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GUIDANCE SYSTEM FOR VISUALLY IMPAIRED PERSON

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Abstract-*Blindness is one of the most feared afflictions in the world. It is difficult to travel to a desired destination for blind people. This system eases this process by providing two core facilities – a short range obstacle detection system and a source-to-destination shortest path guidance system. The features of this device are real time Obstacle Detection, Distress Calling, global position monitoring, Voice Command functionality & Shortest Route Guidance. The System hopes to provide blind people to simply press a button from mobile, speak the desired destination & be guided there by the system's audio instructions. The goal is to develop a system that will provide guidance for visually impaired individuals to reach desired destination.*

Keywords: Blind Guidance, Global positioning system (GPS), embedded system, smartphone application, Bluetooth communication**.**

1. INTRODUCTION

Blind mobility is one of the main challenges that scientists are facing around the world. The number of people with visual disabilities is around 285 million and 39 million of them are blind [1]. According to World Health Organization 90% of blind people live in developing country [1]. Since blind support devices are expensive and many blind people can't afford it. This project aims to develop a cheap blind guidance system for developing countries like Bangladesh.

The goal of this paper is to develop a low-cost intelligent system for guiding individuals who are blind or partially sighted by providing information about the environmental scenario of static and dynamic objects around them. The main functions of this system are path indication and environment recognition.

The system is equipped with a smart phone & a small embedded circuitry. Software is developed in the smart phone to recognize the destination place from voice command and to draw a route from current position to desire destination. Ultrasonic sensors will provide information about obstacles if it is in the range. Ultrasonic sensors are connected with microcontroller circuit and microcontroller timer module is used to determine the sensors output and send them to smart phone via Bluetooth.

2. RELATED WORK

Current Patents and Existing Technologies are Smart Canes with obstacle detection, Sonar vision glasses providing obstacle detection, GPS navigation systems providing directions. There are some devices, like head mounted sonic guide (1974) and KASPA system to assist blind people. Researcher developed a device that acquires Depth data using Microsoft cane sensor. In this research, neural network is used to detect obstacle [2]. Advanced real time mobile robot obstacle avoidance system is used to provide assistance for visual impaired peoples. The Navbelt gives travel aid to user and to choose path [3]. A device is developed for blind people to walk independently by speech guidance on current location. It provides navigation information to reach a particular destination. A system introduces an approach using vision system only and it computes weight between already stored image and real scene [4]. Bluetooth technology applications are implemented also [5]. A voice operated system with GPS and Ultrasonic sensor is developed to assist blind people. But it fails to detect obstacle and give warning alerts.

3. SYSTEM ARCHITECTURE

As shown in figure 1, the architecture of the system mainly consists of five parts: ultrasonic sensor arrays, Bluetooth module, microcontroller board, smart phone (in this project a WINDOWS 8 Phone from NOKIA is used) and a headphone. Ultrasonic sensors are incorporated to detect obstacle [6].GPS sensors used for navigation purpose [7]. PIC16F877A microcontroller is used to send trigger signals to various ultrasonic sensors & then read the output (echo) from different sensors [8]. From this output the PIC16F877A measures the corresponding obstacle distances associate with the individual sensors. PIC16F877A then transmit this distance values from different sensors to the smart phone via Bluetooth device. UART (Universal Asynchronous Receiving

&Transmission) serial communication is used between microcontroller & Bluetooth device.

4. HARDWARE COMPONENTS

The entire system is completely implemented using cost-effective assistive technologies to provide blind people with a greater degree of independence in their daily life. Each unit in the system undertakes a specific job and can be explained as follows:

A microcontroller is a computer-on-chip used to control electronic device. PIC 16F877A microcontroller is used for driving the sensor modules & extracting the distance from the output signal of the sensor module.

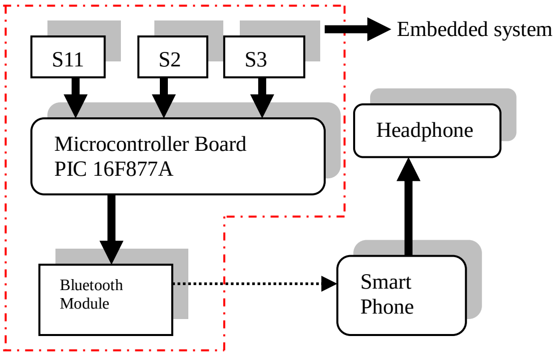


Fig.1: System block diagram

A Bluetooth device which works in slave mode is used to transmit the distance data from microcontroller to user's phone. UART communication protocols are used here for data transmission. A 9v 7,000mAHNi-MH (nickel metal hydride) battery packs to power the device. Ultrasonic Electronic Eye Telemeter Module, HCSR04 is the ultrasonic sensor that will carry out the detection of the obstacles. The sensor is able to transform the data into an impulse of different width by means of microcontroller. A computer processes ultrasonic signals emitted by a transmitter, which is carried by the impaired user and provides real-time information about distance from obstacle. The microcontroller than send it through Bluetooth. HCSR04 ultrasonic sensor module is consists of 2 signal conditioning pin trigger & echo pin. For detecting obstacle & measuring distance Ultrasonic sensor's triggering pin and echo pin should be connected to the microcontroller. The microcontroller's IO (Input/Output) trigger pin should send high level signal for at least 10us.Then The Module automatically sends eight 40 kHz ultrasonic sound burst at 40 kHz and raise its echo. Microcontroller calculates the range through the time interval between sending trigger signal and receiving echo signal. The range of measurement is 0.03 meter to 4 meter. The processing power and battery power that Bluetooth module requires in order to operate is very low. The chances of network interference are very low. Bluetooth functions at less than 100 meters but it doesn't require a line of vision and is cable free

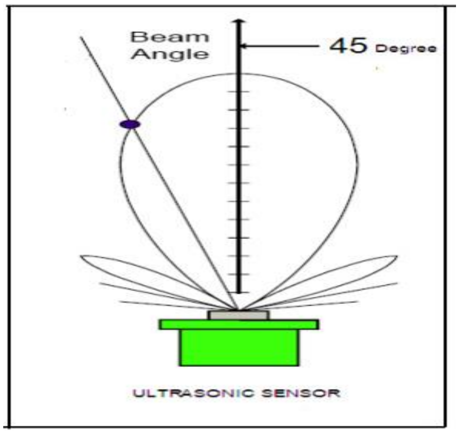


Fig.2:Sonar radiation Angle

5. OBSTACLEDETECTIONANDDISTANCE MEASUREMENT PROCEDURE

This device has three sensor placed in user's body. One is in users hand palm, one is in forehead & one is placed just below the knee on shin. The arrangements of sensors are given in figure 4. Now a visual impaired person can detect any kind of obstacle around him & detect holes on road &stairs by these sensors. Sensor 1 and sensor 3 is used to detect obstacle.

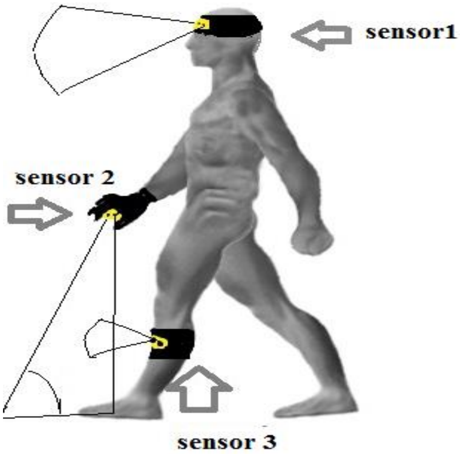


Fig.3:Sensor's placement

This 3rd sensor is used to detect obstacles which are small in height (below knee level) & staircase. As human can rotate his neck about 180 ° sensor one can detect any obstacle in front of user. Sensor 2 is used to find holes on the surface. At first when user starts this application from smart phone it asks the user to stretch its hand at 45 degree angle and it takes the distance value as reference. When a hole comes in front of the user sensor 2's data goes higher than reference value. So software detects hole and inform user using voice instructions. This will work as the virtual cane for the user.

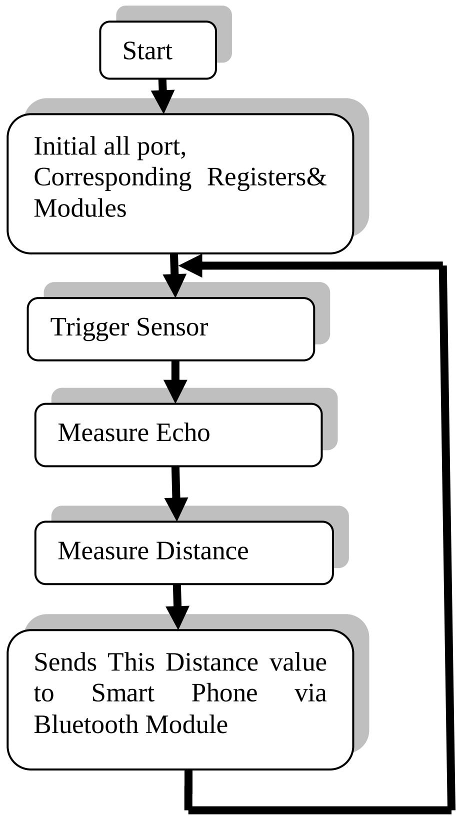


Fig.4 :Program modeling diagram

All the 3 sensor modules are driven & distance data is calculated by single microcontroller. The code for the embedded system is developed using figure 4 program modeling diagram. This process is repeated continuously three times one after another for measuring & detecting obstacles from each sensor.

6. SOFTWARE DESCRIPTION

Software that is developed in the smart phone for this project has the following functions.

When software starts it asks user whether it will start in blind mood or normal mood. If user asks for blind mood then it tells the user to expand his right hand to calibrate the reference value. Reference value is the distance from user's hand palm to ground which is provided by the sensor2 on the right hand of the user. After this session software asks the user for destination. User can select the destination through voice. To support speech recognition, Windows Phone 8 includes a speech runtime, recognition APIs (Application Programming Interfaces) for programming the runtime, ready-to-use grammars for dictation and web search, and a GUI (Graphical User Interface) that helps users discover and use speech recognition features. So, using this API we can easily receive the name of destination place.

In background our apps find the user's current location through the GPS of the phone. This is an asynchronous operation. For this purposes location API for windows phone 8 is used. Here, developed software continuously track user's current loction. At first the status of the user consent in the ApplicationSettings dictionary is checked. If the value of the status is false, then the method exits. When user consent has been confirmed, the method initializes the Geolocator object and sets the Desired AccuracyInMeters property. Than the Get Geoposition Async method is called which obtains the phone's current location. It is done asynchronously. The await operator is used to place code after the asynchronous call that will be executed after the call finishes. This requires this handler method to be declared asynchronous [9].

After receiving destination address our apps draw the shortest path between the user's current position and destination using Bing map from Microsoft Corporation. Firstly destination address is converted to geocoordinates. By creating a new RouteQuery object and stores the coordinates of the current location and the specified destination in the Waypoints property of the RouteQuery. When our apps track current location it will check the waypoints of shortest path and give direction through audio instructions. For this purposes we use Windows phone speech synthesis API. Here we use simple geometric equation to determine whether the next point is in left or right to the current point. We calculate the area using previous point, current point and next point. If the calculated result is greater than zero than our next position is in left to the current point whether the positive result indicate the right direction. If the result is zero then it indicates the straight direction.

If we consider three points P(xp, yp),C(xc, yc) and N(xn, yn) then the area of ΔPCN is xp (yc-yn) - xc (yp-yn) +xn (yp-yc). As it is app to device Bluetooth connection, first the Bluetooth module is paired with windows phone 8. After a certain time period our embedded device sends the surrounding information to the phone through. Receiving that information our apps give necessary instruction to the user through audio instructions. Our sensor sends the data to the device after a certain time period continuously. We have to compare this data with our stored data. If current data is less than stored data then there is an obstacle in front of the user. If the current distance from sensor 2 is greater than reference value then there is a hole in front of the user. According to the comparison our apps notify the user about the surroundings through voice command. When the user will reach at the destination point software will notify the user about arrival. During the journey if the user encounters any danger during this tour, shaking the phone will send a distress call to a preset mobile number.

7. EXPERIMENTAL RESULTS

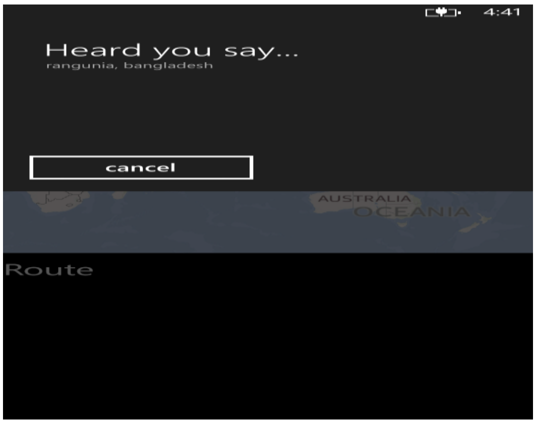
The developed system has been evaluated with two main experiments. In the first experiment, we examines how the ultrasonic sensor functioning. The experimental range from HCSR04 to be 0.05 meter to 3.95 meter and the signal covers an angle of 45 degree (approximately) as measured.

In the second experiment, the developed software is tasted on the following sequence.

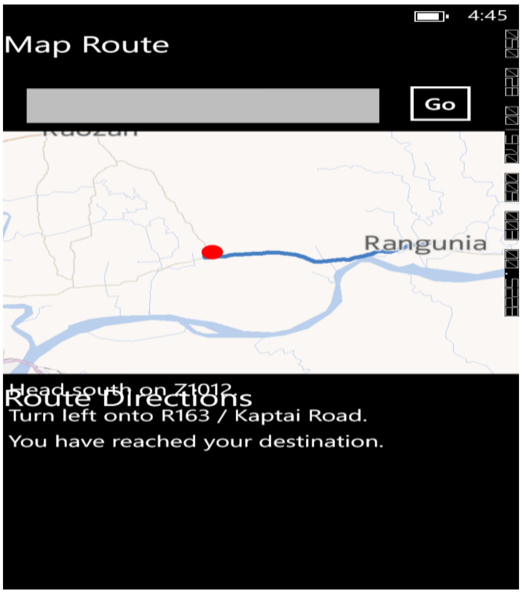
- Connect to the external hardware (with Bluetooth module HC-06).
- Calibrating the short range detector (Receiving reference value from sensor 2)
- Submitting destination via user's voice
- Drawing route to shortest distance.
- Following route through audio directions.

Some outputs from this software are shown below.

(a)



(b)



(c)

Fig.5: Software output (a) asks for destination (b) receive destination (c) Draw route (red mark is the current position & blue colored curve is the route).

This project has satisfactory result in the sense of basic goals. Like detecting obstacle and providing shortest path to destination with voice command. It is possible to detect obstacle, small object and hole and inform the user about it. Meanwhile there are some scopes of improvement to our navigation system like more powerful sensors can be incorporated in the project to provide the detection of obstacles in a wider range, incorporate proximity sensors for high sensitivity, start the phone software through voice command. In experiment it is found that the path should be defined precisely with GPS coordinates. But GPS coordinates does not change if user deviate from right path by one or two steps.

8. CONCLUSION

The project targets one of the most prominent problems of our current society. Till now this problem has not been properly addressed and the visually disabled people still suffer from a lack of physical freedom. Our motivation is to lessen their hardships and make the world a bit easier for them. It is possible to use more sensors to detect different shapes of obstacle precisely. This system can work in both indoor and outdoor environment effectively. The experimental results have shown using this device hole ,obstacle is detected and successfully alarmed the user but due to GPS locations less sensibility blind people can entrust fully. So it should be used as a helping device for better understanding the environment.

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