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Visual Assistance for Blind People Using Raspberry PI

Sanjyot Kapare, Venkatesh Kandkure, Shivam Todkari, Prof S. V. Tathe
Electronics and Telecommunications
Sinhgad College of Engineering Vadgaon, Pune.

Abstract: *Blind people face the problem in daily life. They can't even walk without anyaid. Many times they rely on others for help. Several technologies for the assistance of visually impaired people have been developed. Among the various technologies being utilized to assist the blind, Computer Vision-based solutions are emerging as one of the most promising options due to their affordability and accessibility. This paper proposes a system for visually impaired people. The proposed system aims to create a wearable visual aid for visually impaired people in which speech commands are accepted by the user. Its functionality addresses the identification of objects and signboards. This will help the visually impaired person to manage day-to-day activities and navigate through his/her surroundings. Raspberry Pi is used to implement artificial vision using python language on the Open CV platform*

Keywords: Open CV platform

I. INTRODUCTION

The project "Visual Assistance for Blind People Using Raspberry Pi" leads to develop an innovative assistive device to enhance the mobility and safety of visually impaired individuals. At its core, the system is powered by a Raspberry Pi, which acts as the central processing unit. A camera module captures live video feeds, enabling object recognition and text-to-speech functionalities. An infrared (IR) sensor is incorporated to detect obstacles in the user's path, while the system alerts the user using a buzzer and a vibrator motor. These outputs ensure immediate and intuitive feedback to avoid potential hazards. The setup is powered by a reliable power supply, ensuring uninterrupted operation.This project represents a practical, low-cost solution to assist the visually impaired, promoting independence, safety, and confidence in their daily lives..

Blind and visually impaired individuals often face significant challenges when navigating their environments, particularly in unfamiliar or complex settings. Traditional assistive tools such as white canes, guide dogs, and screen readers help to some extent but have limitations, especially in detecting obstacles or providing real-time situational awareness. local weather conditions without the need for expensive infrastructure. Additionally, ML algorithms can process large volumes of sensor data to identify patterns and make

This project aims to address these challenges by developing a visual assistance system that leverages modern technologies such as computer vision and artificial intelligence. The goal is to create an innovative, mobile-based solution that can detect objects, identify obstacles, and provide auditory feedback to help blind users navigate with greater independence and confidence. The system will use a smartphone or wearable device to capture visual data and provide real-time guidance, improving the mobility and quality of life for blind individuals. This solution offers an affordable, scalable alternative to existing technologies, making it a potentially lifechanging tool for the visually impaired community.

Blind and visually impaired individuals often face significant challenges in their daily lives, particularly in terms of mobility and independence. Traditional aids like the white cane or guide dogs provide basic support, but they have limitations. For instance, they cannot help in detecting obstacles at head height or provide detailed environmental awareness, especially in crowded or complex spaces like shopping malls, streets, or public transport. A system like the Visual Assistance System can greatly improve the quality of life for people with visual impairments by: Increasing independence: With real-time feedback on obstacles and objects, the system enables users to navigate independently

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without relying heavily on others. Enhancing safety: By providing timely alerts about potential obstacles, the system helps avoid

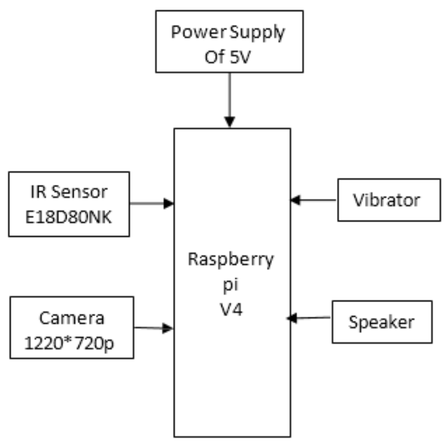
II. PROPOSED SYSTEM

The aim of this project is to develop an innovative, technology- driven visual assistance system that helps blind and visually impaired individuals navigate their environments with greater ease, safety, and independence. By leveraging computer vision and artificial intelligence, the system will provide real-time feedback on obstacles and objects in the user's environment, offering guidance through audio cues. This solution aims to bridge the gap left by traditional assistive devices and provide a more dynamic, scalable, and accessible tool for improving the mobility and quality of life of blind people.

The system functions as an end-to-end solution that:

1. Measuring dimensions of an object from known distance
2. Measuring dimensions of an object from unknown distance.
3. Using artificial intelligence and the YOLOv3 Algorithm, detect an object andmeasure its distance and dimensions.
4. Text-to-Speech Recognition.

Block Diagram



Hardware and Interface

1. IR Sensor :

VCC to 5V pin of Raspberry Pi. GND to GND pin of Raspberry Pi Output to GPIO pin (e.g., GPIO17)

2. Camera Module: Connect the Raspberry Pi Camera Module to the CSI port on the Raspberry Pi.
3. Vibrator : Positive terminal to GPIO pin (e.g., GPIO18) via a transistor (e.g., NPN transistor) and resistor for driving. Negative terminal to GND.
4. Buzzer: Positive terminal to GPIO pin (e.g., GPIO27). Negative terminal to GND.
5. Power Supply (5V): Use a 5V power supply to power the Raspberry Pi via its micro-USB or USB-C port

The Rasperry pi is the central processing unit of the system,

1. Ultra Sonic Sensor : An ultrasonic sensor is an essential component in assistive devices designed for visually impaired individuals, particularly for detecting obstacles and measuring their distance. In such a project, the sensor emits high- frequency sound waves (around 40 kHz) and waits for the echo to return after the waves bounce off nearby obstacles. By calculating the time taken for the echo to return, the sensor determines the distance it determines the distance between the sensor and the object.

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2. Camera

Camera: Raspberry Pi camera module is used to take high-resolution video, as well as still images. It has a resolution of 8 megapixels and 30 frames per second (fps). The output from the camera is fed to Raspberry Pi for further processing.

Raspberry Pi Camera

3. Rasperry Pi

A Raspberry Pi can be used to build an affordable and portable visual assistance system for blind people. The setup typically includes a Pi Camera or webcam, ultrasonic sensors for obstacle detection, and audio output via a speaker or earphones. Using Python with libraries like OpenCV, TensorFlow Lite, and Tesseract OCR, the system can detect objects, read text, recognize faces, and provide real-time voice feedback. Text-to-speech tools like pyttsx3 or espeak convert visual data into audio cues.

Additional features like GPS navigation and voice commands can further enhance usability. This project offers a practical solution for aiding the visually impaired in navigating and understanding their environment. Similar to the

DHT11, the BMP180 uses an I2C interface for easy connection with the NodeMCU, reducing wiring complexity and enhance

4. Buzzer: The Passive Buzzer Module KY-006 is a type of piezoelectric alarm sensor commonly used in DIY electronics and robotics projects. It is a compact, self- contained module that generates an audible tone when a voltage is applied to its input. The KY-006 has a piezoelectric ceramic disc inside which vibrates when a voltage is applied, generating a sound. It is passive, meaning that it does nothave its own internal oscillator and must be driven by an external signal.

5. Button

In a Raspberry Pi-based visual assistance project for blind people, an emergency push button can be connected to a GPIO pin to trigger critical actions when pressed. It can send alerts via SMS or email, activate a sound alarm, or share GPS location using a GSM or GPS module. The button is wired to a GPIO pin with a pull-down resistor for stability, and a simple Python script monitors its state to respond instantly during emergencies. This provides a quick and accessible way for users to call for help when needed.

III. PROCESSING STEPS

Yolo v3: 1. Architecture Overview

• Single Neural Network: YOLO v3 uses a single convolutional neural network (CNN) to predict multiple bounding boxes and class probabilities for those boxes simultaneously. This design allows for faster processing compared to traditional object detection methods.

• Multi-Scale Detection: The model detects objects at different scales using feature maps from different layers, improving detection accuracy for both small and large objects. 2. Input Layer

• Image Capture: The system captures video frames from the camera in real-time. Each frame is passed to the YOLO v3 algorithm.

• Preprocessing: Images are resized to the input dimensions expected by YOLO (typically 416x416 pixels) and normalized (pixel values scaled to [0, 1]). 3. Feature Extraction

• Convolutional Layers: The model consists of multiple convolutional layers that extract features from the input images. It identifies patterns, textures, and shapes relevant for distinguishing different objects.

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• Residual Connections: YOLO v3 employs residual connections to improve training efficiency and accuracy, allowing for deeper networks. 4. Bounding Box Prediction

• Anchor Boxes: The model uses predefined anchor boxes (prior shapes) to predict bounding boxes around detected objects. Each grid cell in the output predicts multiple bounding boxes.

Bounding Box Coordinates: For each predicted box, the model outputs coordinates (x, y, width, height) relative to the grid cell and a confidence score representing the likelihood that the box contains an object. 5. Object Classification

• Class Probabilities: Alongside bounding box predictions, YOLO v3 outputs class probabilities for each detected object, indicating the likelihood that the object belongs to a particular class (e.g., person, vehicle).

• Non-Maximum Suppression (NMS): To refine detections, NMS is applied to eliminate duplicate boxes. It retains only the box with the highest confidence score for each detected object. 6. Output Layer

• Detection Results: The output consists of bounding boxes, confidence scores, and class labels for all detected objects in the frame.

• Real-Time Processing: YOLO v3 is optimized for speed, allowing it to process frames at high rates (up to 30 FPS or more), making it suitable for real-time applications. 7. Integration with Other Components

• Triggering Alerts: Based on the detected objects, the system can activate the speaker to provide audio alerts and the vibrator for tactile feedback, enhancing the user experience.

• IR Sensor Input: The IR sensor can supplement the visual data by detecting nearby objects or movements, allowing for improved situational awareness. 8. Continuous Monitoring . The system continuously captures frames, processes them through YOLO v3, and responds to detected objects in real-time, maintaining an ongoing awareness of the environment.

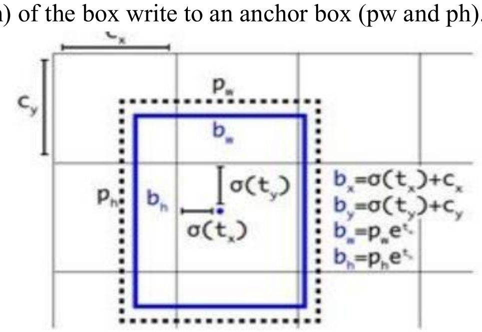
IV. ALGORITHM

In this project, the Yolo algorithm is used to detects and recognizes various objects in real-time. Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images. YOLO algorithm works using the following three techniques: Residual blocks Bounding box regression Intersection Over Union (IOU)

Instead of predicting the absolute size of boxes writes to the entire image, Yolo introduces what is known as Anchor Box, a list of predefined boxes that best match the desired objects. The predicted box is scaled write to the anchors. More specifically:

predict the box center (tx and ty in figure 1) write to the top left corner of its grid scaled by grid width and height.

Predict the width(tw) and height(th) of the box write to an anchor box (pw and ph).



igure1: Bounding boxes with dimension priors and location prediction.

Box center offset (tx)	Box center offset(ty)	Box width(tw)	Box height(th)	Obj score	Class A prob.	...	Class K prob.

Figure2 : YOLO Format

We predict the width and height of the box as offsets from cluster centroids. We predict the center coordinates of the box relative to the location of the filter application.

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Now you know YOLO predicts several bounding boxes per grid instead of just one. The output shape would be something like 13 x 13 x NUM_ANCHOR X (BOX INFO), where the last dimension looks just like an upgraded version of the naive approach. And the final result as shown in Figure 3

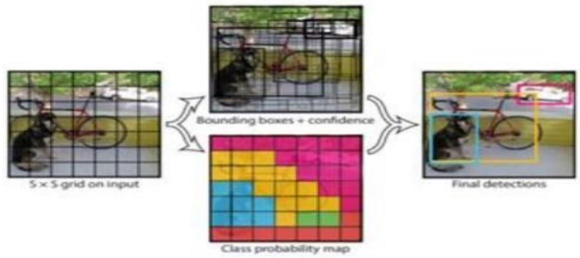

Figure3 : Final Output

V. METHODOLOGY

We propose the following methodologies for identified problems:

Object Detection and Recognition:

With the help of object detection, the system solves the problem of object identification for a blind person.

Object detection algorithm can identify the category of object and object name also. Accuracy of object detection is a minor issue faced in this methodology and can be overcome with the training of models with different data sets.

Object Tracking: The Problem of navigation to an object is solved with the object tracking algorithm which continuously locates the object in the video frame and helps to get closer to the object. The efficiency of this methodology depends on the algorithm we used.

Voice Assistant: The problem of interaction with the system for a blind person is solved with the help of voice assistance. The user simply gives voice commands to search the required object and can be navigated to the object with the use of voice assistance and vibration on the fist. The efficiency of voice assistant depends on pronunciation of words as well as API used for voice assistant.

Open CV and Python:

It is a library of programming functions mainly aimed at real- time computer vision. It is used for various applications such as augmented reality, gesture recognition, feature matching, etc. It is imported by using the command "import cv2" in python. Python is a widely used high-level programming language that has a dynamic type system and automatic memory management and supports multiple programming paradigms including object-oriented, imperative, functional programming, and procedural styles. Python is a lightweight programming tool that has many built-in functions and does not consume many resources while operating on the Raspberry pi.

VI. FUTURE WORK

In the domain of Artificial Intelligence, there was only the capturing the object using Arduino Uno in the existing system. At present, the work was successful to detect, recognize and track the object. Input given to the model is a live video feed with a frame rate of 60-70fps. The output from the system is given in the form of voice assistance and vibration . Thus, in the future, Character recognition, Navigation to multiple objects, Moving object catching would be undertaken.

VII. CONCLUSION

The objective of the initiative is resulting in a system that meets the obligations of people with sight impairments. The system aims to enhance the lifestyle of visually impaired individuals by providing a multifunctional device that can be used on the go. The device combines the functions of various components, to provide a comprehensive solution for visually impaired consumers, which involves object detection, text- to-speech conversion. This feature provides visually impaired individuals with access to printed information that would otherwise be inaccessible.

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