



Advanced Mechanism to Empower Blind and Visually-Impaired

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Abstract: This research study presents a productive and secure artificial intelligence process that helps the blind and visually impaired people in their mobility with the help of the technology. There are a lot of conventional methodologies that are being used to serve the deprived ones but those can be replaced with a stronger methodology, techno backed up wearable device is that device which one can take along without having any additional gadget in their attire i.e. a custom made shoe which provides the benefits of object detection, facial recognition, provides directions for the desired destination with the obstacle detection and the alarm in the real time. Thus this technology will help the blind and visually impaired persons to walk and explore independently without having any physical help.

Keywords— Wearable Smart shoe, Ultrasonic sensors, Location tracking, Obstacle detection, Empowering blinds

I. INTRODUCTION

Sightlessness, short sightedness, visual deficiency and vision loss have intense impressions on individuals suffering such disabilities, impacting their class of natural life and depriving such characters from performing many of the Activities of Daily Living (ADL), the most vital of which is steering around and mobility.

Blindness is a qualitative term describing the clinical condition in which people have no light perception due to the total loss of vision. Blindness also refers to those with so little vision that they mainly have to rely on other senses as replacement of vision skills ^[1]. On the other hand, visual impairments is a qualitative term used when the vision loss condition is characterized by a loss of visual functions at the organ level, such as the visual acuity loss of visual field loss.

This research study aims to present a prototype model and a system concept to provide a smart shoe for blind people. This system is intended to provide overall measures object detection, and send information related to blind people. This project aims at the development of an Electronic Travelling Aid (ETA) kit to help the blind people to find obstacle free path. This ETA is fixed to the shoe. When the object is detected near to the shoe, it alerts them with the help of a vibratory circuit and the integrated camera takes an image and processes it and sends the data to Google API to identify the object, also in advancement with help of head phones that is voice command with the help of android

application. With the help of GPS module integrated in the system, the tracking of the person can be done all the time. The water detecting sensors are attached to detect water.

II. METHODOLOGY

This research study intends to be developed as tool or aid that will help blind people in moving or travelling. The dependency on others is reduced and these people can become more self-reliant.

Prototype has been designed using Raspberry pi controller. Raspberry pi controller is a credit card sized computer that works at a low-consumption power with different abilities. This controller has built-in functions that can be programmed to do different tasks that it is capable of. Here the controller will help the system work as a mini computer that would be connected with different sensors used in the system along with a built-in camera slot.

When at a particular distance, ultrasonic sensors will be sending its ways while walking, when the waves are reflected back by hitting an object the sensor vibrates the shoe, sending an alert to the user that an object is in the way. Also when the object is detected and the chip is alerted it send the camera to take a picture that will be connected to a custom made mobile app that will process the image through the image processing method. This method will collect all the features and characteristics of that particular image and will send that data through the internet connectivity by Google API that would identify the object from the features and characteristics that were send. The name of the object will be picked and send back. Once the name will be received it will convert from text-to-speech and the person will be guided through earpiece.

A. USE CASE DIAGRAM

Figure 2.1 is the representation of the research prototype using basic UML diagram:

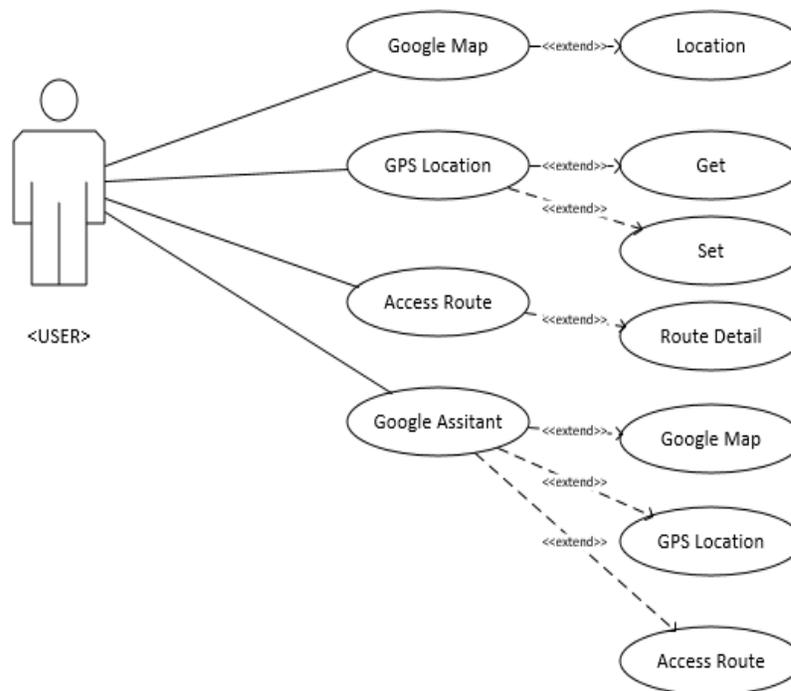


Figure 2.1 Use Case Diagram

B. CIRCUIT DIAGRAM:

Figure 2.2 represents the circuit of the prototype:

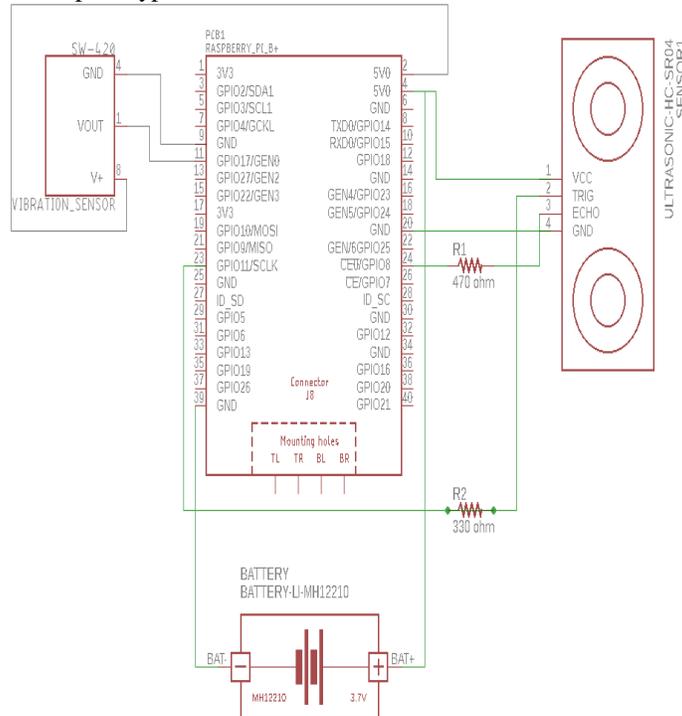


Figure 2.2 Circuit Diagram

C: BLOCK DIAGRAM:

Figure 2.3 represents the block diagram for the prototype:

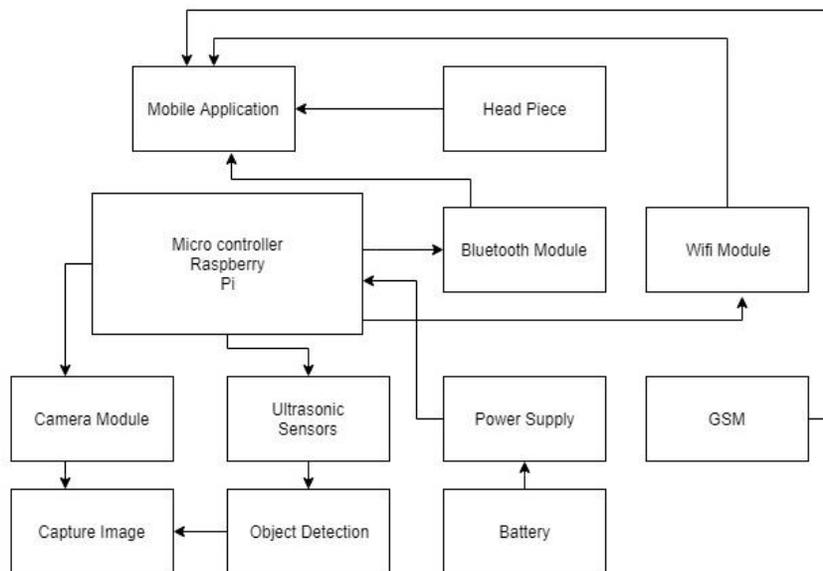


Figure 2.3 Block Diagram

Following is the description of the components that are used in the prototype:

Ultrasonic sensors: An ultrasonic sensor is device which measures distance to the object by using ultrasonic waves. It sends an ultrasonic wave at a specific frequency to the targeted object and waits to receive the reflected wave from the object. The distance is measured through the calculated time between the sound wave sent and received from the object.

Camera module: Camera module is actually consists of an image sensor which detects and conveys the information of an image by converting the light waves into signals.

Mobile Application: The concept of mobile application in our project is we implement a database in application in which we add some type of things which will be used when there is no connectivity of internet. If there is no internet it will pick from the database and then it will text to speech and send it to earpiece. We will integrate Google map into the application which will have many options for the blind to do.

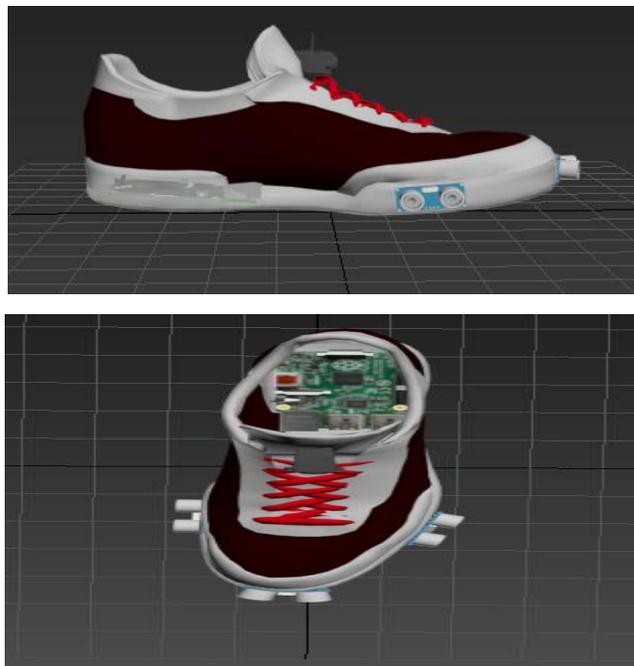
Wi-fi module and Bluetooth module: In this project we use Bluetooth module in the shoe via circuit this will connected to mobile phone.

Wi-Fi module is used because we need internet connectivity as we all know every place have not a Wi-Fi connection so that's why Wi-Fi module is used.

Raspberry Pi: It's simply a microcontroller and is working like a mini computer in which the programming of project is done and we need at least one controller in which we will do the work. In this project the latest raspberry pi 3 B+ is used.

Earpiece: Earpiece is connected to the Bluetooth which is connected to the phone Bluetooth and is used when the object is detected then after text to speech it will directly sounds an object name in ear of blind.

Battery: Battery is simply giving a power to the circuit (Micro-controller).



GSM: GSM is actually working on the network it will be used for emergency call or messages sending or receiving for the blind it will do by the voice of the blind when blind say to the phone for messaging or calling it will call or messages or voice will came out of reading receiving messages. It also create an internet connectivity as if there is no Wi-Fi or Wi-Fi module is not working in a particular area as like mobile data package is working.

D: PROTOTYPE VISUALS:

Following are the illustrations for the standard prototype along with brief description:

- A) Camera mounted on the top of the shoe in order to capture clear picture of an obstacle recognized by ultrasonic sensors.
- B) Whole circuitry is inserted inside the sole for the security of the board and its components.
- C) Ultra Sonic sensors are on three sides of the shoe in order to detect every obstacle coming in front.



The circuitry of raspberry pi along with the sensors and battery pack is fit inside the sole of shoe. The sole which is being used is an Arabian sole which is especially designed for heavy weights and isn't bend easily. This way the circuitry is secured inside the sole.

The sensors are attached and programmed via python code with raspberry pi. Ultrasonic Sensor is implemented in such a way that it depends on the vibration sensor, as when the vibration sensor is vibrated, then ultrasonic sensor is given the access to send and receive waves.

The procedure starts with, when the person walks with their shoes on, it is vibrated via vibration sensor which gives the ultrasonic sensor access to start sending waves via its pin2 i.e. trigger. When a wave is hit by an object, it is bounced back and is received by ultrasonic pin3 i.e. echo. This activates the pi-camera automatically and takes pictures of the detected object. This is when our algorithm starts its working.

The algorithm we are using is a deep learning object classifier algorithm which uses opencv and blob libraries along with MobileNet_SSD for prototxt and Caffe model for pre-trained model.

We are using a pre-defined data set in our project which has basic classes such as, person, animals, chair etc. Our algorithm works in such a way that when ultrasonic sensor's wave is bounced back the pi-camera takes the picture of the object that was detected. This picture is saved to the path defined in the algorithm. This path is then read by the algorithms argument parcel function where the image is passed to the caffe pre-trained model. Caffe is an open source pre-trained model for object detection that is being used in our algorithm. Caffe uses opencv to recognize the objects features and classify them into classes.

A serialized model is then loaded from the disk where the input image is loaded which is resized to a fixed 300x300 pixels and is normalized. The image is then red with the help of pre-defined functions of opencv and blob. Image processing starts by making a bounding box around the detected object, then the object is classified among the classes in our pre-defined data set. When that object is matched from any class, the class name with its accuracy percentage is written on the top of bounding box and is sent to the connected Bluetooth earpiece via text- to-speech.

III. LITERATURE REVIEW

Blind people and visually impaired people face many difficulties in their daily routine life. But the major disadvantage they face is when they travel, because they are not exactly aware of their location and things that came in their way during travelling ^[1].

There are number of researches and projects have been done for blind people, so that blinds can easily move from one place to another place without facing any problem and being dependent on other person.

But not any of them had been done completely and together. Which means some works have been done on navigation (GPS) and some are on object detection. Some are implemented on cane sticks and some are on shoes. Therefore still

blinds are facing many problems because they are unable to get proper guidance in order to go their willing location without facing any obstacle ^[2].

One of the similar study proposed a smart stick using laser sensors to detect the obstacles and down curbs. Obstacle detection was signalized by a high pitch “BEEP” using a microphone. The design of the laser cane is very simple and intuitive. The stick can only detect obstacle, but cannot provide cognitive and psychological support. There exists only beep sound that triggers any obstacle and there is no any assistance to direct them. Another system was developed that was integrated both in shoe and in the white cane. The shoe have 3 IR sensors attached on its left, right and front that may detect and by the voice integrated chip will speak to watch out from the obstacle in the direction it mat detect. In the white cane a range sensor is integrated that will detect through an IR sensor and will tell the range of the obstacle. Here the proposed system was to Navigate the blind/visually impaired people along with obstacle detection on their way integrated in a specially made shoe. This will help them find their way independently ^[3].

One of the research study describes a system which is based on a navigational shoe for blind people. In this system a hardware based electronic kit is fixed in a shoe consists of Sensors, Vibrators, Arduino, Bluetooth connection and a battery. There is a software based android application which is integrated with a shoe. User will enter source and destination in the phone. Then sensors will detect the object sand the vibrators will vibrate according to the paths. Which means vibrator set on the left side of a shoe will vibrate if the left turn should be taken, similarly vibrator set on the right side of a shoe will vibrate if the right turn should be taken. This system’s purpose was to provide user friendly system for blinds and visually impaired which helps them in living independently ^[4].

Electronic Travelling Aid (ETA) kit has been proposed for the blinds and visually impaired people to provide them an obstacle free path. This system consists of a microcontroller, ultrasonic sensors, Bluetooth connectivity, vibratory circuit and smart phone with an integrated application. The shoe is integrated with self-power generation unit so that there will be no power backup problems. The ETA circuit is fixed in a shoe and when the object or a person is detected near the shoe it alerts the user through vibration in the shoe and also through voice command with the help of speakers or head phones ^[5].

A similar concept that describes a system based on the idea to make a shoe for blind people consists of ATmega 328 microcontroller, ultrasonic sensors, vibrating motors, Bluetooth module and a smart phone in with an integrated application. The system will be connected to an application on a smartphone through Bluetooth connection. When the obstacle will be detected the vibrators will vibrate and a buzzer will make a sound according to the distance between the object and user. The user will give source and destination via voice command and then application will directs the user according to the given destination through vibrators and voice command ^[6].

Concept to develop a smart blind stick for blinds which will help them to live an independent life without having any difficulties. The system consists of a microcontroller 18F46K80, ISD1932 flash memory, infrared sensors, ultrasonic sensors, water detecting sensors, and vibration motors. Infrared sensors are used for detecting stair cases. Ultrasonic sensors are used to detect any other object in the range of four meters. And water detecting sensors which is placed at the bottom of the stick are used to avoid puddles. Flash memory is used to store speech warning messages. When any object will be detected through any sensor the vibration motor in the stick will be activated and a warning message will be sent to the blind through earphones ^[7].

Shoe for blind and visually impaired people to provide them with the facility to travel alone without being dependent on anyone. The system is consists of Arduino nano, object detection sensors, battery and smartphone with and integrated application. Google API is used to navigate the user to the destination. Text to speech conversion is used for voice instructions through the smartphone in order to take the input from user and to warn a user about the obstacle. Whenever the object will be detected real time processing will be done and it will notify the blind about the presence of object and the position of object ^[8].

Model of ultrasonic stick for blinds to help them to gain self-confidence and personal independence in life. The proposed model is consists of microcontroller, ultrasonic sensors, vibrating motors, buzzers, camera. Whenever the object will be detected through sensors or a camera the vibrating motor will be activated and buzzer will make a sound to warn the user. GPS system is used to provide information about the current location of blind. SMS system is used to provide a facility to send message to the saved number in case of emergency^[9].

Ultrasonic walking stick for blind people. in this system it consist of a circuit board which contains a PIC microcontroller, a LED for indication ,input from micro-pager motor, inputs from sensors that are installed at a proper position of a stick. The entire project is based and designed upon micro controller and its reliability. In this system micro controller is secured and micro controller is used. All sensors data is taken through micro controller and by taking it produces different pulse width modulation based on sensors output. This system is sensor based. The micro controller read these sensors and drives a buzzer, a LED and a motor with PWM .it is based on the strength of vibration of the motor and beeping the buzzer and then blink the LED embedded with the stick. This system was very friendly and helpful for the blind and visual impaired people .it creates a very high response^[10].

Another study proposed to develop an electronic device for obstacle detection in the path of visual impaired people so that they can move freely. A lots of devices have been created in this field either most of them not required a training .in this it uses DRISHTI which is a wireless pedestrian navigation system for visual impairment it emphasis on enhancing the navigation experience. In this system they are using TYFLOS which focus on the integrating different navigation technologies such as wireless computer. They use NAVBELT which guides system that uses a mobile robot obstacle avoidance system it uses methodology such as region based. The prototype consist of ultrasonic sensors, range sensors, a computer and earphones^[11].

One of the study proposes a system in which they use technology to improve visual impaired person's mobility. They are doing obstacle detection, pit detection, water detection and finding location to reduce navigation difficulties for visually impaired people. The walking cane is a simple and purely mechanical device to detect static obstacle on the ground. This system presents a concept of a smart electronic aid for blind people. In this system embedded system plays a major role. In this system they are using ultrasonic sensors and many things. Ultrasonic sensors works on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes. Pit sensor is used to analysis any dent or pit present in the path and this signal is also given to the embedded system. GPS receiver is used to track the position of the human and given to the level converter. In their reviews this is the best and they are hopeful to be the best in the world.

IV. LIMITATION

- A. **Operating System Limitation:** The mobile application will only be available in Android only not in IOS or any other mobile operating system.
- B. **Design Limitation:** The shoe is not available in all designs and types, only size are vary.
- C. **Internet Dependency:** The internet connectivity has to be there in order to be connected with the map and to stay connected to Google database in order to identify the objects.

V. CONCLUSION

Smart shoe is an innovative shoe designed for visually disabled or visually impaired people for improved navigation and ease in daily life for them. This paper proposes an advanced smart shoe that allows visually challenged people to navigate with ease using advanced technology.

According to many researchers the implementation of the smart shoe has been developed in various ways but we are heading ahead of them by camera integration along with voice guidance and GPS tracking system. The system provides at its extreme help limiting to a very few things that wouldn't affect much. As a result blinds will be empowered to explore independently with their determination to do everything on their own.

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