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Object Detection for Collision Avoidance in ITS

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ABSTRACT

Collision avoidance system is an integral part of successful deployment of intelligent transportation system. This paper deals with the development of joint radar and communication system using Arduino board. System composed of two motors, one having sensor for detection purpose and the other will have antenna to transfer the sensing information to the nearby vehicle. The sensor will rotate at some angle and it will detect the nearest object and calculate the distance and the direction of arrival (DOA), which will help the other second motor to rotate towards the direction of that object and then will communicate with that.

Key words: Ultrasonic Sensor, Arduino-Board, ITS (Intelligent Transport System), DOA (direction of arrival), Servo Motor.

INTRODUCTION

Intelligent transportation systems (ITS) [1-2] are advanced applications which aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport system. So in this project we have used one of the part of intelligent transport system [3] like in collision avoidance [2] ultrasonic sensor measures the distance of the object within its vicinity and gives the measured distance in centimetres to avoid the collision [4]. So, this concept has been used here to calculate the distance within 30cm at some particular angle.

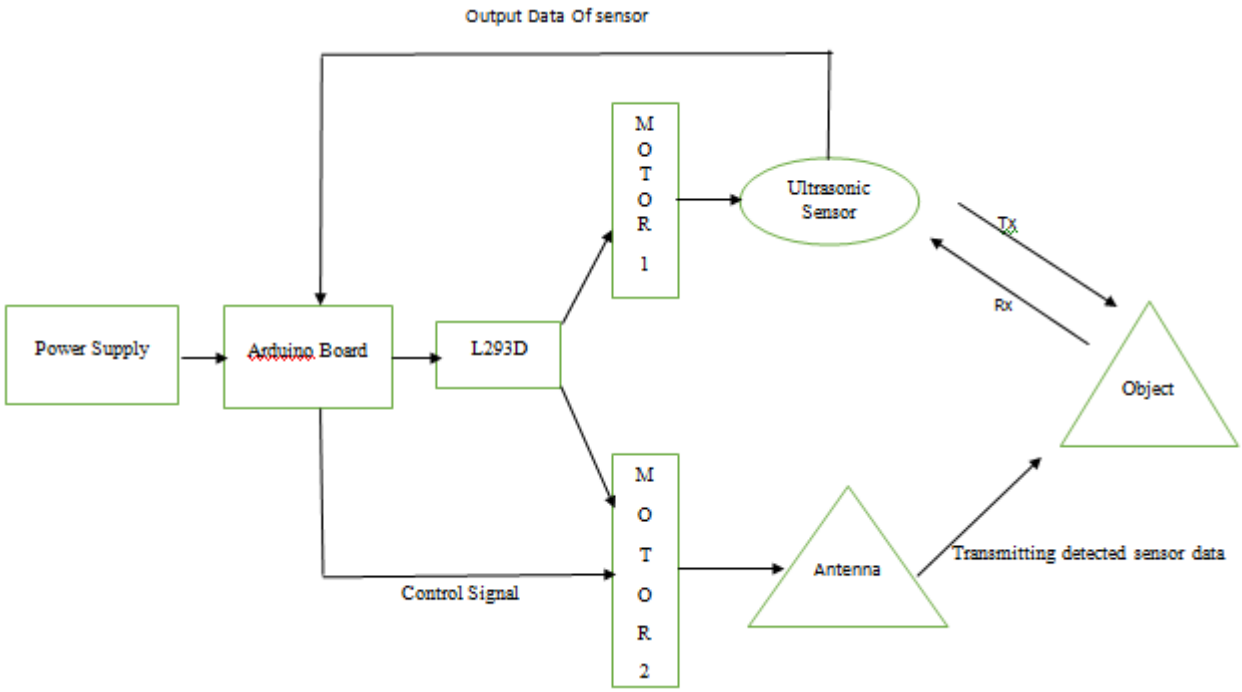

Fig.1 Block diagram of the proposed system

Nowadays we are facing signal strength problem due to low acceptance of signal from the satellite which occur due to LOS problem (when DOA is not equal to DOT) [5].So we can make it correct by manually. But by using of this designed system this manual process can be done automatically. Moreover we can install this system in base antenna which can be used in moving condition (for e.g. in Car, Train). Because in moving condition DOA [5] will not always be equal to DOT, so using this designed system we can use the base antenna in moving condition and can get the maximum strength of acceptance of signal.

BLOCK DIAGRAM, FLOW CHART, CIRCUIT DIAGRAM AND WORKING

There are two functional components in this project. They are Ultrasonic sensor and the servo motor. Thus the Arduino board is programmed using the Arduino IDE software [6]. The function of the ultrasonic sensor is to detect the object in the free environment at some particular angle which will be sent to other motor 2 by programming. Than the antenna over motor 2 will align at the direction of detected object [8].

This block diagram will explain the basic functionality of this project; firstly Arduino will be provided power supply to make it 'ON'. After that, from Arduino two motors are attached: motor 1 and motor 2 through L293D IC (motor driver IC) because the current from the Arduino is not sufficient to drive the motors. From Motor 1 we have attached Ultrasonic sensor which will detect object at some specified given distance. After getting those data of distance and angle (output of sensor) will be sent to Arduino and then after processing, control signals from Arduino will be sent to motor 2 for alignment towards the detected object. Lastly, we have attached one antenna at the top of motor 2 for communication with the detected object.

After the system gets start, motor 1 will activate and then checks for obstacle within its vicinity. If the distance is less than 30cm and more than 2cm than it will stop the motor 1 and send the detected angle to motor 2, which will align to the direction of obstacle detected.

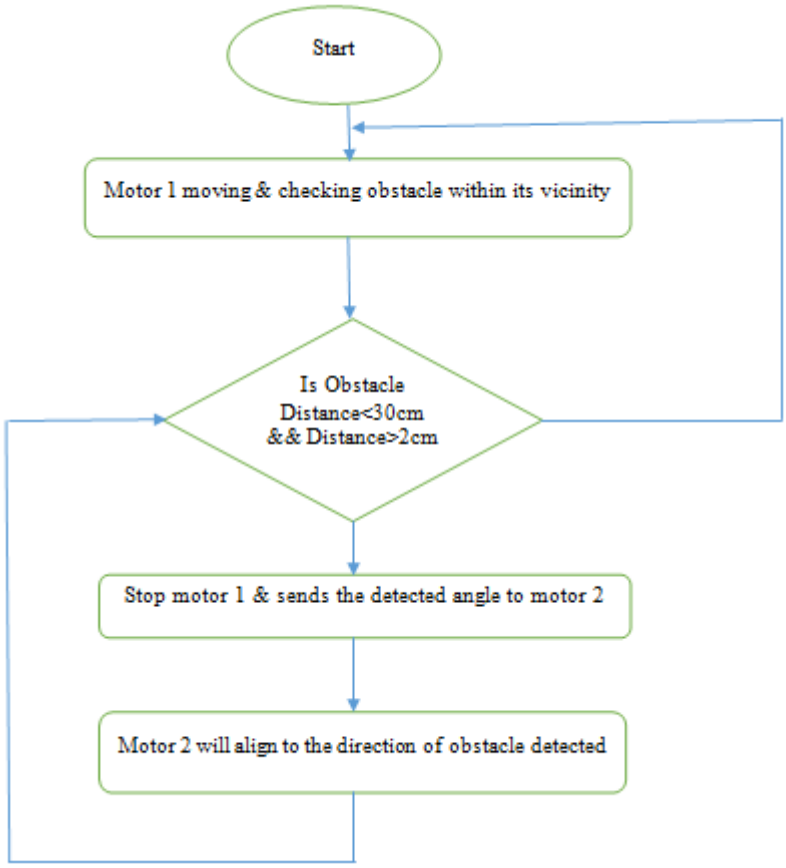

Fig.2 Flow Chart of the proposed system

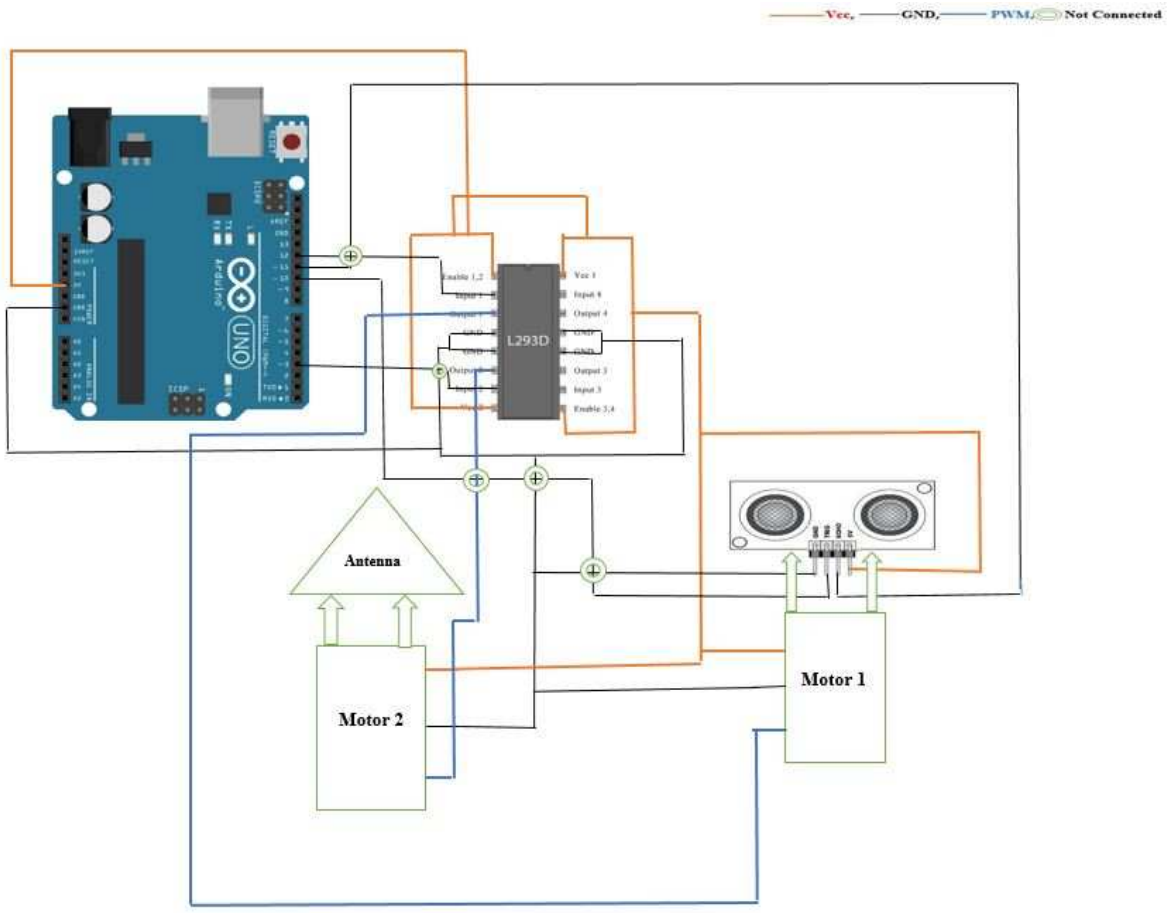

Fig.3 Circuit Diagram of the designed system

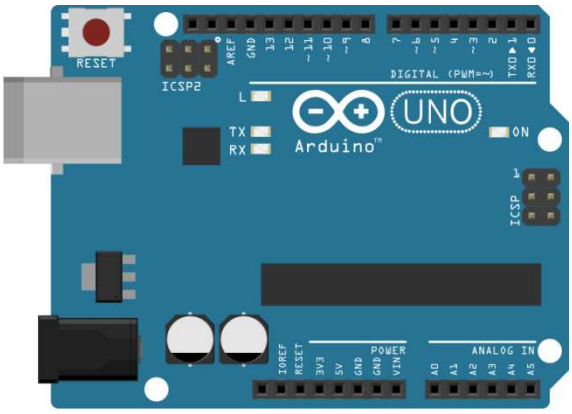

Fig.4 Arduino Uno[9]

Features and pin description
Microcontroller: ATmega328
Operating Voltage : 5V
Input Voltage : 7-12V
Input Voltage (limits): 6-20V
Digital I/O Pins : 14 (of which 6 provide PWM output)
Analog Input Pins: 6
DC Current per I/O Pin: 40 mA
DC Current for 3.3V Pin: 50 mA
Flash Memory : 32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM : 2 KB (ATmega328)
EEPROM : 1 KB (ATmega328)
Clock Speed : 16 MHz

ARDUINO UNO

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicated with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment [6].

Power
The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or

battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and V_{in} pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows:

V_{in}: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from Vin via an on-board regulator, or be supplied by USB or another regulated 5V supply.
3.3V: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
GND: Ground pins.

Memory
The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

ULTRASONIC SENSOR

Ultrasonic Definition
The human ear can hear sound frequency around 20Hz to 20 KHz, and Ultrasonic is the sound wave beyond the human ability of 20 KHz.

Ultrasonic Distance Measurement Principle
Ultrasonic transmitter emitted an ultrasonic wave in one direction, and started timing when it launched. Ultrasonic spread in the air, and would return immediately when it encountered obstacles on the way. At last, the ultrasonic receiver would stop timing when it received the reflected wave.
As Ultrasonic spread velocity is 340m/s in the air, based on the timer record **t**.
We can calculate the distance (s) between the obstacle and transmitter, namely: s = 340*t/2, which is so- called time difference distance measurement principle.
The principle of ultrasonic distance measurement used the already-known air spreading velocity, measuring the time from launch to reflection when it encountered obstacle, and then calculate the distance between the transmitter and the obstacle according to the time and the velocity.
Thus, the principle of ultrasonic distance measurement is the same with radar.
Distance Measurement formula is expressed as: L = C X T

L: Measured distance, C: Ultrasonic spreading velocity in air
T: Time (T is half the time value from transmitting to receiving).

HC-SR04 Ultrasonic Module

Product Features	**Application Areas:**	**Module pin definitions**	**Electrical parameters**
Stable performance Accurate distance measurement High-density Small blind	Robotics barrier Object distance measurement Public security	VCC : 5V power supply Trig : Trigger pin Echo : Receive pin GND : Power ground	Operating Voltage (DC) : 5V Operating Current : 15mA Operating Frequency : 40KHz Farthest Range : 4m Nearest Range : 2cm Measuring Angle : 15 Degree Input Trigger Signal : 10us TTL pulse

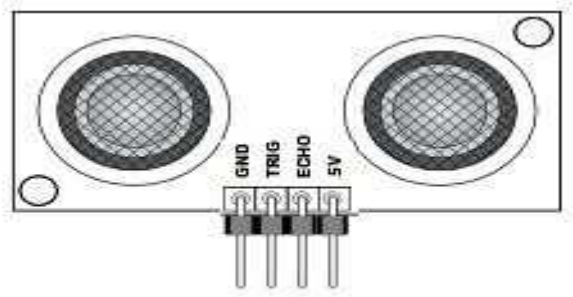

Fig.5 Ultrasonic Sensor [10]

Output Echo Signal Output TTL level signal, proportional with range Dimensions 45*20*15mm.

Module Operating Principle

Set low the Trig and Echo port when the module initializes , firstly, transmit at least 10us high level pulse to the Trig pin (eight 40K square wave), and then wait to capture the rising edge output by echo port, at the same time, open the timer to start timing. Next, once again capture the falling edge output by echo port, at the same time, read the time of the counter. According to the formula:

Test distance = (high level time * ultrasonic spreading velocity in air) / 2. You can calculate the distance to the obstacle.

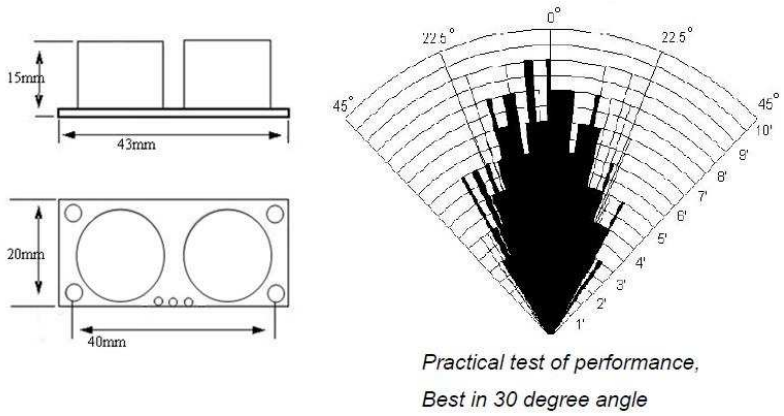

Fig.6 Radiation Angle of Ultrasonic Sensor [11]

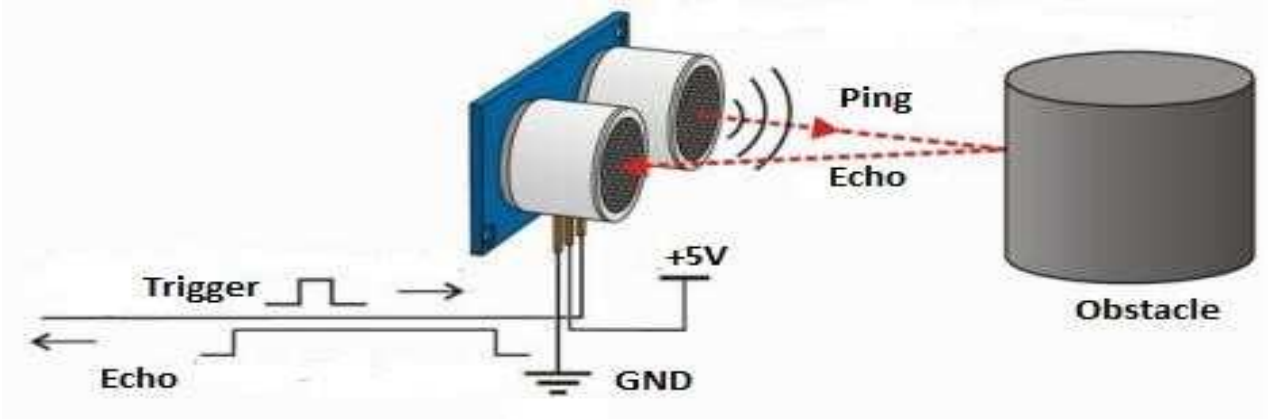

Fig.7 Working of Ultrasonic Sensor [12]

MOTOR DRIVER L293D

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

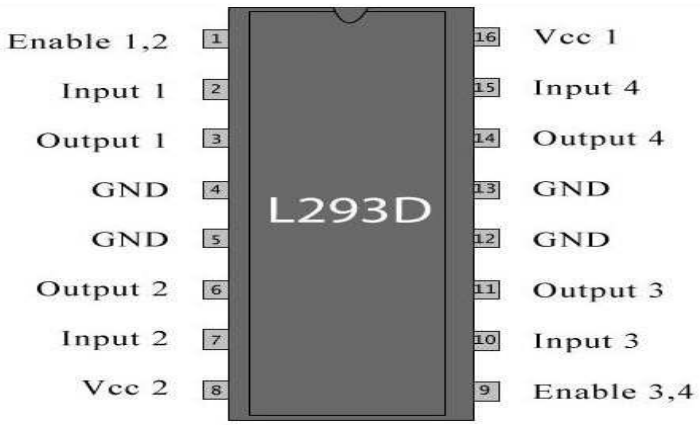

Fig.8 Pin configuration of L293D [13]

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

MICRO SERVO MOTOR

Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware Fig. 9.

Fig 9 Servo motor[14]

Specifications

Weight: 9 g
Dimension: 22.2 x 11.8 x 31 mm approx.
Stall torque: 1.8 kgf·cm
Operating speed: 0.1 s/60 degree
Operating voltage: 4.8 V (~5V)
Dead band width: 10 µs
Temperature range: 0 ºC – 55 ºC

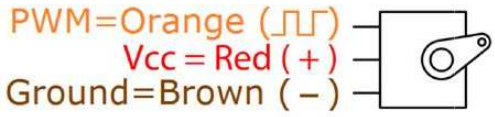

Fig.10 Terminal specification of servo motor[14]

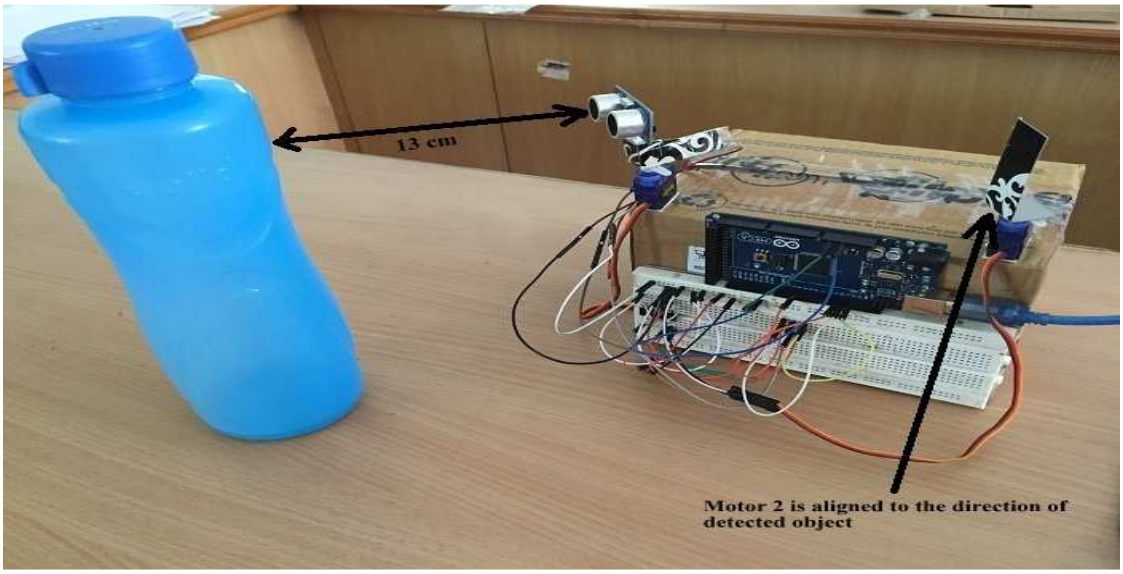

Fig.11 Hardware Realization of the proposed system

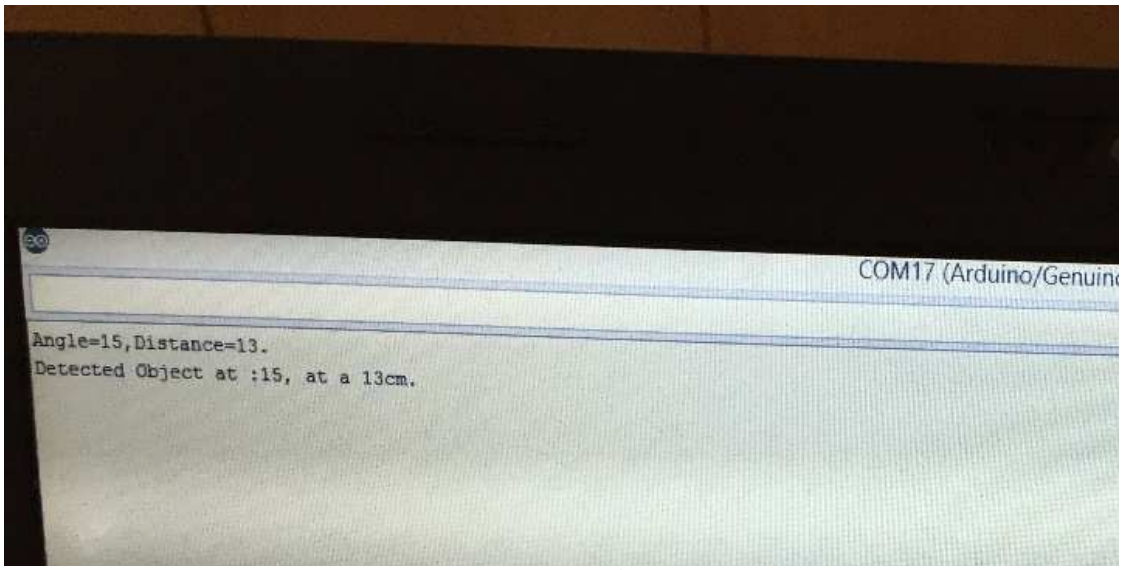

Fig.12 Serial monitor of Arduino

RESULT

Here in Fig.11 ,we can see that object is at distance 13 cm at an angle of 15 is detected by ultrasonic sensor which is attached in top of Motor 1.After we get the angle, it is send to the Motor 2,after that it will align the antenna towards the detected object.

CONCLUSION

Thus the Arduino based object detection for collision avoidance in ITS has been designed and tested successfully. It has been developed by integrated features of all the hardware components used. The ultrasonic sensor measure the distance of the object at some particular angle if its distance is less than 30cm(motor 1 stops), and then sends that particular angle to the motor 2, having antenna at its top which will align to the direction of detected object and then communicate with that object. Thus, the functionality of the entire system has been tested thoroughly and presented in this paper**.**

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