Article

Object Detection using Ultrasonic Sensor

Mohammed Faisal¹, * , Ganta Anurag Reddy¹ , Balusupati Anil Kumar¹ and Dr. D. Ajitha²

1   Student, Department of ECE, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana, India.
2   Associate Professor, Department of ECE, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana, India.
*   Correspondence: faisalmd929@gmail.com;

Abstract: There is a need to observe restricted zones to abstain from intruding. Presently employing humans for this work is exorbitant and furthermore it is unrealistic for observing a territory 24×7. So, for this reason an ultrasonic sensor for unauthorized human/creatures or object recognition system can be used. This system can observe a zone of restricted area and cautions authorities with a buzzer as an alert. This can be implemented with a microcontroller circuit that is associated with a ultrasonic sensor mounted on a servo engine for monitoring of objects. Interfacing a buzzer and Liquid Crystal Display (LCD) screen for observing the location status is very effective for this system. The sensor continues observing the prohibited zones checking the ultrasonic sensor echo. When an object is identified the information of location and where precisely the object was recognized is sent to the authorities. Accordingly, object detection using ultrasonic sensor project ends up being a valuable framework for 24×7 observing of a specific region/zone. The accurate detection of stationary or moving objects by using only one ultrasonic sensor and one Arduino uno board with suitable algorithms makes this paper unique from referred papers.

Keywords: Ultrasonic sensor, microcontroller, buzzer, LCD, Arduino uno.

1. Introduction

In the present developing world, there are various innovations in very field of work. There are some instances where you just need small devices to solve large problems. Innovation of small devices are very essential to save our precious time. There are various resources which are used to develop these devices and help to solve our problems. In olden days, for measuring the distance between the objects, measuring devices like scales were used. But now a days digitalization is on peak. Everything is becoming digital. So measuring distance between the objects can also be digitalized. With the use of ultrasonic sensors, objects can be detected and the distance can be measured from the sensors and it can also be displayed using the lcd screen. Ultrasonic sensor gives a simple route in distance estimation. Ultrasonic Sensor measure the distance of the items in air through non-contact method.

They measure distance without harm and are very easy to utilize and are reliable. These distance measurement sensors associate with all regular kinds of mechanization and telemetry components. Industries in a wide scope of ventures uses these sensors where size or position input is required. Ultrasonic sensors are very effective in detecting the exact location and angle at which the objects are placed[1]. Ultrasonic sensors can detect the elements of items like stature, width and breadth, utilizing at least one sensor. The echo time reaction of ultrasonic sensor locator depends on schedule of movement after trigger heartbeat to the encompassing items relies upon the reflectance attributes of the article surface. Ultrasonic sensors are broadly utilized for distance estimation purposes.

To calculate the distance of the object from the sensor the following formula can be used: Distance = 0.5 * time (T) * speed of sound (C) [2].

This technique of measuring the distances using the ultrasonic sensor in air requires continuous pulse echo system. From the transmission medium, a pulse echo is sent and is to be reflected by the object which is kept at certain distance [3].

Related Work

Research on the utilization of sensors is expanding and has been distributed in diaries in different controls. For instance, there was a proposition of a framework that can distinguish an article and a human in still or movement by utilizing two ultrasonic sensors, LPC2148 and DC outfitted engine; a distance estimation by utilizing Arduino ultrasonic sensor; a radar frame. work that can recognize distance and bearing of item; distance and course planning with a preparing App; distance and heading estimation by utilizing an Arduino ultrasonic radar installed framework; distance and bearing location by utilizing a microcontroller ATmega16; and a tallness identifier with ultrasonic sensor by utilizing a microcontroller ATmega16[2]. The current examination plans to fill the hole by inspecting this by utilizing a minimal expense gadget and a calculation to take care of the computation issues.

In past research, ultrasonic sensor was utilized to recognize the presence of human in a spot where there is a fog. Arduino code and striking examination were likewise used to noticed items in various shapes and sizes. The tallness of an materials could likewise be recognized by utilizing a ultrasonic sensor associated with a cell phone. The length of an item could likewise be recognized by utilizing a ultrasonic sensor consolidate with an extra gear named Raspberry Pi. Another framework can distinguish more than one article position. A radar framework can likewise be created to cover a bigger scope of ultrasonic sensor and transformed into a portable robot with a sonar framework. In any case, the advancements utilized in the examination projects above are costly.

Organization

The rest of the paper is organized as follows. In section 2 the working of the system is described. Circuit design is described in section 3. Hardware components are explained in section 4. Results in section 5. Future scope in section 6. Lastly, section 7 concludes the paper.

2. WORKING

This framework depends on Arduino and ultrasonic sensors. Here the ultrasonic sensor detects the inputs and the LED and buzzer gives the output [4]. As Arduino is switched on, the ultrasonic sensor produces ultrasonic waves through the transmitter. At the point when these waves recognize or hit any object then it will reflect back to the receiver as an echo. At that point it identifies there is an obstruction present in front of this sensor. First the Arduino is programmed with Keil micro vision software [5]. After programming the Arduino, Give the connections as per the block diagram. Now switch on the power supply. First the ultrasonic sensor will rotate 0^0 to 180^0 and back to 180^0. Place an object in front. While an infrared ranger sends a beam of light out of the transmitter and waits for it to return, there are times when you should screen a bigger region and you don't need such explicit information
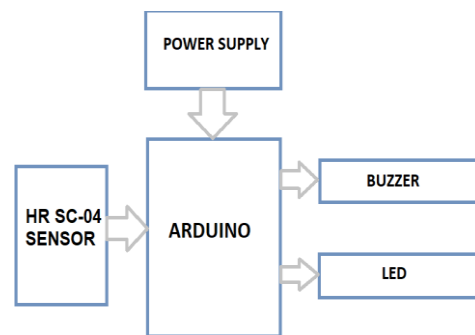
Figure. 1 Block Diagram

You basically need to know whether something moved or not. That is actually the motivation behind passive infrared sensors. All things considered, eventually we would turn a light on or off by setting off a PIR sensor either in a huge room or in a yard. A PIR sensor is basically an infrared camera that transmits light from objects or materials in its view. Piezo – electric buzzer acts an alarm when an object is detected by the ultrasonic sensors.

These buzzers are very much useful when the person cannot see the obstacles and if the buzzer sounds, then he gets cautious as some obstacles is present in front of him. Buzzer is placed so that it sounds when an object is detected by the sensors. The working of the prototype is simple and it contains less components which makes this paper less costly.
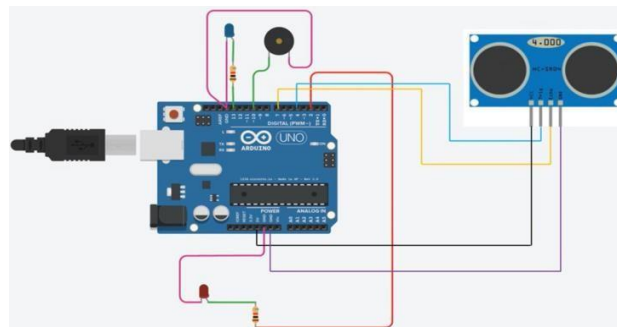
3.CIRCUIT DESIGN

Figure . 2 Circuit Diagram

The above figure gives the description about the hardware connections and input and output devices connected to Arduino. Arduino board is a microcontroller, which process the two types of data i.e., Analog and Digital by the use of two set of pins analog pins, digital pins. Digital pins are also called as PWM – Pulse Width Modulation. And these pins are used to process the digital data i.e., High - Low (1 or 0).

Arduino can be powered by three ways:
1. Through data cable
2. 12v DC Power supply
3. Power supply through Battery
Ultra-sonic sensor (HC SR - 04) has 4 pins [6]
1. Vcc – 5v positive supply must be given to Vcc.
2. Trig – In Arduino digital pin 7, trig is to be connected.
3. Echo – In Arduino at digital pin 4, echo is connected.
4. Gnd – Gnd is connected to the common ground of the Arduino to close the circuit.

The information is prepared and it is sent to the Arduino through receiver end of the ultrasonic sensor. In light of the information Arduino provides orders to the Led and

buzzer. At the point when the object is in the scope of in excess of 50 units of distance, at that point no order is passed to the receiver end (Led and Buzzer). At the point when an object or vehicle is in the scope of under 50 units and in excess of 20 units of distance an alarm is created by shining a red Led to inform the authorities that there is an object in front. Ultra-sonic sensor has two blocks, one is Transmitter and another one is Receiver [7]. It senses the obstacle by sending ultra-sonic waves through transmitter and the receives the echo, which is reflected or when it hits the obstacle.

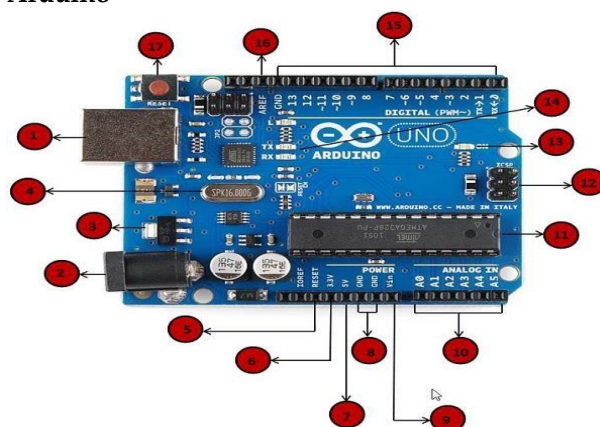## 4. HARDWARE COMPONENTS

Arduino

Figure. 3 Arduino Uno

Arduino is a single board microcontroller which can be used to make some good applications. The hardware of the board comes with an open-source equipment board planned around a 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. Current models comprises of 6 analog input pins, USB interface, and 14 computerized input output pins that permits the users to append different extension boards.

Microcontroller of the Arduino uno board works on ATmega328 microcontroller [8]. Arduino uno board has fourteen advanced i/o pins in which 6 can be utilized as PWM outputs, an ICSP header, a 16 MHz ceramic resonator, a USB association, 6 analog inputs, a reset button and a power jack. This contains all the necessary help required for microcontroller. To begin, they are just associated with a PC with a USB link or battery. Arduino Uno Board is different from the all-other boards and they won't utilize the universal serial bus to serial driver chip in them [9].

HC SR-04 Sensor

The sensor used in this project is HC SR-04 ultrasonic sensor [7]. This sensor has two transducers. It converts electrical signal into ultrasonic sound pulse. Transmitted pulses now will be received by the receiver [10]. The ultrasonic sensor is little, simple to utilize in any mechanical technology projects and has a brilliant non-contact range recognition between 20 mm and 4 m with a precision of 3 mm [11]. Since it works on 5 volts power supply, it tends to be snared straightforwardly to an Arduino or some other 5V microcontrollers.
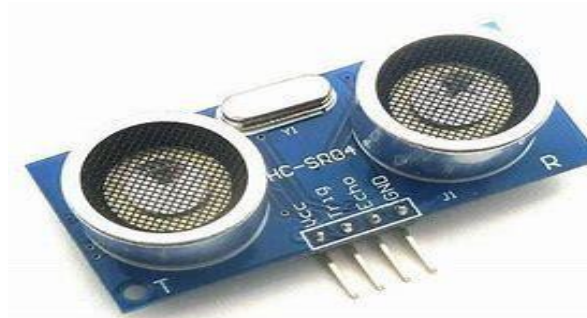
Figure. 4 Ultra sonic sensor

The echo pin goes low if those pulses are reflected back when the signal is received. That creates a pulse whose width shifts between 150 microseconds to 25 milliseconds.The sensor works with the simple formula:

$$Distance= (Duration*0.034)/2$$

Some of the features of HC-SR04 Ultrasonic sensor: it requires a 5v input voltage, 20mA current draw, sensing angle of 30 degree, 15 degree angle of effect, ultrasonic frequency of 40 kHz, it has a range of 2cm to 400cm. The echo signals will timeout after 38 micro seconds if the pulses are not reflected back and it will return LOW.

Servo Motors

Figure . 6 Servo Motor

Servo motors is a control motor which is to be utilized in robotics and many other applications. These motors work on the same principle of electromagnetic motors. The rotor of the servo motor is low while it has a very high response speed. Servo motor has a power rating from fraction of watts to few 100 watts. Servo motors are the one which responds to the error signals [3]. In this manner significant sorts of Servo engine are:

(i)   AC motor,
(ii)   DC motor.

The speed of the DC servo motor should be directly proportional to the input voltage and with a constant load. The speed of the AC servo motor is known by the applied voltage frequency and number of magnetic poles. DC servo motors are preferred for high power usage because they operate more efficiently than the AC servo motors [6].

Required Software

• Keil Micro Vision

This is a software development company which is based in Germany. Keil Micro Vision is a free programming software which settles a large number of the trouble spots for an embedded program designer. This product is an integrated development environment (IDE), which incorporated editors to compose programs, a compiler.

5. RESULTS

During the implementation of the paper, the data was continuously monitored on lcd screen and all the data was recorded for evaluation and validation purpose. The efficiency in detecting the distance of the objects by the ultrasonic sensor was above 90% in most of the cases. The sensor was accurate in detecting the objects which are 10 cms away from the sensors. The efficiency decreased when an object is very close to the sensor. The sensors are also accurate in detecting the actual direction or angle of the objects. Comparison of the readings displayed by the sensor and the actual readings is shown below.

TABLE I
DISTANCE MEASUREMENT FOR ULTRASONIC SENSOR AND ACTUAL DISTANCE

Actual distance (cm)	Ultrasonic sensor distance (cm)	Efficiency(%)
3.5	4	87.5
4.5	5	90
7.2	8	90
9.2	10	92
14	15	93.3
15.5	16	96.8
18	18	100
20	20	100

Table 1 is made from information which was taken from the ultrasonic sensor readings. The actual distance of objects was measured inside the room for different objects, showing the actual and the ultrasonic distance. To evaluate the performance of connection setup, efficiency and error are calculated from these readings.

TABLE II
MEASUREMENT OF ACCURACY OF DIRECTION OR ANGLE

Actual angle (degree)	Servo indicated angle (degree)	Efficiency (%)
10	12	83.3
30	33	90.9
40	42	95.2
50	52	96.1
80	83	96.3
90	94	95.7
110	111	99
120	120	100

Table 2 is made from the information taken from servo motor reading and the actual measured angle values for the objects. To observe the nature of response, efficiency is also calculated for each data set.

This paper is very efficient in calculating the actual distance of the objects using the ultrasonic sensors. Below are some of the images taken while implementation of hardware setup and while detecting single object and multiple objects using ultrasonic sensor.
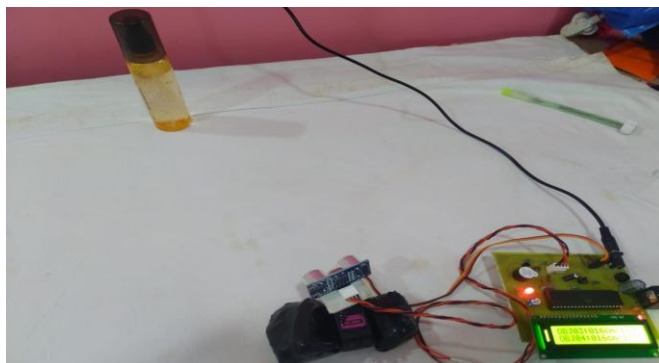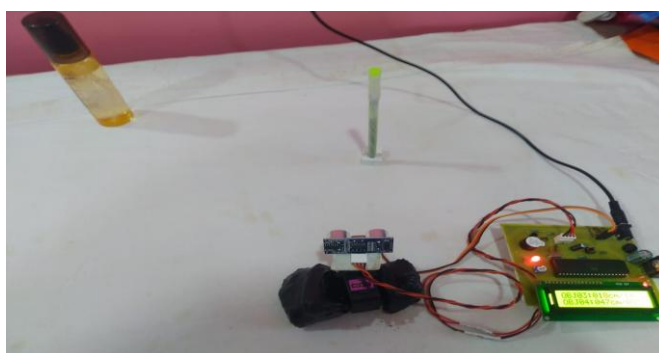

Figure . 7 Single object detection

Figure. 8 Multiple objects detection

6.   FUTURE SCOPE

The interest for ultrasonic sensors is likewise expanding for sanitization bands as they have inbuilt closeness sensors. Implementation of a smart social distancing band using these ultrasonic sensors can be done efficiently. When a person is approaching towards us and is not maintaining 6 feet distance then the sensors can sense the person in front of us and can alert the user that the person in front of us is not maintaining social distancing. Implementation of a smart parking system with ultrasonic sensors can also be done. When an obstacle is near to the vehicle then the sensors will alert the driver that there is an obstacle at some particular distance. There are many applications where ultrasonic sensors can be used and the demand for ultrasonic sensors are increasing rapidly.

7. Conclusions

This paper was aimed to plan and execute an object detection system using ultrasonic sensors with distance estimation. This paper was successful in detecting the exact distance object and calculating the angle or direction of the object from the servo motor. The proposed system has only small error while calculating the objects which are near to the sensor but is accurate in calculating the objects which are far from the sensor.   This paper is very efficient in detecting objects and calculating the exact distance of objects. This paper will likewise have its application in mechanical and civil fields for exact and small estimations. For measuring the distance using this paper, the object whose distance is to be estimated must be horizontal to the plane of propagation of the

ultrasonic waves. Overall, this paper can provide 100% efficiency unless the distance of the objects is less than 1 cm or the size of the object is very small. However, it is important to note that the experiment was done in a constant environment.

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