Study and Design of Bus Navigation System for Blind

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Abstract— The goal of the proposed project is to design a system which is useful for visually impaired people to make them become more independent in tackling mundane tasks. The proposed system uses a transport unit using wireless sensor networks (WSNs) and a wearable assistive smart and intelligent system using flex sensor, which could be the replacement of the blind stick as the real time current location is provided through speaker/headphone using GPS to reduce passengers’ tardiness and offer easy navigation around the city. The blind system contains a Zig Bee unit which is recognized by the Zig Bee unit in the bus. Upon the connection established by the Zig Bees, buzzers in both the blind and bus units ring. This helps in boarding the bus. To alight from the bus, destination is tracked using GPS unit in blind system with the movement of flex sensor placed on his finger and voice system informs him to get off the bus. The blind system is equipped with an ultrasonic sensor to assist him by providing with information about the approaching obstacle.

Keywords: FLEX SENSOR, GPS, ADC, APR9600 and MICROCONTROLLER 8051, ARM, ZigBee

I. INTRODUCTION

The smart bus system is an intelligent wireless bus-station interactive system with the integration of wireless techniques like Zigbee. It consists of two independent interactive systems using WSN as Zigbee : Blind unit system and bus unit system. The proposed project represents the design of a system to help senior citizen people easily identify the bus routes and illiterate people to find out the bus routes.

The proposed smart bus transport system using wireless network sensor like ZigBee uses an accurate transit data of bus route comprising of bus stops stored in bus unit to compare with the destination name fed into blind unit whose output response is given as an announcement through speaker either to board or wait for next bus. This system reduces passengers’ tardiness and offer easy navigation around the city. In addition to the bus navigation system, blind unit is designed to assist him to reach from one place to another safely.

Blind unit comprises GPS, MAX232, Zig Bee, ADC, flex sensors, speaker, APR9600, ultrasonic sensor and ARM processor while bus unit consists of zig Bee, buzzer and microcontroller.

The exact position, orientation and coordinates of any place on the globe will be known to blind using GPS receiver module. GPS technology is very reliable to use as satellite access or link is available throughout the globe. GPS can only give idea of the current location of the place but obstacles /hindrance present in the path can be found out using ultrasonic sensor which improves the resolution and proximity detection to avoid collision.

[13] Ultrasonic sensor uses ultrasound which is noise resistant. It can be used to find out range of the obstacle present in the path away from the blind. Being cost effective, least affected by target materials, surfaces and colour and being small and compact compared to conventional sensors, makes it useful.

[13] Flex sensors are placed on the glove which is worn by the blind person, so that he can get real time assistance by bending his fingers in different modes which results in stable, reliable, compact and efficient system as compared to conventional navigation systems of blind walking cane stick.

When bus approaches the person blind within distance of 100m, ZigBee (bus unit) is connected with ZigBee (blind unit) and 2 way communications is established. Buzzer (bus unit) is on to indicate the arrival of bus to blind person and help driver to know the presence of blind person at the bus stop. Blind speaks the destination to where he wants to go to the microphone present in the blind unit. This is recognized through speech recognition kit in the blind unit. Then the ARM processor analyzes the input and name of the destination is sent to the bus parked in front of the blind through ZigBee in the bus unit. If both the names, i.e., destination and the route stop stored in the bus unit matches, then an announcement is made through speaker in the blind unit to board the bus or wait for next bus.

The destination is monitored using GPS unit with help of flex sensor and voice system informs him to get off the bus.

II. DESIGN AND IMPLEMENTATION

The blind system consists of ZigBee, Buzzer, ultrasonic sensor, GPS, APR9600 and Voice recognition kit, speaker and microphone interfaced with the ARMLPC2148 which is the responsible for performing all operations while bus unit consists of
ZigBee interfaced with microcontroller 8051 along with a buzzer.

The hardware implementation of bus unit is shown in the figure 1.

A. Components of bus unit

1) 8051 microcontroller

This is the central hub controlling the whole and sole functionality of the components interfaced with it. It controls the serial communication through UART between ZigBee present at both sides of blind unit and bus unit. It transmits data through ZigBee interfaced with it to the ZigBee on the blind side and at the same time receives data to establish serial communication. It contains SBUF register to hold data. The special function register SBUF is physically two registers. One is write only and is used to hold data to be transmitted out of the 8051 via TXD. TI is set to 1 when data has been transmitted. This signifies that SBUF is empty so that another byte can be sent. The other is read only and holds the received data from external sources via RXD. Receive interrupt flag, RI, is set after data has been received in all modes. The data gets stored in SBUF registered from where it can be read. Both mutually exclusive registers have the same address 099H. A buzzer is on to output intimate buzzing sound if it receives a particular data sent from ARM processor on the blind unit side and vice versa happens on the other side of blind unit.

2) ZigBee

Zigbee is interfaced with 8051 microcontroller acts as wireless network sensor to communicate with other Zigbee node present within a range of 100m at blind unit. Zigbee starts two way communication once they are in communicable range. The ZigBee modules work at the 2.4 GHz frequency which means smaller board and antenna size. Zigbee modules have the ability to transmit Digital, PWM, Analog or Serial RS232 signals wirelessly. To communicate over UART or USAR, we just need three basic signals which are namely, RXD (receive), TXD (transmit), GND (common ground). So to interface UART with 8051, we just need the basic signals.

3) Buzzer

Buzzer is an electronic device that converts the electronic signal into buzzing noise that is applied to it. The port P1 of the microcontroller is connected to buzzer. This type of connection is possible, if the current requirement of the buzzer is not more than 20mA. The output is in current source mode so that buzzer will turn ON when the output of the port is logic LOW. Switch is connected to port P3 which remains at logic HIGH by pull up resistor.

B. Components of Blind Unit

1) ARMLPC2148

It has two UARTs for two Serial Communication ports.

- Serial Communication: UART0 – ZigBee interfaced with ARM at blind unit, start communicating with ZigBee interfaced with microcontroller 8051 at bus unit.

This is the central hub controlling the whole and sole functionality of the components interfaced with it. It transmits data through ZigBee interfaced with it to the ZigBee on the bus side and at the same time receives data to establish serial communication. It contains U0RBR (read buffer register) and U0THR (transmit holding register) as two different register for transmission and reception of data. There is U0LSR (line status register) which has bit 5 as THRE (transmit holding register empty) and it is checked.
for 1 indicating U0THR is empty to write a character to serial port while bit 0 is DR(data ready) and it is checked for 1 indicating U0RBR is containing valid data to read a character from serial port.

A buzzer is on to output intimate buzzing sound if it receives a particular data sent from ARM processor on the blind unit side and vice versa happens on the other side of bus unit.

2) **Flex Sensor**

Flex sensors are the devices which work on the principle of the change of resistance. The resistance of the flex sensor changes with the change in angle of the bending. The output voltage provided by the flex sensor depends on the change of resistance within the flex sensors. The GPS is controlled by the flex sensor which on bending provides the current location of the blind.

3) **Analog To Digital Converter (ADC)**

Analog to digital convertor is used to convert the analog values of the flex sensor voltage output and convert it to digital values based on sampling and quantization process.

4) **Global Positioning System (GPS)**

GPS is used for the detection of the present location of the blind. This is achieved by interfacing the GPS with microcontroller. The microcontroller after the reception of data from GPS provides the current location of the person through speaker when flex sensor is twisted.

5) **Max 232 And Obstacle Detector**

Ultrasonic sensors are used to detect the approaching obstacle. This is achieved by interfacing the ultrasonic sensor with max 232 which provides TTL output. Microcontroller is compatible with the TTL logic and output of the MAX 232 is fed as the input of the microcontroller. The ultrasonic sensors work on the property of sending and receiving the ultrasonic waves. The ultrasonic waves are sent by the sensor and then the waves are reflected by the obstacle and upon receiving the waves the distance is calculated using the total time and the velocity of the waves. The ultrasonic sensor works at 42 kHz frequency.

6) **APR9600 And Speaker**

APR9600 device offers true single-chip voice recording, non-volatile storage and playback capability for 40 to 60 seconds. The voice synthesizer is used to generate speech signal output of current location and obstacle, if present, which is in the form of announcement through speaker.

7) **LCD**

LCD is used as a reference to check the working of the proposed system. LCD shows the response for obstacle detection and the reading of latitude and longitude of the place where the person is standing or walking.

8) **Voice Recognition Kit**

Voice recognition kit is attached with mono-channel high quality microphone to make the system speaker independent. Serial communication( using UART 1) is used to record the voices like recording of first voice of group one by sending command in hex format as “0xaa” (head) + “0x11”(key) from ARMLPC2148 and response is given from kit ,say, “0xec” meaning successful operation in compact mode. Again, serial communication is used to import voices like importing first voice of first group ,i.e., group 1 and be ready for voice instruction by sending command in hex format as “0xaa” (head) + “0x21”(key) from ARMLPC2148 and response is given from kit ,say, “0xe1” meaning failed importing in compact mode.

9) **ZigBee**

Zigbee is interfaced with ARM processor acts as wireless network sensor to communicate with other Zigbee node present within a range of 100m at blind unit. Zigbee starts two way communications once they are in communicable range .The ZigBee modules work at the 2.4 GHz frequency which means smaller board and antenna size. Zigbee modules have the ability to transmit Digital, PWM, Analog or Serial RS232 signals wirelessly. To communicate over UART or USART, we just need three basic signals which are namely, RXD (receive), TXD (transmit), GND (common ground). So to interface UART with LPC2148, we just need the basic signals.

### III. FLOWCHART OF THE PROPOSED MODEL

![Flowchart](http://www.ijettjournal.org)
The proposed smart bus transport system using wireless network sensor like ZigBee uses an accurate transit data of bus route. The blind upon reaching the bus station can find the buses that pass through a particular location with the help of voice recognition system and voice synthesizer. When the bus approaches the bus station, there is an indication in the bus by the beep sound of a buzzer that there is a blind person available in the bus station and vice versa happens at blind side. This is achieved with the help of ZigBee unit both in the bus unit and blind unit. Finally when the bus reaches , blind unit uses an accurate transit data of bus route comprising of prominent bus stops stored in bus unit to compare with the destination name fed into blind unit whose output response is given as an announcement through speaker either to “valid station” meaning to board or “invalid station” meaning wait for next bus is a system to reduce passengers’ tardiness and offer easy navigation around the city especially to blind and senior citizens.

The wearable assistive smart and intelligent system based on flex sensor is developed to assist visually impaired people. The system is able to handle navigation problems, for e.g., going to unknown places and to detect obstacle present in the pathway.

The results confirmed the usefulness by providing real time assistance and support of the system in reducing the access time required by the blind people to reach different locations. The proposed system is designed and configured for practical use. The system is efficient and unique in its capability.

The Step by step results is as follows:

A. Boarding the bus.

1) Serial Communication: UART0 – Zigbee interfaced with ARM at blind unit start communicating with Zigbee interfaced with microcontroller 8051 at bus unit. LCD initialization: “RVCE” as shown in figure 4.

2) Sending data from zigbee bus to zigbee of blind unit whose ARM U0RBR catches and if data sent is same as data received then audio is played on towards blind side as well as BUS ARRIVED is displayed on LCD for our reference as shown in figure 5. Similarly, data from blind side is transmitted and once it is received on bus side, buzzer is switched on towards bus unit.

3) Serial Communication: UART1 – Voice recognition Kit interfaced with ARM processor. Using this Serial Communication for recording during training phase and importing speech during testing phase as shown in figure 6.
4) Response is sent from bus to blind unit in form ‘Y’ if code sent from blind unit matches with the bus stop code stored in bus unit else response is ‘N’. For Response ‘Y’, audio is played as valid station for blind to board the bus and LCD showing “VALID STATION” for our reference as shown in figure 7.

Fig. 6. Importing speech.

Fig. 7. LCD showing VALID STATION.

B. Finding the destination of the bus.

1) Serial Communication: UART0 – Zigbee interfaced with ARM at blind unit, start communicating with Zigbee interfaced with microcontroller 8051 at bus unit. LCD initialization: “RVCE” as shown in figure 8.

Fig. 8. LCD showing RVCE.

2) Serial Communication: UART1-Voice recognition Kit interfaced with ARM processor. Using this Serial Communications for recording during training phase and importing speech during testing phase as shown in figure 9.

Fig. 9. Importing speech.

3) Speak destination name like location 1, location 2 etc. and if this is identified with already stored speech, then corresponding location is displayed in LCD for our reference as shown in figure 10.

Fig. 10. Location 3 is displayed.

4) If both the location spoken by blind in microphone and that checked when IR sensor obstructed matches, then corresponding Audio is played as location 1 or location 2 or location 3 or location 4 whichever matches as shown in figure 11.

Fig. 11. Audio 3 is played corresponding to Location 3.

In addition to bus navigation system, blind unit act as wearable assistive smart and intelligent system based on flex sensor developed to assist visually impaired people. The system is able to handle navigation problems, for e.g., going to unknown places and to detect obstacle present in the pathway.

C. To find the desired location

1) Hardware Initializing: When the hardware kit is supplied power through battery then LCD shows the output “waiting for response” during its initial stages which signifies that the device is initialized as shown in figure 12.
2) **LCD Showing the Response for Obstacle Detection:** The figure 13 displays the output given by the ultrasonic sensor. The ultrasonic sensor produces the output on the basis of the range. When the obstacle is within a distance of 50 inches from the blind person, the LCD gives the output “object is nearer” with its range in inches displayed in the first row of LCD as shown in figure 13.

3) **LCD Showing the Latitude and Longitude for Different Locations:** The LCD shows the reading of latitude and longitude of the place where the person is standing or walking as shown in figure 14.

4) **Output from Speaker:** Speaker gives the output of voices recorded on APR9600 speech unit for corresponding latitude and longitude of the place.

### V. CONCLUSION

The urban public transportation systems are usually not appropriate for senior citizens and blind passengers. The proposed project introduces an intelligent system that aims at improving the public transportation service so as to meet the needs of blind passengers. The smart bus system is an intelligent wireless bus-station interactive system with the integration of wireless techniques like Zigbee. It consists of two independent interactive systems using WSN as Zigbee: Blind unit system and bus unit system. The proposed project represents the design of a system to help senior citizen people easily identify the bus routes and illiterate people to find out the bus routes. The system is designed in such a way that depending on the satellite information of location the predefined location name will be announced and using the ultrasonic sensor the approaching obstacles will be informed to the visually impaired which makes the overall system smart and unique in its capabilities helping the blind to travel around.

The proposed project resulted in designing a system which is useful for visually impaired people to make them independent and also to lead their life with lesser support from others as shown in figure 15 (Bus Unit) and figure 16 (Blind unit).
VI. FUTURE SCOPE

The future scope of the proposed project is to build a system where a transit web service can be used as a hub to connect buses, bus stops, and smartphones having apps for blind people users also. Buses will send GPS coordinates to the web service in to update bus schedules and the web service will make this information available at bus stops and Smartphones via 3G networks. To request a pick-up, a user standing at a bus stop should send a request to the web service, web service configures which bus to forward the request by using the transit database, forwards the request to the bus, and finally, bus will respond to user via the web service. When the bus arrives, the driver will stop the bus at the bus stop, and will announce the bus number using a microphone or some other voice system so that the blind person know if it is the right bus to board. The interfacing of Transit web service with bus stop, bus and Smartphone is shown in figure 17.

Fig. 18. Interfacing of Transit web service with bus stop, bus and Smartphone.

REFERENCES


