Object Detection for Blind People

RITIK VERMA[1], VIBHU TYAGI[2], SUMIT SHISHODIA[3], DR. BALWANT SINGH[4]
[1, 2, 3, 4] *IMS Engineering College, Ghaziabad*

Abstract*— Even with canes or sticks, walking independently is challenging for blind individuals. They must constantly have someone or trained dogs accompany them to the areas they must go; nonetheless, there may be occasions when no supervisor is present and they become stuck because of their limited mobility. This is the problem that this smart glass solves. Depth estimate and object identification form the basis of its methodology. This method looks for possible risks along a walk path, noting the object's kind and distance from the user. It then alerts the user to the danger, enabling them to roam around freely without constant supervision. An algorithm measures the object's distance from the model once it has detected it. The project "Object Detection for Blind People Using Raspberry Pi and Video Camera Sensor" intends to create a system that will help people who are blind identify and detect objects in their environment. Real-time video footage will be captured by the system utilizing a Raspberry Pi and a video camera sensor, and object detection algorithms will be used to process the footage. The user will be able to navigate and interact with their surroundings more skillfully thanks to the audio feedback that identifies and communicates the discovered things. The independence and safety of people with vision impairments in their daily lives could be greatly enhanced by this research.

Index Terms- Object Detection, Raspberry pi, YOLOv3

I. INTRODUCTION

The detection of objects is a computer vision technology that identifies and locates things in images or videos. This technology is used in a variety of applications, including security systems, autonomous vehicles, augmented reality, and industrial automation. Using a Raspberry Pi, a video camera, and Python programming, object detection can be done at a low cost and with high efficiency.

The Raspberry Pi, also known as a small and cheap computer, is a popular choice for DIY electronics uses like object detection. The Raspberry Pi's GPIO (General Purpose Input/Output) pins and compatibility with a variety of cameras make it an excellent choice for developing an object detection system. Typically, the Raspberry Pi Camera Module is used, however USB cameras can also be attached.

OpenCV (Open Source Computer Vision Library) is a strong library built for real-time computer vision. It includes capabilities for image and video processing, allowing developers to accomplish tasks like object detection, face recognition, and image segmentation.

A basic object detection workflow with OpenCV includes the following steps:

1. Use the Raspberry Pi camera to capture photos and transmit videos.
2. Preprocessing: Convert acquired frames to grayscale, resize, and apply filters to improve features.
3. Detection: Use pre-trained models, like Haar Cascades or deep learning, to identify objects in processed frames.
4. Post-processing: Create bounding boxes around detected items and present the findings.
5. Example code snippet for OpenCV:

II. LITERATURE REVIEW

Existing technologies and Method

- *Traditional Aids*

1. White Cane: A basic but efficient instrument for obstacle identification and navigation.
   o Provides tactile feedback about the surrounding surroundings.
   Limitations: Only detects obstructions at the surface and in close proximity.
   2. Guide Dogs: Trained animals assist blind folks in navigating and avoiding hazards.
   Offer companionship and mobility support.
   Limitations: Requires extensive training and money; not available to all.

- *Smartphone Applications*

1. White Cane: A basic but efficient instrument for obstacle identification and navigation.

o Provides tactile feedback about the nearby surroundings.
Limitations: Only detects obstructions at the surface and in close proximity.
2. Guide Dogs: Trained animals assist blind folks in navigating and avoiding hazards. Offer companionship and mobility support. Limitations: Requires extensive training and money; not available to all.

- *Wearable Devices*

1. OrCam. MyEye is a wearable device that uses a camera to recognize text, faces, and objects. The built-in speaker offers audio feedback.
o Limitations include a high price and restricted field of vision.
2. Aira is a service which pairs blind customers with remote human agents that can see through their cell phones or smart glasses cameras. Agents help with navigation and object detection in real-time.
Limitations: Requires subscription and constant internet connection.

Previous research & Projects

- *Object Detection Systems*

Recent advances in computer vision and machine learning have allowed for the development of advanced object detecting systems:
• Convolution Neural Networks (CNNs) are crucial to recent object detection models. They automatically learn spatial feature hierarchies based on input photos.
• The You Only Look Once (YOLO) system detects things in real-time by dividing images into grids and predicting bounding boxes and probabilities.

- *Emerging Technologies*

1. Augmented Reality (AR) glasses overlay digital information on real-world objects, delivering contextual information.
Google Glass and Microsoft HoloLens have been customized for accessibility.
o Limitations include high costs and possible privacy problems.
2. AI with Edge Computing: - Using AI models on edge devices (e.g., smartphones, Raspberry Pi) for real-time object identification and description.
o Improves latency and decreases reliance on cloud processing.

III. PROJECT DESIGN & METHODOLOGY

Hardware Components

1. Processing Unit: Raspberry Pi-4 module-B [1GB RAM],
2. Camera: For capturing live video feed (Raspberry pi Camera 1.3).
3. FFC Camera cable
4. Power Supply: Portable battery pack.
5. Button: Capturing button for Capture image
6. Perf Board Copper (Zero PCB)
7. Audio Output: Earphones or a small speaker for audio feedback.
8. Jumper Wires
9. Casing

Software

1. Operating System: Linux-based Raspberry pi OS
2. Object Detection Model: YOLO (You Only Look Once)
3. Programming Languages: Thonny Python for the object detection algorithms
4. Frameworks: OpenCV.

Data Collection and Preprocessing

- *Data Collection*

i. Data sources
ii. Data annotation
iii. Data diversity

- *Data preprocessing*

i. Image resizing
ii. Data augmentation
iii. Normalization
iv. Bounding box format conversion

Model Training

Developing an object recognition model to assist blind people entails several steps, including selecting the model design, preparing the dataset, generating the training environment, training the model, and evaluating its performance. Here's a step-by-step instruction to help you through the procedure.

- Choosing a model architecture.
- Preparing the dataset.
- Set up the training environment
- Configure the model
- Train the model
- Evaluate the model
- Fine-tune and optimize
- Deploy the model

IV. IMPLEMENTATION

Hardware Setup

Putting together a hardware setup for a system that recognizes objects to help blind people entails integrating multiple parts, including a Raspberry Pi, a camera module, a power supply, and audio output. Here's an illustrated tutorial on configuring the gear for this project:

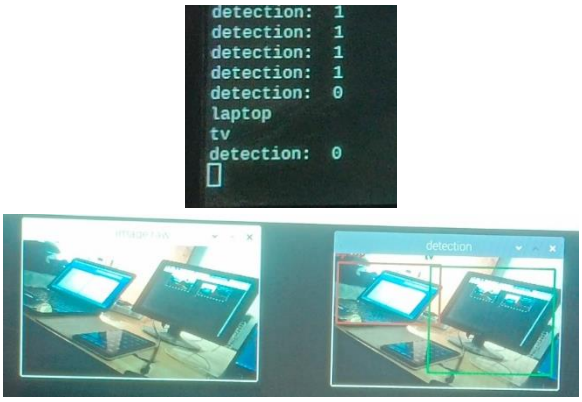
- *Setting up the Raspberry Pi*

i. Install the operating system
ii. Enable the camera interface
iii. Attach the ffc cable:
iv. Setting Up the Tactile Push Button
v. Setting Up Audio Output
vi. Placing the Raspberry Pi in a Case
vii. FFC (Flexible Flat Cable)
viii. Connecting Wires and Resistors
ix. Connecting the power supply

- *Software Setup*

To implement the software installation for a system for detecting objects developed to assist blind people through a Raspberry Pi, you must first set up the Raspberry Pi, then install the necessary libraries, configure the object detection model, and develop the script to integrate all functionalities. Here's a complete handbook.

V. RESULT



- Audio output

For audio output, the voice recording is already on the Compact Disk associated to the project file, as is the video recording.

ACKNOWLEDGMENT

We would like to express our heartfelt thanks to Prof. Dr. Balwant Singh, my semester coordinator, for his persistent enthusiasm, critical thinking abilities, and agility in supervising and guiding me throughout my academic career. This report might never have been published if not for prudent guidance.

We would want to express our gratitude to the library and my colleagues for providing me with necessary materials to finish my report on time and efficiently.

Finally, we would like to thank the faculty members of the ECE branch for their constant support and encouragement. They graciously offered their valuable time with me, explaining in detail how the smart antennas work, replete with flowcharts and layouts.

FUTURE SCOPE

The potential for object detection technology for the blind looks quite bright given the continuous progress being made in computer vision and artificial intelligence. The following are some prospective advances and topics of interest:

1.Improved Accuracy

2.Real-time Feedback

3.Integration with Wearable Devices
4.Semantic Understanding
5.Personalization and Customization

CONCLUSION

This strategy was meant to help blind individuals navigate more safely and independently by enhancing their awareness of their environment and things. This setup uses a Raspberry Pi 4, a speaker, and a Raspberry Pi camera. The Raspberry Pi module, which runs the Thonny Python framework and includes Python code for object identification on each frame, receives video footage taken by the camera. Following object detection, the findings are audibly provided to the blind person via the speaker, notifying them of the discovered item(s) and their estimated distances from them.

REFERENCES

[1] T Karthick, M Manikandan, and M Anandan. 2020. Raspberry-Pi-Based Advanced Indoor and Outdoor Navigation System for the Blind. 183–195 in Journal of Internet Technology 21, 1 (2020).
[2] Guan-Yu Shen, Mind-Da Ruan, Yu-Chen Chiu, Chi-Yi Tsai, and Tsu-Tian Lee. 2020. An enhanced object detection model for embedded devices is called Mobilenet-SSDv2. ICSSE 2020, the International Conference on System Science and Engineering. IEEE, 1–5.
[3] Menglong Zhu, Andrew G. Howard, Weijun Wang, Tobias Weyand, Marco Andreetto, Dmitry Kalenichenko, Bo Chen, and Hartwig Adam. 2017. Convolutional neural networks optimized for mobile vision applications are known as mobilenets. (2017) arXiv preprint arXiv:1704.04861.
[4] Tsung-Yi Lin, Pietro Perona, Deva Ramanan, Piotr Dollár, James Hays, Michael Maire, Serge Belongie, and C. Lawrence Zitnick. 2014. Microsoft coco: Common objects in context. During the European Conference on
[5] Wei Liu, Cheng-Yang Fu, Alexander C. Berg, Scott Reed, Dumitru Erhan, Christian Szegedy, and Dragomir Anguelov. 2016. SSD: Multibox single-shot detector. in the Computer Vision Conference in Europe. Springer, 21–37.