An implementation of a device to assist the visually Impaired / blind people for easy navigation through bus

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Abstract. Talking signs, control stick, echolocations are generally helpful in exploring the visually impaired people to arrive at their goal, but this can’t be used for longer distance of travelling in the traffic .So a wireless sensor network is proposed to help the blind or visually impaired person to navigate easily through the bus in the traffic safely .The proposed system has two modules one is in the hand of blind and other inside the bus .Both the modules has a ZigBee transceiver. The bus arrival informati on is given from the ZigBee in the bus module to the ZigBee of the blind module. When the blind tells his destination through the microphone it is then recognized by the voice recognition software in the blind module .The input is then analyzed by the microcontroller and if it is matched with the stored data base the controller guides the blind to take the right bus to reach his/her desired destination otherwise he has to wait for other bus .The buzzer and LED is connected with the device inside the bus to alert the driver when the blind module starts communication with the device present in the bus. When the bus reached the destination, it is announced through earphone of the blind module with the help of voice synthesizer. Along with this the buzzer is made and LED glows to provide the much more alert to the blind to get down in his/her desired destination. So, this project not only helps the blind but also for the elder or senior people for their independent navigation.

Keywords— Universal Asynchronous Receiver Transmitter, Node Microcontroller unit

1. INTRODUCTION

1.1 HISTORY OF BLINDNESS

In the beginning primitive times the blind or visually challenged people were more reddishly treated. During the early civilization, it is described that blind child were deserted and make them to die without food and many of them as a food for the wild animals and also used them in many in many cruel activities like prostitution, begging and so on. But at the middle ages of civilized society starts to care them by building Alms houses for the blind. The first “School for the Blind” was established in France in 1784.Louis Braille invented the tactile reading and writing systems. So, it has been revised and there
are several competing tactile methods were introduced in the further days. Congress passed an act called The American with Disabilities Act in 1990. In the upcoming days an International Braille and Technology Centre was established by the National Federation of the Blind to secure and evaluate the blind related developing technologies which were introduced to the blind. If anyone want to publish the book they need to send the electronic copy to the federation before getting the copy right for his work. In 2004 the president signed this legislation which was passed by the congress. By selling Louis Braille coins the federation collect the four million dollars and invest them for the Braille literacy projects.

More than a quarter of the world’s population 2.2 billion people are having blindness or visual impairment. According to the first World Vision Report released by the World Health Organization (WHO) on October 8, 2019 one billion of cases were prevented. There was praise for India in the report for its National program for control of Blindness (NPCB). The report illustrates that in 2016-17 6.5 million people in India were provided with cataract surgery achieving a cataract surgical rate of over 6,000 per million population and that time 32 million children were screened in their schools. And approximately 750,000 spectacles were distributed. Due to these concerned attempts there was drastic decrease in the visual impairments rate from 1.1 percent in 2001-02 to 0.45 percent during the years 2015-19 in India.

![Figure 1. Changes in the global prevalence of avoidable visual impairment between 1990 and 2015 and projections for 2020](image)

Due to the digital revolution around the world now a days there are many innovative ideas are developed in order to help the blind people. Some of them are listed as follows

1. Any text reading through Ring like device
2. A device with Touch screen capable of creating Figures and Braille
3. 3D printing Technology
4. Smart glass for blind
5. The “APP STORE “for the blind

2. HARDWARE IMPLEMENTATIONS

This chapter deals with the description of various hardware components used in this project. The hardware components required is

1. Raspberry pi
2. ZigBee Transceiver
3. Node MCU

2.1 Raspberry pi 3B+ module

In the proposed system raspberry pi 3b+ module is used as a source to connect microphone, earphone to assist the blind during his navigation. Raspberry pi resembles like a credit card sized computer which
is designed computer which is designed by the United Kingdom in order to teach the students regarding computer science. Basic modules of Raspberry pi have 256 megabytes of RAM it has been evolved and upgraded to model B and model B+ to have 512 MB to 1GB of RAM. The model B+ uses micro SD card for booting and storage as it is not having inbuilt hard disk in it. Because if its Quad core 1.2GHz Broadcom BCM2837 64bit CPU, 1GB RAM and less power consumption capacity when compared with other Raspberry pi modules a Raspberry pi 3B+ module is used in this project. It also includes inbuilt BCM43438 wireless LAN and Bluetooth Low Energy (BLE). 4 USB 2 ports helps to connect various required components to the board.

2.2. **ZIGBEE TB 387 2.4 GHZ**

In the proposed system a ZigBee module TB 387 2.4GHz ZigBee module is used for communication between the blind device ZigBee module and the bus device Zigbee module as it has high range of operation when compared with the Bluetooth low energy module i.e. up to 500-meter data transfer range and it consumes less power for its operation. The TB 387 is based on the 2.4GHz frequency band wireless transparent data transmission module. This module supports AT commands, baud rate, I D number, frequency settings, version information. When the device is in AT command mode serial port is used to set the device parameters and if it is in data transfer mode then the data and its data frame number, row count can be transmitted and retransmitted at the reliable range with the higher data rate of 250kbps. In the proposed system both the ZigBee modules are paired with the same baud rate of 9600 and using the Universal Asynchronous Receiver Transmitter (UART) protocol the serial communication is made between the two modules.

2.3. **NODE MCU ESP8266**

The Node MCU is an open source firmware and development kit that helps to build an IoT product required within a few Lua script lines. This module includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif system and hardware which is based on the ESP-12 module Node MCU is used to store real-time data and controls the home appliances using blynk App. Node MCU can be interfaced with Arduino, Raspberry pi, AVR development board etc. In the proposed project Node MCU has Station (STA) mode using which it can connect to existing wi-fi network and can act as HTTP server with assigning IP address using the network. Node MCU gets IP from Wi-Fi router to which it is connected. With this IP address, in this project using Telegram app that it can act as an HTTP server to which any wi-fi device can connect.

3. **SYSTEM SOFTWARE**

3.1. **Raspbian OS**

In the proposed system the Blind device uses the raspberry pi with the Raspbian OS using which the device is controlled for various operations. It has web browser, menu bar, a file manager and there is no shortage for desktop shortcut for pre-installed applications. Raspberry pi is an unofficial port of of Debian Wheezy armhf which optimizes the code and compile it to run in it. Due to this performance of the device is increased which helps them to use in several applications and in many floating-point arithmetic operations. By using the upgraded instructions of the ARMv6 CPU in raspberry pi helps other applications to gain performance. Raspberry pi is primarily introduced and invented by team work of Mike Thompson (mpthompson) and Peter Green (plugwash) and other raspberry pi community members. It supports varies programing languages C, C++, Java, Python etc. In the proposed system python version 3.7.3 is used for programing the blind module.

3.1.1. **Speech Recognition in Python using Google Speech API**
Speech recognition plays an important role nowadays for many applications like home automation, artificial intelligence, and in several security requirements, etc. In the proposed system, the Google speech recognition API is used to recognize the speech through the microphone connected to the Raspberry Pi using Python version 3.7.3. This is done by installing the speech recognition library and importing it to the required code to recognize the input which is given by the blind through the external microphone.

3.1.2. Convert Text to Speech in Python

There are different APIs available to convert text to speech in Python. But in that gTTS (Google Text to Speech) API is better because of its easy tool usage and installation process. Using this tool, a text written can be converted into a speech and saved in the mp3 file format. It can be used anytime by importing it into a program when the user requires it.

The gTTS API supports many languages including English, Hindi, Tamil, French, German, and many more. Using this tool, the speed of the converted speech (audio) can be adjusted as slow or fast according to the user requirements.

3.2. Arduino IDE

Arduino IDE software tool is open source which helps to develop many wireless network IoT related projects. It contains a text editor for writing code, a message area, a text console, and a toolbar. Programs can be coded and uploaded to the test board which is connected to the PC, and so the after uploading, the program completeness the light blinks in the board, and the results are shown in the serial monitor. The Node MCU is programmed with the Arduino IDE software tool using C programming language by installing the inbuilt library of esp8266 shown in the library list.

4. METHODOLOGY

4.1. BLOCK DIAGRAM OF THE PROPOSED SYSTEM

A Wireless sensor network is designed to help the blind or visually impaired person to easily navigate through the bus. The proposed system has two modules: one is in the hand of the blind and the other inside the bus. Both the modules have a ZigBee transceiver. The bus arrival information is given from the ZigBee in the bus module to the ZigBee of the blind module. When the blind tells his destination through the microphone, it is then recognized by the voice recognition software in the blind module. The input is then analyzed by the microcontroller and if it is matched with the stored data base, the controller guides the blind to take the right bus to reach his desired destination. Otherwise, he has to wait for other buses. Once the bus reaches the destination, it is announced through earphone of the blind module with the help of voice synthesizer. So, this project not only helps the blind but also for the elder or senior people for their independent navigation.
Figure 2. The proposed system to assist the visually impaired/blind people for easy navigation through bus

Implementation and working

Stage 1: Acquisition of bus arrival information
The ZIGBEE TB 387 2.4 GHZ is used at both the blind and the device inside the bus. The bus arrival information is transmitted through the signal from the ZigBee in the bus module to the ZigBee in the blind module within 500-meter range.

Stage 2: Intake of the destination to be travelled by the blind
The audio input of the required destination from the blind is taken through the microphone attached to the blind module.

Stage 3: Reception of destination information by bus module
The voice input from the blind is then converted into the required text format with the help of python 4.0 voice recognition software installed in the raspberry pi 3b+ module and sends that to a Node Microcontroller Unit (Node MCU) which is present in the bus.

Stage 4: Bus information Processing
The controllers compare the translated text with the bus data base if it matched then only the bus information is sent to the blind module otherwise the blind has to wait for the next bus to reach his/her destination. If the matched is found the blind gets into the bus and alert is given to the driver with the help of Buzzer and the LED.

Stage 5: Audio output for blind interaction
The received signal is then decoded and with the help of voice play back software package the blind is guided through the earphone attached to the blind module to reach his destination safely.
4.2. Interfacing diagram of the proposed system

From the interfacing diagram Raspberry pi and Node MCU is connected with their ZigBee module. The Tx and RX pin of ZigBee is connected to the GPIO 15 and GPIO 14 (RX and TX) pins of
Raspberry pi 3b+ module. Likewise, ZigBee TX and RX of bus module is connected to the Node MCU RX and TX i.e. GPIO 3 and GPIO 1 pins. Here 4x1 switches is designed to guide the blind about his /her destination reached information by pressing the switch button by the driver when the destination reached. These 4x1 switch is connected to digital GPIO pins of Node MCU from D1 to D4. Buzzer is connected to D5 and LED is connected to D6 through a 2.2K ohm resistor.

All these stages of implementation are explained in the flow chart shown in fig 5.

4.3. Flow Chart

![Flow chart of the proposed system](image)

5. EXPERIMENTAL RESULTS

The Proposed systems is successfully tested and results are verified. In this section four test are conducted and their results are found successfully.

5.1. Test 1: If desired destination of Blind is Vijayanagar (Destination 1)
The bus arrival information is listened to the blind through ear phone which is connected to the blind module. This is shown in the Figure 6.

![Figure 6. Bus arriving information listen from the blind module](image1)

After the bus arrived the blind need to say his/her desired destination through the microphone, here the desired destination of the blind is Vijayanagar. The system ignores the unmatched location as the location is not present in the stored database of the bus module.

It is then recognised by the python 3.7 voice recognition software i.e. Google speech recognition API software and in controller it is matched with stored database Vijayanagar.

After the match is found the alert for the driver is made through Buzzer and LED connected to the controller so that driver can know some blind device is connected as show in Figure

![Figure 7. Alert the driver with Buzzer and LED connected with the device inside the bus when the blind module is communicated with the device inside the bus](image2)
Blind can take the right bus parked Infront of him and all the information regarding his desired destination place is announced through the earphone.

**Table 1.** Assignment of 4x1 switch to each destination location

| 4X1 Switch | Destination       |
|------------|-------------------|
| SW1        | Destination 1(Vijayanagar) |
| SW2        | Destination 2(Majestic)    |
| SW3        | Destination 3(Yeshwanthpur) |
| SW4        | Destination 4(Tumkur)     |

**Table 2.** Operation of switches which is controlled by driver

| SW1 | SW2 | SW3 | SW4 | Destination         |
|-----|-----|-----|-----|---------------------|
| 0   | 1   | 1   | 1   | Destination 1 reached |
| 1   | 0   | 1   | 1   | Destination 2 reached |
| 1   | 1   | 0   | 1   | Destination 3 reached |
| 1   | 1   | 1   | 0   | Destination 4 reached |

**Note:** 4X1 pull up switches is used in which ‘0’ indicates that the switch is pressed i.e., destination reached information and ‘1’ indicates that Next stop to alert the blind to reach his/her destination.

**Example:** When driver knows that next stop is blind destination location i.e. destination location 2 then he presses next stop switch SW1 to alert the blind and when the bus reached the desired destination location 2 then he presses the SW2 that is assigned for the required destination location 2 of blind.

When the bus reached the destination, the driver presses the SW1 assigned for the destination1, i.e. Vijayanagar connected with the controller announces that desired destination is reached through the earphone connected with the blind module and also Buzzer is made and LED blinks. The buzzer and LED are used for to provide an additional alert for the blind along with the output heard through earphone when bus reaches his/her desired location or destination All these results are shown in Figure .8 and Figure .9
Figure 8. Comparing the recorded data with the database stored in bus and if match is found alert the blind to get into the bus

Figure 9. Alerting the blind to get down in his/her destination location through earphone when driver presses the particular 4x1 switch assigned for each destination location i.e. Destination1(Vijayanagar)

5.2. Test 2: If the desired destination of Blind person is Majestic (Destination 2)

When the blind person wishes to travel Majestic then the device listens his requirement and guide them to reach their destination safely. The test is done and the results are found which is shown in Figure 10 and Figure 11 and hence conclude that the device is successfully tested and verified.
Figure 10. Comparing the recorded data with the database stored in bus and if match is found alert the blind to get into the bus.

Figure 11. Alerting the blind to get down in his/her destination location when the driver presses the particular 4x1 switch assigned for each destination location i.e., Destination 2 (Majestic).

5.3. Test 3: If the desired destination of Blind person is Yeshwanthpur (Destination 3)
**Figure 12.** Comparing the recorded data with the database stored in bus and if match is found alert the blind to get into the bus

**Figure 13.** Alerting the blind to get down in his/her destination location when the driver presses the particular 4x1 switch assigned for each destination location i.e. Destination 3(Yeshwanthpur)
5.4. **Test 4: If the desired destination of Blind person is Tumkur (Destination 4)**

![Python 3.7.3 Shell](image1)

**Figure 14.** Comparing the recorded data with the database stored in bus and if match is found alert the blind to get into the bus

![Python 3.7.3 Shell](image2)

**Figure 15.** Alerting the blind to get down in his/her destination location when the driver presses the particular 4x1 switch assigned for each destination location i.e. Destination 4(Tumkur)

With all these tests and their corresponding results, the system is successfully verified for different destination locations
5.5. **Error Analysis**

If by chance driver presses the different switch rather than pressing the particular destination switch will misguide the blind to reach his/her desired destination location. Here the destination 4 is the drop location of the blind so the driver has to press the SW4 but he presses the other switch rather than pressing the SW4 so it may lead to misguide the blind. The results are shown in the Figure 16.

![Figure 16. Error analysis of the proposed system](Image)

5.6. **ADVANTAGES OF PROJECT**

1. Safety concerns for blinds
2. Cost effective and consumes less power
3. Automatic operation
4. Continuously quick monitor
5. High alert system

5.7. **DISADVANTAGES OF PROJECT**

1. Difficult to illiterates.
2. If network fails, then it is not possible to intimate.
3. Network oriented system.
4. If by chance driver presses the different switch rather than pressing the particular destination switch will misguide the blind to reach his/her desired destination location.
5. As the destination locations increases the number of switches increases which increases the complexity of the system
6. The driver has a chance to misguide the blind or visually impaired person by unknowingly pressing the different switch rather than pressing the particular assigned destination switch while the bus is in the desired destination of blind person.

6. **CONCLUSION**

In this project a pair of devices is built in order to help the blind and impaired people to make their navigation to his/her destination location through bus easy with the safety concerns. A low power operating with continuously quick monitor and high alert system is designed to fulfill the traveling needs of blind people. With the help of the proposed module a visually impaired person can navigate to his/her desired destination without any problems while travelling. The module developed is not only helps the blind but also for the senior citizens of the society for their safe navigation.
7. FUTURE ENHANCEMENT

This system can further be improved by using GSM with this module in order to help the blind if in case he/she met with any threat or emergency during travelling. This can be done by sending an alert message, live location of him/her relatives and also these information is sent to the nearest police station.

Because of its ability, performance and security applications the proposed system can be adopted for office security, colleges, hospitals and also in parking system. The GPS can replace the switches to assist the blind to get down in his/her required destination location and also the system can be built in a offline mode by using offline maps like Navit offline mapping tool instead of switches as well as the offline speech recognition software.

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