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Featured Stick for Blind using IoT

Kuntanahal Saurab Kumar[1], Prasanna Kumar[2], Shravan Walvekar[3], Chandan Thippari[4], Manoj Kumar[5]
[1, 2, 3, 4]Students, [5]Assistant Professor, Department of computer science and engineering, jyothy institute of technology, Bengaluru, India

Abstract: Blind people face many challenges day by day because they lack vision and usually they should depend on other people. By considering this situation of blind people we have developed a system that helps a blind person to move from point A to B without the need for others' help. In our system, we are implementing ultrasonic sensors that detect objects at a certain distance so that blind can get notified about the obstacles in front of him. If there is any sudden catch of fire in front of a blind person, a fire detector is implemented which helps in notifying the blind about the same. If the blind person falls down his stick is mounted with an accelerometer that detects the acceleration and the controller takes the action by sending a text message to the caretaker along with the live location. If the blind faces an emergency we have provided a panic button so that the blind person can get help from the surrounding and also from the caretaker who receives a text message along with the live location from the system. In addition to these components, we have implemented optical character recognition (OCR) using Tesseract OCR for character recognition and Google text to speech converter so that the blind can hear the characters that he intends to read. We have also implemented image classification using deep learning techniques so that the blind person can know the object that is placed in front of him

Keywords: Blind people, Ultrasonic sensors, Fire sensor, Accelerometer, Panic button, Optical character recognition, Tessaract OCR, Deep learning

I. INTRODUCTION

Electronic travel aids are the devices that assist in the carefree navigation of an individual. The function of ETA is to provide information to the blind person about road and obstacles. Our smart walk stick is also an ETA that helps blind people to know about the objects opposite to them, object identification, and text reading. In this smart walking stick, we use Raspberry pi to control and co-ordinate with sensors that are connected to the system.

The feature of object identification helps blind people to recognize what kind of object is before them and helps them to move around safely.

Visualization of a printed document can be made possible through optical character recognition (OCR). Properties of the proposed system include a feeling of ease as it is made lightweight. Around the world, many people are affected by blindness or some kind of visual intolerance. This condition leads to the loss of a valuable sense of vision. There is a continuous requirement of some kind of assistive systems. According to a survey, as of 2010, there were more than 285 million visually impaired people worldwide, out of which 39 million were blind. A lot of devices have been created in this field however; most of them are either not in use or requires a lot of training. Some of the works done in this field are explained below:

A. Drishti

Drishti is a system that provides navigational features to the blind by using wireless technologies. This project concentrates contextual awareness which enhances the navigation of the blind. However, a lot of effort took into integrating this technology thus; the components were not optimized fully.

B. Navbelt

Navbelt is a guidance system that used a mobile robot obstacle avoidance system. Ultrasonic sensors and earphones were the key components of the system. The disadvantages of this system are that it was bulky to use. Users were required to get extensive training to use the system. Most of the projects that have been created require internet connection i.e. there is a need to maintain continuous connectivity, which is not only difficult to attain in certain areas but also adds the additional cost of data usage. The system consists of a proximity sensor, infrared sensor, and a laser diode which do not function properly as several environmental constraints are affecting it.

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II. OBJECTIVE

A. To design a navigation stick that is easy to maintain and handle by the blind.
B. To provide a safe feeling to the blind by alerting the caretakers in case of an emergency with his/her live location
C. To provide image and text visualization and recognition feature so that the blind can read the text and see the image independently

III. LITERATURE REVIEW

A. [6] Naiwrita Dey et.all, Proposes that a smart stick for the blind and visually impaired people where there are many issues over which humans have no control blindness is one of such issues. It snatches the vivid visual beauty of the world from an individual's life. But missing the beauty of nature becomes one of the last worries of such people as they have to face numerous difficulties to perform even the most basics of tasks in their day to day life. One of their most dominant problems is transport, such as crossing roads, traveling in trains, or other public places. They always require human assistance to do so. But sometimes they are rendered helpless when no such assistance is offered. Their dependencies deteriorate their confidence. Traditionally they have been using the conventional cane stick to guide themselves by touching/poking obstacles in their way. This causes a lot of accidents and hence is dangerous for them and others. As this is a technologically driven era we decided to aid these differently-abled people by coming up with a technology utilizing solution. We call it the “Smart Stick”. It is a device which guides the user by sensing obstacles in the range of stick. It will identify all obstacles in the path with the help of various sensors installed in it. The microcontroller will retrieve data and pass it on as vibrations which will notify the user about hurdles on the way. It is an efficient device and will prove to be a big boon for blind people

B. [1] Akhilesh Krishnan etc.all, Proposes that an autonomous walking stick for the blind using echolocation and image processing he smart walking stick, the Assistor, helps visually challenged people to. identify obstacles and provide assistance to reach their destination. The Assistor works based on the technology of echolocation, image processing, and a navigation system. The Assistor may serve as a potential aid for people with visual disabilities and hence improves their quality of life. There is a lot of work and research being done to find ways to improve life for visually challenged people. There are multiple walking sticks and systems which help the user to move around, indoor and outdoor locations but none of them provide runtime autonomous navigation along with object detection and identification alerts. The Assistor uses ultrasonic sensors to echo sound waves and detect objects. An image sensor is used to identify the objects in front of the user and for navigation by capturing runtime images and a Smartphone app is used to navigate the user to the destination using GPS (Global Positioning System) and maps

C. [2] Ayat A. Nada et.all, Proposes that an assistive infrared sensor-based smart stick for blind people. Blind people need some aid to feel safe while moving. the smart stick comes as a proposed solution to improve the mobility of both blind and visually impaired people. Stick solutions use different technologies like ultrasonic, infrared, and laser but they still have drawbacks. In this paper we propose, lightweight, cheap, user-friendly, fast response and low power consumption, smart stick based on infrared technology. A pair of infrared sensors can detect staircases and other obstacles present in the user path, within a range of two meters. The experimental results achieve good accuracy and the stick can detect all of the obstacles.

D. [3] Himanshu Sharma et.all, Proposes that an embedded assistive stick for visually impaired persons with a smart stick is intended and executed to aid blind persons so that they can walk independently without much difficulty. Firstly, pothole detection and avoidance system are implemented by setting the ultrasonic sensor at 30-degree angle on a suitable blind stick to sense if there is a hole or staircase in front of the blind at about 30 cm distance to avoid a person from falling and as a result may be producing many damages. Secondly, a moisture sensor is placed at the down of the stick to measure the degree of water land soil moisture in the forward-facing of the user and aware of him as soon as that degree exceeds a measured level that may submerge the foot of him. Thirdly, knee above obstacle detection and avoidance system is implemented by using an additional ultrasonic sensor on the top of the stick to turn an alarm and vibration ON when there is a person, obstacle or wall at a distance of 50 cm in front to avoid an accident and thus helping the person to move independently. Fourthly, an ultrasonic sensor is placed down the stick at about 20 cm from the ground level to detect and avoid knee below obstacles and stairs at a distance of 70 cm in front of the user. Fifthly, a wireless remote consisting of RF modules (transmitter and receiver) is implemented, so if a person drops stick or forget it somewhere, he can press a switch of the remote consisting of transmitter part, and as a result, the alarm will turn on, so we will know the location of the person. The stick is implemented practically using single wheel leg blinding cane, Arduino microcontroller three ultrasonic sensors RF modules. Also, two buzzers and two vibration motors are used on the stick to fit on when any difficulties occur.

E. [7] Ahmed El-Koka et.all, Proposes that they Developed an advanced electronics-based smart mobility aid for the visually impaired society. The realm of electronics has been growing rapidly in the past few decades. Nowadays, advanced electronics are employable in assisting the visually impaired society in various ways. According to the World Health Organization, approximately 285 million people of all ages are blind, which is a significantly enormous number [1]. Major researches have been under consideration for developing a smart stick with various sensors attached to it to be used as a mobility aid by the blind as a part of an ongoing study. For seeking a smoother routine life and welfare towards the blind society, this paper proposes and analyses a new thought in eliminating the stick and mount these sensors on the blind person body itself. The mechanism of this system, the electronic flow of the detection signal, and feedback are illustrated.

F. [8] Zeeshan Saquib et.all, Proposes a BlinDar that is an invisible eye for blind people making life easy for the blind with the Internet of Things so that blindness is a condition in which an individual loses the ocular perception. Mobility and self-reliability for the visually impaired and blind people have always been a problem. In this paper, a smart Electronic Traveling Aid (ETA) called BlinDar has been proposed. This smart guiding ETA ameliorates the life of blind as it is well equipped with the Internet of Things (IoT) and is meant to aid the visually impaired and blind to walk without constraint in close as well as open environments. BlinDar is a highly efficient, reliable, fast responding, lightweight, low power consumption, and cost-effective device for the blind. Ultrasonic sensors have been used to detect the obstacle and potholes within a range of 2m. GPS and ESP8266 Wi-Fi modules have been used for sharing the location with the cloud. MQ2 gas sensor is used for detecting fire in the path and an RF Tx/Rx module for finding the stick when it is misplaced. Arduino Mega2560 is the microcontroller used, which has 54 digital I/O pins which make the interfacing of components easy

IV. IMPLEMENTATION

Implementation is the important phase where the development of the proposed system is based on the decisions made previously in the design and system requirement phase. Implementation refers to the post-deals procedure of managing a customer from buy to the utilization of the product or equipment that was bought. This incorporates necessities investigation, scope examination, customizations, frameworks mixes, client arrangements users training, and delivery. A large number of inter-related operations result in a successful system. Utilizing a well-proven execution procedure and enrolling proficient counsel can help yet frequently it is the number of errands, lack of common sense, and insufficient resourcing that causes issues with a usage venture, as opposed to any of the undertakings being especially troublesome.

A. Selecting Platform

The platform is the one on which a program runs. Most platforms are a combination of the OS and the hardware. The details of the platforms are as follows

1) *Tessaract OCR:* Python Tesseract is an optical character recognition (OCR)which is platform-independent. OCR is a technology that is capable of converting documents such as scanned papers, PDF files, and captured images into editable data. Tesseract can be utilized for Linux, Windows, and Mac OS. It tends to be utilized by software engineers to extract typed, printed text from images using an API. Tesseract can use GUI from the available 3rd party page. Only Images containing the text that is arranged in a single column will be accepted for conversion. Support for several new image formats was added using the Leptonica library. Tesseract can detect whether the text is monospaced or proportionally spaced.
2) *Open CV:* OpenCV (Open Source Computer Vision) is a library of programming capacities predominantly focused on constant PC vision. OpenCV is written in C++ and its essential interface is in C++, yet it despite everything holds a less exhaustive however broad more established C interface. The library is supported by python, java, and MATLAB. Coverings in different dialects, for example, C#, Perl, Ch, Haskell, and Ruby have been developed to encourage adoption by a wider audience. OpenCV is also supported by javascript which comes handy in web platforms. All new turns of events and calculations in OpenCV are presently evolved in the C++ interface.
3) *E-speak:* Originally known as to speak and originally written for Acorn/RISC_OS computers starting in 1995. It is a compact open-source software speech synthesizer for English and 11other languages for Linux and Windows platforms. Text to voice conversion is possible. Many small-sized languages are supported. The programming for Espeak software is done using rule files with feedback. It supports SSML. It can be modified by a voice variant. Certain characteristics like pitch range and effects like echo, whisper, and croaky voice can be changed and added to improvise the voice outcome.

4) *Tensorflow:* Tensorflow is an open-source tool developed by Google. The framework so developed by Google lets the programmers develop and implement a machine learning model and deep learning models in a much easier manner. Several languages support TensorFlow, which include python, c++ and java. Here in this project, we have used TensorFlow's lite model which is an API built over TensorFlow to enable deep learning capabilities to small devices that have constrained memory and processing speed. To run the model we have used TensorFlow lite's built-in interpreter. The interpreter takes input tensor and gives output tensor values based on the prediction done by the deep neural networks.

B. Module description:

The project consists of four different modules: Obstacle Detection, Emergency Feature, Image Processing, Fire Detection

1) *Obstacle Detection:* This module concentrates on issues related to obstacles on the way of a blind person. The obstacle detection happens using the ultrasonic sensor. The sensor's accuracy is excellent as it offers good handling capabilities. The reliability of the ultrasonic sensors is increased by connecting redundant sensors to the system. The resolution of detected obstacles is very low as the ultrasonic sensors have a width dihedral detection angle. The implemented approach uses always three ultrasonic sensors for one half of the same angle. Hence, though the triple amount of sensors is needed, the redundancy and resolution are also tripled.

Fig 1: Ultrasonic sensor

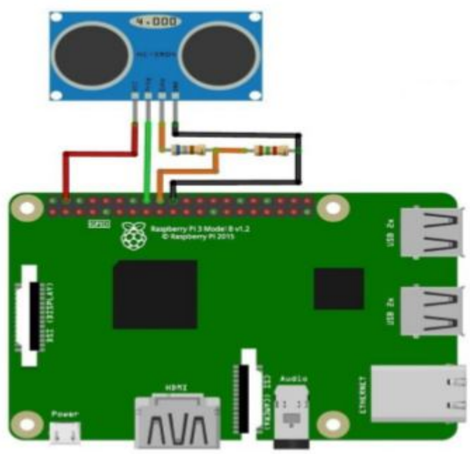

Fig 2: Ultrasonic sensor connected to the circuit

The working of the feature in the form of Algorithm is as follows:

a) *Step 1:* Import the RPi GPIO pins.
b) *Step 2:* Set the GPIO pins mode as BCM mode.
c) *Step 3:* Set the GPIO_TRIGGER Pin=18 and GPIO_ECHO = 24 for one sensor. TRIGGER = Output and ECHO = Input
d) *Step 4:* Start transmitting signals after the RPI OS boots up.
e) *Step 5:* Give an interval in between for 0.01ms.
f) *Step 6:* Call the time function and define Start Time and Stop Time.
g) *Step 7:* Calculate the Time Elapsed by taking the difference between Start Time and Stop Time.
h) *Step 8:* Multiply with the sonic speed (34300cm/s) and divide by 2 for transmitting and receiving.
i) *Step 9:* Returns the distance and then the direction is heard as voice output.

2) *Emergency Feature:* Here for the emergency, we are describing both accelerometer and e-Save our souls as they serve the purpose. An accelerometer estimates legitimate acceleration, which is the acceleration it experiences comparative with free-fall and is the acceleration felt by individuals and objects. An accelerometer at rest relative to the Earth's surface will demonstrate approximately 1 g since any point on the Earth's surface is quickening upwards comparative with the nearby inertial edge (the frame of a freely falling object near the surface). To obtain the acceleration due to motion concerning the Earth, this "gravity offset" must be subtracted and corrections made for effects caused by the Earth's rotation relative to the inertial frame. At the point when the accelerometer encounters speeding up, the mass is dislodged to the point that the spring can accelerate the mass at a similar rate as the packaging. The removal is then estimated to give the acceleration.

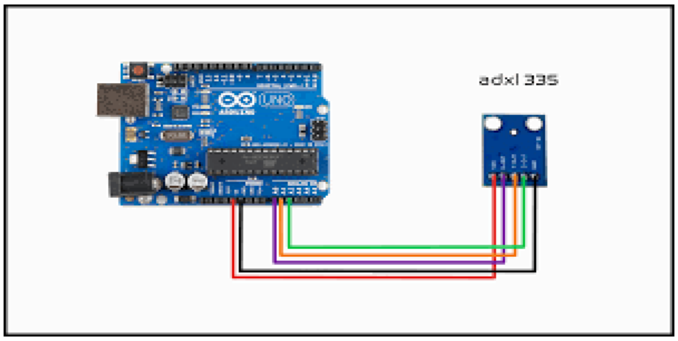

Fig 3: Accelerometer connected to the circuit

The working of the feature is shown by an Algorithm as follows:

a) *Step 1:* After the RPi OS boots up, Accelerometer is turned on.
b) *Step 2:* Store the number of care-taker of the blind person.
c) *Step 3:* Upon the bending of Accelerometer.
d) *Step 4:* The location of the place of emergency occurred is sent to the care-taker instantly.
e) *Step 5:* Send the message having the location's link through the Twilio App having a GSM interface.
f) *Step 6:* The care-taken is thus intimidated via the link

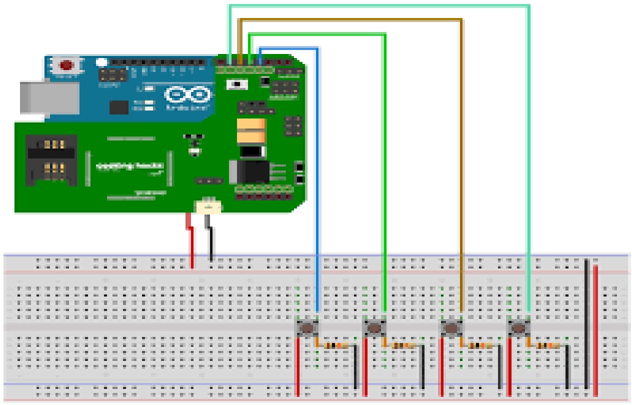

Fig 4: E-sos (electronic save our souls)

For emergency purposes, we have implemented Electronic save our souls system. An electronic save our soul's system is a panic button that is being implemented which comes into action if there is an emergency. The known algorithm is

The working feature of SOS-button is shown by an Algorithm as follows:

- *Step 1:* The raspberry pi boots up.
- *Step 3:* If there is an emergency E-SOS button is pressed by the blind.
- *Step 4:* After getting the response mp3 file is executed and audio output is heard through speakers.
- *Step 5:* Controller (Raspberry pi) authenticates with Twilio API and a text message is passed as a parameter.
- *Step 6:* Text, the message passed as a parameter is sent to the caretaker cell phone

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3) *Image Processing:* Image processing is a kind of processing that involves inputting an image or a series of image which are present in a photograph or frames of video. Image processing involves extracting information from the image by using certain algorithms. These algorithms learn the information that is available on the image gives certain predictions.

a) *Text Recognition:* Here we will be implementing text recognition by using Tesseract OCR API.

The functioning of Image Processing is shown by an Algorithm as follows:

- *Step 1:* Import Tesseract, CV2, and google text to speech majorly.
- *Step 2:* take the image from the Logitech C Series camera.
- *Step 3:* Extract Red, Blue, and Green color components from an RGB image into 3 different 2-D matrices.
- *Step 4:* Create a new matrix with the same number of rows and columns as an RGB image, containing all zeros.
- *Step 5:* Convert each RGB pixel values at the location (i, j) to grayscale values by forming a weighted sum of the RGB color components.
- *Step 6:* Assign it to a corresponding location (i, j)
- *Step 7:* Call the function Image-to-Speech ().
- *Step 8:* Convert image to text using Tesseract OCR.
- *Step 9:* Split the text into the paragraph. text is displayed on the screen.
- *Step 10:* Next, call Text-to-Speech () function.
- *Step 11:* Convert text to speech using an e-speak synthesizer.
- *Step 12:* Voice output is generated.

b) *Object Classification:* Here we will be using image processing for object classification that is when the blind person encounters an object in front of him he needs to recognize that object. Here we will be using TensorFlow lite API for running the model and getting the classification. Here is a basic algorithm for the same.

- *Step 1:* Import TensorFlow lite library
- *Step 2:* Initialize model, graph and labels directories
- *Step 3:* Get the location of model, graph and label directories
- *Step 4:* Initialize interpreter with the path to model as a parameter
- *Step 5:* Initialize input details by calling interpreter.get_input_details which takes a tensor as an input
- *Step 6:* Initialize output details by calling interpreter.get_output_details which gives a tensor as an output
- *Step 7:* Initialize height and width of the input tensor
- *Step 8:* Open camera using OpenCV libraries and capture the picture of the object
- *Step 9:* Convert the input stream of a picture to the frame using open cv modules
- *Step 10:* Resize the frame to height and width specified using OpenCV modules
- *Step 11:* Expand the dimensions of the frame by using np.expand_dims and initialize to a variable input data
- *Step 12:* Run the model using interpreter which takes input_details and input data(input tensor)
- *Step 13:* Get predictions(output tensor) through output_details
- *Step 14:* Match the output tensor to label array which contains object names using the index of the tensor
- *Step 15:* If matched execute mp3 file based on the predicted object

4) *Fire detection:* A fire detector is a sensor that is designed to detect the presence of fire or flame. Fire sensor uses a flame flash method which allows it to detect the presence of fire or flame through the coating of fire or flame. When the flame is detected by the sensor, it outputs a high-level signal.The output voltage is directly proportional to the amount of flame or fire detected.

The working of the feature is shown by an Algorithm as follows:

a) *Step 1:* After the raspberry pi boots up, it waits for the sensor to respond.
b) *Step 2:* If there is a fire/smoke in front of the stick, the sensor response is sent to Controller (Raspberry pie).
c) *Step 3:* After getting the response, if sensor data meets the necessary condition then gain control over the mp3 file.
d) *Step 4:* The mp3 file is executed to give an audio output to a blind person.
e) *Step 5:* The blind are intimidated by the audio output through speakers so he/she can necessary action.

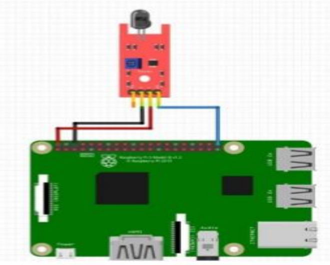

Fig 5: Fire sensor.

V. RESULTS AND SNAPSHOTS

This section says about the snapshots of the final implemented system:

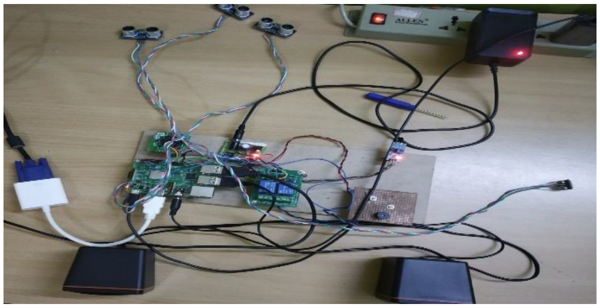

Fig 6: The prototype setup

Here, we can see the basic setup of the smart stick and we can see speakers that are connected to the model setup, one can also use an earphone which completely depends on the user. In this model, we can see the buzzer that beeps when the fire is detected which notifies the blind.

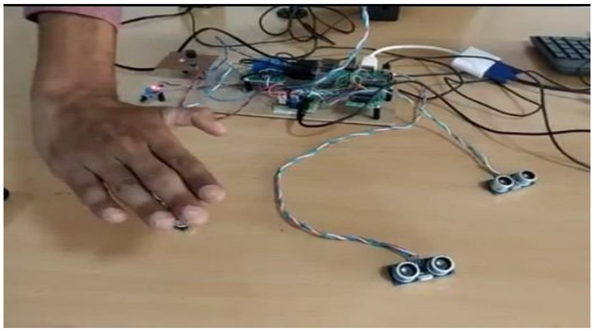

Fig 7: Right side object detected

When the system boots up and when the object is detected at the right side by the ultrasonic sensor (right) the blind is notified about the object through speech.

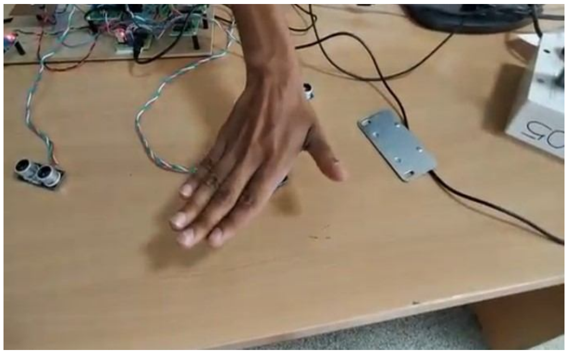

Fig 8: object detected at the centre

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When the system boots up and when the object is detected straight in front of the blind by the ultrasonic sensor (right) the blind is notified about an object through speech.

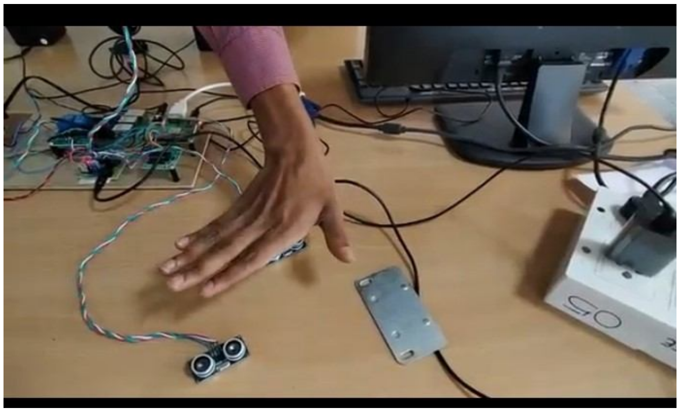

Fig 9: Left side object detected

When the system boots up and when the object is detected at the left side by the ultrasonic sensor (left) the blind is notified about an object through speech.

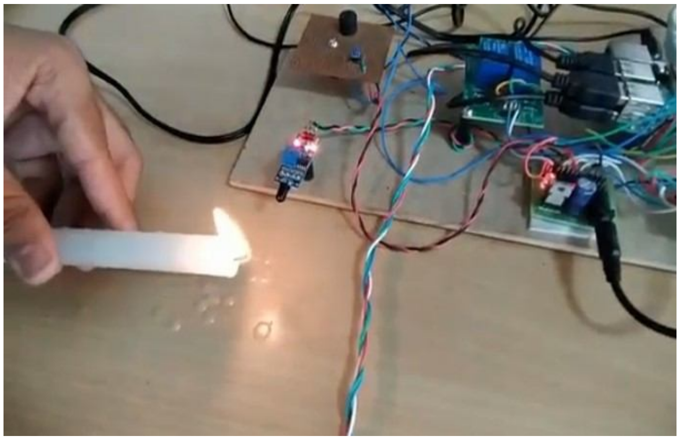

Fig 10 : When fire detected

This figure shown here says that when the fire is detected by the fire sensor the blind is notified by the buzzer and also through speech. The system also notifies the people around the blind through speech so that one can help the blind navigate when the fire is detected.

Fig 11 : Stick falls acceleration detected

Fig 12 : Text message is sent to the caretaker

When the stick falls down acceleration is detected through an accelerometer and hence a text message is sent to the caretaker through a gateway as shown above

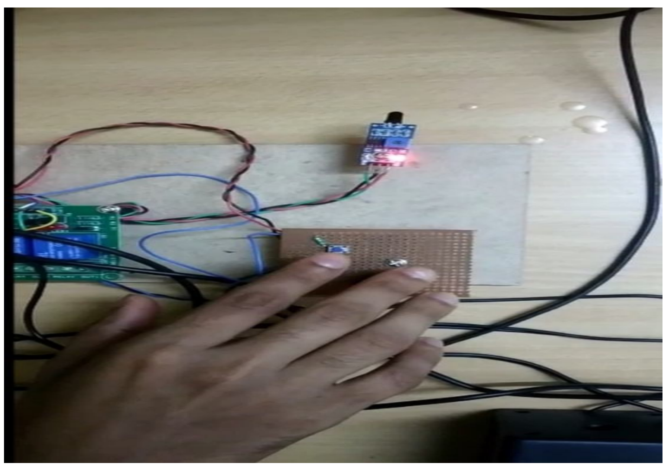

Fig 13 : SOS/Panic button

Fig 14 : Emergency text message

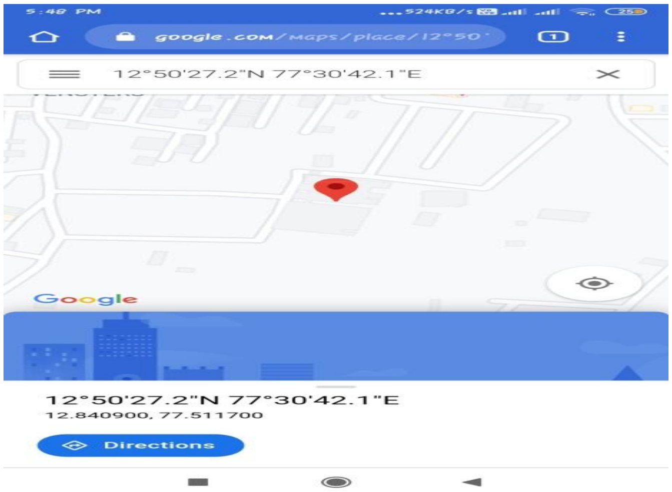

Fig 15 : Live location of the blind

When the SOS button is clicked by the blind an emergency text message is sent to the caretaker which gives a safety feeling to the blind. Fig 8.9 shows the emergency text message received by the caretaker with the live location link of the blind. Fig 8.10 shows the live location of the blind on the map.

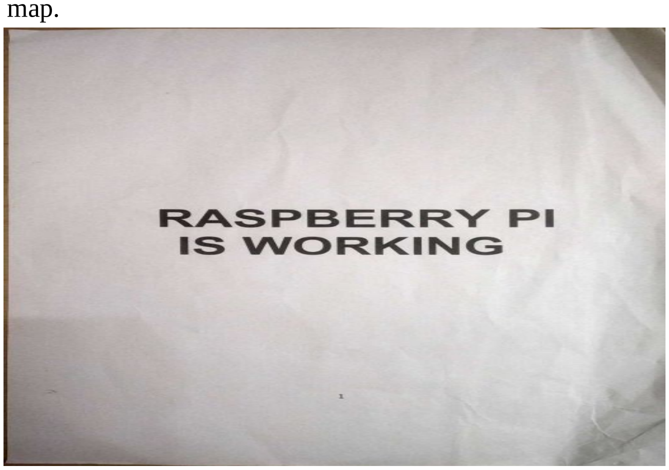

Fig 16 : Text that should be converted to speech

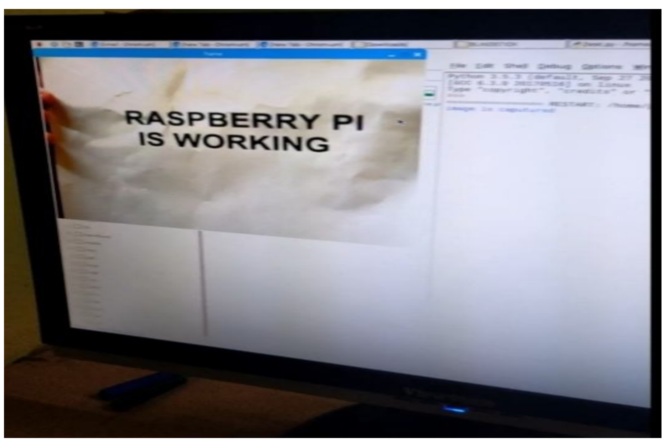

Fig 17 : Image captured and analysed

The image that is taken by the camera is passed to tesseract OCR which recognizes the characters in the image which is converted to text. Fig 8.12 here the image is captured and the text is converted to speech

Fig 18 : Object detection and classification

The object is detected and classified by the system using tensor flow and hence the Blind is notified about the exact object that is in front of him/her through a speech

VI. CONCLUSION

The main aim of this system is to act as a guard and helps the blind to be aware of their surroundings. By using redundant ultrasonic sensors we are increasing the object detection efficiency. It aims to solve the situations faced by blind people in their daily life. A measure is taken to ensure user safety. This system has GPS tracking and voice output which facilitates user independence. The proposed combination of Ultrasonic Sensor and GPS makes a real-time system that monitors the position of the user and provides feedback making navigation more safe and secure. By using E-speak we can provide text reading through voice capabilities. a blind person can easily navigate from one place to another easily and safely.

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