A Smart Hoodie- Assistive Technology for Blind People Using IoT

Kathiravan M[a], Manokar S[b], Rajesekar V[c], SreeSubha S[d], Aravinda Rajan V[e], and Irumporai A[f]

[a]Associate Professor, Department of IT, Rajalakshmi Engineering College, Chennai, India.
[b]Assistant Professor, SRM Institute of Science and Technology, Vadapalani Campus, Chennai, India
[c]Associate Professor, SRM Institute of Science and Technology, Vadapalani Campus, Chennai, India
[d]Assistant Professor (SG), Department of IT, Rajalakshmi Engineering College, Chennai, India.
e Assistant Professor, Department of IT, K.L.N College of Engineering, Sivagangai, India.
[f] Assistant Professor(SS),Department of IT, Rajalakshmi Engineering College, Chennai, India.

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Abstract: Assistive technology for the blind is a field of research that is gaining more and more importance due to the eruption of new interest from different fields. These research findings have had a huge social impact among elderly and blind population. In this paper, we introduced a novel Smart Hoodie which can sense the objects around them and can prevent the blind people from getting hurt accidentally or banging on heavy objects. The technology used here is IoT, where a Raspberry Pi kit is used along with ultrasonic sensors which can sense objects. A micro camera can be fixed on top of the Hoodie, which is triggered once the sensor detects the object and then object recognition is performed; a voice notification is generated either with the speaker or earphones. We can also track the location of a blind person in case they are lost, using a GPS module. A GSM module is used by a blind person to send messages in case of any emergency. Although, there were a lot of discoveries related to the above-mentioned issue, it has inflamed that our invention is much better than other state of the art approaches.

Keywords: Assistive technology, Visually Impaired, Raspberry Pi, GSM/GPRS

1. Introduction

In this modern world, according to WHO estimation the visually challenged people are 386 million in July 2020, out of which 48 million are suffering from loss of vision. Although good eye sight is very important for human beings, unfortunately vision loss is becoming more common in recent years (Jin, et.all. 2020).This particular issue may be caused by defects in organ formation, injury or any medical complaint that restricts power of vision. Regarding this issue, the sufferings that are faced by these people are infinite. The major difficulty was moving around in unknown places. With the vision of innovation and technology support many safety equipment have been found to rescue these blind people. This is generally classified as a primary and secondary aiding tool. The focus on these devices was to provide safety by identifying the objects and obstacles on the road. The good examples for these devices are canes, guide dogs. These devices have been assembled with high end safety requirements for the purpose of avoiding electrical shocking and misplacement or damage of other supporting devices. The secondary one was focusing on localization and surrounding places. The cane is one of the popular devices which is normally used by the blind people to move around the surroundings. This is generally called as electronic travel aid (ETA). Similarly, with more innovation many other devices have come to power, they are Sonic Torch, Sonic Path-Finder, Mowat Sensor and C-5 Laser Cane, Russell Path sounder (1965) and (Pressey,1977) Mowat Sensor.The ETA is mainly used to alert the blind to know the up and down position of the road and their shapes. With this device one can move to their destination without any physical damages, safely. This device is operated by a sensor which determines the hindrances on the road. The next device is sonic torch which operates on hand held devices by transmitting ultrasound to find and get response from the object. Another interesting device helping to notify the blind is by alarm signals that are incorporated with path finder devices, called as sonic pathfinder. The function of this device is to give approximate estimates rather than concentrating high accuracy. The C-5 Laser cane is another closely related device which works by detecting the objects at head-Height of the blind user. Here, since the device was molded in front of the head which can detect only the objects that are covered by the headlight. The Mowat Sensor device is another famous one that works upon tactile vibration. This handheld ultrasonic device detects distanced objects to alert blind to give more safety before causing any disaster. The limitation of this device was failed to find objects and position of the abnormalities. Although it was kind to offer assistance, the worst thing that can be done to a visually impaired friend or family member is to make them dependent. Firstly, it makes them feel helpless, and it removes any possibility for them to learn to do things themselves. Most, sightless people are hesitant to venture outdoors as they always need assistance from others. The problem is that they love going for walks on their own, but sometimes the trail veers off in a different direction and they miss the intersection. In this regard, the model constructed by various latest electronic components is more helpful for blind people.

Differently, our project is to construct a simple guidance system, a smart Hoodie, which detects all kinds of obstacles with a wide range of coverabilities compared to all other existing aiding tools addressed above. In the following section, literature survey discusses the techniques used along with their merits and demerits. The remaining sections are followed by methodology, results & discussion, future enhancement and conclusions.

2. Related Work

There has been a lot of research activities carried out by different scientists over the period of time to help blind people. Though the research was actively participated the complete safety is not yet provided to blind. Due to increasing aspects of disease to blind people, the remedy for the issue becomes complicated when they meet any accident. Even though, existing aiding tool partially helped blind to move around the surroundings in the safe zone.

Throughout this chapter we will bring such exciting tools and techniques into our discussion for the purpose of knowing the strength and weakness of those devices. In the 1950s-1960s (Shashank & Kavitha, 2014), many researchers actively contributed developing electronic mobility aids and this process continued till 1960s-1970s. The primary objective of this attempt was to construct one electronic travel kit. Though the attempt is infinite the successful mobility tool found by Russell Path sounder (1965) and Mowat Sensor (1977). This aiding tool was called a sonar-based mobility device which helped them to detect obstacles on the immediate path. But these tools were not used by most of the people due to lack of safety. Thereafter only computerized development came into picture and resulted into a wearable device that helps blind users to walk around the places little safety.

With increasing technology support a chip-based wearable device found by Jameson and Manduchi (2010). Next to this successful attempt, there were many such tools that came with novelty to fulfil the safety issues addressed in the earlier work. They are indoor navigated modality tool Bhowmick et al. (2017) and a flexible mobile computing tool, cross watch system (Baranski, Strumillo, Bujacz, & Materka, 2009) were mainly focussed to help blind to cross the roads. Subsequently many other systems came up with modern tools and technologies by focusing on specific environments to help visually impaired people. An unknown indoor support system existed (Aguilera et.all. & Radu et.all; 2013), an indoor and outdoor support tool existed (Liu et. all. 2014) (Elloumi et.all. 2013) and with a successful attempt a 3D smart phone-based detection system (Chon et.all. 2011) developed to meet the requirements of most of the blind users. This system encapsulates a modern technology with an easily transferable or wearable device which is very easy to carry and walk around the surroundings compared to other aiding tools.

An electronic aiding device (Kanagaratnam, 2009) was found using two infrared and ultrasonic sensors which operated with a thumb impression for supporting emergency situations of the blind user. Followed by this, a alarm-based water bit indicator (Manoj & Sunil, 2011), a power saving weight less device (Rene et.all. 2006 & Baus et.all. 2002) attached with GPS receiver, a smart mobility cane (Johann et.all.1997 & Sung et.all 2001) and Geo tact (Zul et. all. 2002)) GPS system developed, a radio frequency based aiding tool to use within a premises (Alessio et.all. 2001), a robot based guide stick was used to ensure the position that the blind is moving safely. But all these tools create many issues to elder people whose blindness is severe. Among the survey undertaken, the recent one is closely related to our work but it was not holding many other features that have been incorporated in smart Hoodie.

In our system, the proposed methodology is totally different from all the above devices in the way the data is sent and received. The techniques were effectively modelled to help blind users in all kinds of circumstances with complete safety measurements. Therefore, it is ensured that the working behaviour of our model is novel and more helpful than the existing approaches.

3. Research Methodologies

The proposed model has an ultrasonic sensor, a raspberry pi camera, IR sensor, GPS and GPRS module on the Hoodie. Once the system is given power supply, if any object or obstacle is detected within specified threshold then it triggers the camera module. A Raspberry Pi-board **is** used with an android API called sight. Sight is developed with a raspberry pi 3 and Google android things. A specific threshold is fixed for the ultrasonic sensor to detect the objects and the camera captures the image and tells the blind user about the type of object present. Sensors are integrated with it to help in efficient decision making. The ultrasonic sensor and the camera are used to detect obstacles. Ultrasonic sensor is a sensor that detects objects in the form of sound waves. The sight classification technique helps in classifying the object. This system helps the visually impaired to navigate through areas. Smart Hoodie uses an Ultrasonic sensor to detect obstacles.

The proposed architecture in figure 1 consists of various modules. They are, ODUS (Obstacle Detection by Ultrasonic Sensor), CICO (Image Capturing and Classification of Object), GPS (Global Positioning System), GPRS/GSM, Pit Detection by IR Sensor and SIGHT. The ODUS is a sound-wave based sensor which has a similar principle of radar. It generates high frequency sound waves and assesses the echo and is received by the same sensor. This medium of communication estimates distance to an object. In smart hoodie, once the object is present within the specified threshold then it triggers the camera module. The CICO is capturing the images and separating them by sight module. The sight is manufactured by three components: raspberry pi 3, camera and button. Using the headphone, a blind can hear a sound or alert about the type of object detected and what it is. Sight is responsible for this successful task, which is carried out after analysing the detected object using tensor flow. The GPS is giving accurate information about what is the location of the blind user. The microcontroller enabled GSM device used to share information over the network. This also helps to communicate or share information among the modules. If the blind user touches the button of the Hoodie, the alert message reaches the father or care taker immediately to save the blind. The pit detection sensor is very useful to find the uneven surfaces and alert the user by sound or buzzer when a hole is encountered. The sight module is responsible for taking a picture and analysing them using tensor flow. This is resulting in the nature of the picture and is felt by

the user using headphones. The Smart Hoodie is a device which can provide mobility to the visionless without assistance from others.

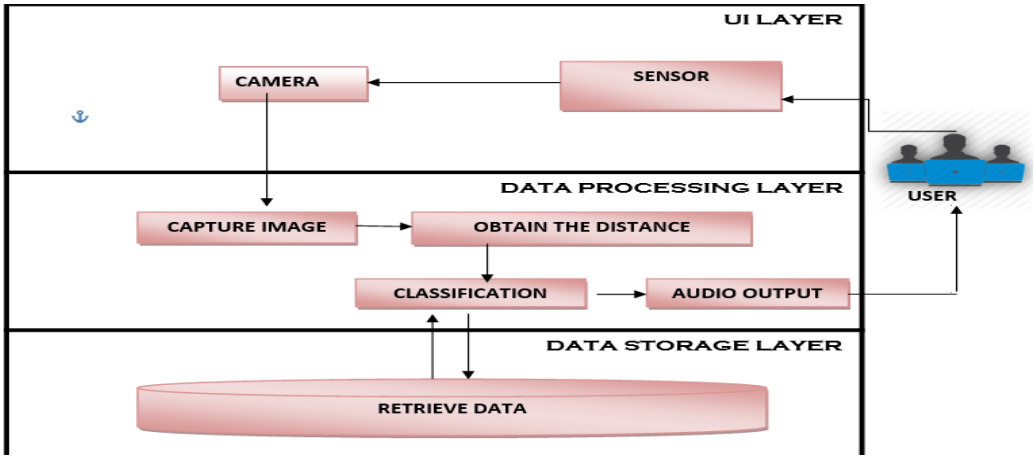

Figure 1. Architecture Diagram of Smart Hoodie

A Hoodie with ultrasonic sensor detects an object which gives a notification to the person if the object is present within the specified threshold. Then the camera captures the image and using object recognition technique tells the person what kind of object is that through the speaker. The GPS module is used to track the location of the blind person if at all they are deviated from the correct path. The GSM module is used to send a text message from wherever they are in case of help. An IR sensor for pit detection is used.

4. Implementation and Result

The figure 2 showed the overall implementation of the system. The system software, hardware and the functionalities used in this system are described below. The open source Arduino IDE uses C++ based interface to communicate with the Arduino processor. It can be used with any Arduino boards. To upload and debug programs the connection is established between Raspberry Pi and Android studio. The Arduino uno is ATmega328P based microcontroller board which connects to the computer through USB cable to convert power from AC-to-DC adapter. It is also installing all hardware and software components of the model. It is a microcontroller based open platform which has a chip that reads input and produces output for the user given commands. The interface medium Arduino IDE is coupled with a chip for proper communication. The ATmega328 based microcontroller board which has 14 digital input/output pins with onboard resonator, reset button and holes for mounting pin headers. Using this board, a smart hoodie model has developed. The obstacles are detected by Ultrasonic sensor and Raspberry Pi 3 is encapsulating the features of the personal computer system. It can be plugged into TV or with a keyboard depending on the purpose of the work. Using this device one can perform all basic computers.

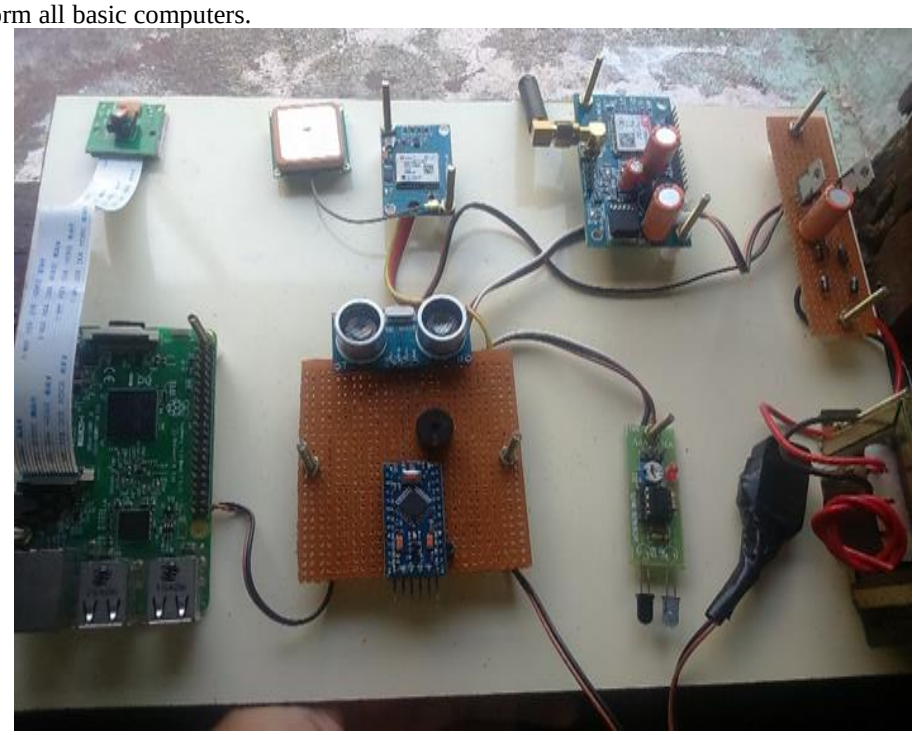

Figure 2. Overall System Setup

The Raspberry pi 3 camera module is used to capture video, images and connects directly to Raspberry pi to detect and alert users of the hoodie. The IR sensor attached is helping to sense the surrounding places and also used to measure object heat. The GPS connection was established with this hoodie to track the blind user

and GSM/GPRS is attached to communicate with blind users. The buzzer that is moulded in the board helps to notify the impaired user if any uneven or hole detected.

Figure 3: A Smart Hoodie

The above figure 3 has shown the final implementation of our proposed system Smart Hoodie. A novel Smart Hoodie can sense the objects around them and can prevent the blind people from getting hurt accidentally or by banging on heavy objects. The technology used here is IoT where a Raspberry Pi kit is used along with ultrasonic sensors which can sense objects. A micro camera can be fixed on top of the Hoodie which is triggered once the sensor detects the object. The camera module thereby captures the image and classifies what image is used in the sensor flow object detection technique. Then, object recognition is performed and notification is generated as voice either with the speaker or earphone. The Smart Hoodie above is also attached with a GPRS module which can track the location of the blind person in case they're lost. A GSM module is also used by the blind person, if they want to send any message in case of any emergency. The GPS and GPRS module are activated once the blind user presses the button in case of emergency and a message along with the location information is sent to the blind's caretaker.

5. Conclusion & Future Enhancement

The proposed techniques were effectively modelled to help blind users in all kinds of circumstances with safety measurements. The way in which the technology was applied to this model highly prevents the blind people from any disaster. The Raspberry Pi kit that is associated with ultrasonic sensors had shown a very high accuracy in terms of sensing the object and detecting obstacles. This module had also given information about the type of object. This feature alerts the user to know the seriousness of the fore fronting object. In this aspect, our model has superior performance than the existing system. Further, the object recognition module that had implemented sound waves to detect objects has secured remarkable performance. The Internet based model associated with GPS had higher accuracy to track the location of the person. At last, the GSM which has been incorporated in our system has proven as one of the most important features to tackle any emergency condition of the blind users. Every technology has impeded for improvement and nothing is considered perfect. In Smart Hoodie, future innovation can be done by adding real time video processing with the help of the technology, which is called You Only Look Once (YOLO). Thus, a live relay of the events that are happening will be explained to the visually impaired people.

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