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## Smart Aided Spectacle for the Visually Impaired People

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**ABSTRACT:** Lacking of the visual perception due to physiological or neurological factors is called blindness and partially or completely blind is defined as visually-impaired. There have been several systems designed to support visually-impaired people and to improve the quality of their lives. Unfortunately, most of these systems are limited in their capabilities. The problem, blind people are facing, is they cannot always avoid the objects around them while moving. It is system which is consist of a small, wearable, lightweight, low cost spectacle for the visually impaired people. It is one type of guidance system. The system consists of two parts. One part is used to determine if there is any high obstacle in-front of the blind people. Obstacle may reside on the left, right or straight. Responses will be given on the basis of the obstacle's position and distance. Another part is used for determining the information about the obstacle on the road which is done using image processing. By using this, they can get assistance to walk easily and detect obstacles around them.

**KEYWORDS:** Visual Perception, Blindness, Visually Impaired People, Guidance System, Object Detection.

### I. INTRODUCTION

Blindness is one of the most severe types of disabilities a person must endure and, despite numerous advancements in technology; it remains a serious problem till now. The World Health Organization (WHO) reported that there are 285 million visually-impaired people worldwide. Among these individuals, there are 39 million who are totally blind [1]. For the blind, the lack of sight is a major barrier in daily living: information access, mobility, way finding, interaction with the environment and with other people, are challenging issues. The white cane is very limited in its ability to provide navigational independence for its users. In addition, the blind people still require the assistance of sighted persons or guide dogs to lead them to most destinations. These shortcomings drive the need for thesis on developing innovative navigational systems for the blind. Many technological solutions commonly known as electronic travel aids (ETA) [2] have therefore been proposed and implemented, but none have been widely successful in improving the mobility and lives of the visually impaired. Many systems exist that utilize this innovation, such as the GuideCane [3], a device which uses echolocation to detect objects directly in front of the cane and steer the user away from them. While many previous tools have been developed but no system has utilized and integrated well enough to be accepted by the blind community as a viable navigational solution.

This thesis proposes the design and implementation issues of automated smart aided spectacles for the visually impaired people. The device receives any reflected waves, and produces vibration response to any nearby object. It also measures the smoothness of the surface by image processing. The reduced cost, lesser weight and simpler design of the proposed system prove the effectiveness over existing work. Therefore, the main objective of this system is to develop a system that will assist the blinds to walk easily and to minimize the accident rate of the blind people.

The remaining of the paper is organized as follows. Section 2 discusses about the used terminologies as well as some research for the visually impaired people which have been done in this field by other researchers. Section 3 describes about proposed methodology briefly. In Section 4 represents the study result of the proposed method. Finally, Section 5 contains concluding remarks and directions for further research in this field.

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## II. RELATED WORK

Many systems are designed to guide blind people. Several institutions have been working for a long time to make cost effective and efficient devices for the visually impaired people. Most electronic aids that provide services for visually-impaired people depend on the data collected from the surrounding environment (via laser scanner, cameras sensors, or sonar) and transmitted to the user either via tactile, audio format or both.

In Kulyukin's 'RoboCart' [6] the authors proposed a RFID based system where everything is tagged using RFID. But, this system is not applicable in real life, because, it is practically impossible to tag everything with RFID. Helal's 'Drishti' [7] the author proposed a location-based system using GPS, where, location information and maps can be provided. But, this system cannot be used in a closed area, like: living room, mosque etc. Speed of GPS's data transferring is also a major problem here. Sonic-Guide [8], Mowat- Sensor [9], Guide-Cane [10], Sonic Pathfinder [11], are some developed system that can only detect obstacle in front of the user, but can't detect anything on the surface. The laser cane [12], white cane [13], and the smart cane [14], are some other tools for the visually impaired people. These also have some limitations, like: large in size, uncomfortable use, difficulties in using in public places and also have the limitation of detecting every object. Bharambe et al developed an embedded device to act as an eye substitution for the vision impaired people (VIP) that helps in directions and navigation [15]. When the obstacle is detected, then the sound will be reflected back to the receiver. It also provides low power consumption.

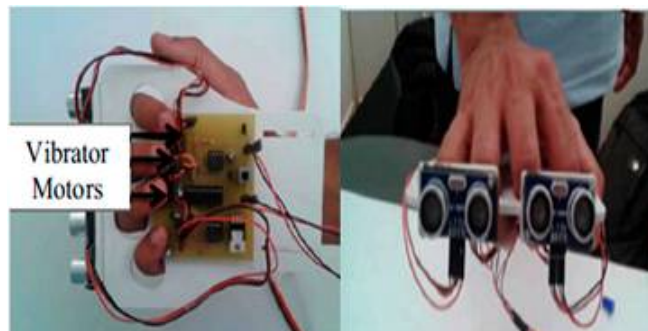


Fig 2.1: The prototype of the eye substitution

By adapting GSM and GPS coordinator, Prudhvi et al. introduced an assistive navigator for blind people in [16]. It helps the users detect their current location, hence, navigating them using haptic feedback. It can detect object's color and also the distance.



Fig 2.2: The Smart Cane prototype

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An assistive device for blind people was introduced in [17] to improve mapping of the user's location and positioning the surrounding objects using two functions that are: based on a map matching approach and artificial vision [18]. The main motive of this thesis is to investigate a solution for the blind. The problem that the blind people are facing is that they cannot avoid the objects around them, so accident occurs. This thesis provides a solution that helps blinds to avoid obstacles around them without holding any sticks or other heavy things.

### III. THE SYSTEM DESCRIPTION

A system is proposed which will help the visually-impaired people to walk easily anywhere. In the improved system, the module was integrated within a wearable 3D printed spectacle which the visually impaired people can easily wear. The integrated module along with the spectacle is so light that it can be worn like normal spectacle. The Raspberry Pi Module along with the sonar sensors and camera module will be fabricated within a small wearable spectacle. I tried to draw the best outcome using the Raspberry Pi Module.



Fig 3.1: Design of Smart Aided Spectacle

The camera module captures pictures on a specific time interval when the user starts using the device. The images are then processed to give result whether the surface is smooth or not. It will help a blind to detect speed breaker on roads or any kind of lower obstacle on his way. The sonar sensors calculate the distance of the object from the user and if the distance is near, an alert is sent for the user.

In our system we divide the whole application in some modules. First one is Main module which detect object and take the image of the surface for further processing. Second module is server module which receives the image sent from the main module and then process the image and finally calculates the surface smoothness.

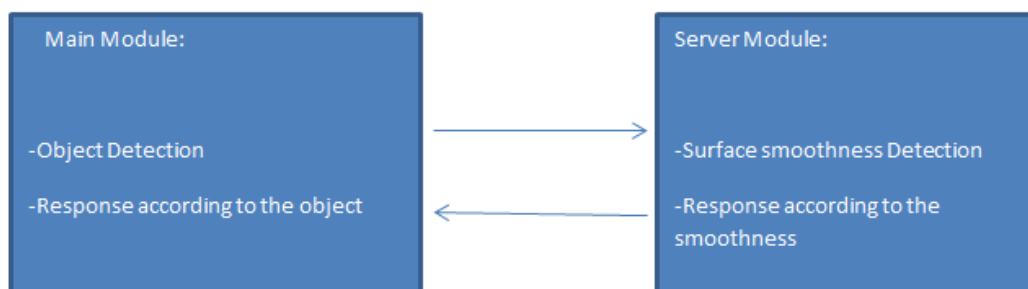


Fig 3.2: Working Flow

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The main methodology of this paper is divided into two phases. One is object detection and another is surface smoothness detection.

### A. OBJECT DETECTION

With more details, this phase is composed by three sequential steps: Interfacing the Sonar Sensors (HC SR04), Sending and receiving ultrasonic sounds and Calculating the distance of objects.

At first the sonar sensors are interfaced with the Raspberry Pi. Two Ultrasonic sensors are used which work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. When there is an obstacle on the right side then it is detected by right sensor and the right vibrator vibrates. When there is an obstacle on the left side then it is detected by left sensor and the left vibrator vibrates. When both left and right sensor detect an object in front of them then both vibrators vibrate which means that the object is in front of the user.

### B. SURFACE SMOOTHNESS DETECTION

In this section, the aim is to detect and calculate the surface smoothness. First take the image of the surface, send the picture to the Raspberry Pi. And then process the image and calculate the surface smoothness and give the result.

In this part Pi Camera starts taking picture, processes the data to send into Raspberry Pi and saves it into a file. We know JPEG image file starts with "FF D8" and ends with "FF D9". So, camera will stop taking picture until microcontroller receives "FF D9". The next step is to process the image which was sent from camera. For processing the JPEG image needs to be converted into bitmap.

The bitmap converts the image into matrix. If the image width is 160 pixels and height is 120 pixels then the matrix has 160 columns and 120 rows which contains 160\*120 data (pixels). The image contains a laser line. The aim is to find the smoothness of the surface. If a straight line of the laser in the images found that means surface is smooth. But if there is any obstacle in the surface then the laser line will not straight all along.

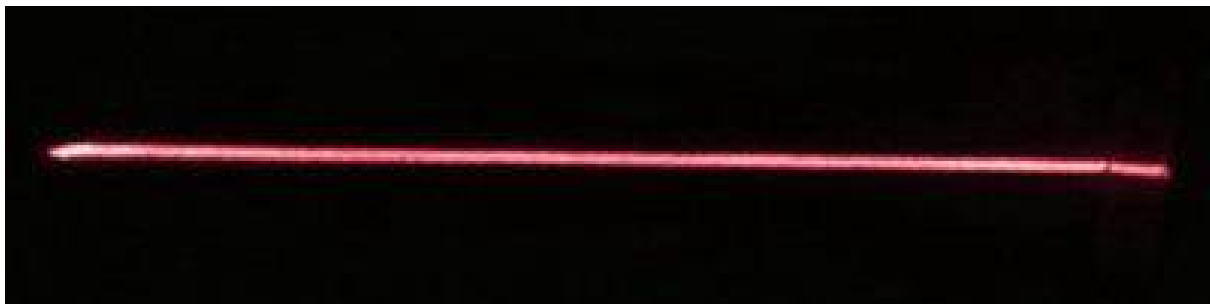


Fig 3.3: there is no obstacle on the surface thus the laser line is straight

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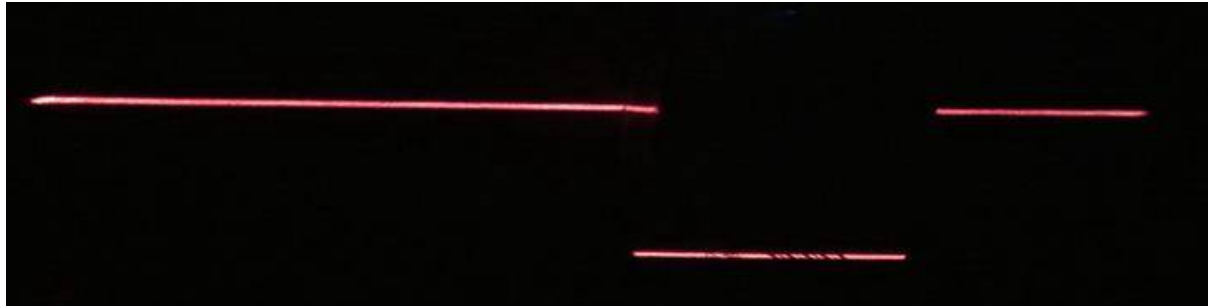


Fig 3.4: there is obstacle on the surface thus the laser line is not straight all along

For calculating the surface smoothness then decides the obstacle nature and or any hole in the surface according to the smoothness of the surface. For example, if the surface is 80% smooth it can say that obstacle or any hole in the surface is tiny and ignorable. If the surface is 50% smooth it can say that there is obstacle or hole in the surface.

For this reason, a challenge came up to match the color of laser. Took several images and do analysis the RGB values of laser line. By analysis the RGB values, it finds a relation between RGB values for laser line and a range of RGB color to match with laser line pixels. Looped through each row and count the matched pixels of laser line.

Finally, a percentage of the smoothness is calculated by subtract the total sum of matched pixels of rows with total columns (that means image width). Then the application will inform the user about the surface and the condition of obstacles. Snapshot of pseudocode of color image processing.

## IV. EXPERIMENTAL RESULTS

### EXPERIMENTAL TOOLS

Raspberry Pi Model-B board, 8-megapixel Pi Camera which is capable of (3280 x 2464) pixel static images, HC SR04 Ultrasonic Sensor and Laser Module are the experimental tools of this thesis. Raspberry Pi is small single board computer. It is a quad core ARMv7 CPU and has 1 GB of RAM. Pi Camera is integrated with Raspberry Pi to capture images of Laser line. Ultrasonic Sensor transmit & receive ultrasonic sound wave & thus measure distance.

### EXPERIMENTAL RESULTS

#### • Finding the RGB Relation to Match Laser Line's Pixel Color

The RGB values of the rows of many sample pictures in different light intensity are calculated to get an optimized result. The process was very large and time consuming. Here, RGB values are given below.

RGB Value for Normal Pixel

```
rgb(10458): row:85Values:--> R: 66 G: 75 B: 74
```

RGB Value for Normal Pixel

```
rgb(10458): row:85Values:--> R: 199 G: 145 B: 163
```

RGB Relation to Match Laser Line's Pixel Color

```
iff(((r<255)&&(r>100))&&(((float)g/r)>=.5f)&&(((float)g/r)<=.8f))
```

#### • Object Detection

The performances of object detection are evaluated by calculating the errors at different area and also by comparing the actual distance and the measured distance. If any object is nearer than 60 cm from the user, the user will be alerted for the obstacle.

#### • Surface Smoothness Detection

Surface smoothness is measured at different lights. The device shows the following smoothness (%) for the corresponding images in the daylight and in the dark.

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Surface Image (in Daylight) & Surface Image (in Dark)  
Surface Smoothness (%) Surface Smoothness (%)



Output: the surface is 86.362% smooth



Output: the surface is 36.341%



Output: the surface is 23.295% smooth



Output: the surface is 96.341% smooth



Output: the surface is 34.675% smooth



Output: the surface is 58.792% smooth

Fig 4.1: Surface Smoothness in Daylight & Dark



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## • Actual Vs. Measured Distance

After calculating the error at different area, the actual distance and measured distance are compared. A significant accuracy in experimented device is found.

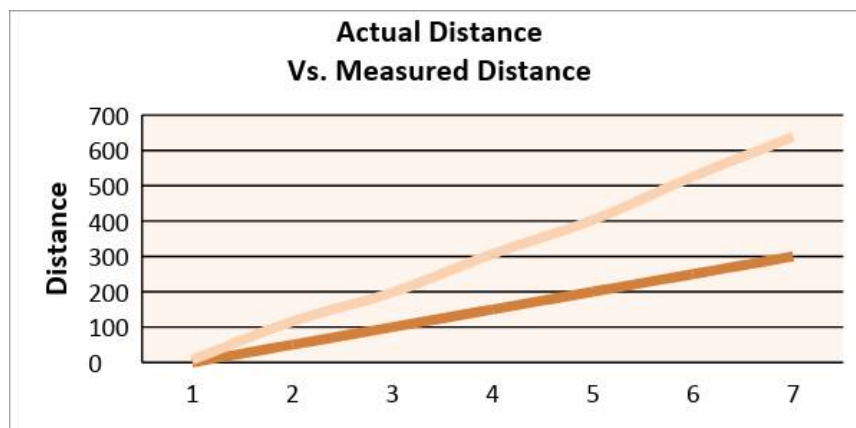


Fig 4.2: Actual Vs. Measured Distance

## V. CONCLUSION

In this research, we adopt a new tool Smart Aided Spectacle to develop the quality of the life of these visually impaired people. The main aim of this research is to aid the visually impaired people by using the latest technology in the area of computer science and engineering. A small, wearable, lightweight, low cost, easy to handle spectacle is proposed to provide help for the visually impaired persons. The system is endowed with different types of alarms that send warnings to the user. It can scan areas left, right, and in front of the impaired person. Using this system, they can walk in the road without any collision with obstacles. Furthermore, this paper can encourage others for further research in this direction. Our future work in this line will focus on the development of this device for the betterment of the visually impaired people.

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