TEST Engineering & Management

May-June 2020
ISSN: 0193-4120 Page No. 4263-4267

A Smart Blind Stick

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Article Info
Volume 83
Page Number: 4263-4267
Publication Issue:
May - June 2020

Abstract

This paper aims at providing assistance to visually impaired individuals to overcome their difficulties in navigation. The proposed system is called a Smart Blind Stick which consists of in-built ultrasonic sensors for sensing obstacles at particular distances and water sensors to detect the presence of water accumulation. On sensing obstacles the sensor signals the microcontroller which in turn calculates the distance and outputs appropriate alerts to the user.

The user is alerted through vibrations of a motor and a buzzer. In addition to this, we have implemented the voice assist feature which will guide the user to take the appropriate direction in case of an obstacle detection. Also, this system proposes a module that tracks the location of the user and sends an e-SOS to his friends or relatives in case of an emergency situation.

Article History
Article Received:*19 November 2019*
Revised: *27 January 2020*
Accepted: *24 February 2020*
Publication: *12 May 2020*

Keywords**:** *ADC, android mobile application, buzzers, e-SOS, GPS module, Raspberry Pi, sensors.*

1. Introduction

Eyes, organs of vision, play a vital role in the lives of humans, because 83% of information from the environment is obtained through the eyes [8]. Many sighted people often have the impression that the experience of the visually impaired is similar to walking around with their eyes closed. But that's not the case. Eyes are the windows to the soul, and when this ability is hindered, the beautiful world outside is left obscure.

According to the World Health Organisation (WHO)[7] Survey done in 2017, there are 327 billion people in the world with visual impairment, 36 billion of people are blind. In India, there are over 258 billion people with low vision, and around 24 million people are blind. It is not a herculean task to comprehend the amount of hardship which is inflicted upon these innocent souls. Also, many children are blind since birth and we must remember the fact that these children have a very long life ahead of them. Their lives can be improved significantly if their dependency on another individual is reduced to a considerable extent.

A lot of research was put into understanding this impairment and we found that one of the main aids that blind people use are trained dogs, but such dogs are very expensive and not very reliable. Some other products available in the market are the smart belt, smart ring, smart cane etc. But these devices have very limited usability and lack approach due to more cost. These restrictions and disadvantages of the existing devices led us into implementing the smart blindstick. [5]

2. Literature Survey

A large number of research works are being performed by various researchers to provide an efficient navigation aid for blind persons. The following subsections describe and discuss some of previous work based on features and technology.

In one of the models, the smart stick uses 3 ultrasonic sensors facing three different directions for the detection of obstacles. It also consists of an embedded e-SOS system which uses a panic button to alert the relatives of the visually impaired person in case of an emergency. This button initiates a video call with the emergency contact using an android application. [1]

In another proposed system, an ultrasonic sensor along with a water sensor is used to detect obstacles and water puddles. If the stick is misplaced it can be easily found using an RF receiver present in the stick. GPS feature is embedded in the stick that gives the real-time location of the individual. [2]

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In another model, the stick detects obstacles with the help of an ultrasonic sensor and signals the individual by using different forms of alerts like buzzer and motor. Low latency communication for transferring data has also been achieved. The implantation of GPS in the stick gives the real-time monitoring of the impaired person in case of an emergency. [3]

3. Proposed System

A. System Architecture:

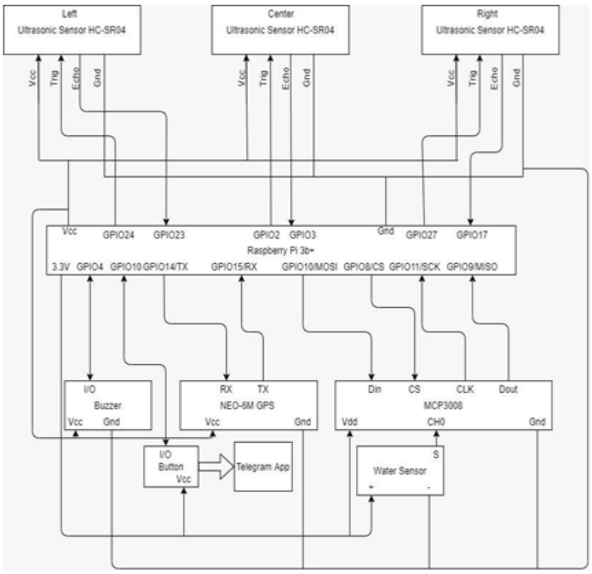

Figure 1: System Architecture of Smart Blind Stick

The block diagram of Smart Blind Stick is shown in Fig. 1. It shows all the important components that are embedded in the smart stick.
Raspberry PI Model 3 B+ is the brain of our system. It will handle all the processing and communication of data. It features Dual Band Wi-Fi (2.4Ghz and 5Ghz), Bluetooth Low Energy and Power Over Ethernet support. This device is integrated with obstacle detection sensors, a voice assist module, MCP3002 ADC, GPS Neo 6M module and an android-based application. This system consists of three ultrasonic sensors each facing different directions. It measures the distance to an object by using sound waves. We are using these sensors in our stick to detect the obstacles like pits, pebbles, and cars etc. The water sensor implanted at the bottom of the stick can detect the presence of water, often by measuring the electrical conductivity of the water present and completing a circuit to send a signal. It detects the presence of water in the path of blind people and provides an alert in time to avoid chances of slipping and drenching [7]. The MCP3008 10-bit Analog-to-Digital Converter (ADC) converts Analog input given by a water sensor into Digital, so that we can control the water measurement [11]. The NEO-6M GPS module is used to get the real-time location of VCP. A panic button is mounted at the top of the stick which in turn sends the individual's real-time location to his emergency contact number using the Telegram Mobile Application [9].

B. System Implementation and Execution:

This Raspberry Pi based intelligent walking stick is integrated with obstacle detective sensors, a voice assist module, MCP3002 ADC, GPS Neo 6M module and an android-based application. The smart blind stick is designed as shown in Figure 8. A polyvinyl chloride (PVC) pipe was used for making this stick, as this material is easily available and also easy to design. Ultrasonic sensors, a water sensor, a GPS module, Raspberry Pi, a vibration motor, a buzzer and a power bank were all fixed to the walking stick. The water sensor is placed at the bottom of the stick. The ultrasonic sensors are placed facing three different directions, left, right and centre. The vibration motor is placed near the handgrip of the stick.

The system execution process is divided into three parts. The obstacle detection part, the voice assist module for guiding and another module for receiving user's location information. When the power supply is given to Raspberry Pi, the whole system is initialized and starts working. The execution of the obstacle detection module is explained in the following paragraphs.

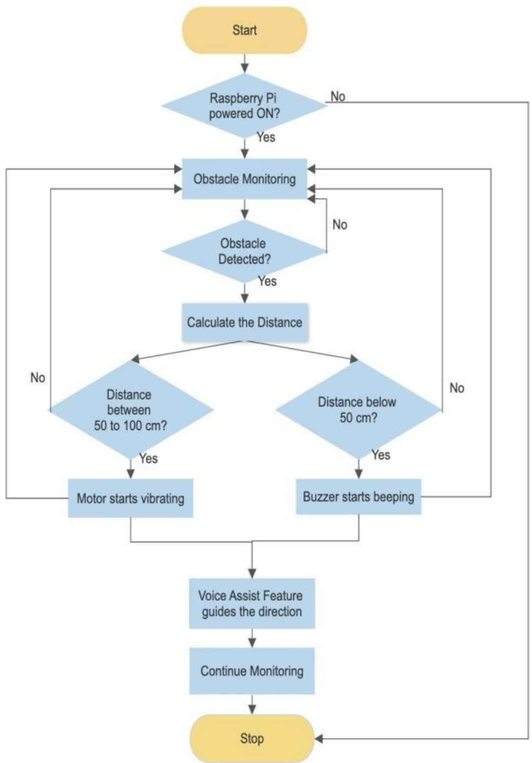

Figure 2: Flowchart of execution of obstacle detection and voice assist

The ultrasonic sensor follows the same principle as of a radar system. These sensors emit short, high-frequency sound pulses which on striking an object, are reflected back as echo signals to the sensor, which itself computes the distance to the target. In this system, all the three ultrasonic sensors are connected to the Raspberry Pi. If the echo wave is received, then it indicates the obstacle is detected. The sensor then sends the data to Raspberry Pi so that it can compute the distance. According to user convenience, the threshold values are set in the Raspberry Pi. The threshold value is a predefined distance range within which the obstacle can be detected. When the obstacle is at a distance between 50 cm and 100 cm, the motor starts vibrating. This vibration alerts the user that the obstacle is approaching and allows him to take the necessary action. When the obstacle is at a distance of 50cm and below, the Raspberry Pi signals the buzzer to start beeping which indicates that the obstacle is very close by.

The water sensor implanted on the walking stick is used for detecting small water puddles. When the stick comes in contact with water accumulation, the Raspberry Pi is triggered. This control kernel uses the Voice Assist feature implemented in the system to alert the individual.

The next module used in this system is the voice assist feature. This feature helps in guiding the individual to take the correct move. The user plugs in his earphones which are connected to his mobile phone. When an obstacle approaches, the ultrasonic sensor sends signals to the Raspberry Pi which guides the user to take the right step using Google's text to speech API. This is done by measuring the amount of free space around him. When an obstacle is ahead of the user, this feature alerts him by a voice message. If the user is unable to move forward, the voice assist feature asks him to either turn left or right depending on the amount of space left beside him. If he is unable to move forward as well as to his sides then this feature guides him to turn around. In case of a water puddle, this feature alerts the individual by informing him that there is water present ahead of him.

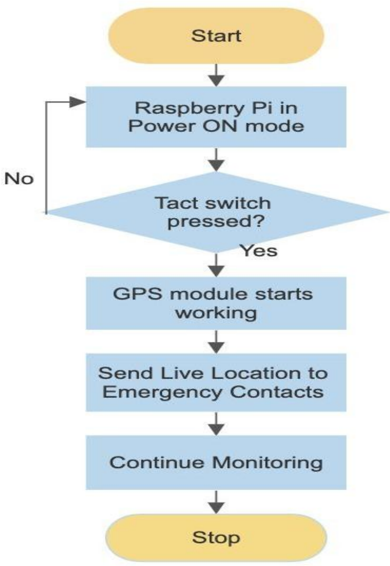

Figure 3: Flowchart of execution of Real-time location tracking

The final module of this system provides the location information of the user. In this system, an Android-based application is used that is downloaded from the open source Google play store [7]. After testing it in several situations, it was found that this application is really helpful for both blind as well as for partially sighted people. This module starts working when the user presses a tact switch mounted on the walking stick. When the switch is pressed, the GPS module is powered on and it sends his current location to his emergency contact number in the form of an e-SOS [7-8].The GPS module is connected to the Raspberry Pi through a UART interface. This message is sent through an android mobile application called Telegram [9]. According to user convenience, it can be configured in such a way that the message can go to one person or to a group of people on this application. This feature will aid the user in case of an emergency situation enabling his friends or relatives to locate him, thus ensuring his safety.

4. Results

A. Obstacle detection:

When the obstacle is detected within the set range of the sensor, the distance to the obstacle from the user is calculated. If distance is above 50 cm and below 100 cm, it alerts the person through vibrations of the motor. If it is below 50 cm then the buzzer starts beeping so that the person can take a move to avoid the obstacle.

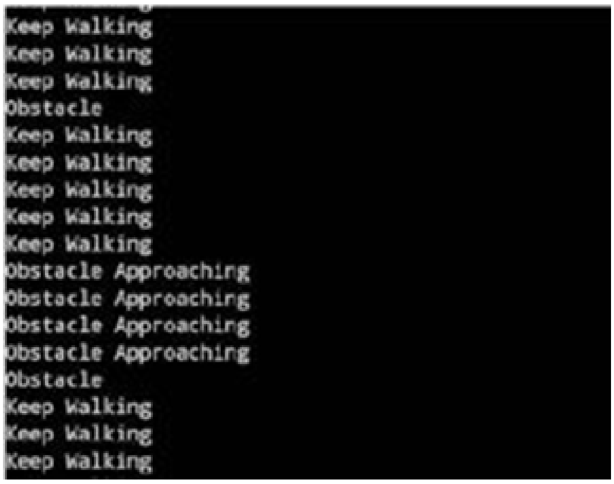

Figure 4: Experimental Result of Obstacle Detection

B. Voice Assistance:

When the obstacle is detected by the sensors placed on the front side of the stick, a trigger is sent to the ones placed on the left and right side of the stick. First, the left sensor checks if there is any obstacle on that side and if there’s none, then it guides the VCP to take that direction. If the left sensor also senses the obstacle ahead, then the VCP is guided to take the right turn. If all the sensors sense an obstacle then the person is guided to turn around.

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Figure 5: Experimental Observation of Voice Assist

C. Real-time location tracking:

In case of an emergency situation the VCP presses the tact switch mounted on the stick. This sends the individual's live location to his emergency contact or to a group of contacts. This is done using an application called Telegram.

Figure 6: Experimental Observation of Real-Time Location Tracking

5. Discussion

In the proposed system, each component was experimented individually to analyze the results and performance. We then combined the codes of each function, executed them simultaneously, and integrated all the components into the smart walking stick for implementation. In the future, we want to collect data regarding the types of obstacles detected by the user, and data analysis will be done using a neural network learning algorithm to predict any dangerous situations encountered by the blind person, so that they can be avoided in the future.

6. Conclusion

We finally conclude that we have implemented all the ideas that we have claimed in our project. The embedded system is implemented in the stick and we have succeeded in integrating the ultrasonic sensor, water level sensor, vibration motor, buzzer, the voice assist module, the GPS module and Raspberry Pi as the master controller. All the components worked well and provided accurate data. It was noticed that when the obstacle was at a distance of 50cm - 100cm, the motor started vibrating and when the obstacle was below 50cm from the person, the buzzer started beeping. This concludes that the observed output and the expected output was the same. Hence, we can say that it's capability in specifying the distance from the obstacle which may be encountered by the individual is efficient and unique.

The different forms of alerts implemented in the system helps the user to get a better picture of his surroundings and thus take the necessary action. The whole project aims at providing assistance to a fully or partially blind individual aiding him to navigate from one place to another using the conventional sensor based technology. Thus, ultimately this could increase the confidence level of the user as well as make him/her feel secure.

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