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Smart Glasses for Visually Disabled Person

Pavan Hegde[1], Neha Devathraj[2], Sushma SK[3], Pasupuleti Aishwarya[4]
[1,2,3,4]*B.E Students,Dept. of Information Science Engineering,* Sir M. Visvesvaraya Institute of Technology, *Bangalore, Karnataka, India*
Guided by ***Dr.Vanipriya CH,****Asso. Professor,Dept. Of Information Science,* Sir M. Visvesvaraya Institute of Technology, *Bangalore, Karnataka, India*

Abstract
Blind mobility is one among the main challenges encountered by visually impaired persons in their daily lives. Their life and activities are greatly restricted by loss of eyesight. They normally travel using blind navigation system or by their accumulated memories in their future exploration. The main objective of this work is to develop a low cost, reliable, portable, user friendly, low power and robust solution for smooth navigation. This paper (Smart Glasses for visually disabled people), is meant for the visually impaired people. It has an in-built sensor in it which spreads ultrasonic waves in the direction the person is going by scanning at most 5-6 meters of range. As soon as the obstacle is detected, the sensor detects it and sends it to the device which generates an automatic voice within the earphone connected to the person's ear.

Keywords: *Raspberry Pi, Pi Cam, Face Recognition, Ultrasonic Sensor, Espeak, IoT, OpenCV, Haar Cascade Algorithm.*

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I. INTRODUCTION

The number of visually impaired people has been growing over the past decades. About 285 million people worldwide are estimated to be visually impaired. However, so far, many faculties and jobs cannot accommodate them mainly thanks to lack of assistive technologies and economic barriers. As a result, most of them still live on a low level of income. Even though technologies are available, they are too expensive and the affordable ones have limited functions. The main goal is to help blind people and people who have vision difficulties by a technology that involves IOT. Main aspect here is to give them support to walk independently.

1.1 Literature Survey

[1] Paper Name: photoOCR

Authors: Alessandro Bissacco, Mark Cummins,Yuval Netzer and Hartmut Neven. In **photoOCR**, which is a system designed to detect and extract any text from any image using machine learning techniques, it also uses different distributed language modeling. The goal of this system was to recognize any text from any challenging image such as poor quality or blurred images. Alessandro Bissacco, Mark Cummins, Yuval Netzer and Hartmut Neven from Google Inc.Were the people who built the algorithm and working module for this research of reading text at a difficult moment and at a complete blur view.

[2] Paper Name: A new computer vision-based system to help rollator users

Author: A group of researchers from Switzerland. In 2014, a group of researchers from Switzerland proposed a new computer vision-based system to help rollator users in their indoor and outdoor navigation. Using 3D and stereo data, they implemented two obstacle detectors to capture any possible danger in the user's pathway. They also introduced a new way to enhance the distorted 3D objects by using the pose estimation technique for the combined 3D points. Although this work could help visually impaired people in their navigation, the detection stage (the core module in work) does not work in sophisticated scenarios such as multiple moving objects. In addition to this, no motion compensation methods were presented to overcome the camera movement.

[3] Paper Name: Headlock

Author: Fiannaca et al. In 2014, Fiannaca et al. presented Headlock, a wearable device to assist blind people in traversing open spaces. The system used Google glasses and OpenCV blob detection algorithm to detect doors and guide the blind person towards it with minimum veering and the shortest path. Although the presented work provided quantitative and qualitative results after testing the system's usability with blind subjects, limiting the

object detection and navigation to doors only make it inefficient for hazard avoidance or general blind navigation systems.

[4] Paper Name: Smart Glasses for visually impaired individuals

Authors: Dr.Stephen Hicks. To validate the utility of smart glasses for visually impaired individuals, research by Dr.Stephen Hicks at the University of Oxford set out to determine if the mobility of people with low vision and registered as blind could be improved. Dr.Hicks and colleagues created smart glasses with a camera and displays to present information about the distance of obstacles to the wearers. The glasses are also able to increase the brightness of obstacles. Indeed, Dr.Hicks' team concluded that low vision patients using their smart glasses had improved independent mobility. These findings were published in the Journal of Investigative Ophthalmology & Visual Science.

[5] Paper Name: AR vision for people with severe peripheral vision loss (tunnel vision)

Author: A group developed at Harvard. In 2001, a group at Harvard developed a device that produced AR vision for people with severe peripheral vision loss (tunnel vision) . The device comprises a wide-angle camera and one display unit that projects a processed image (cartoon style) from the camera on the regular (healthy) vision area. The device was tested on healthy and vision impaired people and the results showed improvements of self-navigation and object finding. However, this solution created a double vision that could cause distraction and reduce the efficiency of a healthy vision.

[6] Paper Name: Detecting traversable area and avoiding obstacles

Authors: Yang et al. Detecting traversable areas and avoiding obstacles for visually impaired people was proposed by Yang et al. The authors presented a sensor combination, multi-thread assistance framework integrating wearable smart glasses, Inertial Measurement Unit (IMU) sensor, and the Intel RealSense RS410 depth camera. Although the proposed work enhanced the path finding task for blind and visually impaired people, the system did not provide any information about the type of the detected objects or the motion model of the dynamic objects in the user's environment.

[7] Paper Name: A lightweight device to help visually impaired people

Authors: A group of researchers from Munich. A group of researchers from Munich developed a lightweight device to help visually impaired people during their everyday activities. This wearable device uses two depth cameras for data collection and a real-time depth processing algorithm extracts information from the video stream to produce acoustic outputs. The use of this low power, low latency sensor is useful to develop a user-friendly device that performs real-time processing. However, the clinical tests for this system revealed that real-life scenarios are far more complicated and need more sophisticated systems and algorithms to deal with dynamic motion and multiple object detection.

[8] Paper Name: Obstacle Detection for Visually Impaired

Authors: Ayush Wattal. This paper proposes to develop an electronic device for obstacle detection in the path of visually impaired people. This device assists a user to walk without colliding with any obstacles in their path. It is a wearable device in the form of a waist belt that has ultrasonic sensors and raspberry pi installed on it. This device detects obstacles around the user up to 500 cm in three directions i.e. front, left and right using a network of ultrasonic sensors. These ultrasonic sensors are connected to raspberry pi that receives data signals from these sensors for further data processing. The algorithm running in raspberry pi computes the distance from the obstacle and converts it into text message, which is then converted into speech and conveyed to the user through earphones/speakers. This design is beneficial in terms of its portability, low-cost, low power consumption and the fact that neither the user nor the device requires initial training.

[9] Paper Name: Smart Visibility Glasses for the Blind

Authors: Amogh Rane, Siddhesh Pujari, Gandhar Khopkar, Azhar Khan, Jyoti Dange. People with visual impairment face various problems in their daily life as the modern assistive devices are often not meeting the consumer requirements in terms of price and level of assistance. This paper presents a new design of assistive smart glasses for visually impaired students. The objective is to assist in multiple daily tasks using the advantage of wearable design format. As a proof of concept, this paper only presents one example application, i.e., text recognition technology that can help reading from hard copy materials. The building cost is kept low by using a single board computer raspberry pi 2 as the heart of processing and the raspberry pi 2 camera for image capturing. Experiment results demonstrate that the prototype is working as intended.

II. PROPOSED APPROACH

Our main motive of this project is to help the visually impaired people, not accurately but to make their life a little bit easier and become self- dependent. In this project, the glasses we will be using would be able to take pictures via camera. "Glasses can recognize images and determine each object in the images". It can determine the distance between the blind person and each object. Conversion of captured image information

into the voice will be provided to the user through headphones that help the blind people to know who is in front of him/her. It will also give notification to the user if the object is very close or far away from him/her.

2.1 Face Recognition
System Requirements
OpenCV

OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc.

Haar-Cascade Classifier Algorithm

It is basically a classifier which is being used to detect objects for which it has been trained for. First and foremost, the algorithm needs a lot of positive pictures and negative pictures to prepare the Haar cascade classifier. Positive pictures are pictures with clear faces where negative pictures are those with no countenances. Each feature is represented as a single value obtained from the difference of the sums of pixels in white rectangle from the sum of all pixels in the black rectangle. All different possible sizes and locations of the classifier are used for calculating plenty of features. As the number of classifiers increase, the arithmetic computations seem to take a long time. Instead, the concept of Integral Image has been used. Image Processing Integral image is a data structure which is a summed area table and algorithm for quickly and efficiently generating sum of values in a rectangular grid subset. To avoid the complex calculation, we use the Ad boost machine learning algorithm, which is inbuilt in the OpenCV library that is a cascade classifier, it eliminates the redundancy in the classifiers. Any classifier which has a probability of 50% or more in detection is treated as a weak classifier. The Sum of all weak classifiers gives a strong classifier which makes the decision about detection. Classification takes place in stages, if the selected region fails in the first stage, we discard it. One does not use the classifiers on that region which is discarded.

There are three types of features in Haar Cascade classifier algorithm
1. Edge Features
2. Line Features
3. Four-Rectangle Features.

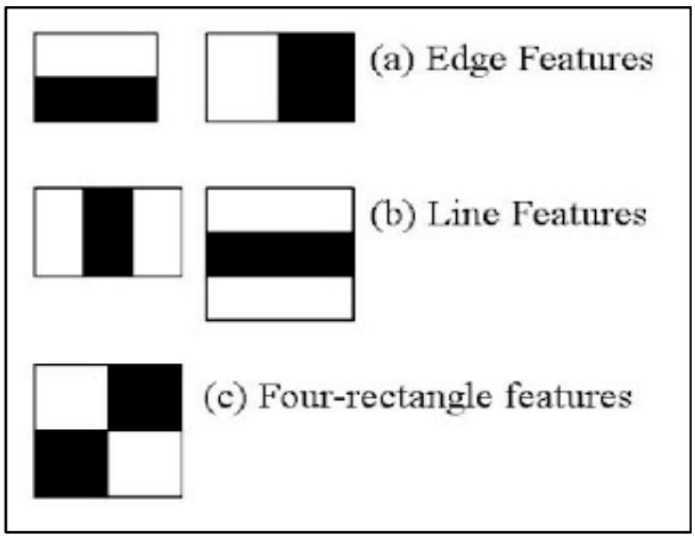

Fig 1 Haar Features

Hardware Implementation

Raspberry Pi

Raspberry Pi (or RPi) is a low priced, credit card sized computer that plugs into a computer monitor or TV and uses a standard peripheral like keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It can do everything one would expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. The RPi works in the open-source environment: it runs Linux (diverse distribution), and its principle supported working system, Raspbian, is open source and runs a suite of open-source programming. The Raspberry Pi Foundation adds to the Linux part and different other open-source extensions just as releasing its very own lot of programming as open source.

Raspberry Pi Camera

The Pi camera comes with a flex cable. The flex cable is inserted into the connector which is located between the Ethernet and HDMI port with the silver connection facing the HDMI port. The flex cable connector is opened by pulling the tabs on the top of the connector upwards then towards the Ethernet port. The flex cable is then inserted firmly into the connector. The top part of the connector is then pushed towards the HDMI connector and down, while the flex cable is held in place. Here, the Pi camera is being utilized for the face detection and the face recognition process.

Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound. Ultrasonic sensor is being used as a source to detect the obstacle present in front of the user. Connected serially to the raspberry pi processor.

Raspbian

Raspberry Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. ... Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller.

III. METHODOLOGY

SDLC is a strategy that is used to ensure that products that are developed, are optimized for their users, based on a set of requirements. It is a very common strategy in software development projects. SDLC involves several steps shown in Figure 2.1: Requirements Gathering, Analysis, System Design, Object Design, Testing, and Implementation. Each step ensures that the developers are ready for the next one and the approach tries to minimize the development time by having predefined expectations for each step. By following this process, the developers ensure that their finished product meets and addresses the needs of their users.

The Smart Glasses works on the bases of IoT and Sonic wave mechanism. When the person or an object comes Infront of the glasses the user is notified by Espeak module on the distance he is from the object/person. The camera module shall recognize the person face using Face dataset folder and shall display a name or shall display as unknown. The Smart Glasses is powered by 5 Volt battery and runs on python3.

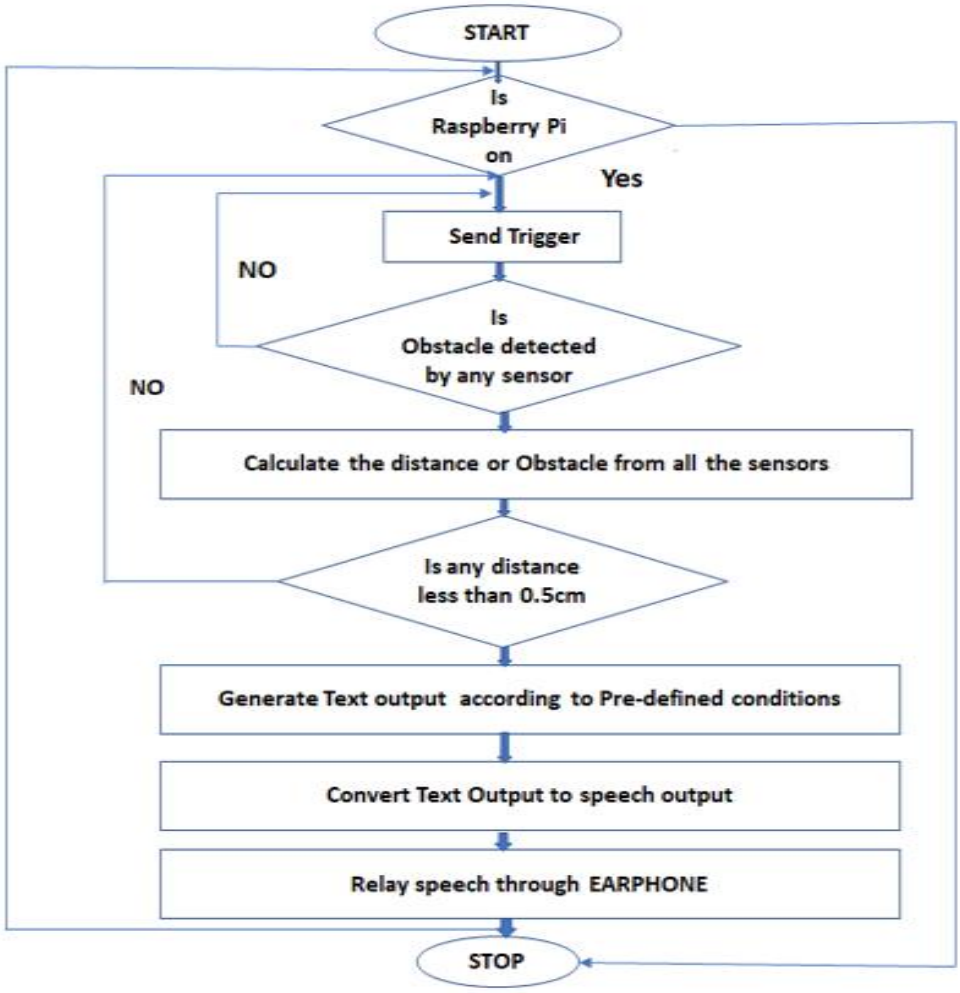

Fig 3. Flowchart of the proposed approach

IV. RESULT OF IMPLEMENTATION

The above SDLC module shows that the camera module shall recognize the person face. And is powered by 5-volt battery. VNC viewer is installed on the remote computer and VNC server on to the raspberry pi 4.

Face recognition

A facial recognition system is a technology capable of identifying or verifying a person from a digital image or a video frame from a video source. It is a biometric software application capable of uniquely identifying or verifying a person by comparing and analysing patterns based on the person's facial contours. Facial recognition is mostly used for security purposes, though there is increasing interest in other areas of use. Most facial recognition systems function based on the different nodal points on a human face. The values measured against the variable associated with points of a person's face help in uniquely identifying or verifying the person. With this technique, applications can use data captured from faces and can accurately and quickly identify target individuals. There are many advantages associated with facial recognition.

Compared to other biometric techniques, facial recognition is of a non-contact nature. Face images can be captured from a distance and can be analysed without ever requiring any interaction with the user/person. As a result, no user can successfully imitate another person.

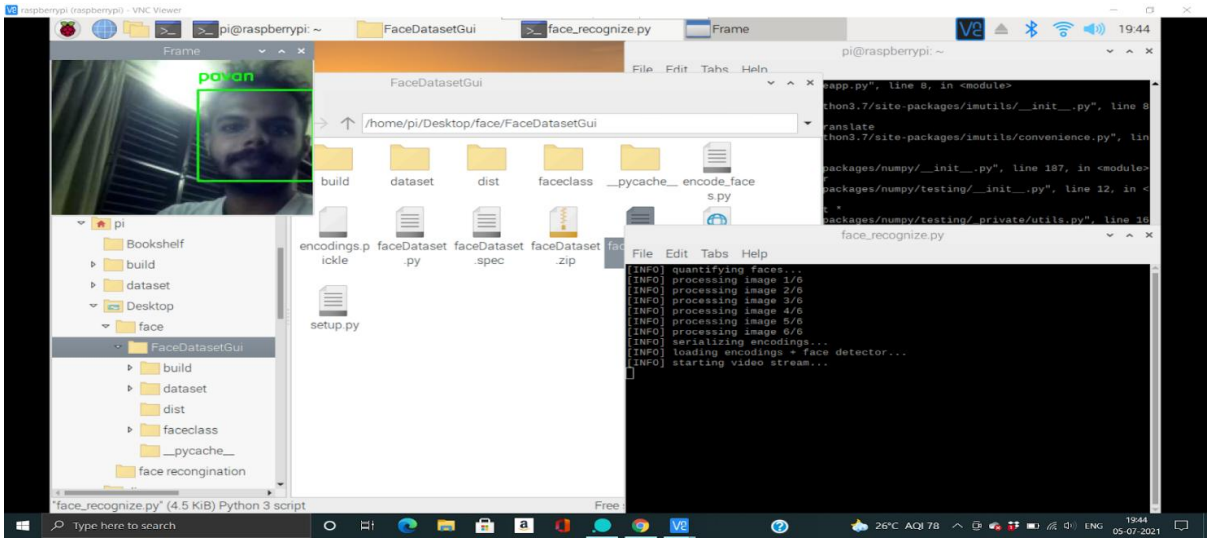

Fig 4. Screenshot of Recognized face by the Smart glass

The screenshot of live demo of the camera module is shown. When a person comes Infront of the smart glasses, the camera module ie Pi camera captures the image of the person and will run a analysis with the Face Dataset folder and if any matches is shown then the name of the person is displayed using the Haar-Cascade Classifier Algorithm. If no matches found it shall display as unknown.

V. CONCLUSION

Smart Glasses for Visually Disabled People is currently an existing Technology outside of India. As computer vision algorithms, sensor technologies and hardware have been used together, the idea of developing wearable or portable assistive technologies for visually impaired people evolved. The device has been developed by us at a low cost of manufacturing, comes with audio output, and is convenient to use for day-to-day activities. The primitive version of these systems used basic image processing and computer vision techniques, while the recent versions are smart enough to draw a safe path for user navigation. The system proposed in this paper is consumer cost friendly and can be worn easily as a glass.

Using face recognition, ultrasonic sensors and IoT, we have proposed an advanced system providing the distance calculation, voice outputs and face recognition. Since the option of loading and training the face recognition module we can store and process N number of familiar faces. And would bring in hassle free and without anyone else assistance for a person to lead a life.

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