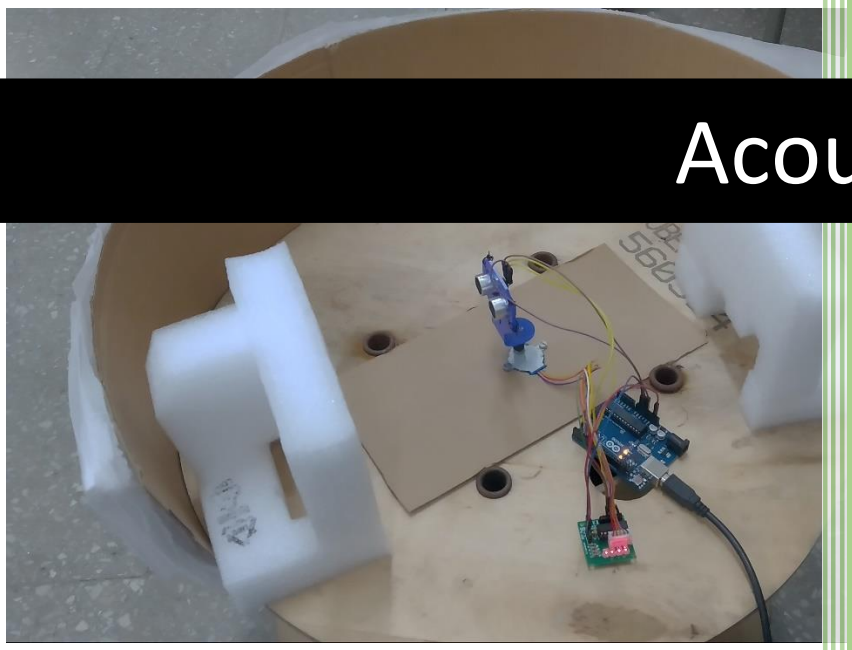
2019

Acoustic Radar



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7/1/2019

Acoustic Radar
PROJECT REPORT

Abstract

The aim of this project is to achieve the obstacle detection by the help of ultrasonic sensor. The system will be made so as to rotate the ultrasonic sensor clockwise and anticlockwise by the help of Arduino IDE. MATLAB will be used for serial communication between the Arduino and the system (PC) and the distance map distance i.e. distance with respect to steps will be plotted accordingly.

Introduction

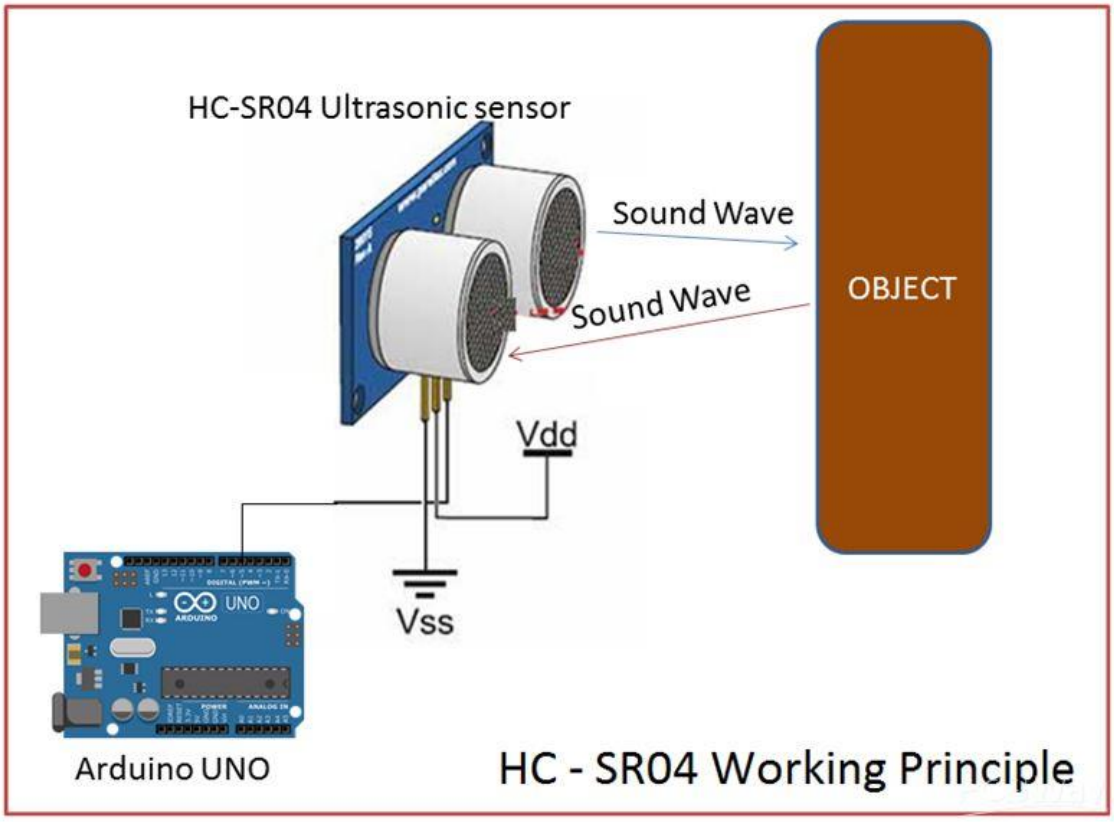
Ultrasonic sensor

- The ultrasonic sensor used here is **HC-SR04**. **HC-SR04** is an ultrasonic sensor mainly used to determine the distance of the target object. Transmitter and receiver are two main parts of the sensor where former converts an electrical signal to ultrasonic waves while later converts that ultrasonic signals back to electrical signals
- The **HC-SR04 Ultrasonic (US) sensor** is an ultrasonic transducer that comes with 4 pin interface named as Vcc, Trigger, Echo, and Ground. It is very useful for accurate distance measurement of the target object and mainly works on the sound waves
- As we connect the module to 5V and initialize the input pin, it starts transmitting the sound waves which then travel through the air and hit the required object. These waves hit and bounce back from the object and then collected by the receiver of the module.
- Distance is directly proportional to the time these waves require to come back at the receiving end. The more the time taken, more the distance will be.

Following formula is used to calculate the distance of the object

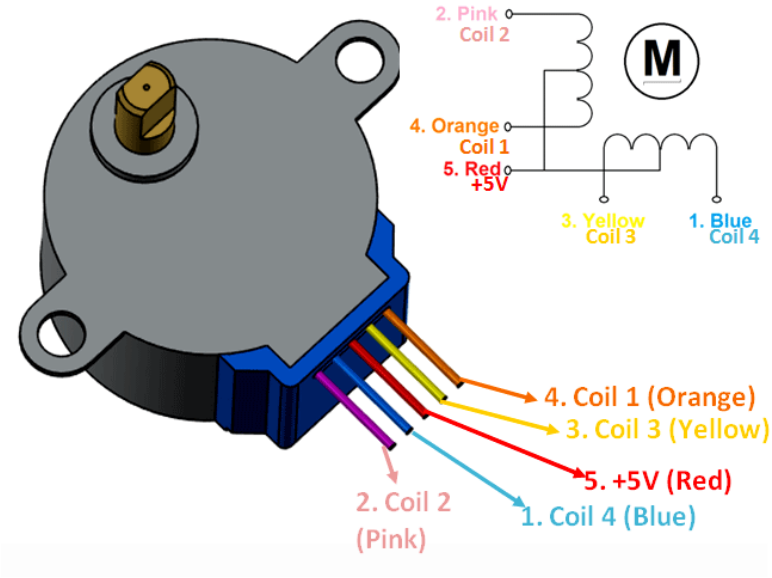
$$S = (V \times t)/2$$


Y1
HC-SR04
Vcc
Trig
Echo
GND
T
J1
R


HC-SR04 Ultrasonic sensor
Sound Wave
Sound Wave
OBJECT
Vdd
Vss
UNO
Arduino UNO
HC - SR04 Working Principle

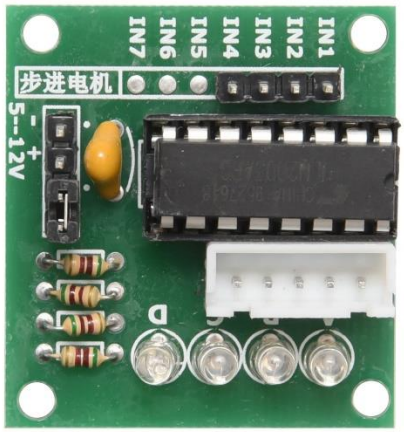
Stepper motor

- The most commonly used stepper motor is the **28-BYJ48 Stepper Motors**. You can find this (or similar) motors in your DVD drives, Motion camera and many more place. The motor has a 4 coil unipolar arrangement and each coil is rated for +5V hence it is relatively easy to control with any basic microcontrollers. These motors has a stride angle of 5.625°/64, this means that the motor will have to make 64 steps to complete one rotation and for every step it will cover a 5.625° hence the level of control is also high. However, these motors run only on 5V and hence cannot provide high torque, for high torque application you should consider the **Nema17 motors**. So if you are looking for a compact easy to use stepper motor with decent torque then this motor is the right choice for you.



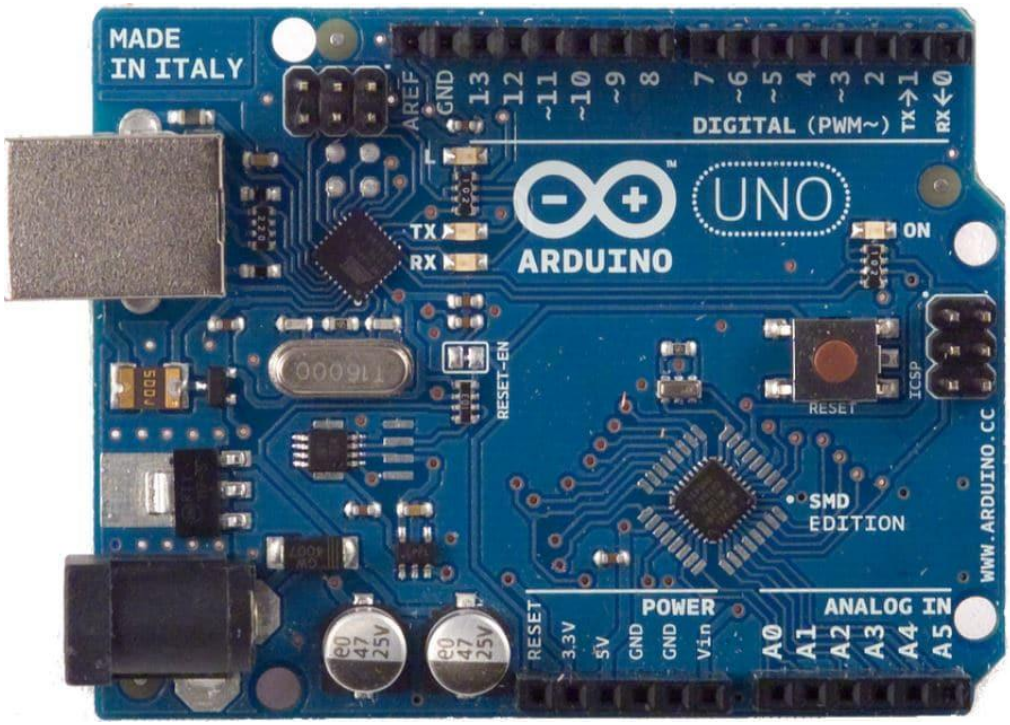
Stepper motor driver ULN- 20003

- This driver for stepper motor enables control over stepper motor that does not require more than 500mA of current and works at 5V-12V voltage. Except for the driver, it has built-in LED lights that indicate which phase of the motor is currently active. Connecting on Arduino is simple, and control is direct through the library



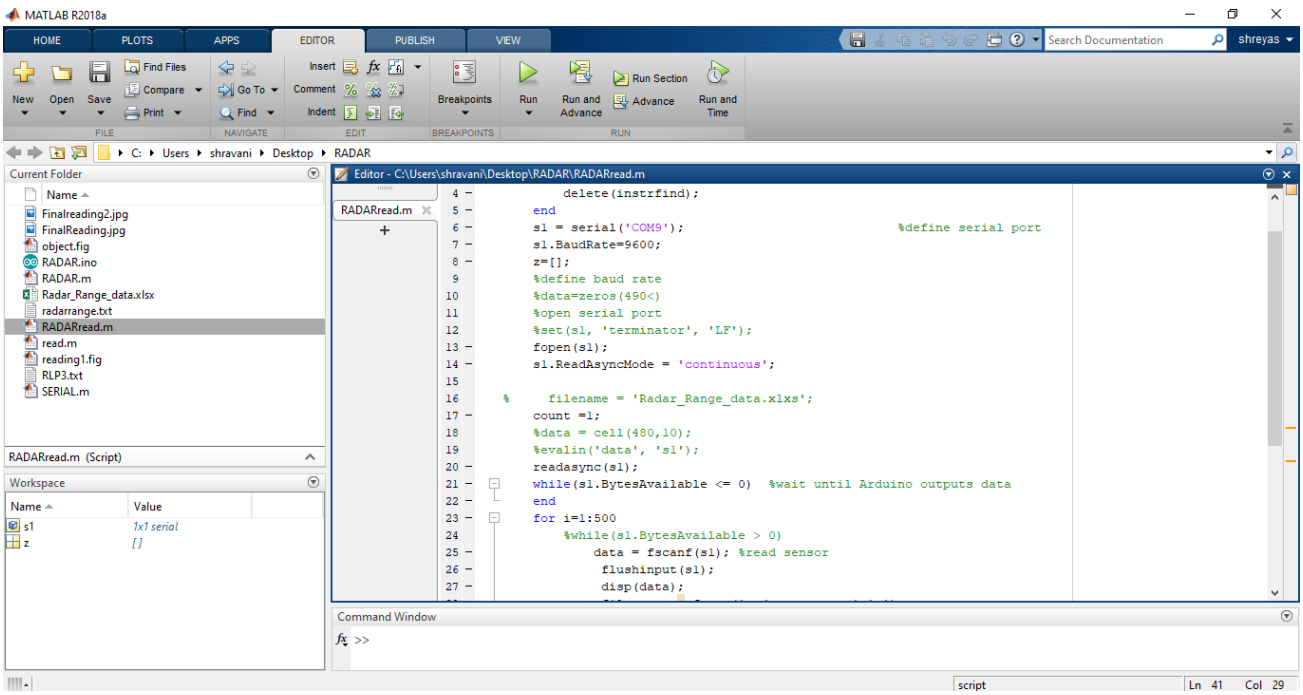
Arduino UNO

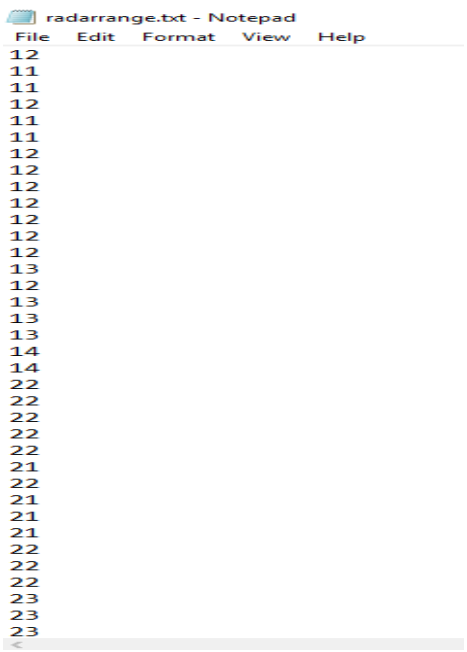
- The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.



MATLAB

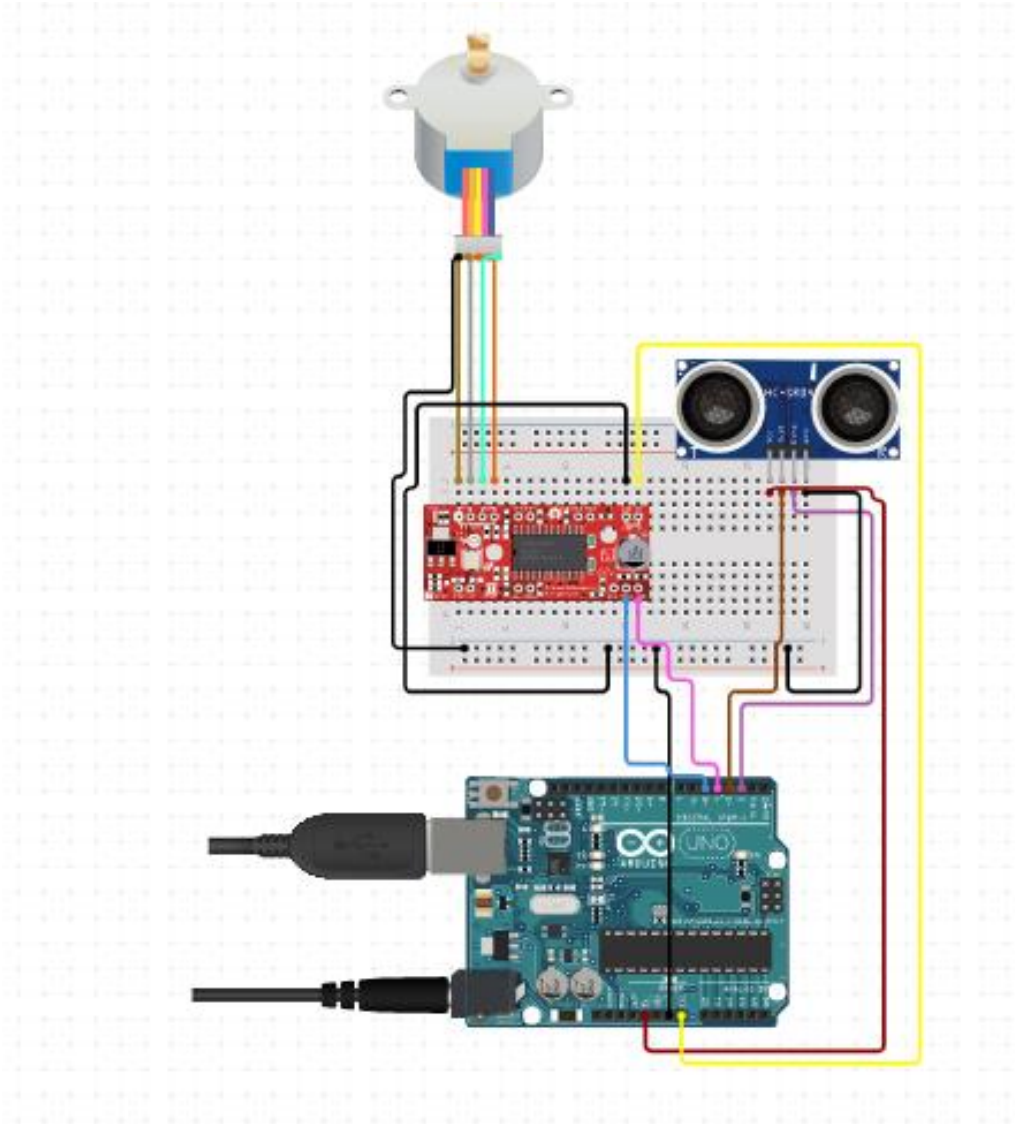
MATLAB is a multi-paradigm numerical computing environment and proprietary programming language developed by Math Works. Matlab here was used for establishing a serial communication between the Arduino and the system. The data obtained from the serial port was processed and Distance vs Steps graph was plotted. Matlab is also used for making of the graphical user interface for the rotation of the stepper motor. Matlab has many tool boxes that are used to interface with many microcontrollers here it was used to interface with the Arduino. One of the major application of Matlab is Signal and Image processing, one can also code the Arduino board by the Matlab simulation software.





Software used: Arduino IDE and Matlab.

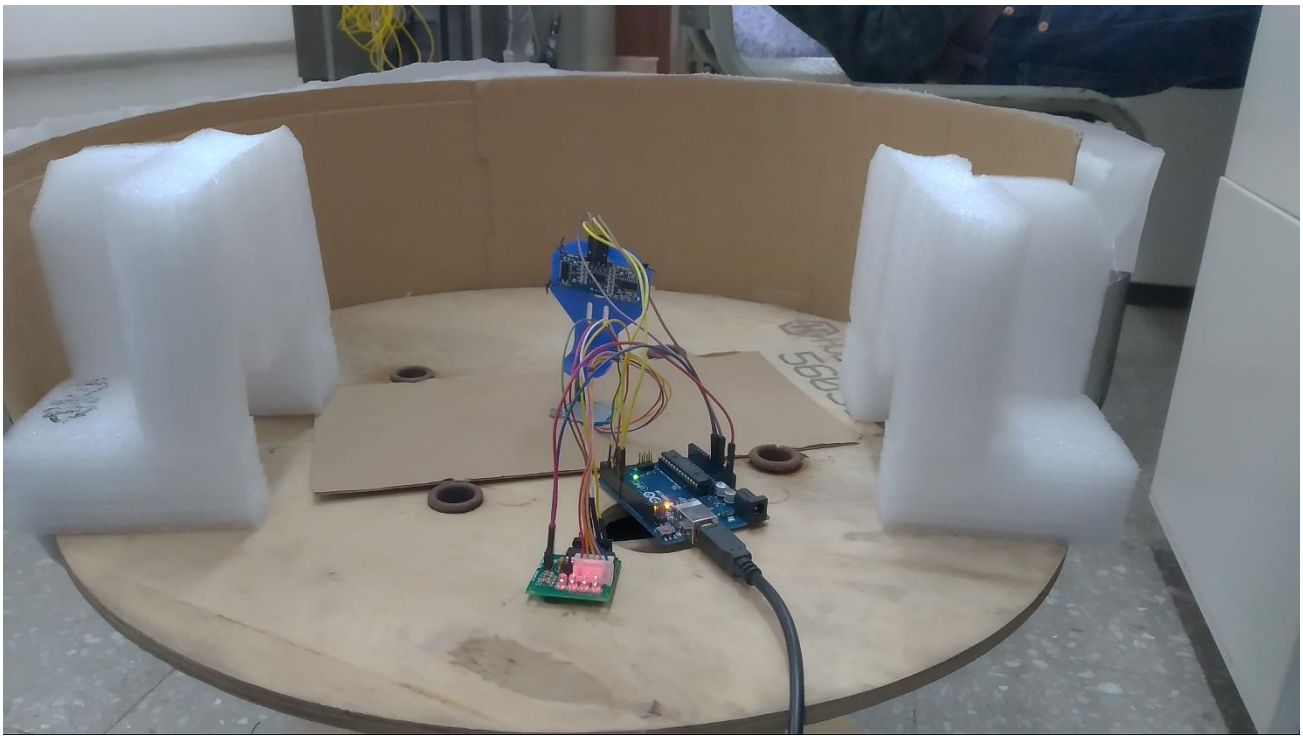
Circuit Diagram:

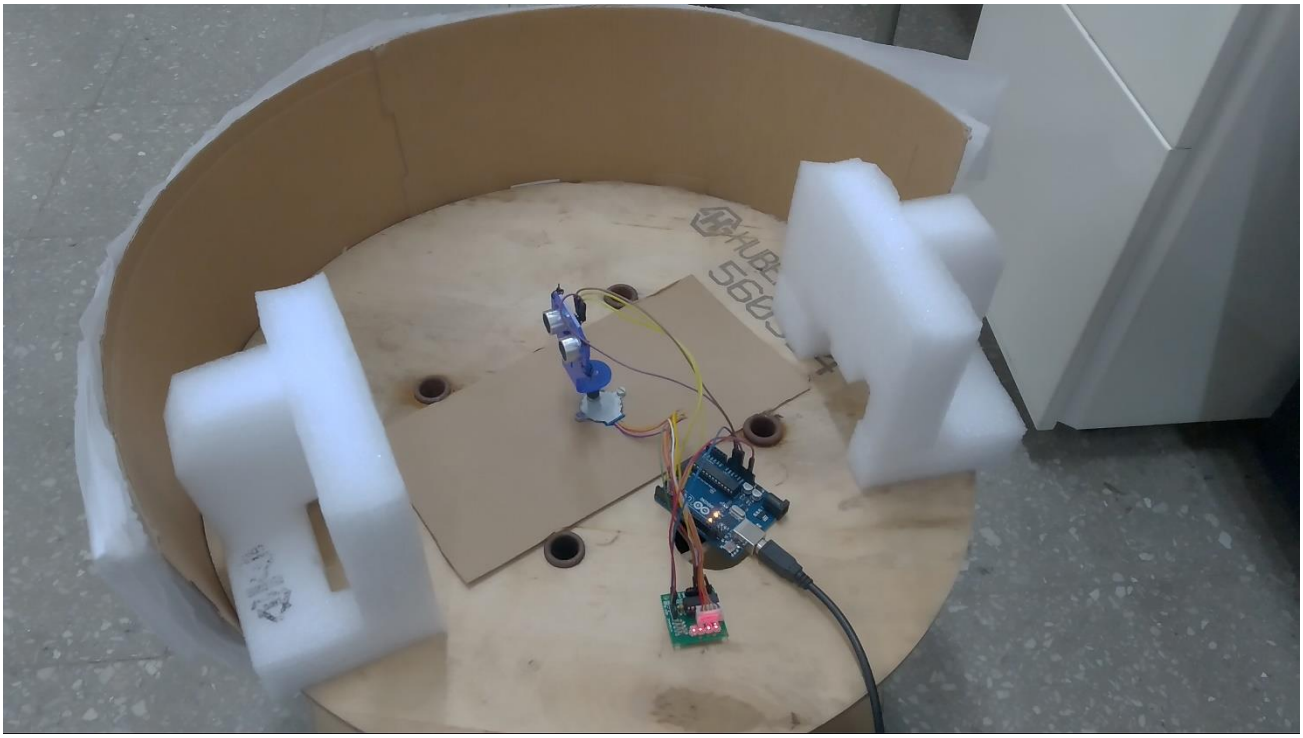


Connections:

The Arduino's digital pins 2 3 4 5 are connected to the driver's input pins that are IN1 IN2 IN3 and IN4, the Ultrasonic sensor's trigger and echo pins are connected to the digital pins 6 and 7 of the Arduino. The wires from the Stepper motor are connected to the stepper motor driver.

System and Working:

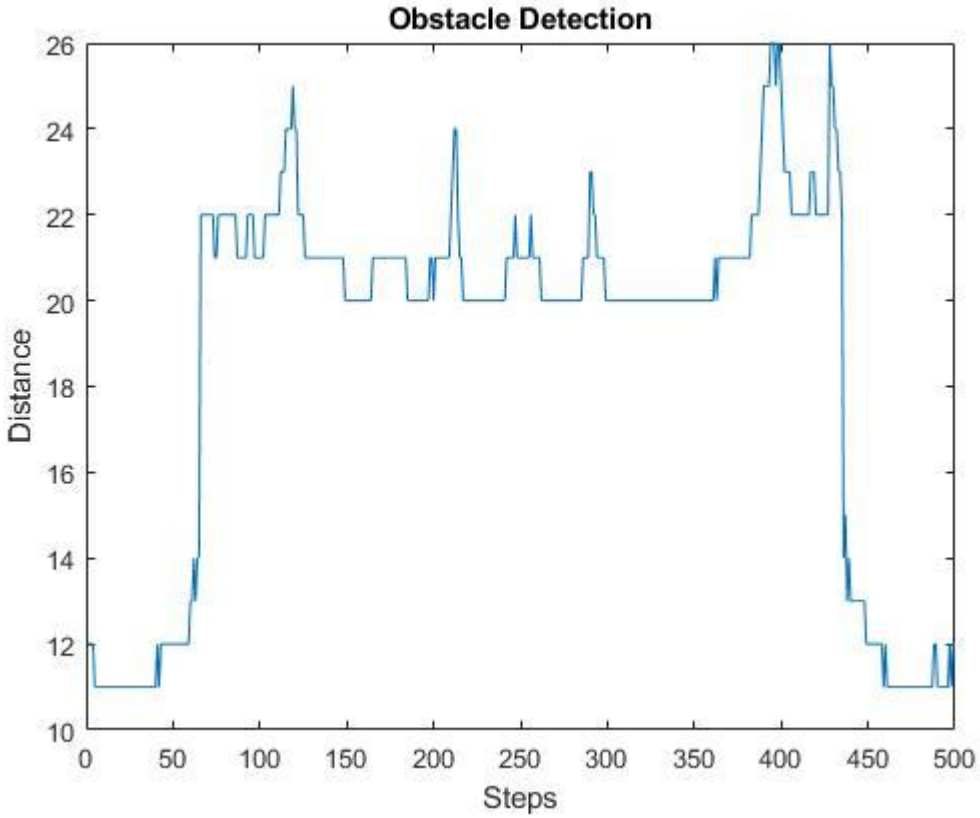


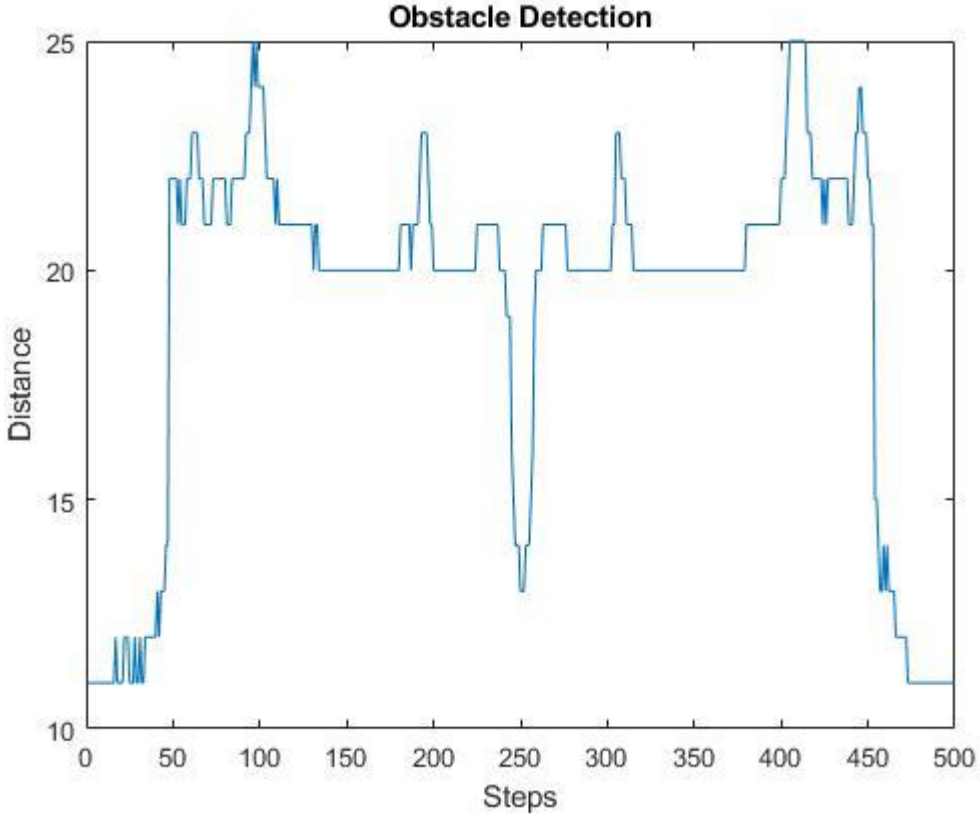


Working:

1. As soon as the Stepper motor receive the inputs from the Arduino the Stepper motor starts moving in the clockwise direction.
2. Once the motor's shaft completes half the revolution the shaft starts moving in the anticlockwise direction. So the motor keeps shifting between clockwise and anticlockwise direction.
3. The ultrasonic sensor is fixed on the motor's shaft, also the ultrasonic sensor continuously takes the readings as the motor goes on rotating.
4. The above circuit is placed in a semicircular setup of constant radius, the circumference is covered with a cardboard sheet of height same as that of the case of the ultrasonic sensor.
5. When an object is placed between the sensor and the cardboard sheet the distance is reduced.
6. The data from the Arduino is serially transferred to the pc via the serial port.
7. These readings are then read from the serial port by the help matlab software.
8. Matlab stores these reading into a txt file and plots the changes in the distance with respect to the steps at the end of every cycle.

Readings:


Obstacle Detection
Distance
Steps
26
24
22
20
18
16
14
12
10
0
50
100
150
200
250
300
350
400
450
500


Obstacle Detection
Distance
Steps
25
20
15
10
0
50
100
150
200
250
300
350
400
450
500

Results and Discussion:

The readings from the ultrasonic sensor were successfully retrieved from the serial port and were plotted with respect to the steps accordingly, but it was observed that due to the irregularity of the cardboard surface the readings were not constant, hence a smoother and a better reflecting surface should be used instead of the cardboard.

It was also observed that sometimes the readings were more than the required limit, for example sometimes the readings that were given were of the range 2000 to 2500 cm, which is not possible.

1. The reason for such readings is that the ultrasonic sensor takes too much time to receive the sound signal back, since there is a delay in the reading the distance returned is very large.
2. The other reason for such readings can be that the ultrasonic sensor is going out of the desired range and hence returning the maximum value that the sensor can read.

Applications

1. Detection of cracks in pipelines as the system requires very less space, it can easily fit into a pipe, and also the depth measurement can be done by the sensor.
2. It can be used for Garbage management system, as it will indicate whether the garbage can is fully filled or partially filled.
3. Can be used in self drive cars, to detect the vehicle ahead or behind our vehicle.
4. Non-contact range measurement can be used for situation in which a man manually cannot detect the target.

Conclusion:

An obstacle detection system was developed by the help of Arduino and ultrasonic sensor .The Arduino was coded by the Arduino IDE so as to rotate the motor and record the readings from the ultrasonic sensor, hence successful obstacle detection was achieved by the sensor. The data from the Arduino was successfully retrieved by serial communication between the hardware and the system, which was achieved by the help of the Matlab software.

References:

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https://www.youtube.com/watch?v=7rcVeFFHcFM

Acknowledgment:

With great pleasure, I avail this opportunity to express my deep sense of gratitude to my guide Mr. Akshay Rathod and Ms. Aradhana Kaintura who is my coguide, for their inspiration, encouragement and for guidance. It helped me to work in right direction and to attain desired objective. My sincere gratitude to Mr. Deepak Kulkarni, my research advisor, for continuous support, for his patience, motivation and immense knowledge. His guidance helped me in all the time of research. His constant supervision, providing the right kind of exposure, always providing all the necessary information and resources regarding the project, timed roasts and discussions helped me to be a condent researcher. I am thankful to Mr. Raymond Pinto, HOD Radar Division for his support and encouragement, I am thankful to my Project Coordinator, Mr. Abhishek Dabi who devoted their valuable time and helped me in all possible ways towards successful completion of this project.