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ARM7 based Bus Passenger Alert System for the Blind and Visually Impaired

Anuj Narayanaswamy
Electronics and Communication Department
SRM University
Chennai, India
anujnarayanaswamy@gmail.com

U. Ashwin
Electronics and Communication Department
SRM University
Chennai, India
unni.ashwin@gmail.com

Srichakradhar Kadavendi
Electronics and Communication Department
SRM University
Chennai, India
sri2569312@gmail.com

***Abstract*—** *Safe mobility is among the greatest challenges faced by the visually challenged in day-to-day life, and making this available to them at an economical price is very important. This paper aims at the development of*:

1. An affordable ARM7 based device that helps a visually impaired person keep track of buses that halt at the station and safely board the desired bus using RF transmitter and receiver modules, voice chip, loudspeaker.
2. Ultrasound based ranging to enhance the horizontal and vertical range of the smart cane to help blind person navigate comfortably with required instructions from audio output or beeper.

Keywords- *ARM7 Microcontroller, Transmitter, Receiver, Voice Chip, Loudspeaker, Ultrasonic Sensor, ASK (Amplitude Shift Keying), Beeper.*

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I. INTRODUCTION

Travelling by bus and other modes of public transport is highly difficult for those who have congenital blindness or blindness from a very young age. Walking safely and confidently without any human assistance in urban or unknown environments is a difficult task for blind people especially while commuting in a confusing and highly populated city like Chennai.

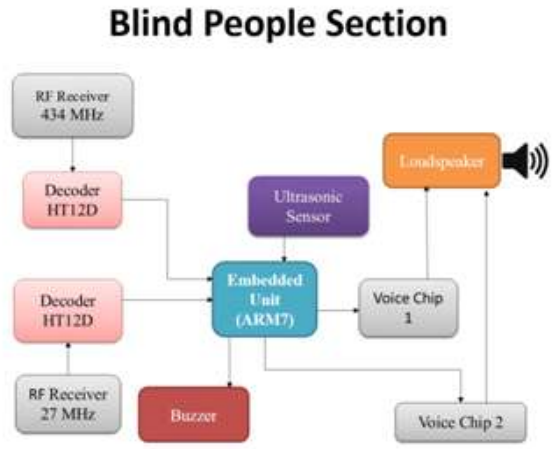
Several solutions have been proposed like walking stick or smart cane, guide dogs and GPS guidelines to deal with this difficulty. This project aims to develop a bus detection prototype using Radio Frequency transmission and reception for blind.

In addition to being the only viable mobility option it also offers an individual to connect with others easily. The blind and visually impaired in general live in a limited environment and this paper aims also at ameliorating the daunting task of socializing with others.

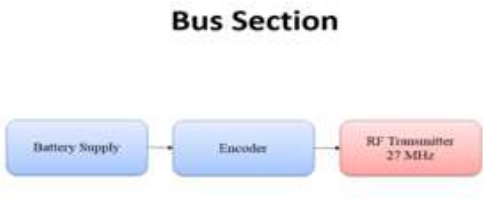
The current system poses problems like no easy identification or information provided on public transport and navigation**.** This paper fundamental goal is to find solutions to these problems and improve the efficiency and convenience on such a device.

II. HARDWARE REQUIREMENTS

The Hardware architecture in the figure below depicts the first part of the proposed design required to help a blind person identify and board a bus. It is called the Blind People Section. The elements of the system consist of various subsystems. The ARM7-TDMI unit serves as the main processing unit. It is used to interface two receiver units with the ultrasonic sensor and the voice chip and loudspeaker system. The ultrasonic sensor feeds a signal to the buzzer according to the distance measured. The two receiver units are linked to two other transmitters that operate at different frequencies. Decoders are used to decode the received encoded information.



The second part is known as the **Bus Section** and consists of a Transmitter-Encoder System given to each bus and is set to transmit the bus number at all times.



The third section of the system aims to help the blind person identify the destination station as he sits in the bus called the **Station Section** shown in the figure below.

1. ARM Architecture:

The ARM core makes use of RISC or Reduced instruction set computing architecture. The concept concentrates on the reduction in the complexity of instructions performed by the hardware as it is easier to provide greater flexibility and intelligence in software rather than hardware.

Features:

- 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 *(Low Profile Quad Flat Package)* or HVQFN (*Heatsink Very-thin Quad Flat-pack No-leads)* package.
- 8/16/32 kB of on-chip static RAM and 32/64/128/256/512 kB of on-chip flash program
- Internal memory.
- 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip bootloader.

Some more features:

- Full chip erase in 400 ms.
- Embedded ICE RT (In-circuit emulation Real Time) and Embedded Trace interfaces used for real-time debugging.
- On-chip Real-Monitor software along with high-speed tracing of instruction execution.
- Up to 9 edge or level sensitive external interrupt pins available.
- Programmable on-chip PLL offers 60 MHz maximum CPU clock with settling time of 100 µs.
- Operation voltage range of 0 V to 3.3 V.

The **ARM7TDMI** (**ARM7**+16bit **T**humb+JTAG **D**ebug +f-ast **M**ultiplier+enhanced **I**CE) processor implements the ARMv4 instruction set. It was licensed for manufacture by an array of semiconductor companies.

2. RF Transmitter & Receiver (434 MHZ, 27 MHZ):

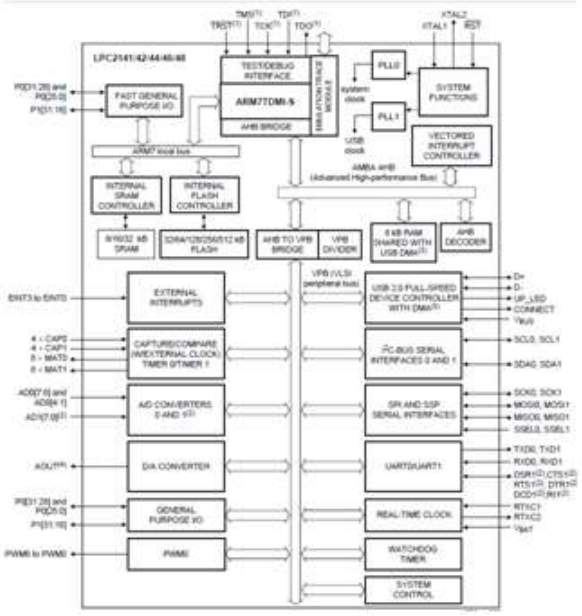


Figure 1: ARM Architecture

Transmitter: An electronic device which, usually with the aid of an antenna, propagates an electromagnetic signal.

Receiver: An electronic device that detects and changes a radio signal from a transmitter into useful information.

Carrier signal: The underlying frequency or frequencies used to carry information.

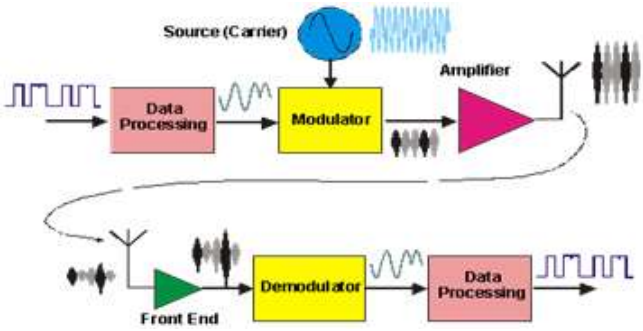


Figure 2: Transmitter-Receiver Block Diagram

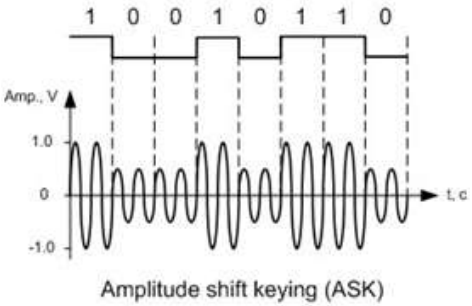
Modulation: The method of imposing the information signal onto the carrier signal is termed modulation.

Types of Modulation:

- Amplitude Modulation
- Frequency Modulation
- Phase Modulation
- ASK – Amplitude Shift Keying
- FSK – Frequency Shift Keying
- PSK – Phase Shift Keying

Modulation Mode: Amplitude-shift keying (**ASK**) is a form of amplitude modulation that represents digital data as variations in the amplitude of a carrier wave. In ASK, the binary 1 represents transmission of a fixed-amplitude carrier wave at fixed frequency for a bit duration of T seconds. If

binary 0 is given then the carrier is either not transmitted or a carrier with a different amplitude is transmitted.



Amplitude shift keying (ASK)

Demodulation is the act of extracting the original information-bearing signal from a modulated carrier wave. A demodulator is an electronic circuit used to recover the information content from the modulated carrier wave.

RF Module (Radio Frequency):

Radio Frequency is any frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on RF field propagation.

The 434 MHz transmitter-receiver unit is used to transmit bus name and number and the 27 MHz unit transmits name of destination station.

In the model used, four different switches which use the same 434 MHz frequency represent four different buses carrying a transmitter and if switched on, they transmit the bus number and name to receiver.

On the 27 MHz transmitter two switches are provided that represent two different destination stations that the bus is travelling to.

TWS-434 RF Transmitter Features:

- Frequency: 433.92MHz
- Output Power up to 0.5W
- Voltage Supply: 4.5V to 5.5V
- Transmitter Data Rate: 8 Kbps
- Modulation Mode: ASK (Amplitude Shift Keying)
- Supply Current: 270mA

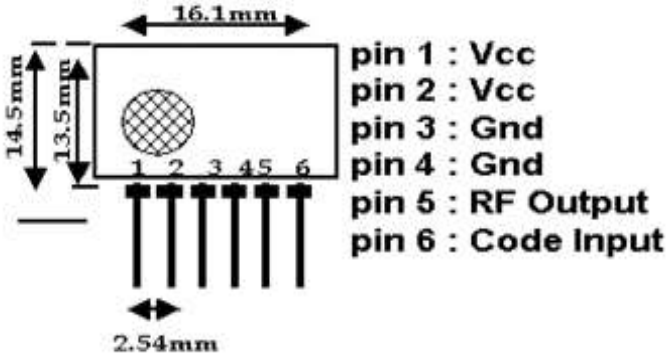


Figure 3: TWS-434 Pin Layout

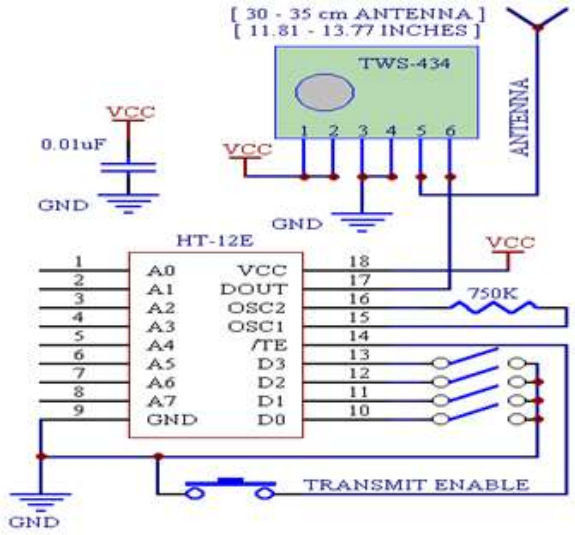


Figure 4: TWS-434 Application Circuit

WS-434 RF Transmitter Features:

- Frequency : 433.92MHz
- Voltage: 4.5V-5.5V
- Bit-rate: 0.2kbps-4kbps
- Current: 4.8mA on 315MHz; 6mA on 433.92MHz
- **Sensitivity: -105dBm**
- **Operating temperature: -20℃-70℃**

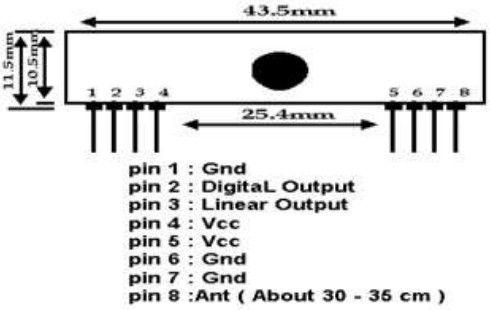


Figure 5: WS-434 Receiver Pin Layout

TX-2B/RX-2B RF Transmitter/Receiver Features:

- Frequency of operation: 27 MHz
- Voltage Range: 1.5-5.0V
- Low stand-by current
- Auto-power-off function

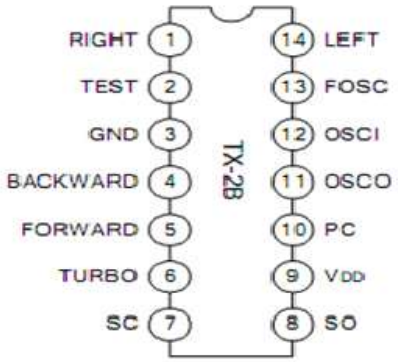


Figure 6: TX-2B Transmitter Pin Layout

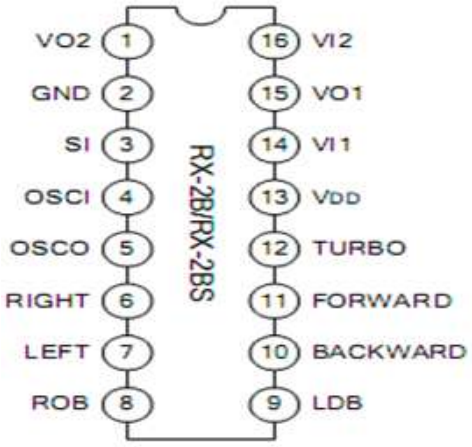
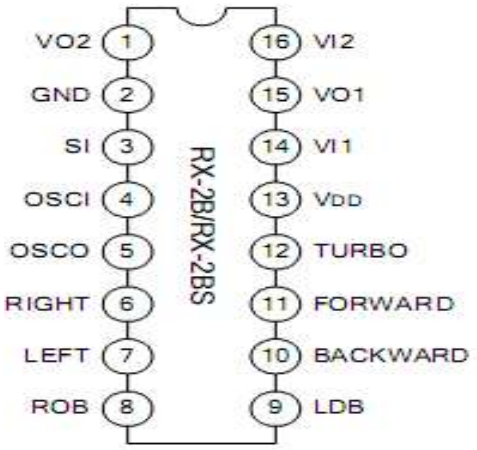


Figure 7: RX-2B Pin Layout



3. Voice Module:

This is an **8 channel recordable voice module.** Each channel can hold up to **1 minute of recorded voice** and/or music with a combined total record time of 8 minutes. For the sake of representation in this model, 4 channels are reserved for 4 different bus numbers and 2 channels store 2 different destinations Recording is quick and easy using the built-in microphone and push to record button. A line-level output jack allows connection to external earphones, headsets or loudspeakers.

Features:

- 8 Channels that can store recorded information.
- Maximum record time of 8 minutes.
- Recordings stored in non-volatile memory.
- Makes use of continuous playback
- Built-in condenser microphone for recording
- Speaker volume and the current drawn can be adjusted.
- Powerful and clear 24 watt audio amplifier for the loudspeaker unit.

Figure 8: Voice Chip Module

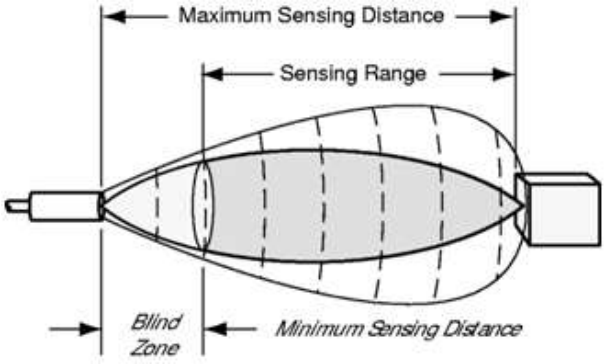
4. Ultrasonic Module:

The proposed system uses ultrasonic sensor which basically works on the principle of the ultrasonic wave generation and reflection. Ultrasonic sensor poses as a low-cost and easy way of distance measurement. This sensor is suitable for applications that require one to perform measurements between moving or stationary objects.

Ultra-Sonic Sensor Features:

- Provides precise, non-contact distance measurements upto 10 cm range.
- Employs pulse in/pulse out communication.
- Power Consumption: 20 mW.
- Acceptance Angle is narrow.
- 3-pin header for easy connection.

Vcc- Connects to 5V of positive voltage for power
Trig- A pulse is sent here for the sensor to go into ranging mode for object detection
Echo- The echo sends a signal back if an object has been detected or not. If a signal is returned, an object has been detected. If not, no object has been detected.
GND- Completes electrical pathway of the power.



5. Buzzer Alarm Unit:

A buzzer or beeper is a signaling device that is based on an electromechanical system which is identical to an electric bell without the metal gong (which makes the ringing noise).

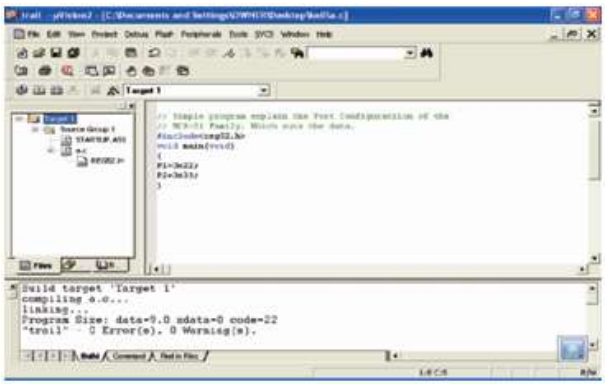
- Rated Voltage: Max 30 V
- Current Consumption: 12mA at 10Vp-p Square Wave 4.1kHz
- Sound Pressure Level(10cm): 90dB at 10Vp-p
- Square Wave 4.1kHz
- High and Clear Sound
- Range of sound: 3-5 meters
- Dimensions: 24mm Diameter, 5mm High, 29mm between mounting holes

III. SOFTWARE REQUIREMENTS

1. Tools and Purpose:
a. Keil IDE
i. Compiler
ii. Linker
iii. Simulator
iv. Debugger
b. Flash Programmer
i. Dumping the code
c. Orcad Design
i. Schematic
ii. Layout
d. Embedded C

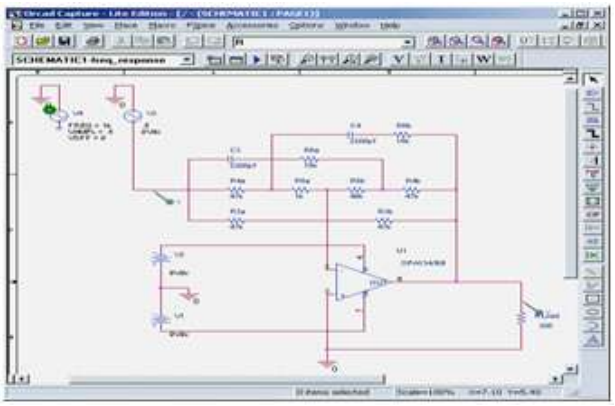
2. Keil uVision5:

Integrated development environment or IDE is a suite of software tools that facilitates microcontroller programming. The Keil IDE enables the embedded professional to develop the program in C and assembly as well. The IDE passes through the source code to check the syntax. The compilation leads to a hex file to be dumped in the microcontroller on-chip ROM. A quick session of simulation and debugging using the IDE ensures the working of the program beforehand. The user can verify the results as the package presents screenshots of on-chip resources.

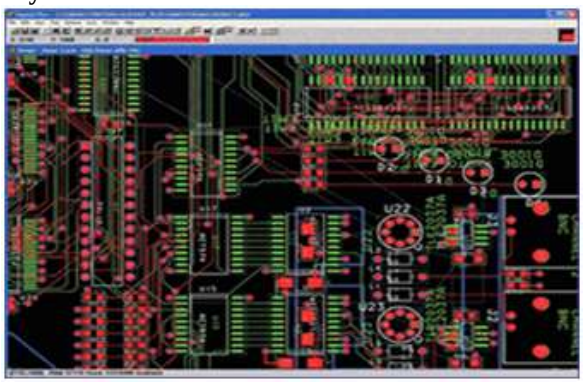


3. ORCAD:

ORCAD is a software tool suite used primarily for electronic design automation. The software is used mainly to create electronic blueprints for manufacturing printed circuit boards or PCBs, by electronic design engineers and electronic technicians and also for a simulation. The latest version can maintain a database of available integrated circuits which can be uploaded at any time and modified. This database may be updated by the user by downloading packages from component manufacturers, such as Analog Devices or Texas Instruments.

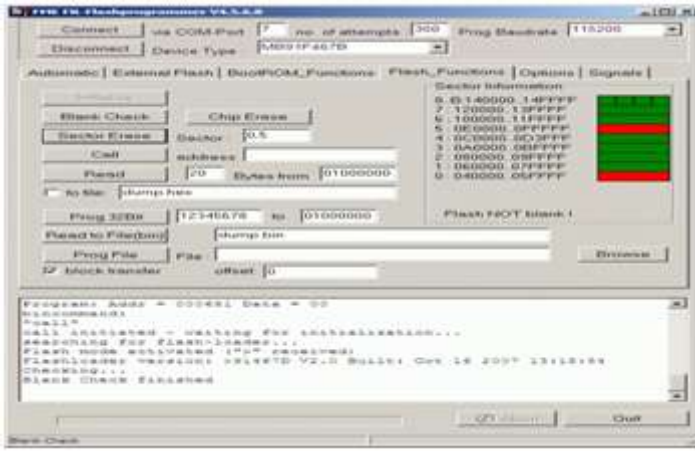


Layout:



4. Flash Programmer:

- Used for dumping the code in HEX format into ARM processor.
- Easy to use
- Programs Intel Hex Files
- Automatic verifying after programming.
- Ability to automatically program checksums for checking errors.
- Read any section of Flash and save as an Intel Hex File
- Display the contents of Flash in ASCII and Hexadecimal formats
- Can be used with high-speed serial communications on devices.
- Flash Magic calculates the highest baudrate (rate of data transfer) that both the device and your PC can use and switches to that baudrate automatically.



IV. FUTURE WORK

1. The RF transmitter receiver Range can be improved by using a higher range transmitter-receiver module like the ZigBee. ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low power digital radios but is more expensive so it will increase the overall cost of the device.
2. An additional Ultrasonic sensor can be used to provide a better and enhanced range of detection (short and tall obstacles) and a better sensitivity.
3. We can improve the sensitivity and efficiency of the whole system by using a low power consuming processor like the Raspberry pi or the Cortex processors. This also is found to increase the cost substantially but the trade-off is faster and more efficient processing.

V. CONCLUSION

The design and architecture of this new concept of guidance for blind people was tested in real time and proved to be very convenient to blind candidates as they used buses to commute between a few preferred locations. The Blind Section system was encased in a portable box of dimensions 10cmx10cmx5cm that can be carried in a bag by the blind person. The advantage of the system lies in the fact that it is a low cost solution to millions of blind persons worldwide owing to the economical cost of ARM7 processor and since half the system is inbuilt in the bus and station.

VI. ACKNOWLEDGEMENT

We would like to express our deepest thanks to mentor and guide Assistant Professor (O.G) Mr. E. Elamaran, Department of Electronics and Communication.

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