevant information, retrieving documents, or providing assistance with publishing tasks.

Result: Finally, the Google Assistant API provides the result of the query or action to the user, either through spoken responses or through text output that can be read aloud or displayed in a format accessible to the user.

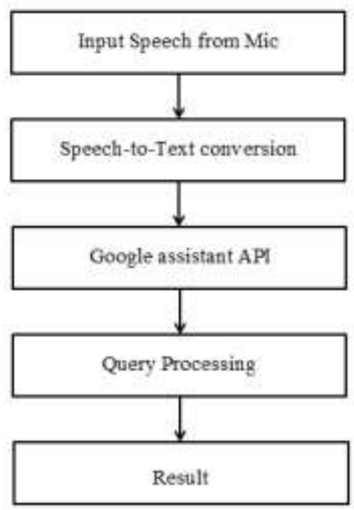

Figure 6 : Flow Diagram of Google Assistant API

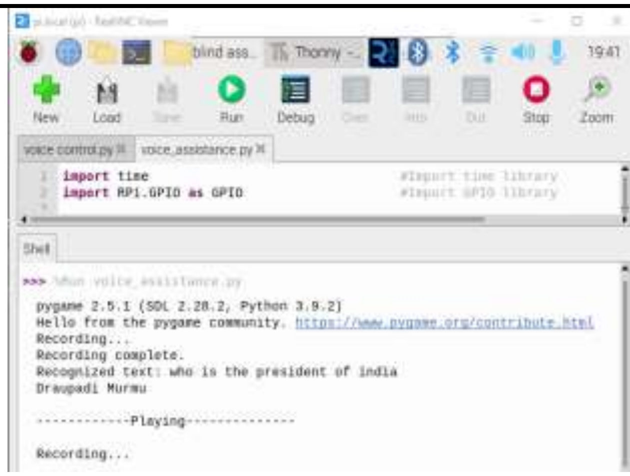

Figure 7 : Snapshot of Google API

OBSTACLE DETECTION

Obstacle detection implementation is done using TensorFlow Lite, it involves utilizing a trained machine learning model to identify and classify objects like people, vehicles, and animals in images or video streams. TensorFlow Lite is a framework for deploying machine learning models on mobile and edge devices, making it efficient for real-time applications. The process typically begins with collecting and labeling a dataset containing images of various obstacles. Then, a deep learning model, such as a convolutional neural network (CNN), is trained on this dataset to recognize different types of obstacles. The model analyzes input images or frames from a video stream and detects obstacles by classifying them into predefined categories, such as person, vehicle, or animal and the robot stops. This enables applications like autonomous driving, surveillance systems, and wildlife monitoring to identify and react to potential obstacles in their environment in real-time. Additionally, Open CV has been employed for fire detection, a process that entails scrutinizing video or image frames for color and motion patterns indicative of flames. Upon detecting such patterns, the robot stops, thus averting potential danger.

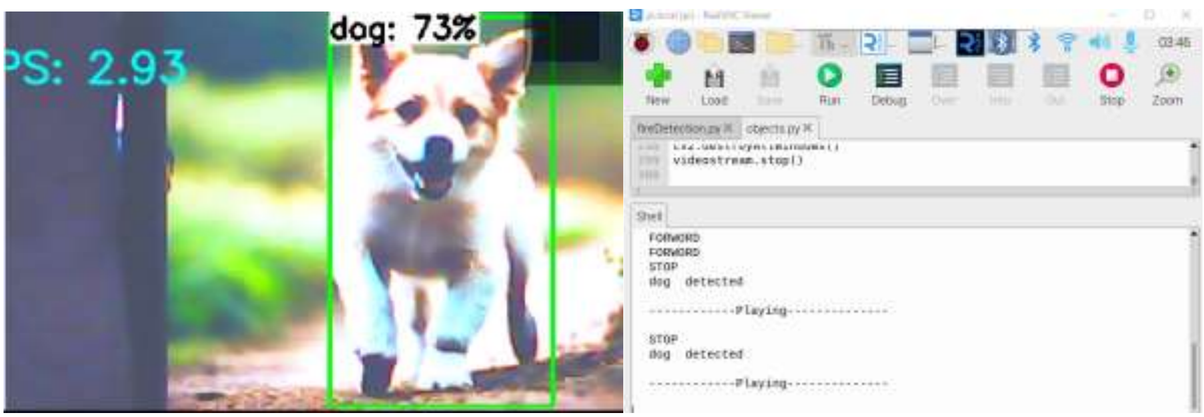

Figure 8 : Snapshot of obstacle detection

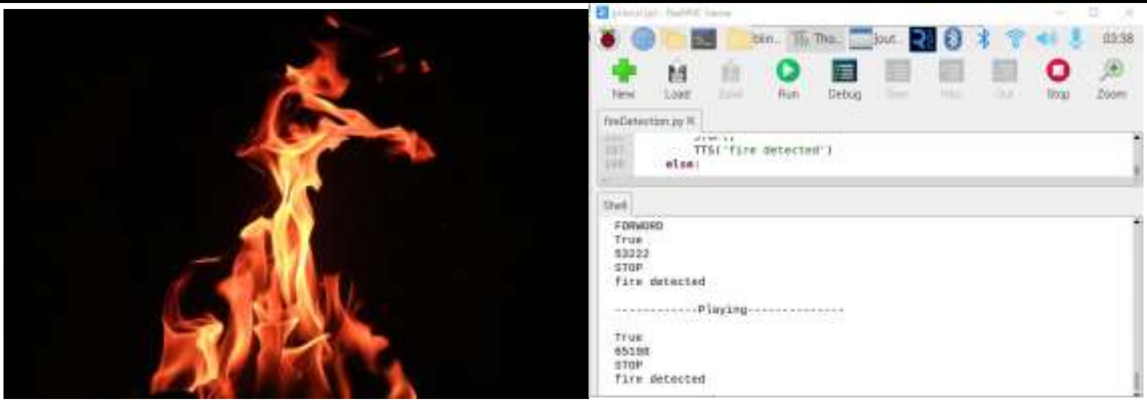

Figure 9 : Snapshot of Fire detection

V. CONCLUSION AND FURURE SCOPE

The creation of a customized robot for the blind provides a comprehensive approach to improving their safety and freedom. The robot is meant to travel in certain directions, and it uses cutting-edge image recognition technology to translate its surroundings into text so that it can interact with its surroundings with ease. Users' experience is further enhanced by integration with the Google Assistant API, which gives them access to a wealth of information and services. Additionally, adding obstacle detection features guarantees that the robot can navigate securely by spotting possible dangers including people, animals, cars, and even fires, improving user safety. All things considered, this all-encompassing system combines state-of-the-art technologies to empower people who are visually impaired and promote increased security and autonomy in their daily lives. In order to further empower people with visual impairments to lead more independent and fulfilling lives, future iterations may investigate incorporating sophisticated sensors for environmental mapping, integration with smart home systems for seamless interaction, and enhanced connectivity for remote monitoring and control.

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