2019 IEEE 4th International Conference on Computer and Communication Systems

Smart Assistive Navigation Devices for Visually Impaired People

Arjun Pardasani
School of Electronics Engineering
Vellore Institute of Technology
Vellore, India
e-mail: arjunravi.pardasani2016@vitstusent.ac.in

Prithviraj N Indi
School of Electrical Engineering
Vellore Institute of Technology
Vellore, India
e-mail: prithvirajn.indi2017@vitstudent.ac.in

Sashwata Banerjee
School of Electrical Engineering
Vellore Institute of Technology
Vellore, India
e-mail: sashwata.banerjee2016@vitstudent.ac.in

Aditya Kamal
School of Computer Science Engineering
Vellore Institute of Technology
Vellore, India
e-mail: aditya.kamal2016@vitstudent.ac.in

Vaibhav Garg
School of Information Technology
Vellore Institute of technology
Vellore, India
e-mail: Vaibhav.garg2016@vitstudent.ac.in

***Abstract*—This paper is based on the design of a smart assistive device to help visually impaired people. Visually impaired people have been facing a lot of hardship in their day to day life. Navigating from one place to another is a toilsome task for them and the conventional blind walking stick has its own drawbacks or limitations. It is not of much assistance to these people of our society. Our research is motivated by the inability of the physically disabled people in their ambulation and we took an attempt to make their routine life painless and trouble-free. We designed two devices which can be of immense utility to the sightless people. We designed a smart glass and a smart pair of shoes by integrating various sensors with raspberry pi. The paper presents the functionalities and the working principle of the smart glasses and shoes and the varieties of tasks they are capable of accomplishing. The novelty of our work lies in processing data from both the devices and provide a better solution for navigating and day to day activities.**

Keywords-text to braille; OpenCV; image processing; video processing; object detection

I. INTRODUCTION

People suffering from visual impairment have decreased the ability of visual perception. Visual impairment can include a person who has lost his ability to see completely or it can also include a person who is suffering from a partial loss of vision. According to the [1] World Health Organization (WHO), there are around 285 million visually impaired people in the world. Among the 285 million people, 39 million people are completely blind and 246 million people have low vision. The limited vision of the sightless people put them in various challenges. Visually impaired people face difficulties while reading, locating objects, navigating from one place to another and countless others. People suffering from night blindness cannot read in absence of light. Blind people need some assisting device to help them interact with the environment. For ages, they have used sticks to help them locate obstacles in their way. Needless to say, this was not an efficient way of commuting. [2] Less than 1 percent of the books available in the market are in braille's script causing lack of learning resources for the visually impaired.

[3] Many technologies have been evolved around visual impaired people like the depth sensing and sonification. [4] Research has going on GPS enabled guide for blind people, usage of sensors like ultrasonic and cloud systems to store the data received

In this paper, we have discussed a couple of devices which is designed to help the visually impaired people. We have developed a smart pair of glasses which has multiple functionalities. Over the past few years, noticeable improvements in the image processing techniques have immensely ameliorated the visually impaired. [5] Involvement of computer vision along with other sensors has been essential in many devices. Our multifunctional smart glass is integrated with a basic optical sensing device (camera) and a microcontroller. The optical sensor (camera) senses the surrounding and feeds data into the microcontroller for processing. The microcontroller manages and processes the raw data and provides the user with the desired information. Impaired people cannot localize objects. Our proposed smart glass can detect and classify objects. It detects the name or label of an object and provides the user with audio output. It has the ability to read the text and render the user with audio output of the same. It can also convert the text to braille which is stored in the memory for

978-1-7281-1322-7/19/$31.00 ©2019 IEEE

further processing like printing the braille output for the blind people.

The second type of device which we discussed in the paper is a smart a shoe. We developed a working prototype of a shoe which is integrated with sensors to alert the impaired people of the obstacles. Thus, saving the user from probable danger or accidents. [6] Apart from this there are devices like OEM ultrasound for Indoor and Outdoor Navigation for the visually impaired. [7] Several technologies have involved google glasses for visually impaired.

Both the devices have been developed by using simple, cheap sensors. It has many advantages, for example, it is lightweight keeping in mind that it must be convenient for everyone to use it. Our motive is to make both the devices as a part of the user's regular and frequently used objects. Our research focuses on integrating the outputs from both the devices to the visually impaired people to help them in navigation.

II. METHODOLOGY

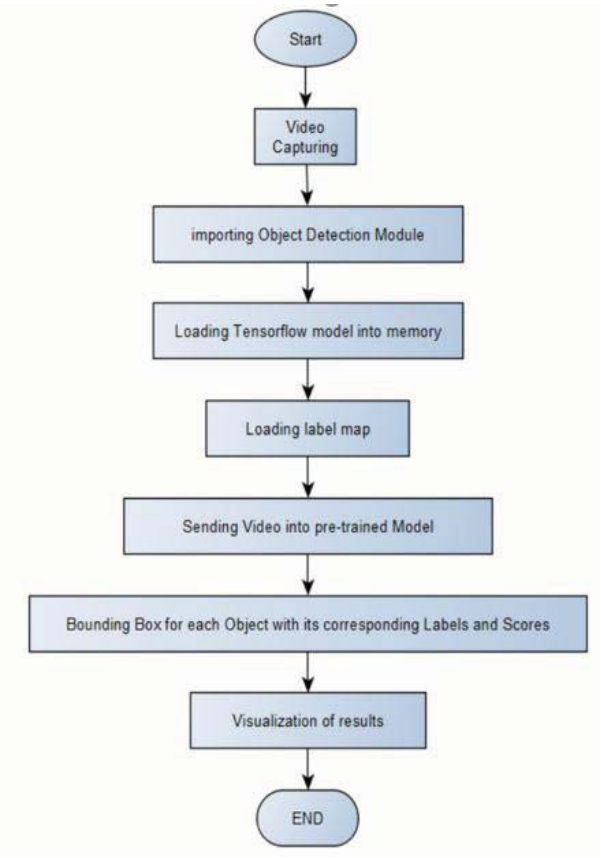

Figure 1. The figure depicts the workflow of the object detection algorithm.

One of the features of smart glasses is object detection. For Object Detection, we used TensorFlow Object Detection API. This API can be used to detect with bounding boxes, objects in images. The Object Detection Model that we used was based on the detection model pre-trained on dataset available on the internet. We added our data to that dataset and further trained it to get a better accuracy. As shown in Fig.1, it shows our algorithm

For Optical Character Recognition (OCR) we used the prebuilt Tesseract software developed by Google specifically for Optical Character Recognition.

A Braille Cell as shown in Fig.2 [8] is made up of six dots that fit under the fingertips, arranged in two columns of three dots each. Each cell represents a letter, a word, a combination of letters, a numeral or a punctuation mark. So, this is how a braille work, every letter is made up from the combination of these 6 dots and with the help of that visually impaired people are able to read.

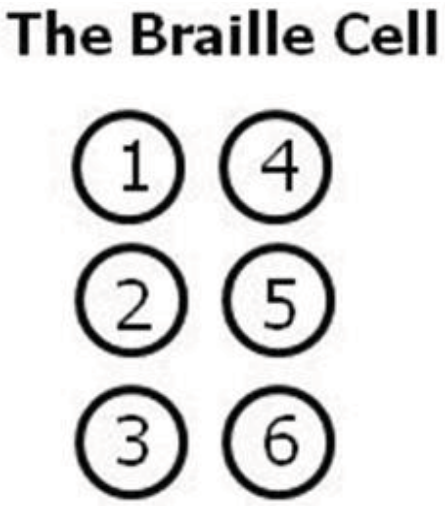

Figure 2. Braille cell.

For text to Braille conversion, we applied our OCR module and extracted the text out of the images. Then we saved the input in text format and used it as the input for our text to braille module. We mapped every character in the string to its equivalent braille-utf-8 character. After that, we reduced the characters to get the string of braille-utf-8 which is the braille-utf-8 conversion of the string which was fed as input. The formatted file was fed to the braille printer. The following Fig.3 shows our algorithm

The next device is a smart pair of shoes which can be analyzed by detection of an object's distance and proximity relative to the IR (Infrared) Sensor which is placed on the smart shoe.

The sensor is powered with 5V either by Arduino or any other power source. The data from the sensor is given to the Arduino where it sets the Red LED on if the object if more than 5cm away or not in the near proximity, else the Green LED is set on if the object is less than 5cm or in the near proximity of the smart shoe. The corresponding result is conveyed to the user in terms of voice output, which makes the assistant more modular to the user. This process continues in the loop until the smart assistant is on use.

The following Fig.4 shows our algorithm

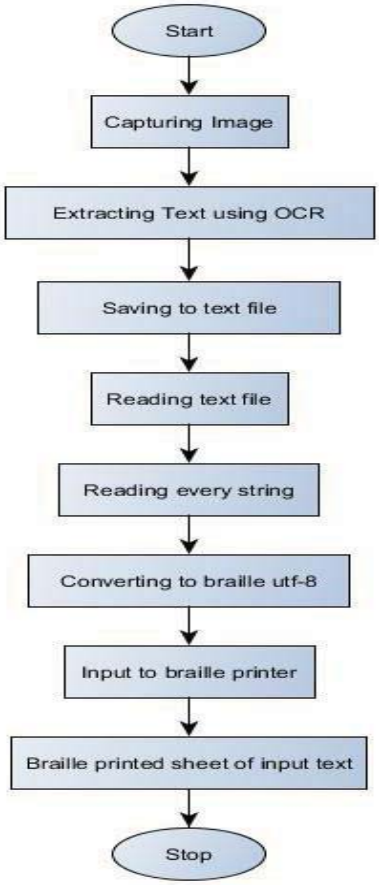

Figure 3. The figure describes the working of text to braille conversion algorithm.

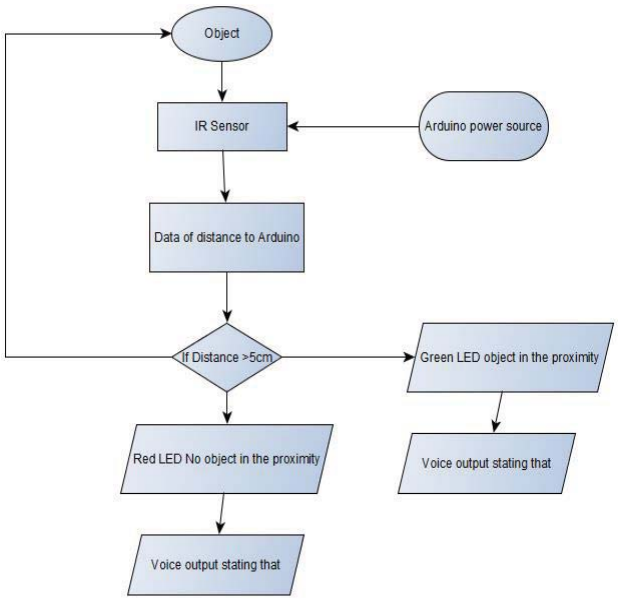

Figure 4. The above flowchart describes the working of the proposed smart shoes.

III. Result and Discussion

This is the output we got for our text to braille converter as shown in Fig.5 we are getting output in the form of UTF-8 and then it matches to the corresponding character. Then this output can be given to the braille printer. The advantage of this device is it can convert from text to braille in real time.

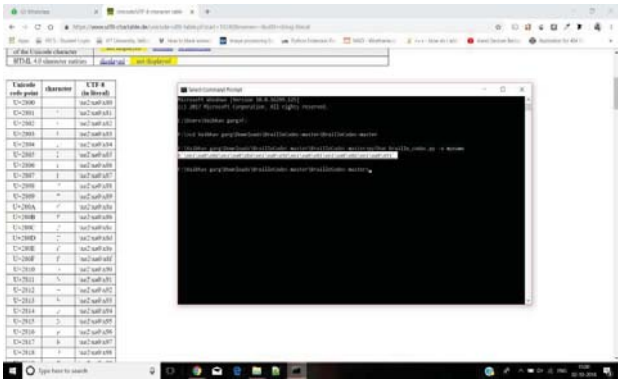

Figure 5. The output of text to braille.

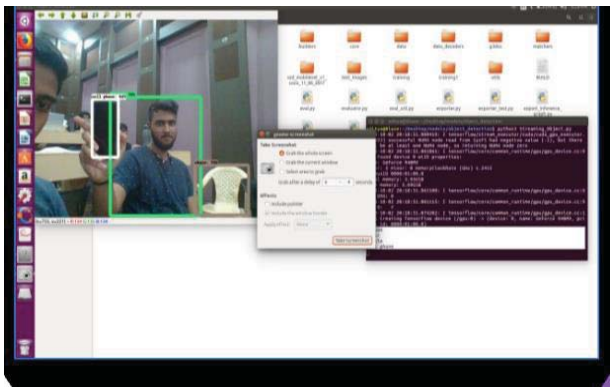

Figure 6. The output of object detection.

So, this was the output of our object detection as it can be seen in Fig.6 and it was showing the accuracy of more than 95 percent. It was able to detect certain objects like a water bottle, phone etc.

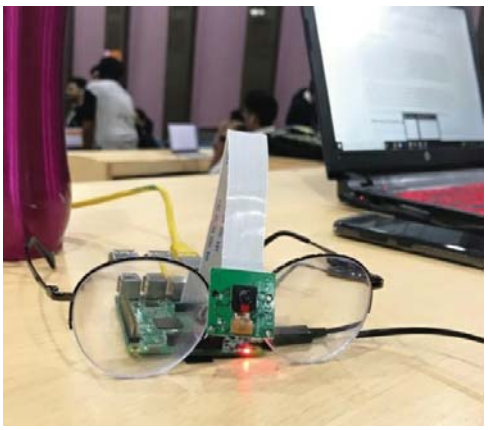

Figure 7. A prototype of smart glasses.

The above picture in Fig.7 depicts the first prototype of the mentioned smart glass. We attached a raspberry pi camera to a pair of glasses and used the raspberry pi to execute the operations. The final prototype will be 3D printed and will be much more compact than this one.

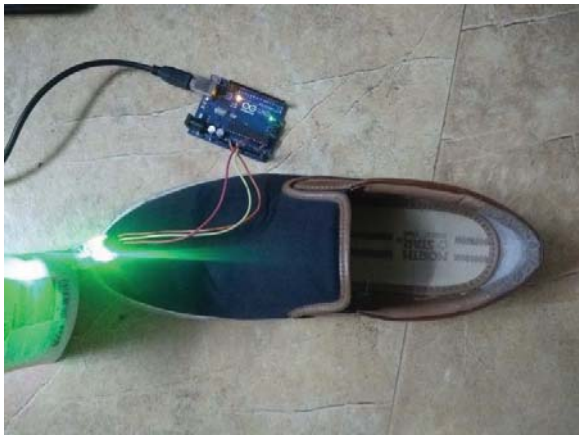

Figure 8. The first prototype of the mentioned Smart shoes.

The smart shoes as shown in Fig.8. uses IR for obstacle detection. These are shoes which are capable for detection of the nearby objects by using the implemented IR sensors inside it. Shown in the figure that the LED color changes from red to green when the obstacle is in close vicinity and the caution message is given to the user (visually impaired) person in terms of voice via Bluetooth to the wearable device, this makes the entire setup easy to use and modular to the user.

[9] Similar devices have been developed in earlier researches using ultrasonic sensors around the sole of the shoe for object detection.

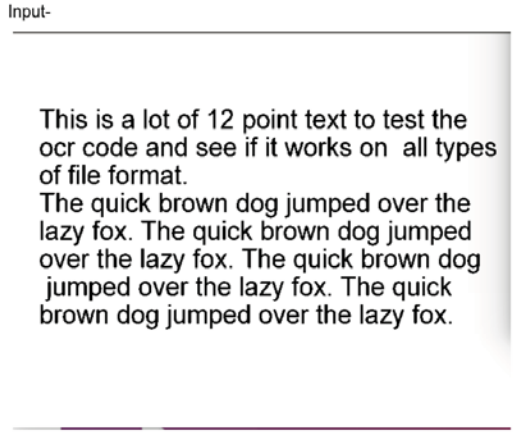

Figure 9. The above image is the input provided to the OCR.

Fig 9 is the input image we fed to our OCR program which computed the result shown in Fig 10. We convert this output into audio using a python framework text to speech, using this facility blind person can easily listen and sense the environment better. Serves our objective to make the device easily usable for the visually impaired.

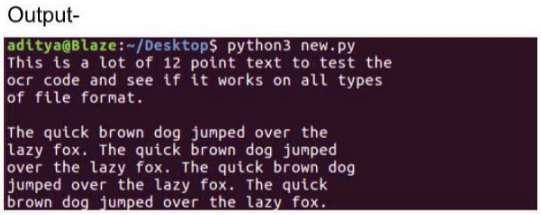

Figure 10. Output of OCR.

IV. CONCLUSION

Visually impaired people face a lot of problems when they go to an unknown area or while commuting from one place to another, usually visually impaired person is dependent on any other person to help them as a guide dog. So, we have created navigation devices which would make visually impaired people more independent in their day to day task and to commute particularly visually impaired person wants to know what is that particular object that can't be sensed, what is the distance from the user to the obstacle and also what is relevant information available in that object so our technology deals with that and gives appropriate information to the user.

In this paper, we have presented a wearable technology in the form of smart shoes and smart Glasses which help blind as well as visually impaired people in their daily mobility and perception of the environment. Smart Shoes are able to detect the distance of the obstacle from the user and alert the user by giving an audio output and smart glasses is able to detect letters with the help of optical character recognition, object detection, and alerts to the user and also gives important information to the user so that they can navigate easily.

Our product can be also integrated with smart glasses which are already available in the market.

We have also added one more module that is text to braille because less than 1 percent of the book available in the market are in braille. Our technology directly converts text to braille and gives the visually impaired user an option to read in braille.

So, with the help of our technology visually impaired person can easily detect and avoid an obstacle and help them in commuting in an unknown environment and also technology like object detection and optical character recognize enhance the information about that particular environment and object

Our goal is that at the end of the user can get relevant information about their environment and enhance their ability to commute and navigate and do their day to day task easily without depending on other.

REFERENCES

[1] Global data of visually impaired from WHO website www.who.int/blindness/publications/globaldata/en/

[2] E-BOOK LEGAL RESTRICTIONS ARE SCREWING OVER BLIND PEOPLE article taken from www.wired.com/2014/12/e-books-for-the-blind-should-be-legal/

[3] Brock, M., Kristensson, P.O.: Supporting blind navigation using depth sensing and sonification. In: Proceedings of the 2013 ACM

Conference on Pervasive and Ubiquitous Computing Adjunct Publication, pp. 255–258. ACM, September 2013]

[4] Yánez, D.V., Marcillo, D., Fernandes, H., Barroso, J., Pereira, A.: Blind Guide: anytime, anywhere. In: Proceedings of the 7th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, pp. 346–352. ACM, December 2016

[5] Sensor-Based Assistive Devices for Visually-Impaired People: Current Status, Challenges, and Future Directions, by Wafa Elmannai and Khaled Elleithy.

[6] Drishti: An Integrated Indoor/Outdoor Blind Navigation System and Service Lisa Ran, Sumi Helal and Steve Moore Computer & Information Science & Engineering Department University of Florida, Gainesville, FL 32611, USA

[7] ASM Iftekhar Anam, Sahinur Alam, Md Yeasin, "A dyadic conversation aid using google glass for people who are blind or visually impaired", *Mobile Computing Applications and Services(MobiCASE)6th International Conference*, 2015.

[8] "Visual impairment and blindness Fact Sheet N°282". August 2014. Retrieved 23 May 2015

[9] Syed Tehzeeb Alam, Sonal Shrivastava ―Smart Device for Blind Peoplel Journal: International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 4 Issue 03, March-2015