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Enhancing Indoor Mobility for Visually Impaired: A System with Real-Time Obstacle Detection Using QR Code with Audio Feedback

Shubham Nimkar[1], Ajay Kumar[2], Mrs. Pradnya A. kamble[3]

[1,2]Final Year Student, Department of Electronics and Telecommunications Engineering, Sinhgad Institute of Technology, Lonavala, Maharashtra, India
[3]Professor, Dept. of Electronics and Telecommunications Engineering, Sinhgad Institute of Technology, Lonavala, Maharashtra, India

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Abstract – *It's tough for people with visual defects to maneuver freely in their surroundings. The essential demand for them is to maneuver freely, knowing the concerning obstacles around them. The system presents the thought of an indoor navigation system using the QR Code equipped with audio feedback. The system bestowed is capable of detecting an obstacle with the assistance of ultrasonic sensors. The visual markers (QR Code) will give the knowledge about the thing or location on which it's placed. The user will get audio feedback through headphones or speakers, enhancing the user's expertise about the environment. The system proposed is simple, efficient and robust.*

***Key Words*: Human echolocation, QR Code, ATmega 328, aPR33A (Voice Recording IC), HC SR-04 (Ultrasonic Sensor), HC-05 (Bluetooth Module)**

1.INTRODUCTION

Visual Impairment is one of the biggest problems in all over the world. The people suffering from it face a lot of difficulties in their daily life. They are not able to perform a variety of activities without anyone's help. Mobility for them is a crucial issue and moving freely while knowing about the nearby obstacles is even tough. While ordinary people experience new technologies and make their day to day life much easier, people who are visually impaired don't have enough. For outdoor mobility and navigation, we have GPS but for indoor positioning, we don't have any. Currently, several methods have been identified to help visually impaired people but they may not be the most appropriate way which benefits them. Various works have been made in the past to help people with a visual impairment such as guiding sticks, ultrasonic equipped shoes, etc. Human echolocation is a human ability to detect objects by sensing the echo sound from the objects. This prototype uses sonar echolocation for sensing the environment. To aware user about hindrances which are there in his front view, this device uses audio feedback. Personalization of this obstacle detection system can be done through a mobile device according to the user's suggestions and needs.

2. PROPOSED SYSTEM

The system proposed here is developed to provide visually impaired users with easy mobility in indoor environments with real-time obstacle detection with audio feedback. The basic block diagram of the system can be seen in the figure below.

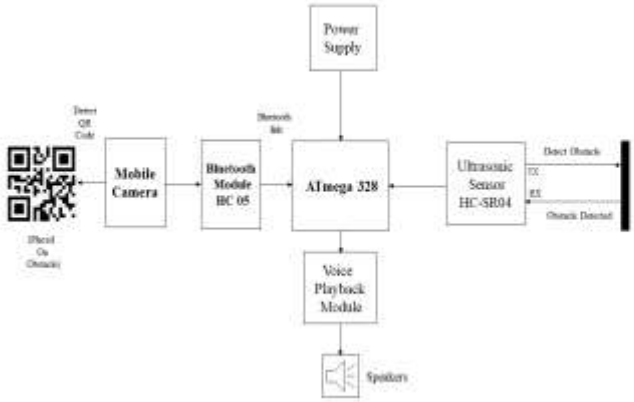

Fig -1: Basic Block Diagram of System

2.1. WORKING OF THE PROPOSED SYSTEM

As we can see in fig -1, the system is using the QR code for storing the information about the location or the type of object on which it'll be placed. The QR code will be decoded using a mobile camera, that information will be sent to the microcontroller using Bluetooth link. To provide the Bluetooth module (HC 05). The ultrasonic sensor (HC-SR04) will detect the obstacle in real-time and will send the data to the microcontroller. There the information will be processed in the microcontroller, from both the ultrasonic sensor and from the BlueTooth link. Here we are using ATmega 328 for the proposed system. The microcontroller will then send the signal to enable the voice recorder module to provide the audio feedback via speakers or headphones. For voice playback, we have used aPR33A chip with 60 seconds voice playback module. The obstacle detection and voice playback can work parallelly or independently.

2.2. MAIN CIRCUIT DIAGRAM

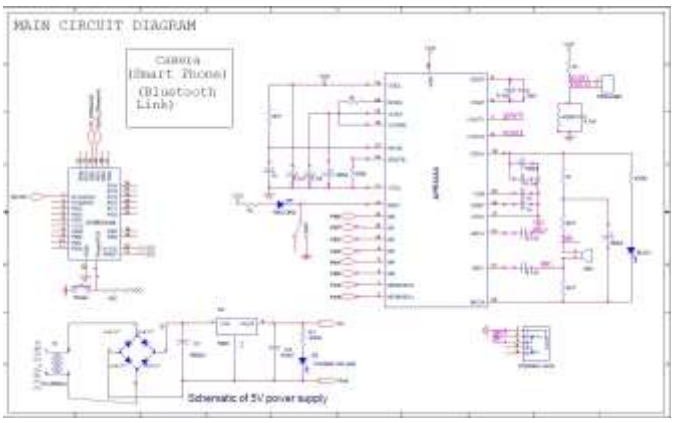

Fig -2: Main Circuit Diagram

2.3. HARDWARE USED

1) **ATmega 328**:

ATmega 328 is a microcontroller created by Atmel in the megaAVR family. ATmega 328 is using 32KB flash memory, 1K - EEPROM, 2KB - SRAM. It is an 8-bit microcontroller.

Fig -2: ATmega 328

2) **APR33A3**:

It is an 8 channel voice recording module. With 340-680 sec voice recording length. Powerful 16bits digital audio processor. Non-volatile flash memory technology.

Fig -3: APR33A3

3) **HC SR-04 (Ultrasonic Sensor)**:

Ultrasonic ranging module HC SR-04 is having a range of 2cm-400cm or 1 inches to 13feet , the measurement function ranging is accurate up to reach 3mm. The modules include 3 main parts of the ultrasonic transmitter section, receiver section and control circuit.

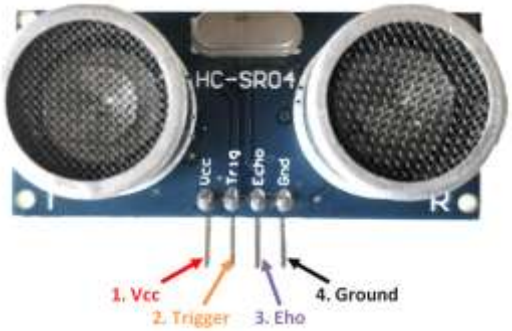

Fig -4: HC SR-04

4) **HC 05 (Bluetooth Module)**:

HC 05 is a Bluetooth module, designed for wireless communication. The HC-05 Bluetooth Module can be used in a Master and Slave configuration, making it the best solution for wireless communication. 3Mbps rate of Modulation with a complete 2.4GHz radio transceiver and baseband. It utilizes the CSR Bluecore 04 External single-chip Bluetooth system using CMOS technology working with AFH (Adaptive Frequency Hopping Feature).

Fig -5: HC 05

5) **Speakers:**

The main purpose of a **speaker** is to produce audio output that can be heard to everyone. Speakers are the transducers that convert the electromagnetic waves into sound waves. It receives audio input. The input fed to the speaker is in analog or digital form. Analog speakers simply amplify electromagnetic signals or waves into sound waves while digital-first convert the signal into analog and then amplify it.

Fig -6: Speaker

2.4. QR CODE

QR code is meant by **Quick Response code** (or two-dimensional barcode). It is the same as the barcode. QR code contains the information in encoded form and can be seen using a QR code scanner. The QR codes are faster to detect and the data is safe with them. The QR codes are basically a matrix of random black and white squares. They provide information to any user using them. And hence we are using this in our proposed system, to store the information about the location.

Fig -7: QR CODE

3. DESIGN FLOW

3.1. SYSTEM DESIGN FLOW

The system design flow is shown in the figure. 8. The diagram gives us an idea about how the flow model will work for the proposed system.

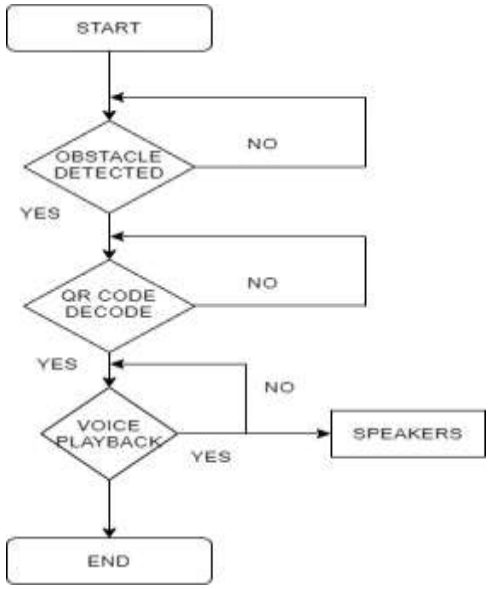

Fig -8: System design flow

3.2. QR CODE DECODING FLOW

The decoding flow for the QR code is shown in figure.9. How the QR code will get detected and what exactly will be the flow is shown.

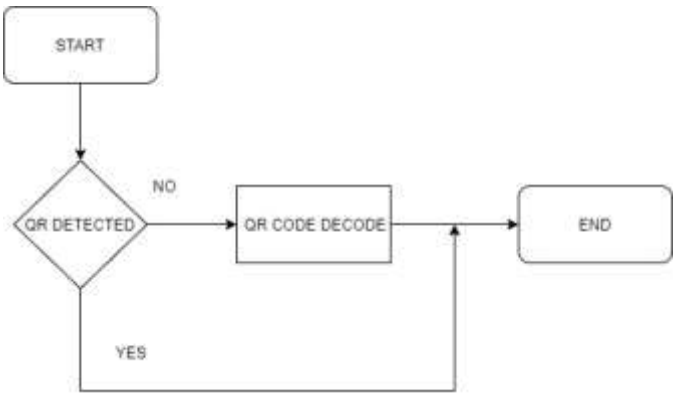

Fig -9: QR Code decoding flow

4. IMPLEMENTATION

The hardware implementation is shown in the fig-10.

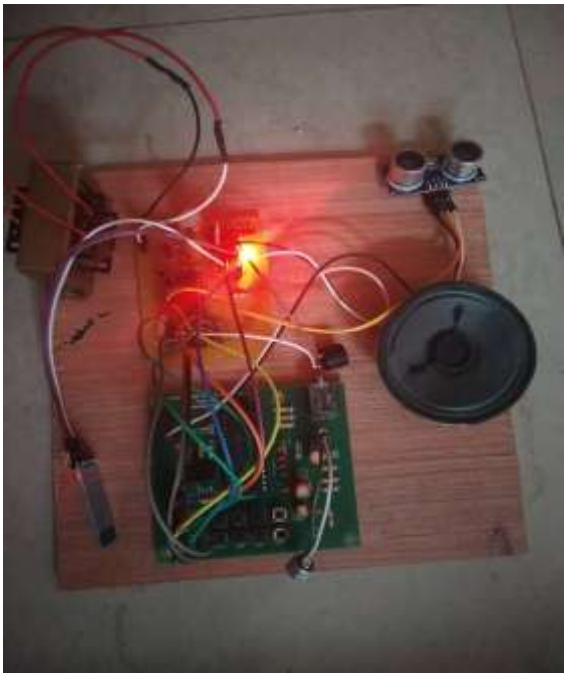

Fig -10: Implemented System (Hardware)

Fig -10: QR Code Detection using mobile camera

5. CONCLUSION

The system is implemented using Atmega 328 microcontroller. The HC SR-04 (ultrasonic sensors) are used for obstacle detection. The QR code detection was done using a mobile camera. The audio feedback was provided using APR33A3 (voice playback module). The system implementation is done successfully. The goal was achieved.

6. FUTURE WORK

In the future, there are many possibilities to improve this presented system. The system can be made wearable using high-performance processors which will also be having minimal size. For QR Code detection, an embedded micro camera can be used. And the obstacle detection can also be provided using micro transducers. All together implemented as one system on a single platform.

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