EE3422- Embedded and Realtime Systems
LAB-2

Section 1: Introduction to Ultrasonic Sensor and Servo Motor

Ultrasonic ranging module HC-SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules include ultrasonic transmitters, receiver and control circuit.

Figure 1 Ultrasonic Sensor (HC-SR04) pin diagram

The basic principle of work is mentioned below,

1. The trigger pin is set to a HIGH signal level for at least 10us. (make sure it is on LOW state before)
2. The Module automatically sends eight pulses of 40 kHz pulses and detect whether there is a pulse signal back.
3. If there are signals received back, the module will output through IO port of ECHO, the duration time (High-level time) is the time between wave sending and receiving.
4. Using High-level time and velocity of sound, distance can be calculated by the formula given below

Test distance = (high level time×velocity of sound (340m/s) / 2,

Electrical Parameters

Working Voltage	DC 5 V
Working Current	15mA
Working Frequency	40Hz
Range	2cm to 4m
Trigger Input Signal	10uS TTL pulse
Echo Output Signal	Input TTL level signal and the range in proportion

How does it work?

The timing diagram of the Ultrasonic Sensor (HC-SR04) is shown in Figure 2. You need to supply a High pulse of duration 10us to the Trigger Pin. This enables the module to send 8 cycle burst of ultrasound at 40kHz and raise its echo. An echo is a distance object that is pulse width and the range in proportion. The range can be calculated through the time interval between sending a signal and receiving echo signal. It is suggested that use at least 60ms measurement cycle to prevent trigger signal and echo signal overlap.

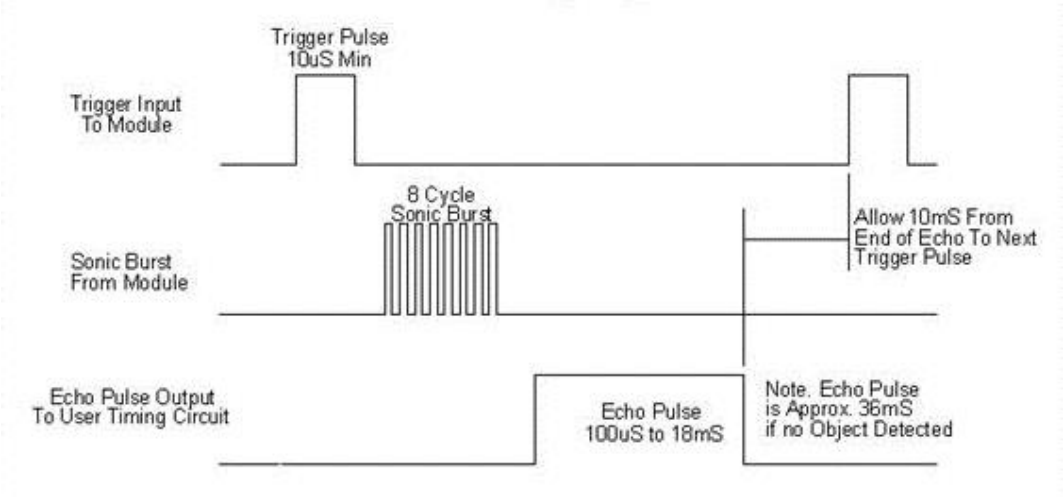


Figure 2: Ultrasonic Timing diagram

Section 2: Tasks to Perform

2.1 Example – Distance measurement using Ultrasonic Sensor

In this example, you will learn how to use an ultrasonic sensor to find the distance and make a decision on the basis of that. You will need an ultrasonic sensor, two LEDs and Arduino Uno board for this example.

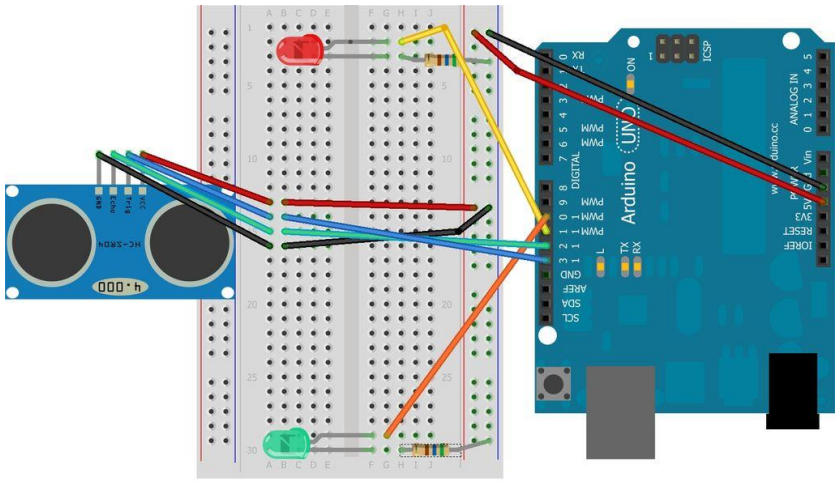


Figure 3: Schematic of Ultrasound sensor with Arduino Uno

Connect the Ultrasound sensor and LEDs with Arduino Uno as shown in Figure 3. Here TRIG and ECHO pins are connected to the PIN 13 and PIN 12 respectively. Similarly, two LEDs are connected to PIN 11 and PIN 12.

Download the program name: ("Ultrasonic_Distance.ino") from Moodle and run it. Go through the program and write your observations, especially why LEDs switch from ON to OFF state and vice versa.

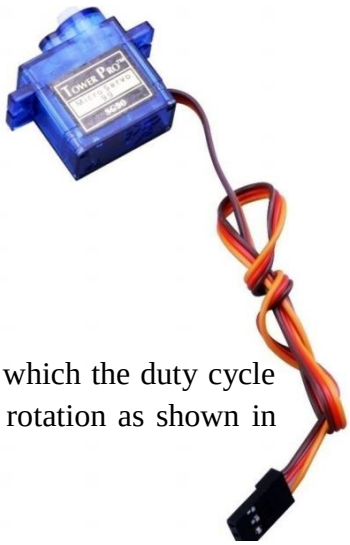
Write your observations in the area below.

2.2 Example – Controlling Servo Motor

The servo motor is actually an assembly of four things: a normal DC motor, a gear reduction unit, a position-sensing device, and a control circuit. The function of the servo is to receive a control signal that represents a desired output position of the servo shaft and apply power to its DC motor until its shaft turns to that position. It uses the position-sensing device to determine the rotational position of the shaft, so it knows which way the motor must turn to move the shaft to the commanded position. The shaft typically does not rotate freely round and round like a DC motor, but rather can only turn 180 degrees or so back and forth.

Connection to the given Servo motor are given below

Brown wire	GND
Redwire	5V
Orange wire	Signal



How to Control Servo Motor?

To control servo motor you need to apply a 20ms time pulse signal in which the duty cycle (HIGH pulse width) varies 0.5ms to 2.5ms depending on the angle of rotation as shown in Figure 4.

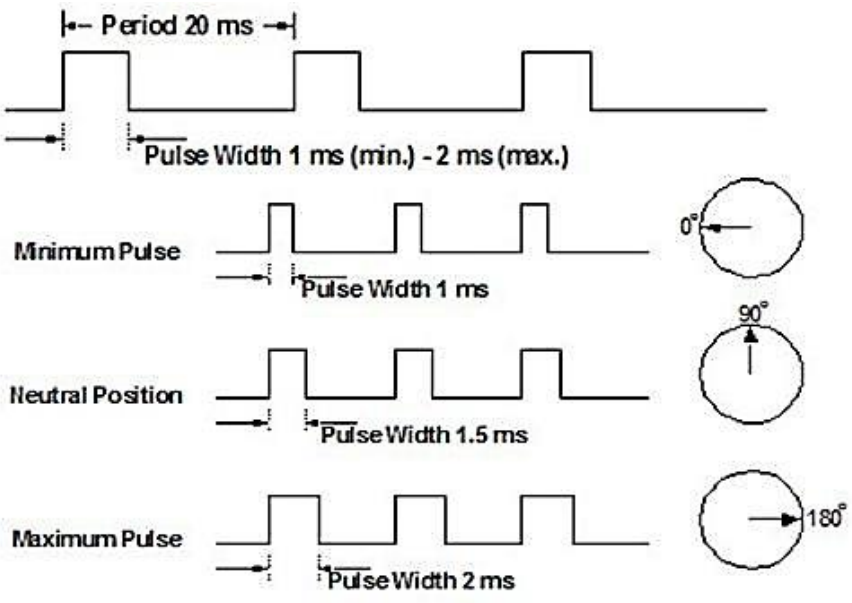


Figure 4: Servo motor signal and corresponding angle of rotation

For servo motor to run we need to install its library first. Open the **Sketch → Include Library →Manage Libraries**. Search the **Servo** and install the newest version.

Connect the Servo as shown in Figure 5. Supply the 5V, GND and for the signal connect the orange line to digital Pin 3.

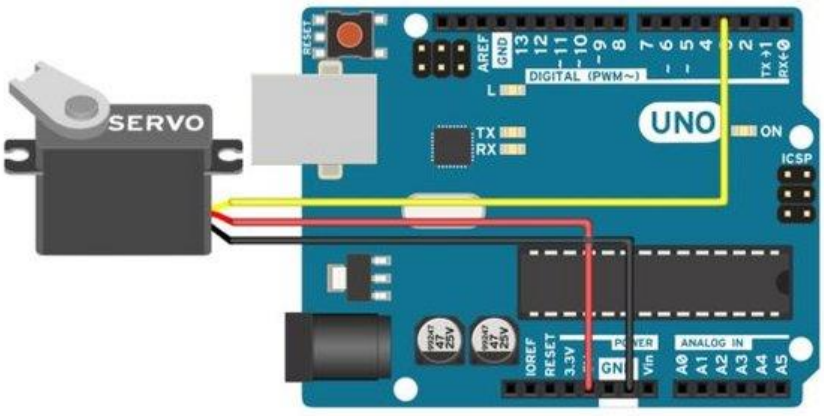


Figure 5: Servo connection with Arduino Uno

Download the program name: (“Servomotor.ino”) from Moodle and run it.

Section 3: Solve the Challenges

You need to write a program and build a circuit for the given challenges and show the results to Lab Demonstrators and get your report signed.

NOTE: You can perform subsections 3.1 and 3.2 in one program.

3.1 Distance measurement and Display

Attach the Ultrasonic sensor to the servo motor and display the FRONT, LEFT and RIGHT distance on LCD and keep updating. Your LCD should display FRONT= "__" cm on 1st row, LEFT= "__" cm on 2nd row and RIGHT= "__" cm on 3rd row.

3.2 Distance alert!

In addition to the sketch you have written in Section 3.1, now add three LEDs and name them front, left and right. Each time servo motor rotates it will find the distance in three directions and check if the distance is less than or greater than10cm in any direction. If the distance is greater than 10cm the corresponding LED will remain OFF. When the distance is less than 10cm in any direction, the corresponding LED should turn ON.

LAB-2 END