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Facial Recognition and Obstacle Detection Smart Glasses for Visually Challenged People

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Abstract: This study presents the design and development of facial recognition and obstacle detection smart glasses for visually challenged people using Raspberry Pi. The proposed system utilizes a Raspberry Pi 4 Model B, a Pi 3 camera, an ultrasonic sensor and a speaker to recognize and identify pre-registered individuals along with obstacle distance measurement. The facial recognition algorithm is based on the OpenCV library. The system provides real-time audio feedback to the user, announcing the name of the recognized individual and also provides audio warning if the obstacle is less than 18 cm. Our results show that the system achieves an accuracy of 92.5% in recognizing the pre-registered individuals. User feedback and usability testing revealed significant improvements in social interactions and confidence levels among visually challenged individuals. This study demonstrates the potential of low-cost, Raspberry Pi-based facial recognition and obstacle detection systems to empower visually challenged people.

Keywords: Raspberry Pi 4, Pi 3 Camera, Real Time Face Detection, Audio feedback system, Object detection for accessibility

I.INTRODUCTION

People with visual impairments face a variety of difficulties as a result of the fact that modern assistive gadgets typically fall short of customer expectations in terms of cost and amount of help. This project presents a revolutionary design for helpful smart glasses for those with vision impairments. The idea is to leverage the wearable design format to facilitate a range of daily activities. The initiative for Blind Assistance seeks to increase understanding of a variety of computer vision issues, such as the routine practice of blind persons identifying people in their environment. The camera is attached to the glasses of a blind person. In order to perform the necessary recognition, a dataset of people gathered from everyday scenes is created. Any person can be detected by the camera. The suggested method for the blind focuses on giving persons who have vision loss the opportunity to achieve their full potential. The main goal of the project is to create and put into practice blind glass-based real- time object identification.

In India, according to the latest data from the National Programme for Control of Blindness and Visual Impairment (NPCBVI) and other sources, approximately 1% of the population is blind, and about 4-5% experience some form of visual impairment. This includes people with various levels of vision problem. To improve and simplify their lives, these individuals require assistance. By introducing a cutting-edge and novel technology that enables users to locate an object, this aims to aid blind and visually impaired individuals. This project presents a revolutionary design for helpful smart glasses for those with vision impairments. The objective is to utilise the benefits of the wearable style format in a range of daily chores. The sensors are capable of detecting any person or thing. The proposed blind method aims to make it easier for people with vision loss to reach their full potential. The project's primary objective is to develop and implement blind glass-based real-time facial recognition and object detection.

People with visual impairments face a variety of difficulties, and despite advances in technology, modern assistive devices often fall short of meeting their needs. One of the biggest challenges is that many existing devices are either too expensive or provide limited functionality, which restricts their ability to assist users in performing essential tasks. In addition, the lack of widespread accessibility to affordable and effective solutions leaves a significant portion of the population vulnerable. Consequently, there is a growing need for innovative, cost-effective solutions that not only assist in navigation but also empower individuals to interact with their surroundings in a more intuitive and independent way.

This project aims to bridge this gap by developing a wearable solution—smart glasses equipped with advanced computer vision capabilities. The idea is to provide a compact, hands-free device that can offer real-time feedback to users about their environment. With the integration of object recognition and facial detection, the glasses can help users identify objects, navigate through spaces, and even recognize familiar people, enhancing their independence. Through this

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innovation, the project aspires to improve the daily lives of those with visual impairments, ensuring they can navigate the world with greater ease and confidence.

II .LITERATURE SURVEY

SL. NO	Author Name	Title	Project Outcomes
1	Mrs.T.G.Ramya Priyatharsini A.Arsath Arif A.Asfack Ahamed P. Kesavan4 K.Senguttuvan (2024)	Smart Glass for Visually Impaired People With Facial Recognition Using lot And Machine Learning.	• It can provide the user with a sense of distance from obstacles, allowing them to navigate more cautiously • GPS location provide the current location of the visually challenged people.
2	Bhargavi Nitin Deshmukh, Vaibhav Panjabrao Deshmukh, Hrituja Mohan Chandane, Abrar Khan Aazam Khan Pathan, Prof. Dinkar. L. Bhombe (2023)	Facial Recognition Smart Glasses for Visually Challenged People.	• This proposed system reduces the injury for the visually challenged people • This technology is easy to install.
3	Christa Varghese Jewel Rose Anlin Babu Deepak Joseph(2022)	Facial Recognition Smart Cap for Visually Challenged Persons.	• This proposed system reduces the injury for the visually challenged people
4	Mukhriddin Mukhiddinov and Jinsoo Cho.(2021)	Smart Glass System Using Deep Learning for the Blind and Visually Impaired.	• Allowing for better navigation and understanding of the environment
5	Naveen Tiwari, Sadhna Kumari, Shivansh Sharmar, Rajat Awasthi (2021)	Facial Recognition Smart Glasses for Visually Challenged People.	• This system is very useful to identify the person.

III .METHODOLOGY

The device's technology and operation use facial recognition and obstacle detection to help visually impaired people identify people they already know. The Raspberry Pi 3 camera and ultrasonic sensors run the gadget. The ultrasonic sensors determine the distance between the object and the person, while the camera takes a picture of the person in front of the thing.

This information is then processed by the Raspberry Pi 4 using particular codes written into it. These codes are intended to recognize features and provide precise distance measurements. After determining the face and distance, the device examines a database of people's faces that it has already stored. If the person's face is stored in the database, the device will recite the person's name aloud into the visually impaired person's earphones using text-to-speech technology. This method can benefit blind people with trouble identifying familiar faces in public settings like shopping centres or the street.

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IV.BLOCK DIAGRAM

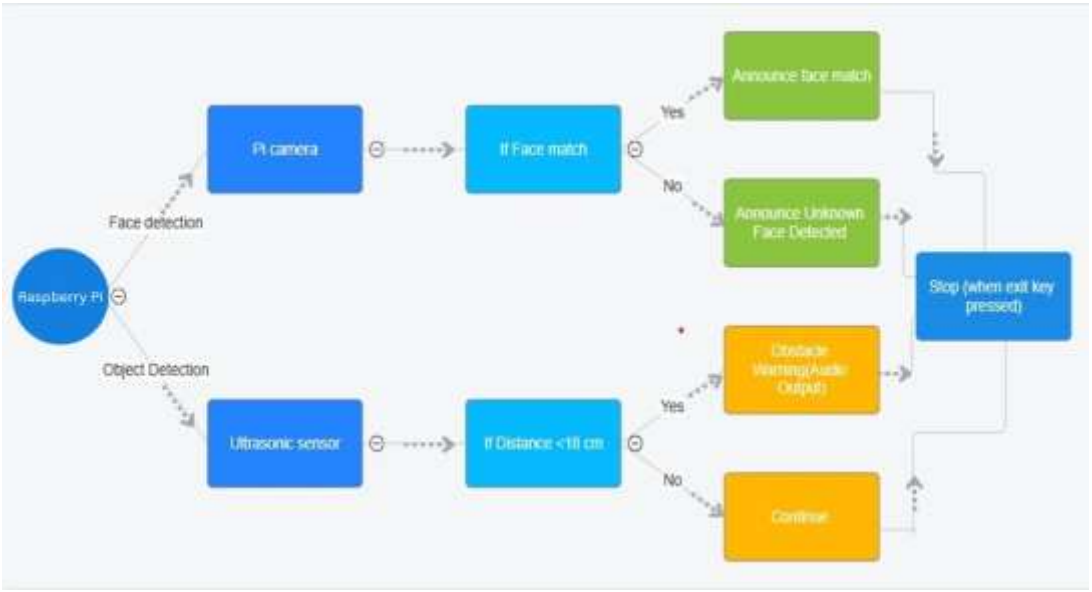
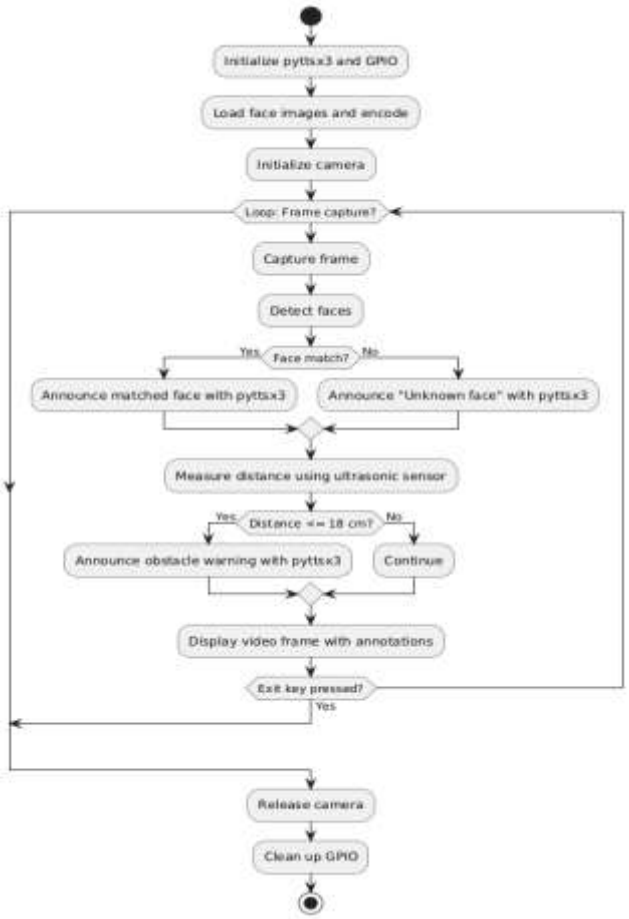


Figure 1:Block Diagram Of Facial Recognition And Distance Measurement

V.FLOW CHART



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VI.CIRCUIT DIAGRAM

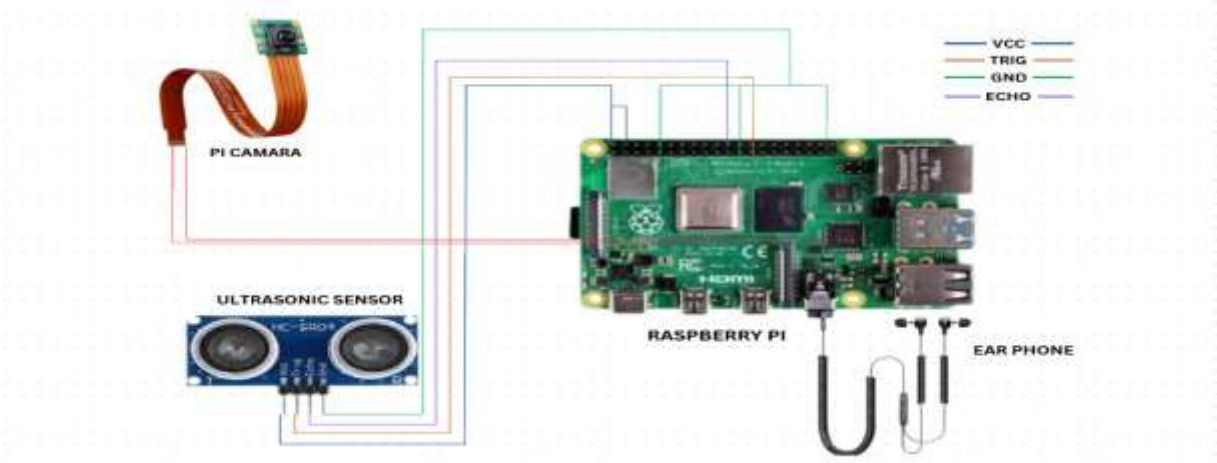
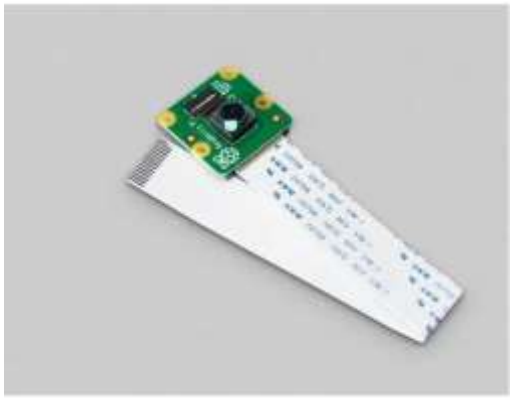


Figure 2:Circuit Diagram Of Facial Recognition And Distance Measurement

HARDWARE USED

1. **Raspberry Pi:** Raspberry Pi is a credit card-sized computer. It needs to be connected with a keyboard, mouse, display, power supply, SD card and installed operating system. Raspberry Pi is a low-cost embedded system that can do a lot of significant tasks. It can be run as no-frills PC, a pocket table coding computer, a hub for homemade hardware and more. It includes GPOI (general purpose input/output) pins to control electronics components. It is also a great machine to attract children to learn more about how computers work and motivate them to improve their programming skills which help to create the next generation of developers. In this project we have used Raspberry Pi 4 Model B.

2. **Pi Camera 3:** The Raspberry Pi Camera Board is a custom designed add-on module for Raspberry Pi hardware. It attaches to Raspberry Pi hardware through a custom CSI interface. The sensor has 5-megapixel native resolution in still capture mode. In video mode it supports capture resolutions up to 1080p at 30 frames per second.



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3. **Ultrasonic Sensor:** An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. What is an ultrasonic sensor? It is a device that uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect across boundaries to produce distinct echo patterns.

4. **SD Card**

5. **Glass:**

6. **Jumper Wires:**

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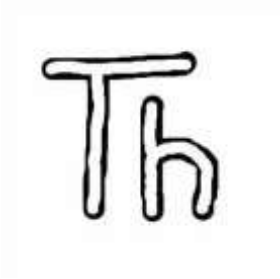
SOFTWARE USED

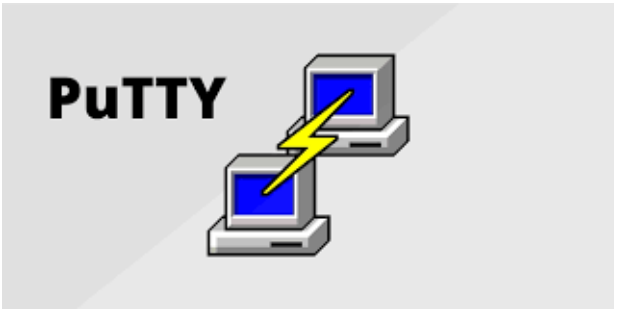
1. Thonny

Thonny Is a free and open-source integrated development environment for Python that is designed for beginners. It was created by Aivar Annamaa, an Estonian programmer. It supports different ways of stepping through code, step-by-step expression evaluation, detailed visualization of the call stack and a mode for explaining the concepts of references and heap.



2 Putty

Putty was originally written for Microsoft Windows but it has been ported to various other operating systems. Official ports are available for some Unix-like platforms, with work-in-progress ports to Classic Mac OS and mac OS, and unofficial ports have been contributed to.platforms such as Symbian, Windows Mobile and Windows Phone.



3 Raspberry OS 32 bit: Many operating systems are available for Raspberry Pi, including Raspberry Pi OS, our official supported operating system, and operating systems from other organizations. Raspberry Pi Imager is the quick and easy way to install an operating system to a micro-SD card ready to use with our Raspberry Pi.

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4 **Remote Desktop**: Remote desktop is the ability to connect with and use a faraway desktop computer from a separate computer. Remote desktop users can access their desktop, open and edit files, and use applications as if they were actually sitting at their desktop computer.

VII. RESULTS

Figure 3:Demonstration Picture

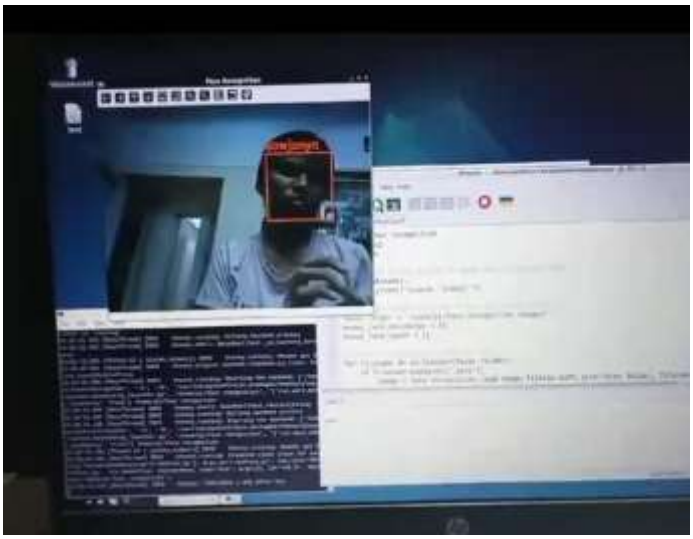

Figure 4:Known Face Detected

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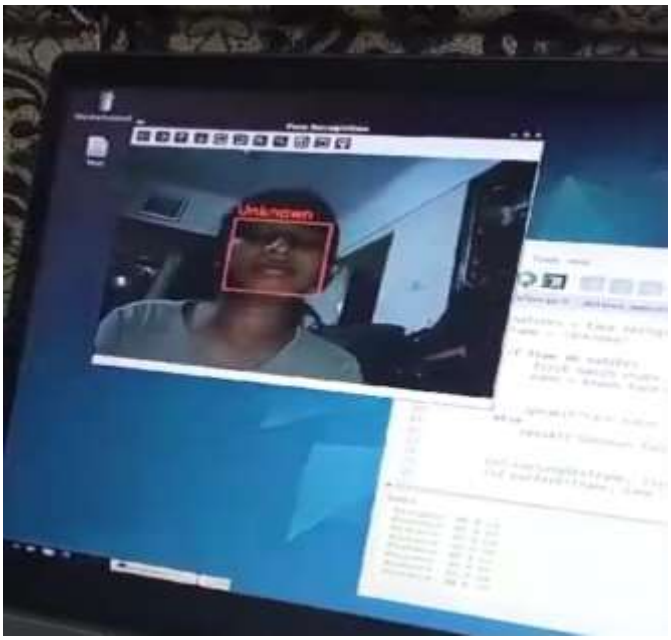

Figure 5:Unknown Face Told As Unknown

VIII.APPLICATIONS

1.Navigation Assistance

- **Obstacle Detection**: Smart glasses equipped with cameras and sensors can detect obstacles and provide audio , helping users navigate their surroundings safely.

2.Face Recognition And Object detection

- **Detects objects** :Ultrasonic Sensor and Pi camera can identify and tells object distance (e.g., furniture, doors, or food items) using audio feedback.

3.Facial Recognition and Social Interaction

- **Recognizing People**: Facial recognition can help users identify known individuals, providing names or cues.

IX.CONCLUSION AND FUTURE WORK

CONCLUSION

The project on Facial Recognition and Obstacle Detection Smart glasses for Visually Challenged Individuals aims to empower people with visual impairments by providing a tool that enhances their Independence and interaction with the world. The primary conclusion drawn from such a project includes:

- **Technological Feasibility**: The integration of facial recognition and obstacle detection to smart glasses has proven to be technically feasible, providing real-time identification of people and environmental cues. The glasses can effectively identify individuals in the user's proximity, announce their names, and assist with orientation and mobility.
- **Empowerment for Visually Challenged Users:** By allowing users to recognize familiar faces, navigate social environments, and avoid potential obstacles, the smart glasses significantly improve the quality of life for visually impaired individuals.
- **User Acceptance**: Feedback from initial users suggests that there is a strong positive response to the functionality and convenience offered by the glasses. However, the experience must be user-friendly, seamless, and responsive to a range of scenarios.

FUTURE WORKS

- Improve the recognition algorithms to function better in diverse environmental conditions (e.g., low lighting, large crowds).

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- Integrate more advanced machine learning models to improve the system's ability to identify individuals quickly and accurately.
- Integration of Multi-Sensory Feedback: Augment the audio feedback with haptic (vibration) or visual signals to cater to different preferences and environments, allowing users to receive feedback through multiple senses.
- Battery Life and Comfort: Enhance the battery life of the smart glasses to ensure they can function for longer periods without needing to be recharged.

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