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Real Time Assistive Shoe for Visually Impaired People

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Abstract- **Visually disabled people come across many challenges on a daily basis, some challenges are new and some routine. Since blind people cannot detect the obstacles or move to any destinations independently. Most of the times the blind typically use traditional canes that cannot detect the objects higher than the waist. The innovation with one of the wearable technology aids underprivileged visually impaired people with a new merge for eyes-free navigation in an environment that is in identifying the obstacles ahead of them and moving to the destination through a navigation path. More importantly, when visually challenged people using this wearable technology need not carry any other additional support instruments. This technology is embedded into the shoe part, making the footwear powerful in determining the obstacles ahead of the bearer.**

The prototype consists of two modules namely the phone module and shoe module. The shoe module is incorporated with a lightweight controller device and sensors whereas the phone-module includes GPS system. The controller in the shoe module is attached with a Bluetooth transceiver which syncs to a smart phone app that uses Google maps to direct the person and facilitates the user by providing the information about the path. Once the user selects the destination then the route is laid, the direction is constantly updated to allow the user to go according to the pattern from being dynamically adaptive and avoids any diversion from a planned directional path. The signal sent from the phone module will be determined by the Bluetooth and a corresponding message is sent to the controller in the shoe module. The major objective in this paper is to keep the device smart and cost efficient. The software used is reliable and stable.

Keywords – Blind Wearable technology; Eyes-free navigation; GPS (Global Positioning System); Bluetooth module(HC-05), LCD display, Renesas microcontroller, Ultrasonic sensor.

I. INTRODUCTION

India has been home to the world's largest number of blind people; of the 37 million amaurotic people across the world around 15 million are from India. In addition, India needs 25 thousand donated eyes. The barrier of low vision does not let them become a part of this society.

Generally, visually disabled persons are reliant on cane sticks [1]and other people either for asking directions or completely depend on them for moving from one place to another. Currently, technologies like Google Maps and other navigational apps[4] on mobile devices are the primary sources of finding a better route. On comparison mobile based map applications offer a wide range of information over the normal paper maps. However, the use of a mobile based map application requires visual attention of the user. Special tactile maps are designed for the blind people to navigate easily in new places. Understanding tactile maps requires more effort and they fail to provide accurate information whether the user is on the right path or not. On the contrary, the audio feedback along with the mobile based map application can serve visually impaired people to navigate[4] with ease. This also minimizes the effort which in turn helps them in better understanding of their path.

Considering all these resources we intend to apply this in our technology helping the blind to reach their destination with ease. Once the user (blind/guardian) inserts the destination and chooses a route, he can amicably move with the help of audio output guiding through the path. Destination can be set through Google speech-to-text converter which is an inbuilt feature in device applications and makes it more user-friendly for visually challenged people to navigate. Ultrasonic sensors[1] are integrated with the shoe that detect obstacles in the path and provide audio feedback so that collision can be avoided and helps the visually challenged person to navigate easily and reach the destination.

II. OBJECTIVE

The main objective is to assist blind people to navigate with audio output by detecting the obstacles ahead. To develop a prototype with high accuracy and better comprehensibility. The prototype aims at providing low weight products with immediate sensory feedback.

To develop user friendly application software which will help the user to operate the prototype easily. A feature that enables the user to know the exact location through audio output with the help of GPS. The product must be economically feasible and should be open for future upgrades.

III. STRUCTURE DESIGNING

Structure designing is basically composed of Phone-module and Shoe-module. The shoe module in prototype

consists of a microcontroller, ultrasonic sensor, moisture sensor, Bluetooth module and an LCD display panel. The microcontroller in the shoe module is attached with a Bluetooth transceiver which syncs to a smart phone app that uses Google maps to notify the user turn-by-turn information. Moisture sensor detects humidity.

Bluetooth module(HC-05) acts as two-way communication, commands and information is exchanged between controller and mobile. Alternate technologies like ZigBee, Wi-Fi can be used for faster rate of communication between the shoe module and the phone module. Once we set the destination, the direction is constantly updated to allow the user to go according to the pattern from being dynamically adapted to any wrong deviations from a planned directional path. Once the obstacle is determined by an ultrasonic sensor[1] a speech output is given by the device. The ultrasonic sensor will continuously emit ultrasonic waves so when any obstacle is encountered the receiver receives the reflected signal and notifies the user.

The phone module must be a Smartphone with GPS and should install an app which controls and communicates with the shoe module. The exact location can be determined by switching the power button five times consecutively.

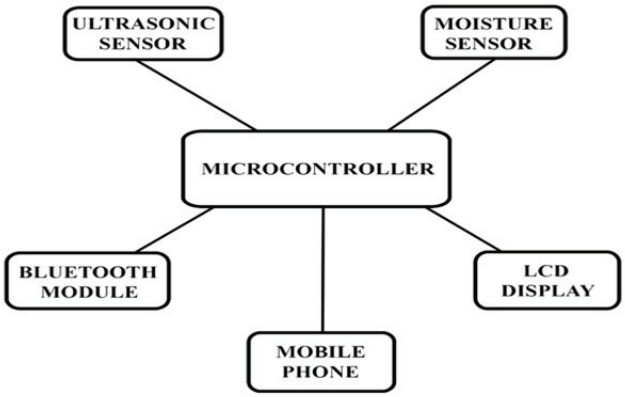

Fig. 1. Functional Block diagram

IV. HARDWARE AND SOFTWARE REQUIREMENTS

A. Hardware components

1) Renesas microcontroller

Fig. 2. Renesas microcontroller

Reansas microcontrollers are widely known for their low level power consumption with supply voltage varying from 1.6 - 5.5 volts. The RL78/G13 microcontroller provides high performance with accurate output and the execution time can be varied from 32Mhz - 32kHz. It consists of 64 pins which include code flash memory, DMA controller, high-speed on-chip oscillator, serial interface, data flash memory and more. Renesas microcontrollers are used in many applications such as home appliances, security, office automation and healthcare.

2) Ultrasonic sensor

Ultrasonic sensor emits the ultrasonic waves from the transmitter and receiver receives the emitted signal [1]bounced back from the obstacle. VCC, trigger, echo and ground are the four pins available in the sensor. It works on the formula Distance = Speed x Time. The ultrasonic sensor measures the distance between 2cm-80cm.

Fig. 3. Ultrasonic sensor

3) Moisture sensors

Moisture sensor measures the water content in the soil. The water content in the soil is measured in terms of percentage with help of dielectric constant, electric resistance and interaction with neutrons. The working temperature of a moisture sensor is between 10 degrees to 30 degrees Celsius.

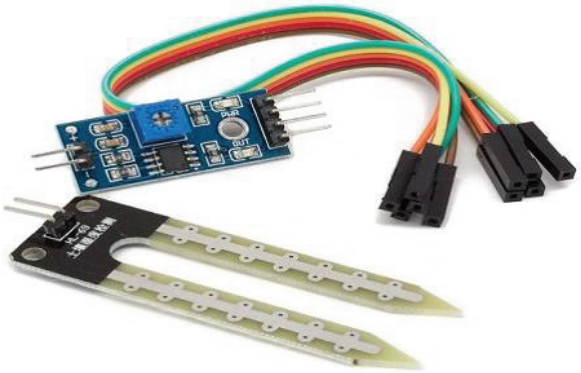

Fig. 4. Moisture sensor

4) Bluetooth module

Bluetooth is a technology for wireless communication.It is short range and the communication between bluetooth and microcontroller takes place via serial port. The operating frequency of HC-05 Bluetooth module is 2.4 GHz. It is used in electronic devices like television, mobile phones etc.

Fig. 5. Bluetooth module

5) LCD display

Liquid crystal display works on two modes 4-bit and 8-bit. It consists of two rows each row can display up to 16 characters. Characters can use alphanumeric that is both alphabets and numbers can be displayed. Operating voltage is between 4.7-5.3 volts. LCD displays are much thinner compared to cathode ray tubes.

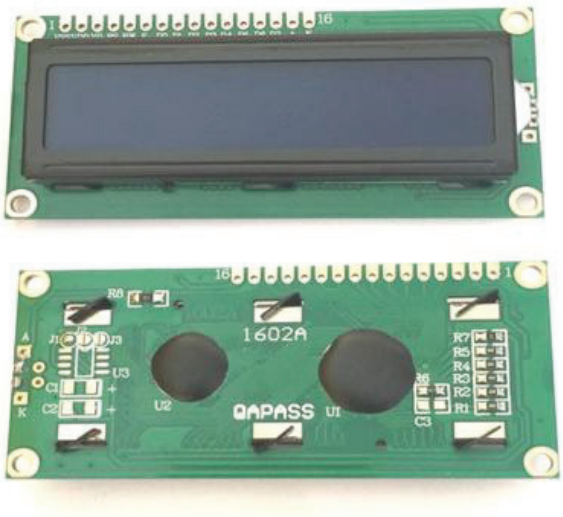

Fig. 6. LCD display

6) Li-ion battery

Li-ion is a portable rechargeable battery. It is widely used in electronic devices,electric vehicles and also in military and aerospace application. The voltage capacity is 12 volts with sleep mode conception less than 2mA.

Fig. 7. Li-ion battery

7) Mobile Phone

The smartphone should be GPS enabled[4] with proper internet. An app called drishti must be installed, with the help of this app the location of the user can be traced and its signals the user on reaching the destination point. The app uses the bluetooth module to interact with the shoe module.

Fig. 8. A smartphone device

B. Software Requirements

- IDE: Renesas Microcontroller
- Operation system: Renesas flash programmer
- App name: Adristhi

V. FLOW CHART

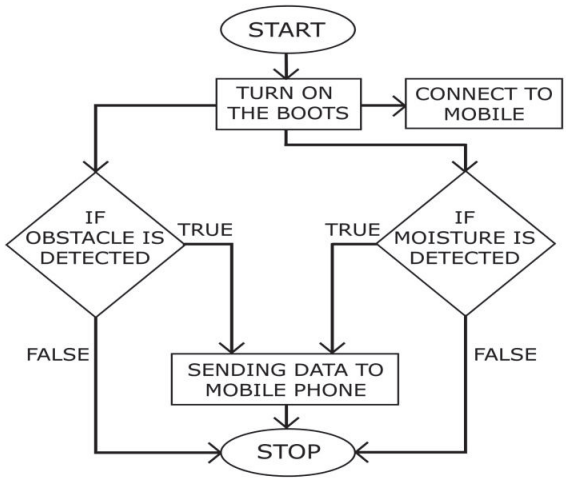

Fig. 9. The workflow of Shoe module

First step in the shoe module is to start. Start will turn on the boots, once the boots is turned on then the next step is to connect it to a mobile phone (smartphone) with the help of Bluetooth module in the shoe. The basic setup of the module is done and is ready to use. We have two case scenarios one is to detect the obstacle and the other scenario is to detect the moisture. If the obstacle is detected, then the condition proves to be true and this data will be sent back to the mobile device[4]. Similarly, if the moisture is detected the condition proves to be true and the data will be communicated back to the mobile device. If both of the scenarios cease to be false, then no data will be sent back to the mobile device. If both

the cases appear to be true simultaneously then that data will be sent back to the mobile in a successive order (first come first serve).

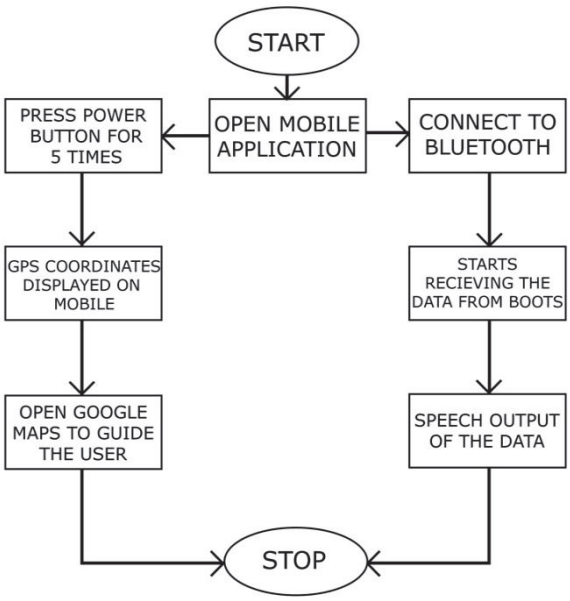

Fig. 10. The workflow of Phone module

Start the phone module and open the pre installed application on the smartphone[4]. Here we have two cases one is to find the location of the user and other is mobile device communication with the shoe module. The first case is to connect the mobile device to the shoe module through Bluetooth connection. Once the connection is set the mobile starts to receive data from the boots and if any obstacle or moisture is detected then that information will be passed back to the mobile which will deliver an audio output. The second case is when the power button is pressed five times simultaneously then the GPS coordinates [2] will be displayed on the mobile device by opening the google maps to assist the user, the location will also be notified through audio output. The cycle of the two cases mentioned will be active till the device is turned off.

VI. RESULT

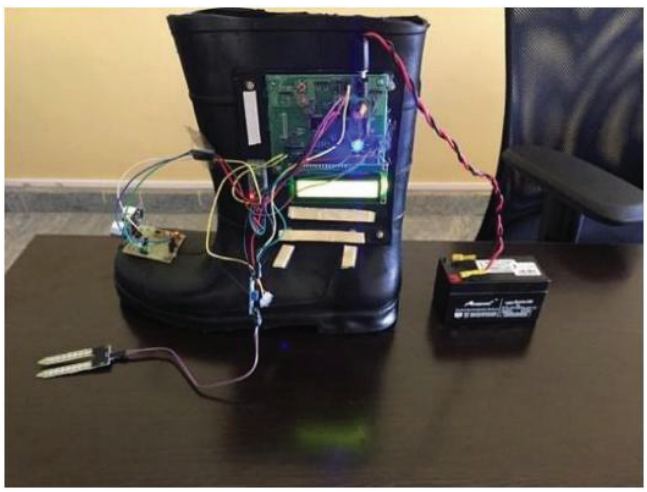

Fig. 11. Prototype with all the components

Once the obstacle is detected by the ultrasonic sensor emergency alert is being displayed on the LCD display and the user will be notified through audio feedback. Similarly, when moisture is detected by the moisture sensor it will be displayed on the LCD panel and also alerts the user through speech signal. The interface is easy and user friendly. This helps all the people who have eyesight less than fifteen degrees. This paper undertakes a new approach of transferring and representing the requested information by the design and implementation for visually challenged people. There is no other global way to thank society other than stretching and helping hand as an engineer.

A. *Applications*

- Economically Accessible- The device is economically accessible for the blind people in order to enhance the quality of life.
- Wearable- From conducted study and review, it is more flexible and comfortable to the blind person to wear the device rather than carrying it.
- Simple- Interface is simple and user friendly which requires minimum practice to get used to the device.
- Reliable- The device meets the specifications both in terms of software and hardware.
- Wireless Connectivity- The device is connected wirelessly which ensures great comfort during mobility.

B. *Advantages*

- The main application is the product assists the blind to navigate independently.
- The real time systems also help in detecting different shapes, materials and distances.
- The sensor and the entire circuit are attached to the shoe which is low in weight and portable.
- The device has capability in specifying the source and the distance of the objects that may encounter the blind in future scope.
- Alerts the user when stepping on damp roads.
- The product has scope in military application.

VII. COMPARATIVE ANALYSIS

This shoe is quite different from all those technologies which are invented for blind people like:

A. *Eye-Stick*

It is a portable device which uses rays and ultrasonic sensors. Users can get information about the product since it automatically scans books and reads barcodes of the product through a cam-scanner. This information is sent through Bluetooth after being converted into voice.

B. *Telveut*

It is a device which is designed in the form of open cap type. Its aspect is in the form of spectacles. There is a small camera which is fixed in front of the spectacles where a small sized electronic device is connected to the camera at the back of the head. It is wise to read a book or a magazine for a visually challenged person. When the person tries to focus on the book, the camera captures the letters. These captured

letters are converted into voice with the help of electronic devices in a such way the device is programmed .This voice message is audible to the blind people with the help of earphones connected.

C. *No place like Home*

This is an art project that features a pair of shoes which were specifically built for the project. The shoes are augmented with a microcontroller, a GPS module[2], and a set of LED switches rearranged in the toe-cap of the shoe. It is guided by different light patterns as they walk around.

D. *Paradiso*

This prototype was used for expressive, interactive dance performances, in which the dancer generated a stream of music based on shoe-embedded sensors. As a bridge between interest in Wearable Computer systems and new performance interfaces for digital music, a highly instrumented pair of sneakers has been built for interactive dance. These shoes each measure 16 different, continuous parameters expressed by each foot and are able to transmit them wirelessly to a base station placed well over 30 meters away, updating all values up to sixty times per second. It is used for some musical mapping and demonstration in dance.

E. *How our innovation is better than all these technologies.*

Our main aim is to make visually challenged people move to the destinations safely without facing any problems throughout the navigation. Design is simple and many components are not involved. We use single actuators rather than two in each shoe which reduce the circuit complexity. Also, the wearer will not get confused about the vibrational patterns.

VIII. CONCLUSION

With the effective use of existing technology, a smart device has been developed to implement a user-friendly, easy to use interface that is capable of assisting the user. A real-world prototype has been developed, based on a low-cost microcontroller with GSM module which will help blind to navigate easily to reach their destination.

IX. FUTURE SCOPE

Possible future work is in the review process in order to add new technologies that are available which may include edge sensitivity. Routine weather forecast on a timely basis can be done that alerts the user beforehand about rainfall and storms. The product can further be enhanced for wider applications by using Artificial Intelligence and image processing which helps to detect the obstacles much more accurately and with precision. Implementation in the defence sector which uses sensors to detect land mines and gives feedback to the soldiers to prevent casualties.

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