Voice Based Navigation System for Guiding Visually Impaired People

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Abstract—Navigating the visually impaired people are challenging in the unfamiliar environment. This paper proposes a system for the impaired people to guide them towards a destination in the unfamiliar environment. The proposed system at first informs the way to destination then guides towards the destination by making different sound informing different things in the environment. Following the sound, the impaired people know the characteristics of the environment and predicts the position of the things and moves towards the destination. This system design by using Bluetooth wireless network to accomplish the navigation. Two types of module are used namely receiver module and transmitter module. Receiver modules are located on different things in the environment. The impaired people carry the transmitter module in his/her hand and transmits a signal by pressing a button. During the movement of the impaired people the nearby receiver modules receive the transmitter signal and make sound informing the location and nature of the things. The study shows that the proposed system is useful in navigating the visually impaired people.

Keywords—Visually impaired people, Wireless guidance system, Bluetooth network, Navigation system, Transmitter module, Receiver module.

I. INTRODUCTION

According to the World Health Organization (WHO) estimation (2017) 253 million people in the world live with vision impairments: 36 million are blind and 217 million are severe impairments [1]. In spite of being blind they are not free from their social responsibilities. They need to go to different places including city office and bank on a regular or non-regular basis. In such public offices they cannot move around in the environment to do the work independently. They need help of someone else.

A number of research works could be found on navigation of visually impaired people in both indoor and outdoor environments. Some of the existing works use smartphone as the device for the impaired people in the indoor environment. But operating smartphone is not easy for the impaired people of developing countries especially for Bangladesh where most of the people have no sufficient education facilities.

The object of this research is to develop a system that enables the visually impaired people to do their work in both indoor and outdoor environments without being dependent on someone else. The proposed system consists of a Bluetooth wireless network with multiple receiver modules and one portable transmitter module. The receiver modules are mounted on different objects on the environment. The impaired people hold the transmitter module and walk around the environment. The transmitter module has a keypad consists of different push buttons. Each push button has a specific predefined purpose and work on two modes: the first mode provides information about the way to destination and second mode is used to navigate in the environment.

The receiver modules periodically sense the channel for the signal from the transmitter. The receiver module receives the transmitter signal when the impaired people with the module reaches under the communication range and press the button. Upon receiving the transmitter signal the receiver module starts making sound informing the object on which it is mounted. The module continuously makes the sound until the transmitter module reaches out of its communication range or press the button by the user one more time. The proposed system is easy to understand the operating procedure for the impaired people without pre-knowledge of the system.

This paper consists of five sections. Section I discuss the introductory concept of the proposed system. Section II discuss the recent works on navigation system. The proposed system designing procedure is discussed in Section III. Section IV discusses the installation of the modules in the environment and performance analysis. Finally, Section V concludes the works and places some direction of future works.
II. RELATED WORK

A number of works could be found on navigating the impaired people in both indoor and outdoor environment. Most of the methods assume that visually impaired people have knowledge of environment where they act in either well-known or partially known of surrounding [2]. There are many navigation systems for the visually impaired people which are based on Global Positioning System (GPS) [3], [4], Smart phone [6], [7], Radio Frequency Identification (RFID) [8], [9], [10] and wearable devices [11], [12].

In GPS based system a GPS receiver is required by the visually impaired people to move in the indoor and outdoor environment. Using the longitude and latitude values received from GPS satellites [3], [4] the user system finds the position. This system has the disadvantage that the location of the blind person could be tracked only by using the specified cell phone number i.e. if the saved number in the system is lost or deactivated the location tracking would fail [5]. Only outdoor navigation could be provided using GPS as it doesn’t work for indoor navigation in Bangladesh.

The Smartphone cannot easily be driven by the visually impaired people. For example, authors in [6] and [7] use android app and database to generated instructions for the impaired people to reach the destination. These kinds of app-based system are complex to hand by the blind people especially for the developing countries where most of the impaired peoples are not familiar with the advanced technology.

The RFID based navigation system needs the deployment of RFID tags in the environment [8], [9], [10]. The system needs RFID cane reader, Bluetooth interface and personal digital assistance which provide technical solution for the visually impaired to pass through public locations easily. But its initial development cost is high and chances of interference in heavy traffic.

Wearable sensor-based navigation [11], [12] is proposed by different researchers where the impaired people have to carry different devices in his body. These sensors collect the information of the environment and inform the impaired people. However, it relies on heavy and complex handhold devices.

Thus, a simple, robustness, low cost and high-performance indoor and outdoor navigation system is desirable that is proposed in the following sections.

III. THE SYSTEM DESIGN AND WORKING PRINCIPLE

The system was designed and implemented using two devices.
1. Transmitter or user end device, and
2. Receiver or environmental device.

![Fig. 1. Block diagram of (a) user end device and (b) environmental device.](image)

The block diagram of transmitter and receiver devices are illustrated in Fig. 1(a) and (b), respectively. The transmitter and receiver devises consist of different hardware components. A brief introduction of the components are as follows:

A. Hardware Components
- Microcontroller
- HC-05 Bluetooth Module
- Micro SD Card Reader module
- LM386 Audio Amplifier
- MicroSD Card
- Speaker
Ultrasonic Sensor
DC Adapter
Battery

B. Design of LM386 Audio Amplifier Circuit

For the transmitter and receiver, we designed a LM386 audio amplifier circuit. The integrated chip LM386 is a low power audio frequency amplifier requiring a low-level power supply. It is an 8-pin mini-DIP package. The IC is designed to deliver a voltage amplification of 20 without external add-on parts. But this voltage gain can be raised up to 200 (Vu = 200) by adding external parts [13]. A simple but efficient audio amplifier is designed using LM386 audio amplifier IC. The working of the circuit is very straightforward as all the work is done by the LM386 IC itself. When the system is powered on and proper audio input is given at the input, the LM386 amplifies the input signal by a factor of 200 and drives the output speaker. The circuit diagram of LM386 audio amplifier is illustrated in the Fig. 2.

![Fig. 2. LM386 audio amplifier circuit.](image)

C. Design of Transmitter Circuit

Fig. 3 illustrated the transmitter or user end device circuit diagram. The transmitter circuit consists of the following sections.

- Keypad section
- Audio input section
- Audio amplifier section
- Obstacle detection section
- Transmitter section
- Power source section

The keypad section of the transmitter circuit consists of several push buttons.

![Fig. 3. Circuit diagram of user end device.](image)
The SD card reader module is used to interface between micro-SD card and Arduino Uno. The communication interface between micro-SD card reader module and microcontroller is standard SPI. The audio amplifier section consists of the designed LM 386 audio amplifier. This audio amplifier circuit is used in both transmitter and receiver. In the transmitter the HC-05 Bluetooth module work as master module and transmit the different signal according to the user command. One ultrasonic sensor is used in the transmitter circuit to detect the obstacle in front of the visually impaired people. The transmitter circuit is the control device of all the receiver devices in the installed environment (public service places, banks and offices and so on).

**D. Design of Receiver Circuit**

Fig. 4 shows circuit diagram of receiver device. This circuit consists of the following sections

- Receiver section
- Audio Amplifier section
- Micro SD Card Reader section

![Fig. 4. Circuit diagram of installed environmental (receiver) device.](image)

In the receiver circuit the HC-05 Bluetooth module is set as slave module and it receives the transmitted signal. The recorded voice makes sound and gives the information of the environment according to the command in the transmitter circuit. The user controls the receiver circuit using the transmitted signal by the pressing the push button of the user end device. The design of all receiver circuit is same but the pre-recorded stored voices are different, it depends on the object of the environment and user requirement.

**IV. SETTING MODULES IN THE ENVIRONMENT AND RESULTS**

**A. Experimental Setup**

We set different modules in the office of the Department of Information and Communication Engineering of University of Rajshahi. We consider there are eight locations, where the visually impaired people want to move. We place the receiver modules in the door and the corner as shows in Fig. 5. Since the receiver modules are fixed in position we power the receiver modules with cable connected from ac source.

![Fig. 5. Installed receiver door and corner modules.](image)
Finally, Fig. 6 shows the user module. Since the impaired people carry the transmitter module. The user end module is powered by the rechargeable battery. The power consumption of the transmitter circuit is relatively low, since it’s turning on power, when user required to move one location to desired destination location. We performed the experiment by keeping the transmitter module in a fixed position of the office. The user module has eight buttons in the keypad. The functions of the all key are related to the direction of 8 locations in the office. In the outdoor environment, the receiver module could be fixed in different position including turning of a road, on a tree, on an electric pillar, near a canal, a staircase of a shop, a door of a shop or a house and so many. To detect the temporary obstacles the ultrasonic sensor is used to send a signal to the transmitter module.

![User module](image)

**Fig. 6. User end (transmitter) module.**

For the experiment we install the devices only in an indoor environment. For the fixed obstacles in the outdoor environment such as airports, public parks, colleges, the devices can install similar to the indoor environment.

### B. Cost Analysis

The cost of a transmitter and a receiver is given in Table I. It is seen from the table that the designed system is cost effective and economical. The total cost of this system depends on the setup environment.

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Cost (BDT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontroller (No. 2)</td>
<td>2x175=350</td>
</tr>
<tr>
<td>HC-05 Bluetooth module (No. 2)</td>
<td>2x250=500</td>
</tr>
<tr>
<td>SD card reader module (No.2)</td>
<td>2x240=480</td>
</tr>
<tr>
<td>HC-SR 04 ultrasonic sensor</td>
<td>120</td>
</tr>
<tr>
<td>Speaker</td>
<td>2x50=100</td>
</tr>
<tr>
<td>AC to DC adapter</td>
<td>120</td>
</tr>
<tr>
<td>Switch, Battery and other parts</td>
<td>800</td>
</tr>
<tr>
<td>Total amount</td>
<td>2470</td>
</tr>
</tbody>
</table>

### V. CONCLUSION AND FUTURE WORK

The range of applications of navigation system is still growing up, from indoor to outdoor environments. In this paper, we designed a system specially for the public offices including city office and bank, where the visually impaired people need to move one location to another location to get the services. Usually smartphone-based navigation system is not easy to operate by the impaired peoples specially for those who have no sufficient literacy. The designed system is easy to operate and within very short time the visually impaired people becomes familiar with the devices and can move in the installed environment, by pressing different buttons in the keypad of user end device. The advantages of the designed system are low production cost, low design time, applicable for both the indoor and outdoor environment. A destination setting with the device is very easy. The system is capable to use in public places including indoor and outdoor environments.

Future works will be focused on enhancing the performance of system. Several improvements can be made on the proposed system. The user module can inform the distance between the user and the objects. The number of desired locations is fixed in the present system. So, the system could be extending for increasing the number of service points in...
the office. Bluetooth wireless communication system can be replaced with another wireless communication system for coverage of large areas.

REFERENCES