

Obstacle Detection on Railway Track Using Ultrasonic Sensor

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Abstract: The history of Indian Railways dates back over to 160 years ago. It was first introduced by the Britishers in colonial rule. In the recent years. Railways have become a primary source of transportation for the majority of Indians, not only is it cheap but is also easily accessible and convenient. Each year Indian railways incur great loss in accident involving humans and animals. With increase settlement of slums along railway tracks some places have become more accident prone. Other incidents include involving Trackmen and gang men working on tracks meeting accidents. Accidents also happen due to severe winters in Northern India and drastically increasing smog. The main objective of this project is to develop a system which would readily help in avoiding accidents by detecting obstacles and thereby triggering a Buzzer which then could be heard by train driver and accordingly the speed of train could be reduced or the train can be stopped.

Keywords — Buzzer , Indian railways , Obstacle detection , train accidents ,ultrasonic detection

I. INTRODUCTION

Due to increase in speed of train, smog and advancement in Indian Railway Technology, railway trackmen have become prone to accidents. It is important to secure life of Railway men as well as it is our moral duty to protect animals from accidents. This paper aims on making a prototype device for giving indication to animal/railway men and the driver using a Buzzer. The detection of presence is done using Ultrasonic sensor which is mounted over a servo motor for giving 150° field view. The ultrasonic sensor used is HCSR04 which has both transmitter and receiver in one single module. The transmitter transmits a HIGH signal in the surrounding. If there is a presence of any object then it is reflected back which is then received by the receiver. To calculate the distance of the object simple speed-distance formula is used where distance is calculated by multiplying time elapsed with the speed of sound.

Here elapsed time is combination of both time for sound wave to reach object and the time required by sound wave to travel back hence the actual distance is half of the distance calculated by this formula:

$$\text{Distance} = (\text{high level time} * \text{velocity of sound})/2$$

A piezoceramics crystal is inbuilt in an ultrasonic transmitter with a conical metal sheet. It vibrates with continuous expansion and contraction when an electrical voltage is applied. As the Resonator is conical in shape, the generated Ultrasonic waves propagates straight. The functionality of Ultrasonic receiver is just the reverse of transmitter. Because of the functionality of piezoceramic

crystal Electric current is produced due to the vibration of piezoceramic disc on the vibrator. This electric current is further taken out from the two external leads [1]. There are various ultrasonic sensor available in market some have transmitter and receiver in one unit other have separate device for transmitter and receiver. We are using ultrasonic sensor which have both transmitter and receiver in one single unit.

The servo motor is used to provide 150° rotation to Ultrasonic sensor. If any obstacle human or animal comes in range, the buzzer is triggered along with the Red led.

II. SYSTEM DESCRIPTION

The basic circuitry of the prototype is given in figure below:

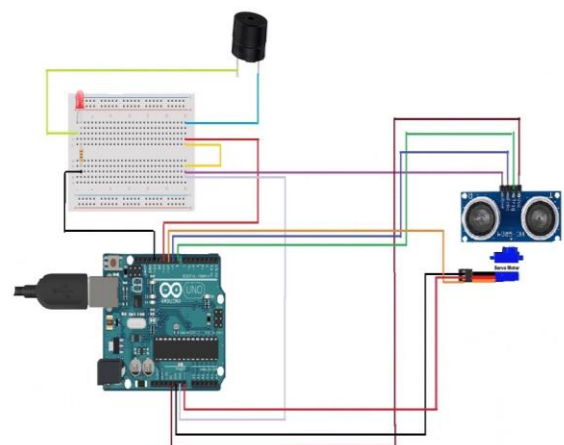


Figure-1 :Circuitry of proposed system

TRIG and ECHO of Ultrasonic sensor is connected to pin 8 and 9 of arduino respectively. The GND and VCC is then

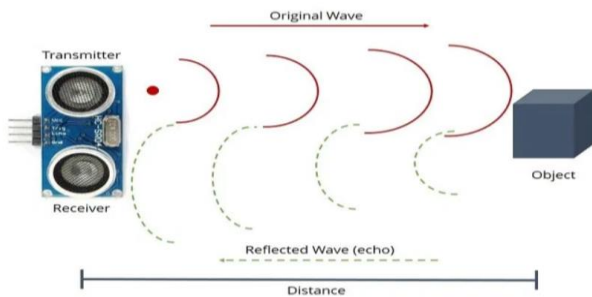


Figure-2: Working of ultrasonic sensor

connected to ground and 5V of arduino. The servo motor have GND and Vcc which are connected to Gnd and 5V pin in arduino. The control pin for servo motor is here taken as pin10.

III. WORKING OF PROPOSED SYSTEM

The proposed system is implemented using microcontroller arduino uno. The system can be installed in accidents prone areas near railway tracks. Different obstacles animals /gangmen /children can be detected and accidents can be prevented. The distance is calculated using Ultrasonic sensor HCSR04. A servo motor is used for 150° area of view. Whenever ultrasonic wave is reflected back from obstacle the receiver of Ultrasonic sensor calculate the distance. If the distance is in a particular range then the piezo buzzer is triggered. The sound then could be heard by the train driver and actions are accordingly taken. A red led is also used for indication of presence of obstacle. Buzzer and led together works well even at the places with high fog.

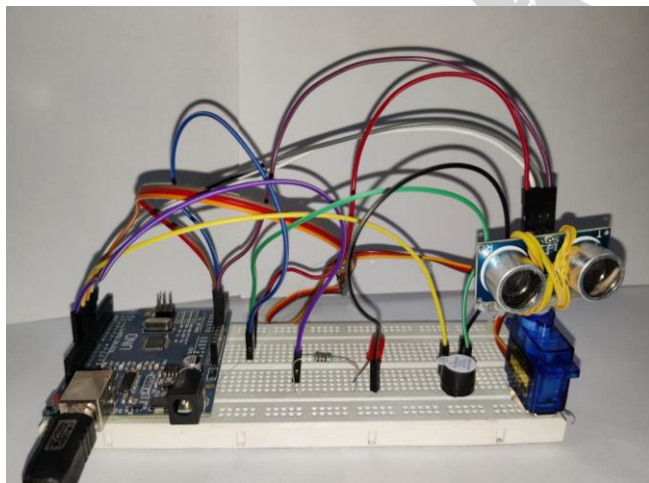


Figure-3: Proposed design

IV. TECHNOLOGY /METHODS

1. Ultrasonic Sensor –HC-SR04

The HC-SR04 ultrasonic sensor uses principle of sonar to determine distance of an object as bats do. It incorporates ultrasonic transmitter module, receiver module and a

control circuit [2]. The range of this sensor module is 2cm - 400cm non-contact measurement function and accuracy can reach up to 3mm. The basic principle of work:

A HIGH signal of 10µs duration is provided to TRIG input as a trigger signal. Automatically the module transmit eight 40 kHz ultrasonic burst. In presence of an obstacle the Received ECHO will be HIGH level.

Pin out:

- VCC: +5VDC
- Trig : Trigger (INPUT)
- Echo: Echo (OUTPUT)
- GND: GND

Figure-4: Pinout of HC-SR04

2. Servo Motor-SG90

Servo motors provides high level of torque at high speed with an efficiency of 80-90%. They are commonly used in robotics as their rotation is easy to control. The servo motor has a geared output shaft which is used to turn one (1) degree at a time which is also electrically controlled. Unlike the DC motors, Servo motors has three wires in it. Servo motors has two power pins Vcc and GND which are the signal pin, it also has an additional pin which is control signal. The Signal pin is the one used to feed the control signal from the microcontroller to a particular angle is needed in the servo motor which is done by the signal pin by feeding the control signal from the microcontroller to the servo[4]. Unlike any other standard electric motor which start rotating as soon as power is applied servo motor has a major advantage i.e. angular precision which is that it rotate as the signal is sent and then stop and wait for other signal to come. In a normal electric motor control is limited to switching On/Off of the motor and rotation progress cannot be controlled but with servo motor this can be achieved. The Wire Configuration is below:

Wire	Wire Color	Description
1	Brown	Connection made to ground pin in arduino
2	Red	Used for providing 5V power supply to the motor
3	Orange	The arduino gives PWM signal through this wire to drive the motor

Table-1: Wire Configuration of Servo motor

3. Buzzer

Buzzers are simple audio signaling devices which generate basic beeps and tones to alert people, a signaling equipment. Two of the most commonly available Buzzers used universally are Magnetic and Piezo. The basic

principle used in the producing the sound from the magnetic buzzer is by the movement of the ferromagnetic disk whose functionality can also be compared to how sounds are produced in cone of speakers [7]. A piezo crystal is present inside the piezo buzzer which is a very special material that changes shape as voltage is applied to it, a pressure wave is generated when the crystal pushes against the diaphragm which the human ear registers as sound. The sound is then generated when the voltage is changed and sent to the piezo which then changes shape very quickly[5]. The buzzer used in our prototype is the piezo buzzer whose Pin Configuration is given below in the table

Pin Number	Pin Name	Description
1	Positive	Used for providing power supply of 5Volt to Buzzer.
2	Negative	It is the short terminal and is connected to ground of arduino.

Table-2:Pin configuration of Buzzer

4. Arduino Uno

Arduino Uno is a microcontroller board dependent on 8-bit ATmega328P microcontroller. Alongside ATmega328P, it comprise of different parts, for example, precious stone oscillator, sequential correspondence, voltage controller, and many more to help the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be utilized as PWM yields), 6 simple information sticks, a USB association and a reset button. A Power barrel jack, an ICSP header and a reset button[6].

V. CONCLUSION

Trains have been the main source of transportation since the beginning of its creation and hence safety is supposed to be the highest priority of the Indian Railways. It is their duty and their responsibility to not only safeguard the passengers but also gang men, innocent animals and humans who might come in front of the trains unknowingly. The developed system would be installed at regular intervals in accident prone areas. When the system encounters any obstacle, it will give an indication using buzzer and would avoid any hazard in advance. The engine driver can then control the train based on the information passed by the system .There have been many systems created in the past to detect obstacles on railway tracks, some projects use GPS system to track the obstacle and then send exact location to the driver, other uses Image recognition techniques. We also came across video based obstacle detection in which video is sent to the driver and one of the major problem we discovered was that all of these systems require high speed internet connections thus making it difficult to use. The

proposed system we have developed is easy to implement and construct as there is no need for internet connection or any other hefty means to detect an obstacle. In the future, we plan to expand this project to different and larger location or to mold it into a system where we can further send the exact location to the engine driver. Furthermore, we would like to research on improving our system for better performance.

VI. EXPECTED RESULT

- (1) To develop a system to ensure safety and avoid accidents by detecting obstacles like animal/human on Railway tracks. The obstacle is detected with the help of ultrasonic sensors. The ultrasonic sensor is mounted over a servo motor to provide 150° field view.
- (2) To notify the train driver with the help of a buzzer, which is triggered whenever an obstacle comes within a specific range on railway track. The buzzer and led can then be seen and heard by the driver and accordingly speed of train can be reduced or the train can be stopped.
- (3) To develop a prototype of the entire setup that can be used to verify the application. The developed system is easy to install and can be used to warn train driver.

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