Vibrotactile Feedbacks System for Assisting the Physically Impaired Persons for Easy Navigation

M Safa¹, G Geetha², U Elakkiya³ and D. Saranya⁴
¹,²,³Department of Information Technology, SRM Institute of Science and Technology
⁴Department of Electronics and communication engineering, AEC, Kumbakonam

safa.m@ktr.srmuniv.ac.in, geetha.@ktr.srmuniv.ac.in

Abstract: NAYAN architecture is for a visually impaired person to help for navigation. As well known, all visually impaired people desperately requires special requirements even to access services like the public transportation. This prototype system is a portable device; it is so easy to carry in any conduction to travel through a familiar and unfamiliar environment. The system consists of GPS receiver and it can get NEMA data through the satellite and it is provided to user’s Smartphone through Arduino board. This application uses two vibrotactile feedbacks that will be placed in the left and right shoulder for vibration feedback, which gives information about the current location. The ultrasonic sensor is used for obstacle detection which is found in front of the visually impaired person. The Bluetooth modules connected with Arduino board is to send information to the user’s mobile phone which it receives from GPS.

1. Introduction

According to the survey it is estimated that in India approximately 125 crores people are living but more than 15% of the people are blind. The blind person generally uses white canes or some external help for navigation. At present many devices are available for providing guidance to reach the destination from anywhere. Many technologies are introduced but for common people, it is most expensive to acquire.

Blind people can get information through his/her sense either through contact with objects, or take external help from others in day to day life, by exploring the environment and using their hands to understand the shape of an object, moreover, blind people can become aware of other features of the objects such as temperature, texture, weight and etc..

Generally, the blind people use the white cane techniques to move independently from one place to another without taking help from others. In order to lead easy, comfort and joyful life, one of the most significant requirements is the ability to move independently without taking any external help for mobility. So to help blinds for convenient navigation we developed a versatile device. Due to the wide popularity and availability of Wireless Sensor Network (WSN), it is used in different domains starting from Military, Healthcare, logistics and transportation, structural health monitoring, agriculture, smart homes etc., hence the same is used in our device for transmitting the information without any hindrance from anywhere. The Arduino board remains very popular as the general purpose microcontrollers and it is a self-contained system with a processor and memory, and even it arrives at a low cost. In this project, we have developed a prototype for the blind people. This
prototype has been designed to help the blind people to navigate everywhere and anywhere very easily. The low-cost affordable microcontroller /processors, embedded systems, communication standards and other allied technologies contribute the exponential growth of WSN technology. NAYAN has been designed to help the blind person to familiarize them with the known and unknown environment. Smart phones with GPS enabled devices are mainly used to provide navigation information to the visually impaired person. We have used the Bluetooth module to connect the mobile to the Arduino board. The mobile phone gets connected to Bluetooth modules through Bluetooth interface. With the help of GPS module, the current location information is collected and communicated to the physically impaired person through the smartphone with GPS enabled using Arduino Uno board. Ultrasonic sensor has been used to detect obstacle present in front of the walking path and if any obstacle detected it sends the voice message to the physically impaired person to take an alternate path. The vibrotactile system helps the blind person to move either left or right direction according to the vibration detected in the respective shoulder.

There are several systems that have been designed to assist the visually impaired person on daily task. Our proposed system consists of eight vibration motor shad arranged around the visually impaired person’s waist. Vibrotactile provide sensory vibration effective coding scheme that does not require any training. All this approach used for tracking with help of specialized hardware. [2] Generally the system is linked with GPS GSM modules which will pinpoint the location of a blind person through GSM GPS modules and send SMS Message of current location which was configured and preprogrammed already in a module which makes the call to cell phone and provide information from the GPS satellite [3]. The Author proposes to use sensory contact speakers on the users back to indicate the direction of the next waypoint. The authors concluded that a combination of sensing and voice-based information provide reliable and deliverable to a user and greatest number of visually impaired people are covered in this conduction. Some of the related works are used to tactile belts demonstrated GPS- based waypoint navigation using a single [4]. For sensing of the immediate environment of the blind people to travel with the help of GPS and navigate to the remote destination. [5] Azenkot and Ladner resort to just one tractor to provide turn-by-turn instructions to people with visual impairments. Three methods have been evaluated for giving blind and low-vision people with help of mobile phone. Results demonstrate that one impulse is a viable means of communicating directional information without demanding the user’s auditory attention or requiring special hardware. [6] ANDHA ASTHRA in their paper presented that, through the ultrasonic sensor also called as obstacles sensor. An ultrasonic pulse is generated in particular direction if there is an object in the path pulse, part or all the pulse are reflected back to the sensor as an echo and provide the navigation to the visually impaired person. [7] Implementation a wearable zig bee based guidance system in which a microcontroller collects ultrasound and GPS signals for sensor attached to sub-controller and provide the appropriate direction for the blind person.

2. Proposed Implementation

Our proposed system classified as an assistive technology for blind people. This system provides a software and hardware prototype that guides them in any environment. As we know the blind person can help themselves to obstacles. By using simple assistive technologies like white cane and even they rely on their own sense. The proposed system consists of three major components each component linked with each other and communicates with each other as shown in Figure 1.

2:1:Navigation System:

Navigations system is the base for this prototype. It is responsible to determine the navigation of the visually impaired person through the help of smartphone and GPS modules. The Vibro tactile which act as sensing device helps for the blind to know the path route. The Two tactile
devices which have been placed on their every shoulder will vibrate and provide alert to move in
which direction either left or right.

2.1.1: GPS Module:
   The GPS module gets current information about the locality and provides through the Arduino
   board to the blind. As we know GPS works according to NEMA data, which provides the latitude
   and longitude information and it is sent to the microcontroller connected with the computer. It
gives the following information
   • About roads or paths available
   • Traffic congestion and alternative routes
   • select the road to reach the destination
   • If some roads are busy at any particular point in time or historically, the best route to take are
     suggested
   • The shortest route to reach the locations.

2.1.2: Ultrasonic sensors
   Ultrasonic sensors are defined as electronic devices that will measure the distance it can use
sound to accurately detected and measured its distance upper range of human hearing called the
audible range, between 20 hertz and 20 kilohertz – and determine the distance between
The sensor and an object based on the time it takes to send the signal and receive the echo. The ultrasonic sensor can
provide information about the obstacle in the visually impaired person

2.1.3: Arduino
   The Uno is a microcontroller board based on the ATmega328P. It contains everything needed
to support the microcontroller; this is user-friendly device compare to another microcontroller.

2.2: Communication component:

2.2.1: Bluetooth module
   HC-05 Wireless Bluetooth RF Transceiver Module Serial/TTL/RS232 used for Arduino. The
   Arduino BT is a microcontroller board. It is based on the ATmega168, but now it is supplied with the
   328. It supports Wireless serial communication over the Bluetooth. We need to have an Android
device with Bluetooth enabled and it is connected to the Arduino board. The Bluetooth modules are
preprogrammed.

2.2.2: TTS (Text to speech)
   Text to Speech Component: It is responsible for speech synthesis, i.e. it converts text to
   speech. The system will use one of the text to speech engines that are supported by Android OS. Use
   the android application to convert the information get from the board.

2.2.3: Interface component.
   The system will use voice-based interface since it is most suitable for the blinds

3. Architecture Design
   Figure 1 shows the architecture of a proposed model. There are many voice recognition system
with up to 10 possible interpretations to select from a different language. The user can tell the
location where they need to reach. Through Bluetooth module, it reaches the Arduino Uno board
where the distance can be calculated and the shortest path can be calculated. For every 10 to
15us Pulse is sent to trigger the module. Then it checks the echo for every for 8 cycles of 40 KHz
ultrasound signal. The signal which strikes with an obstacle returns back and is captured by the
receiver. Thus the distance of the obstacle from the sensor is simply calculated by the formula given
as
Figure 1: Proposed system architecture

Figure 2: Formula calculation

Distance = \( \frac{\text{time} \times \text{speed}}{2} \). The product of speed has been divided and time by 2 because the time is the total time it took to reach the obstacle and return back is also calculated. Thus the time to reach obstacle is just half the total time taken. The left and right vibrator rotates and show the path for the blind.

Floyd–Warshall's Algorithm is helped to find the shortest paths between all pairs of vertices in a graph, where each edge in the graph has a weight which is positive or negative. The major benefit of using this algorithm is that all the direct spaces between any two vertices could be intended in \( O(V^3) \), where \( V \) is the number of vertices in a graph.

For a graph with \( N \) vertices:

- Prime the direct paths between any two vertices with Eternity.
- Novelty all pair shortest paths that use 0 in-between vertices, then find the shortest paths that use 1 intermediate vertex and so on. Until using all \( N \) vertices as intermediate nodes.
- Decrease the shortest paths between any 22 pairs in the preceding action.
- For any 2 vertices \((i,j)\), one should actually cut the spaces between this duo using the first Knodes, so the shortest path will be: \( \min(\text{dist}[i][k]+\text{dist}[k][j], \text{dist}[i][j])\).

\[
\text{dist}[i][k] \text{ characterises the shortest path that only uses the first } K \text{ vertices, } \text{dist}[k][j] \text{ represents the shortest path between the pair } k,j. \text{ As the shortest path will be a series of interconnected things of the shortest path from } i \text{ to } k, \text{ then from } k \text{ to } j.
\]

```java
for(int k = 1; k <= n; k++){
    for(int i = 1; i <= n; i++){
        for(int j = 1; j <= n; j++){
            \text{dist}[i][j] = \min( \text{dist}[i][j], \text{dist}[i][k] + \text{dist}[k][j] );
        }
    }
}
```
4. Conclusion and Future Work

Blind people are facing many problems in day to day life. Thus, with the intention to promote the Integration of blind people in society; we proposed a prototype with a new approach based on mobile phone and GPS and vibrotactile feedback. With the help of android phone information about the navigation provided to the visually impaired person. The navigation prototype is shown the navigation system "NAYAN". In a future aspect, the design will be simplified and implemented in the real-time setup for a visually impaired person, and in the place of GPS module, we will use mobile GPS system for navigation. The navigation system is more user-friendly to operate for the blinds and even the illiterates.

The real-time interface of the Global Positioning System (GPS) module helps in tracking the person at each and every time instantly for the visually impaired person in his life. In the future version for the visually impaired person, we are going to give marketing information in the user’s application, allowing blind users to easily beware of recent promotions and products. This additional feature may bring commercial relevance to brands and store owners since it enables publicity of services and products to a wide audience.

REFERENCES

[1] Erp, Veen, Jansen C., and Dobbins T., 2005 Waypoint navigation with a vibrotactile waist belt ACM Transactions on Applied Perception, 2, pp. 106-117.
[2] Abdul Ilabnour Alshbalat, 2013 Automated mobility and orientation system for blind or partially sighted people 6, pp. 423-426.
[3] Ross D.A and Blasch B.B., 2000 Wearable interfaces for orientation and wayfinding Proc. 4th International ACM conference on Assistive technologies - Assets, pp. 193-200.
[4] Marston J, Loomis J, Klatzky R, and Golledge. R., 2007 Nonvisual route following with guidance from a simple Haptic or Auditory display Journal of Visual Impairment and Blindness, 101, pp. 203.
[5] Manoj Badoni and Sunil Semwal, "Discrete Distance And Water Pit Indicator Using Avr Atmega8 In Electronic Travel Aid For Blind", International Journal of Disaster Recovery and Business Continuity Vol. 2, November, 2011.
[6] Sung Jae Kang, Young Ho, Kim, In Hyuk Moon, "Development Of An Intelligent Guide-Stick For The Blind", IEEE International Conference on Robotics & Automation Seoul, Korea, May 21-26, 2001.
[7] Alessio Carullo and Marco Parvis, "An Ultrasonic Sensor For Distance Measurement In Automotive Applications", IEEE Sensors Journal, Vol. 1, No. 2, August 2001.
[8] Johann Borenstein and Iwan Ulrich, "The Guide Cane-A Computerized Travel Aid for The Active Guidance Of Blind Pedestrians", IEEE International Conference on Robotics and Automation, Albuquerque, NM, Apr. 21-27, 1997.