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Smart Vision Goggles for Blind People

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***Abstract*— People who are visually impaired face various problems in their daily life. Their daily activities are greatly restricted by loss of eyesight. They usually travel using blind navigation systems or by their accumulated memories in their long-term exploration. This paper is about a new design of assistive smart vision goggles for visually impaired persons. The main objective of the proposed model is to make the user comfortable carrying the device that is designed in a wearable format. This device includes a pair of glasses and an obstacle-detection module fitted in it the center of goggles, an output device i.e., voice through a headset, a camera to find the obstacle, and text recognition i.e., it helps the blind to read out the text by scanning through the camera where the input is given through a switch. For image capturing, we use Raspberry pi and for obstacle detection, we use ultrasonic sensors which can scan at most 5-6 meters of 30 degrees range. Cloud technology is used to identify the object scanned by the camera. These Smart Vision Goggles for Blind People are portable devices, lightweight, easy to use, and user-friendly. These glasses could easily guide blind people and help them to avoid obstacles.**

***Index Terms*— Smart goggles, Blind People, Raspberry pi, Ultrasonic Sensors, Text recognition.**

I. INTRODUCTION

People who are visually impaired have decreased ability of visual perception. Blind mobility is one of the major challenges encountered by visually impaired persons in their daily lives. Their life activities are greatly restricted by the loss of eyesight. Visually impaired people are who have lost their ability to see completely and who have partial loss of vision [1]. According to the world health organization (WHO), there are around 285 million visually impaired people in the world. Among the 285 million people, 39 million people are totally blind and 246 million people have a low vision. Because they don't require usage of hands or just minimal hand use, wearable gadgets are thought to be the most helpful of all assistive technologies. The head-mounted type is the most common. Their primary benefit is that, unlike other devices, they naturally point in the direction of the viewer, negating the need for extra direction signs. This paper highlights a brand-new style of smart glasses that can help with a variety of jobs while yet having a modest construction cost. To communicate information to the user, the design makes use of the latest Raspberry Pi 4 Model B, a camera, and earphones.

II. LITERATURE SURVEY

A. Previous Works and their Limitation

There are already many existing devices that help a blind person in walking. The most common one is a simple

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walking stick. With this simple walking stick, the blind man may identify the obstacle. A few authors came up with the smart cane for the blind which detects the obstacles in front of them [2]. Still, it has many disadvantages such as they can't detect the obstructions that are hidden but very dangerous for the blind such as stairs, holes, etc., Shoes that point you in the right way, which aid the blind, are another example of a smart device in use. The audible directions on your smart phone are no longer necessary to pay attention to while you're walking somewhere new. Bluetooth allows the shoe insoles to communicate with the associated app, which is accessible on iOS, Android, and Windows. Then, a vibration will notify you as you walk when you need to turn. As the turn draws closer, the buzz in your left shoe will tell you to turn left, and the vibration in your right shoe will tell you to turn that way. Both feet will vibrate at once if you need to turn around. The shoes can't yet assist you in avoiding obstacles, through their path. The Eye Stick, a walking stick with eyes, is another gadget. A lens is fixed to the bottom of the eye stick. The distinctive features, such as traffic lights, stairs, the subway, and so forth, can be recognized. After that, blind persons can receive each communication via vibration. These gadgets still have limitations in that they cannot detect obstacles such as poles or other objects that are directly in front of the user [3].

B. Proposed Model to Overcome the Limitations

In this regard, to overcome the limitations, Smart Vision Goggles for the Blind by using raspberry pi is proposed in this paper. It is designed in the shape of eyeglasses for providing guidance efficiently, comfortably and safely. It uses ultrasonic sensors and a webcam which are placed on the goggles to detect an object and alert the user. The advantage is, it is easy to carry the goggles and it provides a lot of features like it identifies the obstacles in front of the person and alerts the person with a message through headphones. Also, it detects the image in front of the user by scanning through a webcam and gives the information to the user through headphones. The proposed model will also provide text reading by scanning the image through a webcam and converting the text using google text to speech converter. If the user feels unsafe, then a message will be sent to the user's caretaker mobile by pressing an input switch.

III. IMPLEMENTATION

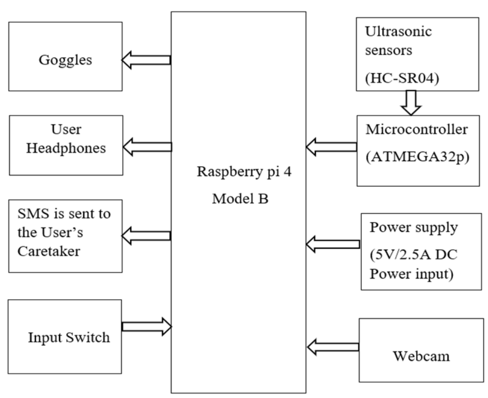

Figure 1. Functional diagram of the proposed prototype

The implementation of Smart vision Goggles for the Blind is achieved with the help of components such as Raspberry pi, ultrasonic sensors, a webcam, and earphones. All these components are placed in a compact and secure manner which helps the person to carry them easily. The person will be comfortable with the model, he can use it whenever he needs it and can remove it when it is not necessary. These goggles will help blind people to reach their destination independently. The reason these glasses are more reliable and easier to implement is that they are developed using ultrasonic sensors and raspberry pi which are commonly available almost everywhere. These ultrasonic sensors have a specified range (2cm-4m) for sensing the objects. These sensors detect the obstacles in front of a person, like they can sense objects, stairs and buildings and give a voice-over to the person through headphones. We designed the goggles in such a way that they can identify the object in front of the person by taking pictures via camera. Conversion of captured image information into voice will be provided to the user through headphones that help the blind people to know who/what is in front of them. These goggles also help the blind to read text by scanning the book through the camera. Another feature we have added to this project is, if the blind person is feeling insecure then he can press an input switch upon which a message will be sent to the caretaker of that blind person immediately.

The Raspberry pi is a low-cost and small size computer that is used for running programs. Ultrasonic sensors are used to measure the distance by using ultrasonic waves. Here, the sensor head emits an ultrasonic wave and receives the wave reflected from the target. These sensors measure the distance from the target by measuring the time between the emission and reception. They have a limited range to detect the obstacle i.e., 2cm-4m. Ultrasonic sensors are placed on the top of the model, some with a certain angle to identify the obstacles, digs, holes, and stairs and alert the user with a message through the earphones. The functional diagram of the proposed model is shown in Figure 1. The features such as voice-out obstacles, detecting the image, reading the scanned image, and sending the current location are programmed on the raspberry pi. A specific button is provided to execute all these features. Pressing the button at different periods enables the features execution accordingly. The output of all the features is in speech format using the gTTS (google Text to Speech) library [4].

IV. PROPOSED SYSTEM DESIGN FLOW

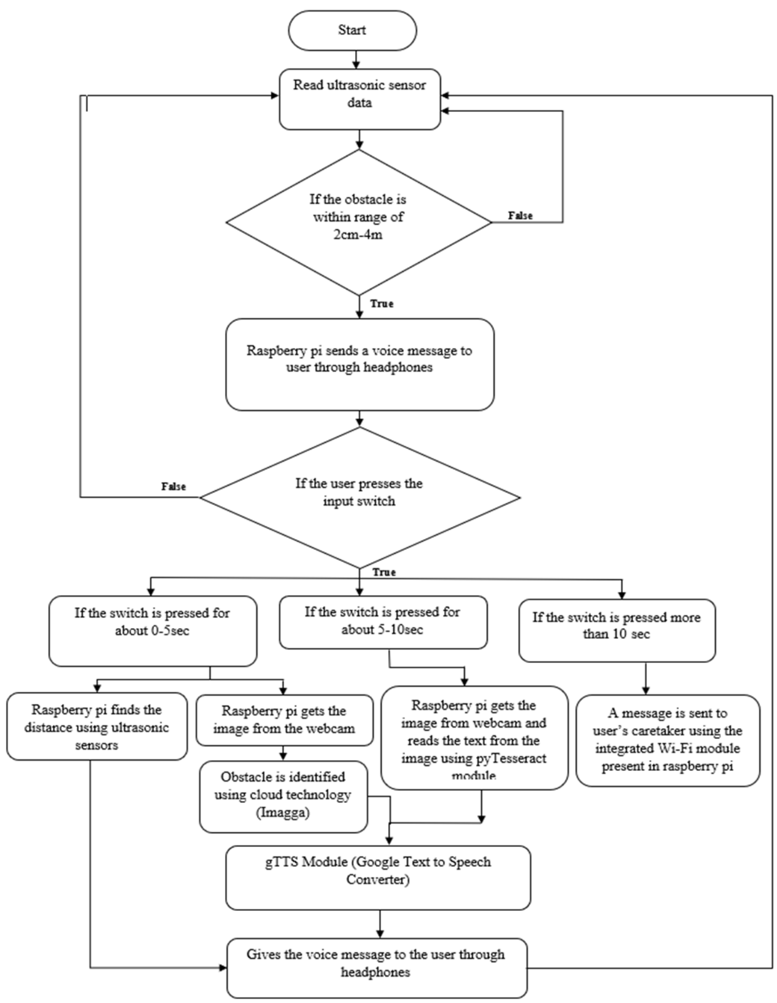

Figure 2. Flow diagram of the proposed system

Stepwise procedure to use this prototype model is as follows.

Step 1: First, make a connection of all the modules and other components to the raspberry pi, and microcontroller.

Step 2: Get the option from the user through the input switch.
Step 3: Ultrasonic sensors automatically sense the obstacles in front of the user and alert him by specifying the range of distance as shown in Figure 5.
Step 4: If the input switch is pressed for less than 5sec then the image is captured through camera and the obstacle is identified using cloud technology Imagga as shown in Figure 3.
Step 5: If the input switch is pressed for 5-10sec then the image is captured and the text present in that image is extracted using pyTesseract module and converted to speech using gTTS library as shown in Figure 4.
Step 6: If the input switch is pressed for more than 10sec then a notification is sent to the user's caretaker.
Step 7: All the actions are converted into a resultant text document and given to gTTS module which converts the text into speech that can be heard by the user through earphones.

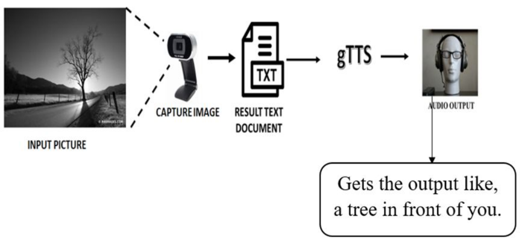

Figure 3. Capturing the image and identifying the object.

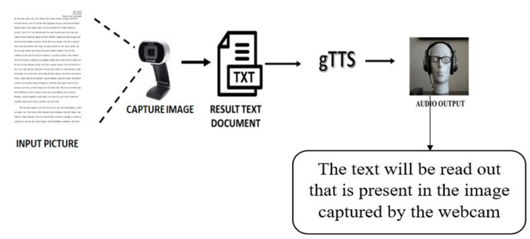

Figure 4. Capturing the image and reading the text

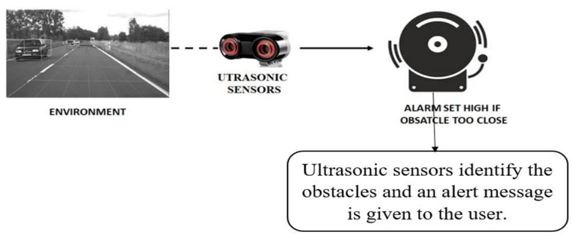

Figure 5. Reading the obstacle distance and warning the user

V. Hardware description

A. Raspberry pi processor

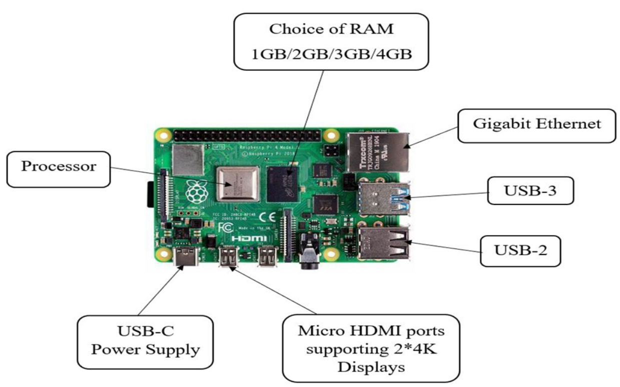

Figure 6. Raspberry pi 4 Model B

The raspberry pi used in our project is "Raspberry PI 4 Model B" (shown in figure 6) with a high-speed 64-bit quad-core processor, 4GB RAM and Dual-band 2.4/5.0 GHZ wireless LAN [9]. It is the heart of this project which is responsible for performing all control actions [8].

B. External Webcam

Figure 7. Webcam

An external webcam is attached to the goggles which are used for capturing the images for the optical character recognition (OCR) feature and the dominant feature [10]. The external webcam that is used in this prototype is shown in Figure 7.

C. Ultrasonic Sensors

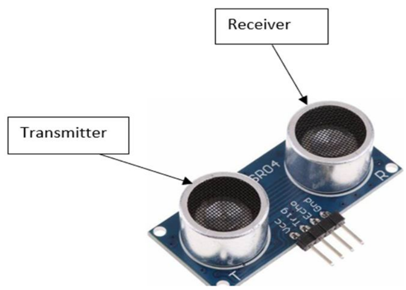

Figure 8. HC-SR04 Ultrasonic sensors

Ultrasonic sensors are used to detect obstacles, digs, and stairs in front of the user. These ultrasonic sensors work in a particular range of distances [11]. The ultrasonic sensors that are used in this project are shown in Figure 8 and their range is 2cm-4m.

D. Input Switch

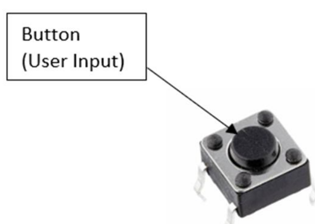

Figure 9. Input Switch

The input switch provided would act as a hand-held remote through which the user can select a particular feature to execute and hear the result. The switch will be operated based on the period the user holds it. If the time is less than 5sec then the obstacle is identified by scanning through a webcam. If the time is 5-10sec the text recognition will be enabled. If it is more than 10sec then a message is sent to the respective person who takes care of the user [12]. The switch used in this project is shown in Figure 9 and the power rating is MAX 50mA 24V DC and the operating temperature range lies between -20 to 70 ^{0}C.

E. Microcontroller

The microcontroller used in this project is ATmega328p. It is an 8-bit AVR RISC-based microcontroller chip. It consists of flash memory 32 KB ISP with read-while-write capabilities, EEPROM of 1KB, 23 general-purpose I/O pins, SRAM (Static Ram) of 2KB, 32 general-purpose working registers, etc [13]. Microcontroller is used to get the information from the ultrasonic sensors and gives it to the raspberry pi for processing the data.

VI. SOFTWARE USED

IDE— IDLE software is needed to be installed on the computer to give the optimal functioning of the application [14]. The specifications of the software used are:

- Operating System – Windows
- Programming Language – Python3 [15]
- IDE – IDLE

Libraries – requests, time, cv2, speake3, pytessseract, pyttsx3, json, telepot, RPi.GPIO, Imagga.

VII. PYTHON MODULES

A. Voice out results

gTTS (google search to speech library): It is used to convert the text format to speech format. It is vital in providing voice output for users [5].

B. pyTesseract

Python-tesseract is an OCR tool for python. That is, it will recognize and “read” the text embedded in images [6].

C. Geocoder

This module is used to find the current location of the user. Geocoding uses spatially explicit reference datasets (e.g., digital road networks) to identify the location to best match the input address, essential for comparing and interpolating the address to the range of addresses for each segment of the referenced dataset [7].

VIII. HARDWARE AND SOFTWARE INTERFACING

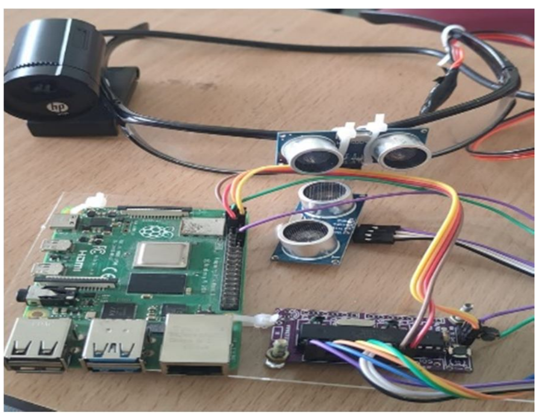

Figure 10. Hardware and Software Interfacing

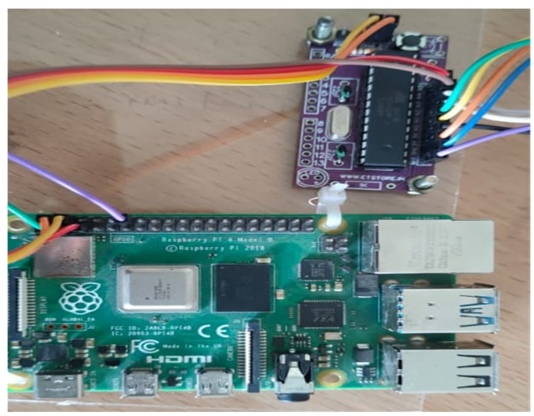

Figure 11. Hardware connections

The hardware and software interfacing is shown in Figure 10 and hardware connections are depicted in Figure 11. The USB cable is connected to Raspberry pi for the power supply and earphones are plugged in. After interfacing, the program is compiled and run, then the respective features will get executed based on input from the switch and the output is heard through earphones.

IX. RESULTS

The output of the smart vision goggles is observed as shown in figures 12 to 15. When the user is walking with these goggles on, if there is any obstacle then he is hearing a message “obstacle in front of you (if there ia any object or stairs)” or “digs infront of you (if there is downward stairs or hole)” as shown in figure 12. If the user wants to know what the obstacle is then he can press the input switch. The features offered here are:

Case 1: If he presses it for about less than 5 sec, then it captures the image and gives the information about the objects that are captured in the image to the user through earphones. That information is shown in Figure 14.

Case 2: If he presses it for about 5-10 sec, then it captures the image and and it reads the text and gives that information to the user through earphones, which is shown in Figure 15.

Case 3: Another feature included in the project is, if the user felt insecure he can long press (>10sec) the input switch so that a message is sent to his caretaker as shown in Figure 13.

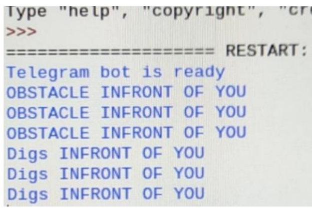

Figure 12. Obstacle message to the user through earphones

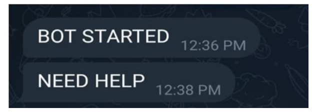

Figure 13. A message sent to the caretaker's mobile

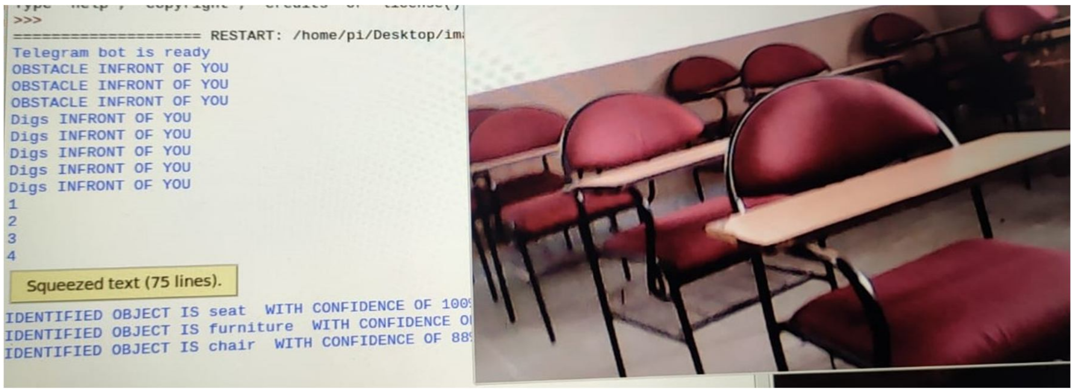

Figure 14. Captured image and Obstacle Information heard by the user

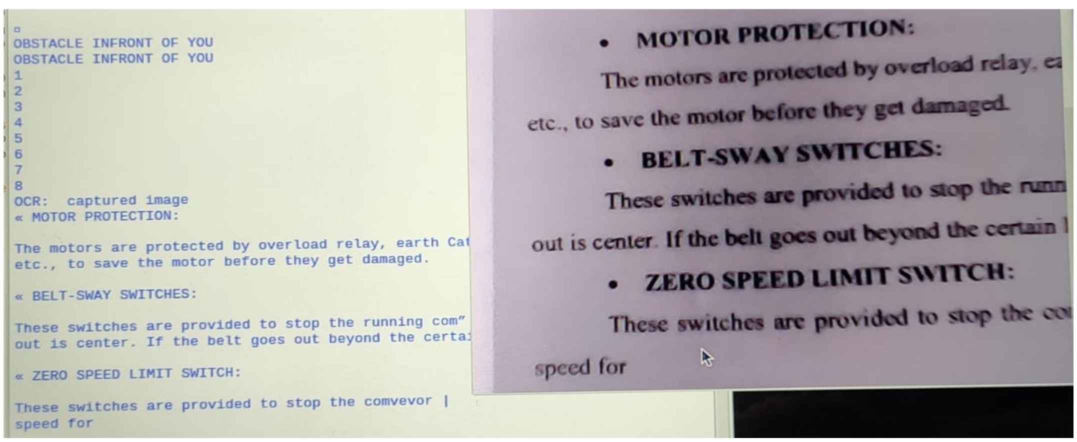

Figure 15. Text captured and text information heard by the user

X. Conclusion

Smart vision goggles, is a project in which we have used raspberry pi model to provide assistive care for blind people. This product helps blind people to read newspapers, and books, it helps to identify the obstacles in front of the user, captures the images, and can send an alert message to the person who is taking care of the user. All these features have voice output to the user through headphones. These features are accessed by the user through the input switch provided. This proposed model is providing efficient results and it is easy to use. With this model the user is able to walk through roads, labs and hallways without any assistance.

Future scope

All the features that are developed in this product are processed by the raspberry pi processor. For further enhancement of the project, we can add directions to guide the person, help the user to know the current date and time, help him to know the exact location where he is, weather information, and can get the top 10 headlines of present-day news. All these features can be processed by using raspberry pi. This may help the person to know the things happening in society without any assistance.

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