A SMART WALKING STICK FOR VISUALLY IMPAIRED PERSON

A report submitted in partial fulfilment of the requirements

for the degree of B.Tech. Electronics and Communication Engineering

with specialization in Design and Manufacturing

by

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Certificate

We, **P.Rajkumar & Mohammed Imran**, with Roll No: **ECE15B018 & ECE15B002** hereby declare that the material presented in the Project Report titled **A Smart Walking Stick For Visually Impaired Person** represents original work carried out by us in the **Department of Electronics and Communication Engineering** at the **Indian Institute of Information Technology, Design and Manufacturing, Kurnool** during the years **2018–2019**. With our signature, We certify that:

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Abstract

A Smart stick system concept is devised to provide a smart electronic aid for visually impaired people. Visually impaired people find difficulties in detecting obstacles during walking in the street. The system is intended to provide artificial vision and object detection, real time assistance via outputting the names of shop/bus nos by making use of Raspberry Pi. The system consists of ultrasonic sensors, Camera module and the feedback is received through audio, voice output works through TTS (text to speech). The proposed system detects an object around them and sends feedback in the form of speech, warning messages via earphone and also converts images of typed, handwritten, or printed text into machine encoded text. The aim of the overall system is to provide a low cost and efficient navigation and obstacle detection aid for visually impaired which gives a sense of artificial vision by providing information about the environmental scenario of static and dynamic object around them, so that they can walk independently. The text files are processed by OpenCV library python programming language and audio output is achieved.
Keywords—Raspberry Pi 3B+, Ultrasonic sensor, Earphone, Speech Output, OpenCV, Python Programming, Pytesseract.

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Chapter 1

Introduction

1.1 Why this?

There are many guidance systems for visually impaired travelers to navigate quickly and safely against obstacles and other hazards faced. Recent statistical data [1] reported that there were 46,000 blind persons in Korea, 1999. In general, the blind travels using a white cane or carries a guidance dog. But, the guidance dog is very expensive for the blind and hard to maintain. Therefore, most blind use white canes without the information of environmental situation.

The most important function for the blind persons is to get information on the shape of the road and the position of obstacles when they are in unknown places. With this information, they need to arrive at their destinations, avoiding unexpected obstacles.

There are number of blind people in the society, who are suffering while exercising the basic things of daily life and that could put lives at risk while travelling. There is a necessity these days to provide security and safety to such people. There have been few devices designed so far to help them. Eye sight plays a major role in collecting most of the information from the real world and that information will be processed by brain, visually impaired people suffer inconveniences in their daily and social life. Blindness or visual impairment is a condition that affects many people around the world. This condition leads to the loss of the valuable sense of vision. Worldwide there are millions of people who are visually impaired, where many of them are blind. The need for assistive devices was and will be continuous. There is a wide range of navigation systems and tools existing for visually impaired individuals. The blind person truly requires an identifying objects. The study of previously developed systems and analysis of the implementation methods used, led us to define a new system which could overcome the disadvantages in the previous systems. Therefore using the existing technologies we provide a solution to the stated problem.

1.2 Motivation

1.Vision is the most important part of human physiology as 83the environment is via sight.
2.The 2011 statistics by the World Health Organization (WHO) estimates that there are 285 million people in world with visual impairment, 39 billion of which are blind and 246 with low vision.
3. The traditional and oldest mobility aids for persons with visual impairments are the walking cane (also called white cane or stick) and guide dogs. The most important drawbacks of these aids are necessary skills and training phase, range of motion and very little information conveyed.
4. With the rapid advances of modern technology, both in hardware and software front have brought potential to provide intelligent navigation capabilities. Recently there has been a lot of Electronic Travel Aids (ETA) designed and devised to help the blind navigate independently and safely.
5. Also high-end technological solutions have been introduced recently to help blind persons to navigate independently.
6. Many blind guidance systems use ultrasound because of its immunity to the environmental noise. Another reason why ultrasonic is popular is that the technology is relatively inexpensive, and also ultrasound emitters and detectors are small enough to be carried without the need for complex circuit.

1.3 Objectives & Scope

The main objective of our project is to provide a voice based assistance to blind people. Here we have developed an intelligent system that helps blind person to travel independently and works efficiently. Our project focuses on designing a device for blind people that help them to travel independently and also it must be comfortable to use. The proposed device is used for guiding individuals who are blind or partially sighted.

The device is used to help blind people to move with the same ease and confidence as a sighted people. The main objectives of this project are:

- To design and implement a solution for walking stick for blind people.
- To achieve maximum efficiency and make it easy for the blind people.
- Safety and confidence with devices that give a signal to find the direction of an obstacle-free path in unfamiliar or changing environments.

1.4 Organization of This Report

- Chapter 1 is all about introduction to this report.
- Chapter 2 is about the literature survey about this project.
- Chapter 3 is about the proposed design and the explanation of the project with the outputs.
- Chapter 4 is about the conclusion and future scope of this project.

Chapter 2

Literature Survey

Visually impaired people in general use either the typical white cane or the guide dog to travel. The white cane is a most widely used mobility aid for them that helps visually impaired people to navigate in their surroundings. Although the white stick gives warning about few meters before the obstacle, for a normal walking speed, the time to react is very short . The idea of designing and manufacturing ultrasonic sensor combines the properties of sound monition and that benefit the visually impaired and vibrating alert feature, which benefit from the experience of deafness. Sensor can detect obstacles within the designed range to avoid the visually impaired person through the issuance of distinctive sound or vibration can be issued by the sense of the deaf by putting his finger on the button at the top of the vibrating device when there is a risk. This system involves more manual work and it does not provide better result. The existing system does not provide proper navigation and is not much effective.

From the very beginning of history of human, many people are suffering from many disabilities which need to overcome to give them a better life. Among those, visually impairment is very common and unendurable. With the help of science and technology we always try to make the human life easier. So the main purpose of this project is based on abating the disabilities of visually impairment by constructing a microcontroller based automated hardware that can corroborate a blind to detect obstacles in front of person instantly. The hardware consists of a microcontroller incorporated with ping sonar sensor, proximity sensor, wet detector, a micro pager motor and some additional equipments.This visually impairment aid system can be of useful assistance and gives a sense of artificial vision along with dedicated obstacle and hollow detection circuitry. This light weight and cost effective device can be designed to take of pattern of a

FIGURE 2.1: Visually Impaired Person with Stick and Dog Guide

portable device, which can be easily mounted on an ordinary white cane or blind stick. The aimed combination of several working sub-systems makes a time demanding system that monitors the environmental scenario of static and dynamic objects and provides necessary feedback forming navigation more precise, safe and secure.[8]

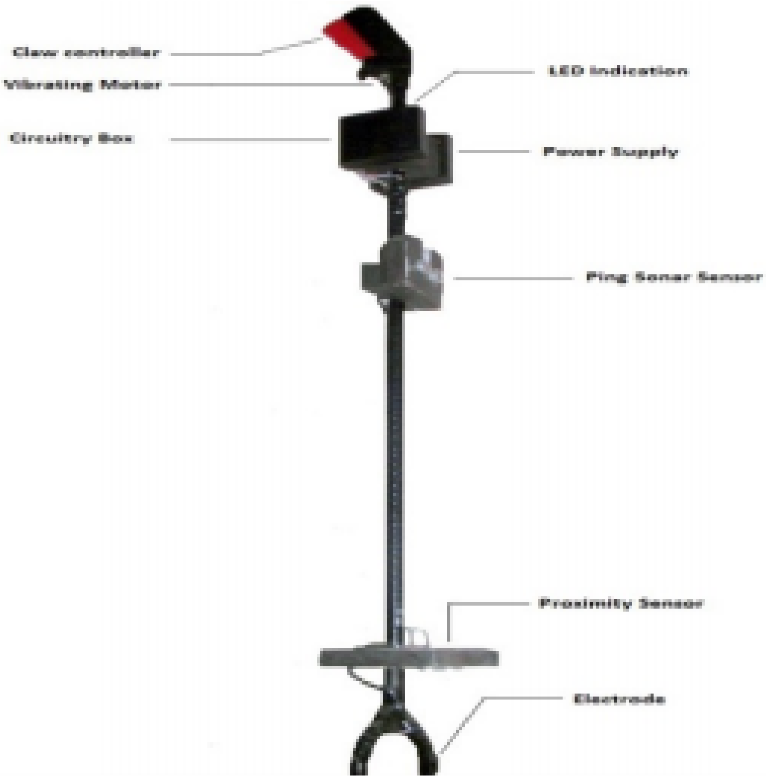

FIGURE 2.2: Smart Stick with Different Sensors

Any individual with limited or no sight is a disadvantage in today's society. Walking safely and confidently without any assistance in urban or unknown environments is a difficult task for visually impaired people. Throughout the world, there are approximately 39 million individuals who are totally blind plus an additional 284 million who are visually impaired. Persons who are visually impaired and deaf frequently suffering when exercising the most basic things of daily life and that could put lives at risk while travelling, visually impaired people generally use either the typical white cane or the guide dog to travel independently. Although the white stick gives a warning about 1 m before the obstacle, for a normal walking speed of 1.2 m/s, the time to react is very short (only 1 s).

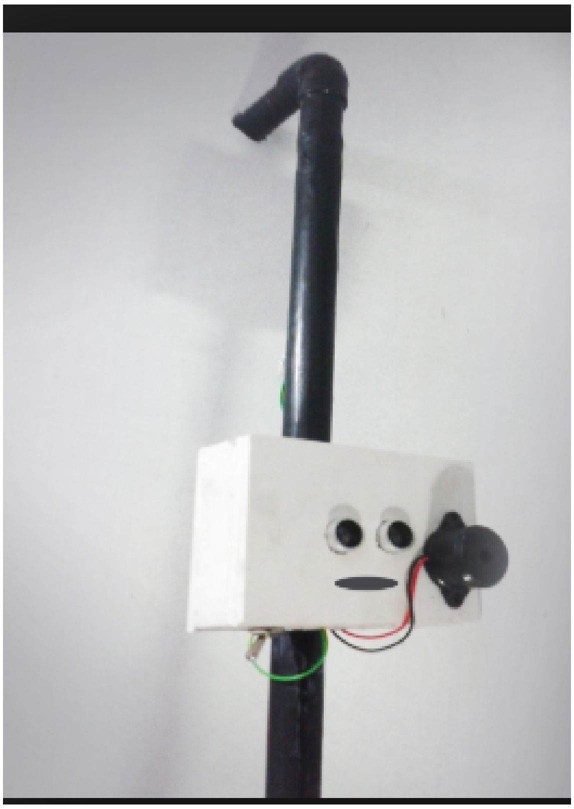

FIGURE 2.3: A Smart Stick Using Ultrasonic Sensor and Buzzer

The idea of the following research in the design and manufacturing of ultrasonic sensor handheld combines the properties of sound monition and that benefit the visually impaired and vibration alert feature, which benefit from the experience of deafness. Sensor can detect obstacles within the designed range we decide to avoid the blind person through the issuance of distinctive sound or vibration can be issued by the sense of the deaf by putting his finger on the button at the top of the device vibrate when there is a risk. The conventional walking stick has limits in range because the stick only detects the object when the stick taps the object or ground.

A smart walking stick with a distance sensor can help visually impaired people to avoid the obstacles better without tapping the object or ground. Sharp infrared distance sensor is used to detect the object within the distance range of 10 cm to 80 cm since it is small in size and very efficient in detecting the object. A buzzer is kept as the signalling element which generates sound whenever the object is sensed by the IR distance sensor. As the object gets closer to the IR distance sensor, the sound produced becomes louder. The sound of buzzer depends on the output voltage of IR distance sensor by varying the distance between object and the sensor. The data taken from the experiment shows that the output voltage of Ultrasonic and IR distance sensor is decreasing when the distance between object and IR and Ultrasonic distance sensor is increasing which in turn makes the sound volume of the buzzer get decreased. In conclusion, the objective of the said project is successfully achieved because a walking stick for the visually impaired using infrared distance sensor is successfully created to detect the object in front of the user within the specific distance range which can help them in mobility with ease and less difficulty. [6]

Smart stick comes as a proposed solution to enable visually impaired people to find difficulties in detecting obstacles in front of them during walking and to identify the objects around. The system is designed to act like an artificial vision and alarming unit. The system consists of five sensors: ultrasonic sensor, IR sensor, water sensor, fire sensor, and light (LDR) sensor, microcontroller (Arduino Uno R3) to receive the sensor signals and process them to pulses to the Arduino pins where buzzers, vibrator and voice alarms are connected. GPS navigation in the mobile can be used to guide the blind for new places and unfamiliar places. The blind man uses an earphone to listen to the navigation directions that are coming from the GPS and buzzer alarm to warn by sound. In this project to provide a smart walking stick i.e, affordable and suitable for most visually impaired people, and also it is less in weight. This can be made available to all segments of the society and the families of those who need it.The developed prototype gives good results in detecting obstacles placed at distance in front of the user; it will be real boon for the visually impaired. At the same time global positioning system (GPS) can be linked with the voice aided stick for navigation, so that person can know his current position and distance from the destination which will be informed to users through voice instructions to visually impaired person.[1]

Nowadays the blind and impaired people are suffering a lot because there are so many struggles for blind peoples to reach their destination and also there are dangerous risks that blind persons must face. In order to avoid uncomfortable walking experience, we have designed a smart electronic walking stick for visually impaired people. Our paper proposes a low-cost walking stick based on latest technology and a new implementation are made for efficient interface for blind people. Basically, the ultrasonic sensor is implemented in the walking stick for detecting the obstacles in front of the visually impaired persons. If there are any obstacles, it will alert the visually impaired person to avoid that obstacles and the alert in the form of buzzer daily in different aspects in order to provide flexible and safe movement for the impaired people. In this technology driven world, where people strive to live independently, this paper propose a low-cost 3D ultrasonic stick for blind people to gain personal independence, so that they can move from one place to other quite easily and safely. A portable stick is design and developed that detects the obstacles in the path of the blind using ultrasonic sensors. The buzzer and vibration motor are activated when any obstacle is detected. In addition, the stick is equipped with GPS and SMS message system. GPS system provide the information regarding the location of the blind person using the stick to his family members. SMS system is used by the blind to send SMS message to the saved numbers in the microcontroller in case of emergency. The programming of GPS modem, GSM modem, buzzer and vibration motor has been successfully done for this system. Computer simulation has also been done to essence the performance of the system using proteous software.[2]

Several devices have been developed to improve the mobility of visually impaired people , talking GPS, devices for landmark identification (near-infrared (IR) light or radio frequencies), ultrasonic obstacle detectors (K sonar, Ultracane, Miniguide, Palmsonar , Ultra-Body-Guard , and iSonic cane), and optical devices (the laser long cane). In indoor or outdoor crowded environments, ultrasonic devices are limited due to multiple reflections .

An intelligent guide stick for the blind was developed. It consists of an ultrasound displacement sensor, two DC motors, and a micro-controller. The total weight is 4.0kg,

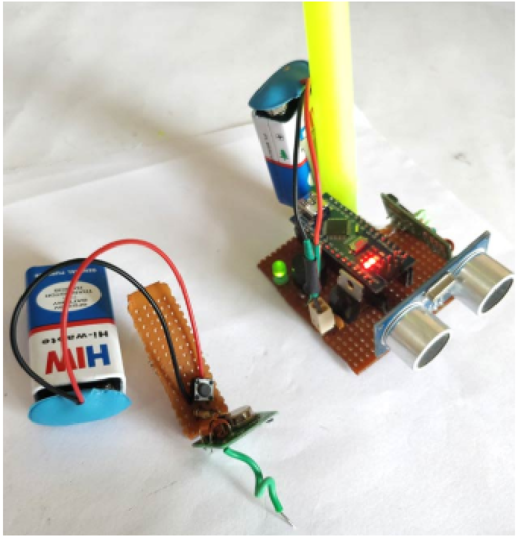

FIGURE 2.4: Smart Blind Stick Using Arduino and Ultrasonic Sensor

and the width and the height of the guide stick are 24cm and 85cm, respectively. Computer simulations were performed in order to find the traces of the guide stick at three different paths using an in-house Visual C++ software. Actual experiment were also performed to compare with the computer simulation results. The difference between the actual experiment and the simulation was 1.19cm in the straight path. However, the difference after the first 90 degree turn was 9.3cm and became 11.9cm after the second 90 degree turn. Nevertheless, the intelligent guide stick followed the path of the road successfully avoiding the obstacle. The intelligent guide stick will help the visually impaired travel with providing more convenient means of life.This guide-stick system used the ultrasonic sensor for detecting both back-and-front obstacles and left-and-right obstacles, and applied the artificial intelligence for avoiding the obstacle. Through various experiments, it was shown that this system could be applied in the straight path, the right angle path, and the curved path. At least 1m width was required for the proper management of the guide stick. The adaptation training of the actively controlled guide stick is not needed but the response of the blind is instantaneous.[3]

Numerous attempts have been made in the society to help the visually impaired. A literature survey is a proof essay of sorts. This is a study of relevant literature materials in relation to a topic we have been given. For thorough development of the device ”Smart Walking Stick for Visually Impaired Using Raspberry Pi”, we need to go through each and every technical aspect related to it. This chapter provides an introduction to the area of research. A Brief Study and Survey has been Carried out to understand various issues related to the project which involves providing a smart electronic aid for blind people to provide artificial vision and object detection. A survey is made among the visually impaired people finding difficulties in detecting obstacles during walking in the street .Our project mainly focuses on the visually impaired people who cannot walk independently in unfamiliar environment .The main aim of our project is to develop a system that helps the visually impaired people to move independently. Smart Stick for visually impaired systems usually consist of three parts to help people travel with a greater degree of psychological comfort and independence: sensing the immediate environment for obstacles and hazards, providing information about the objects.

Chapter 3

Proposed Cost Effective Smart Stick for Visually Impaired Person

“Smart Walking stick for Visually Impaired Person” system is easy to maintain and understand. This system uses Raspberry pi which is a small processing device which works as computer at relatively low cost.Visually impaired people find difficulties in detecting obstacles during walking around the street.The system intention is to provide artificial vision and object detection. The system consists of ultrasonic sensors, Camera module, and the feedback is received through audio. Voice output works through TTS (text to speech). The proposed system detects an object around them and sends feedback in the form of speech i.e. warning messages via earphone. The aim of the overall system is to provide a low cost, efficient navigation and obstacle detection aid for blind which gives a sense of artificial vision by providing information about the environmental scenario of static and dynamic object around them, which can help them in walking independently.

Power supply to the circuit is given by using a power bank.

3.1 Ultrasonic Sensor

High frequency sound waves is generated by ultrasonic sensor. It evaluates the echo which is received back by the sensors. The time interval between sending the signal and receiving the echo is calculated by sensor to determine the distance to an object.

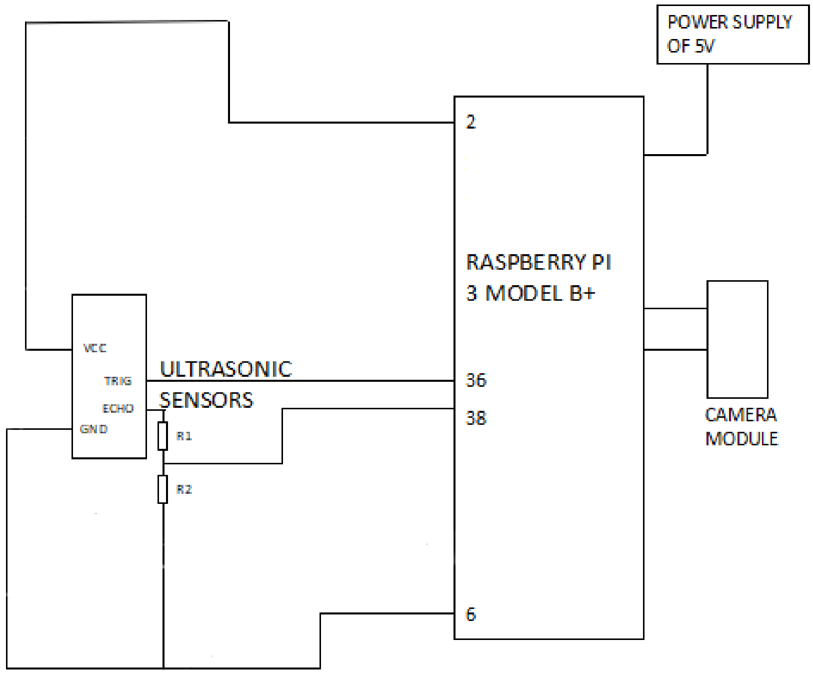

FIGURE 3.1: Circuit Diagram of the Proposed System

Ultrasonic is like an infrared where it will reflect on a surface in any shape, but ultrasonic has a better range detection compared to infrared. In robotic and automation industry, ultrasonic has been highly accepted because of its usage. In our Project the Ultrasonic sensor distance measurement Module deals with the distance measurement between the obstacle and the blind person. This module starts the process when the user turns on the device using power supply. Firstly when the device turns on, the ultrasonic sensor will automatically gives the distance measurement of the obstacle in front of the blind, and then the distance measured is stored in the SD card.

Formulae:

Distance = Speed x Time/2

Speed of sound at sea level = 343 m/s or 34300 cm/s

Thus,Distance = 17150 x Time (unit cm).

Calculation of Resistor values:

Vin=5v

Vout=Vin(R2/(R1+R2))=3.3v

Let R2=1kohm

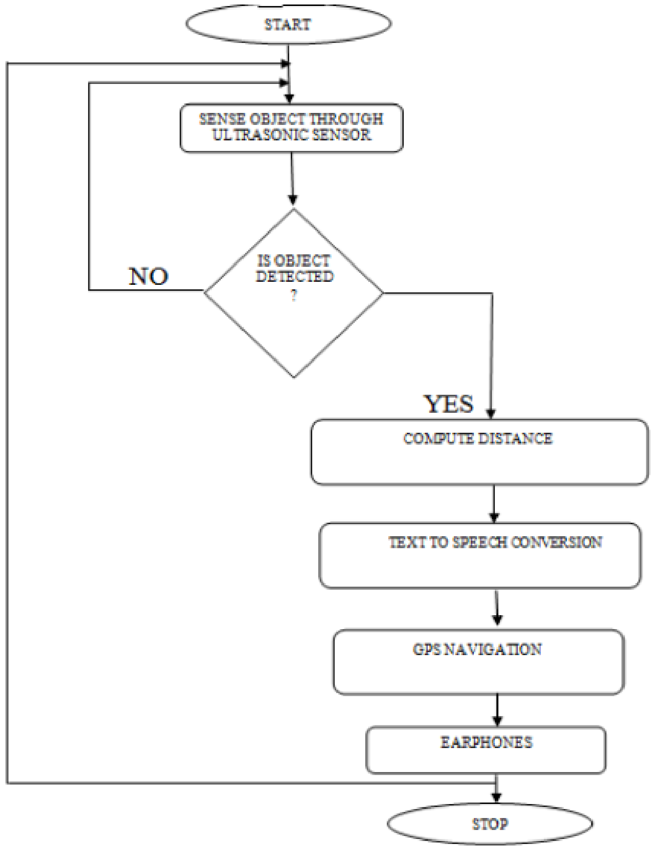

FIGURE 3.2: Flow Chart of Working of Ultrasonic Sensor

This gives,R1=515ohm.
So,we can use the nearest to this value,we used 580ohm.

3.2 Camera Module

We used this camera module for taking an image which will be processed and the output will be given as a voice command through earphones. This is divided into two parts:
1.Text Processing
2.Voice Through Earphones

3.2.1 Text Processing

For doing the text processing we need to perform Opencv OCR Text recognition with tesseract. This process is done in two parts:

1.Performing text detection using OpenCV's EAST text detector, a highly accurate deep learning text detector used to detect text in natural scene images.
2.Once we have detected the text regions with OpenCV, we'll then extract each of the text ROIs and pass them into Tesseract, enabling us to build an entire OpenCV OCR pipeline.

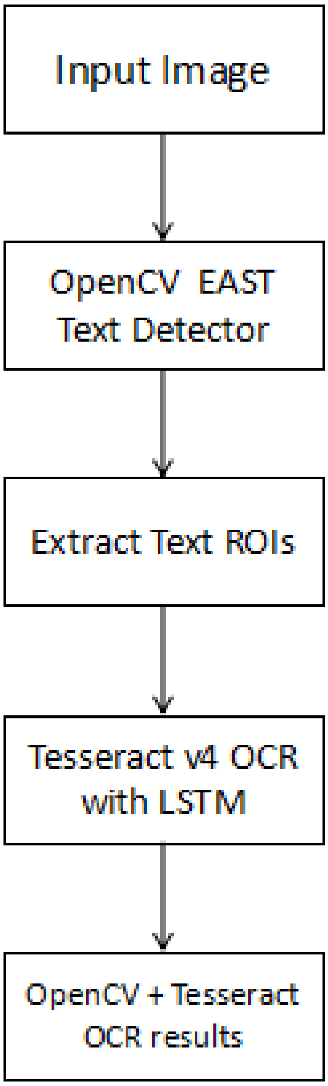

FIGURE 3.3: The OpenCV OCR pipeline

The function decode_predictions uses a deep learning-based text detector to detect (not recognize) regions of text in an image. The text detector produces two arrays, one containing the probability of a given area containing text, and another that maps the score to a bounding box location in the input image. As we'll see in our OpenCV OCR pipeline, the EAST text detector model will produce two variables: scores : Probabilities

for positive text regions. geometry : The bounding boxes of the text regions. . . . each of which is a parameter to the decode_predictions function. The function processes this input data, resulting in a tuple containing
(1) the bounding box locations of the text and
(2) the corresponding probability of that region containing text:
rects : This value is based on geometry and is in a more compact form so we can later apply NMS.
confidences : The confidence values in this list correspond to each rectangle in rects .
Both of these values are returned by the function. Our image is loaded into memory and copied (so we can later draw our output results on it. We grab the original width and height and then extract the new width and height from the args dictionary. Using both the original and new dimensions, we calculate ratios used to scale our bounding box coordinates later in the script. Our image is then resized, ignoring aspect ratio . Then, our pre-trained EAST neural network is loaded into memory. To determine text locations we construct a blob and pass the blob through the neural network, obtaining scores and geometry. Decode the predictions with the previously defined decode_predictions function and apply non-maxima suppression via my imutils method. NMS effectively takes the most likely text regions, eliminating other overlapping regions.Now that we know where the text regions are, we need to take steps to recognize the text! We begin to loop over the bounding boxes and process the results, preparing the stage for actual text recognition. Then we begin looping over the boxes where we scale the bounding boxes based on the previously computed ratios and pad the bounding boxes and finally, extract the padded roi. The pytesseract library takes care of the rest where we call pytesseract.image_to_string, passing our roi and config string.Our result (the bounding box values and actual text string) are appended to the results list. Then we continue this process for other ROIs at the top of the loop. Our results are sorted from top to bottom based on the y-coordinate of the bounding box. From there, looping over the results, we send this text to the next step i.e. sending the detected texts through a voice command.

3.2.2 Voice Through Earphone

A computer system used to create artificial speech is called a speech synthesizer, and can be implemented in software or hardware products. A text-to-speech (TTS) system converts normal language text into speech. There are many modules for TTS of which we used espeak.eSpeak is a compact open source software speech synthesizer for English and other languages, for Linux and Windows. In the results list,we will call this espeak which will give us a voice of text.

3.3 Outputs

3.3.1 Distance measured using Ultrasonic Sensor

```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.5.3 (default, Sep 27 2018, 17:25:39)
[GCC 6.3.0 20170516] on linux
Type "copyright", "credits" or "license()" for more information.
>>>
========================= RESTART: /home/pi/dist.py =========================
Distance = 218.5 cm
Distance = 206.8 cm
Distance = 217.3 cm
Distance = 6.3 cm
Distance = 15.1 cm
Distance = 206.5 cm
Distance = 206.5 cm
Distance = 204.8 cm
Distance = 216.8 cm

========================= RESTART: /home/pi/dist.py =========================

Warning (from warnings module):
  File "/home/pi/dist.py", line 9
    GPIO.setup(TRIG,GPIO.OUT)
RuntimeWarning: This channel is already in use, continuing anyway.  Use GPIO.se
warnings(False) to disable warnings.
Distance = 206.5 cm
Distance = 9.2 cm
Distance = 2.7 cm
Distance = 10.8 cm
Distance = 205.5 cm
Distance = 217.5 cm

========================= RESTART: /home/pi/dist.py =========================

Warning (from warnings module):
  File "/home/pi/dist.py", line 9
    GPIO.setup(TRIG,GPIO.OUT)
RuntimeWarning: This channel is already in use, continuing anyway.  Use GPIO.se
warnings(False) to disable warnings.
```

FIGURE 3.4: Output Showing Distance Measurement

Using the above measured distance we fixed a case for distance less than 1 meter for which we used the voice command where it says "Obstacle ahead at __cm"

3.3.2 Text processing

Example 1:

FIGURE 3.5: Captured Image-1

The above image was captured by the camera and is processed then and we will be showing below the output images of the text processed which in actual will be processed through the earphones.

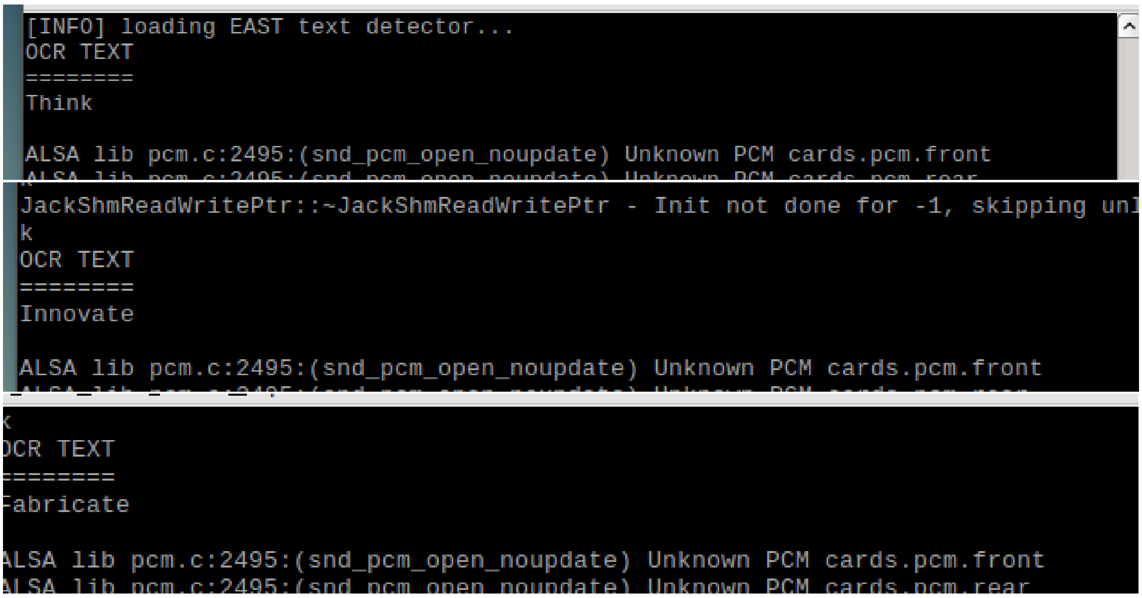

FIGURE 3.6: The above pictures are showing text outputs of captured image-1

Example 2:

The image was captured by the camera and is processed then and we will be showing

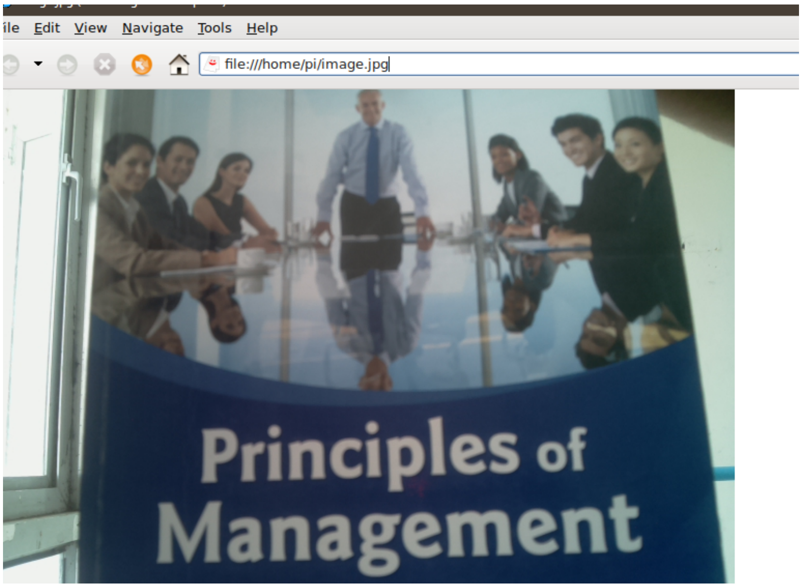

FIGURE 3.7: Captured Image-2

the output images of the text processed which in actual will be processed through the earphones.

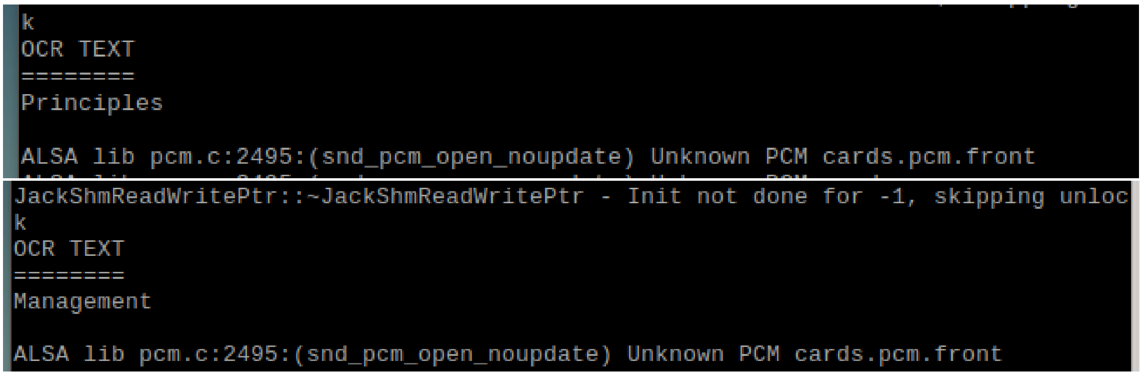

FIGURE 3.8: The above pictures are showing text outputs of captured image-2

And furthermore, expecting 100% accurate Optical Character Recognition is simply unrealistic.
As we found out, our OpenCV OCR system worked in well in some images, it failed in others. There are two primary reasons we will see our text recognition pipeline fail:

- The text is skewed/rotated.
- The font of the text itself is not similar to what the Tesseract model was trained on.

Even though Tesseract v4 is significantly more powerful and accurate than Tesseract v3, the deep learning model is still limited by the data it was trained on — if your text contains embellished fonts or fonts that Tesseract was not trained on, it's unlikely that Tesseract will be able to OCR the text.
Secondly, keep in mind that Tesseract still assumes that your input image/ROI has been relatively cleaned.
Since we are performing text detection in natural scene images, this assumption does not always hold.
In general, you will find that our OpenCV OCR pipeline works best on text that is
(1) captured at a 90-degree angle (i.e., top-down, birds-eye-view) of the image and
(2) relatively easy to segment from the background.
If this is not the case, you may be able to apply a perspective transform to correct the view, but keep in mind that the Python + EAST text detector reviewed today does not provide rotated bounding boxes, so you will still likely be a bit limited. Tesseract will always work best with clean, preprocessed images, so keep that in mind whenever you are building an OpenCV OCR pipeline.

3.4 Features of Smart Walking Stick

1. Smartest than the other mainstream white canes.
2. Entirely automated.
3. Can be maintained & operated easily.
4. Very comfy to function.
5. Authentic & Durable.

FIGURE 3.9: Proposed Prototype

6. Low power consumption.
7. The Microcontroller can be code protected.
8. Simplicity of the design makes it effective navigation assistant.
9. Obstacle can be determined easily by sensors readings.
10. Name boards text can be found easily using the text recognition.
12. Apart from others blind guidance systems; it has a text recognition; which provides advantage beyond anyone's imagination.
13. Additional features like digital compass, GPS, voice guidance can be incorporated .
14. Special lineament like extra secondary IR/laser sensor package, remote monitoring package, weather monitoring package and other hardware can also be integrated .
15. Overall manufacturing cost is low & parts are available in both local & international market.[6]

FIGURE 3.10: Visually Impaired Person with Proposed Stick

Chapter 4

Conclusion & Future Scope

4.1 Conclusion

The project “Smart Walking Stick for Visually Impaired Person” is designed to create a system using Ultrasonic sensors, Camera module and providing Voice command through headphone to the blind people. It would help a visually impaired person navigate through a public place independently. The proposed system tries to eliminate the faults in the previous system. It aims to solve the problems faced by the blind people in their daily life. The system also takes measures to ensure their safety. This cost effective and light weight device can be designed to take of pattern of portable device, which can be unconditionally mounted on an ordinary white cane or blind stick. The design Smart Stick for Blind using ultrasonic sensors and Camera module with voice output is of great benefit to blind people when it comes to independent mobility. The aimed combination of several working sub-systems makes a time demanding system that monitors the environmental scenario of static and dynamic objects and provides necessary feedback forming navigation more precise, safe and secure.

4.2 Future Scope

This project can be extended to work on the image processing where the output can be directly said whether in the picture it is a car/bus/house etc.
This can be extended to add a GSM module, using which a signal can be sent to his friends about some information.
This can be extended to add a GPS module, using which the impaired person can find the routes to some places he wants.

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