# Ultrasonic Scanning System for Imaging

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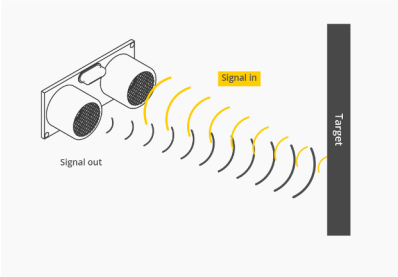
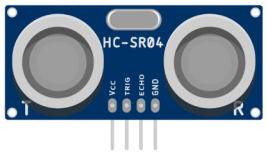
## Ultrasonic Distance Sensor

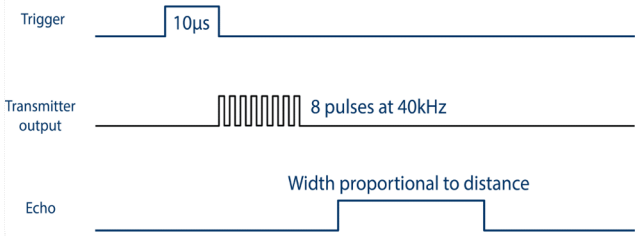
An ultrasonic distance sensor measures proximity by emitting high-frequency soundwaves and recording the time elapsed before an echo reflects to the transducer. The time taken for the specific frequency to return to the signal transducer is known as the round trip time; the total distance traveled from the ultrasonic emitter to the object and back. To determine proximity to an object, the ultrasonic distance sensor multiplies the roundtrip time by the speed of sound – approximately 1129 feet per second (f/s) in ambient conditions – and halves the calculation.




## HC-SR04

Contains two ultrasonic transducers, one is the transmitter of the sound waves and the other is the receiver. The sensor then creates an 8 cycle burst of ultrasound at 40 kHz. This sonic burst travels at the speed of sound, bounces back and gets received by the receiver of the sensor. The Echo pin then outputs the time that the sound waves traveled in microseconds.

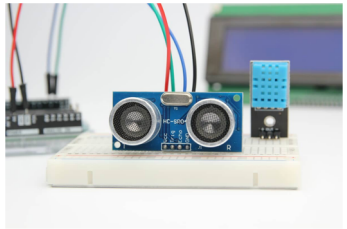



## Overview

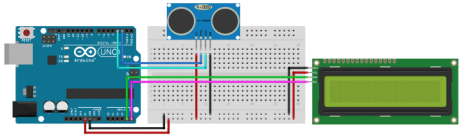
Ultrasonic scanning systems are used for accurate and automatic data retrieval and emission into images. The system integrates an ultrasonic equipment which uses high frequency sound energy to conduct examinations and records measurements. Ultrasonic scanning can be used for detection and evaluation of previously unseeable objects in terms of depth or concealment. The significance and fascination behind ultrasonic scanning is the new realm of depth and possibilities of imaging within a medium, such within air, through walls or even image items submerged in water.

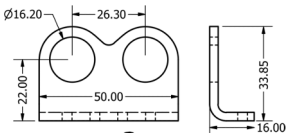
For our design, we created a prototype utilizing an Arduino Uno circuit board, and a HC-SR04 sensor attached to a rotating motor. The purpose of the prototype is to utilize the HC-SR04 sensor in order to first create a range detector, to translocate the ranges of objects within the peripheral of the sensor.

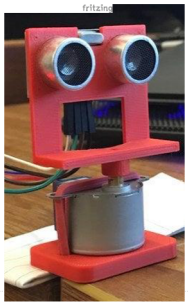


## Design

This is the final design we implemented, using Arduino Uno board, 28BYJ-48 Stepper Motor and the HC-SR04 Sensor. We also 3D printed a chassis in order to mount the sensor onto the motor, to perform precise calculations while controlling the motor speed and stopping points.

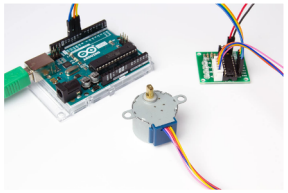






## Arduino Uno + 28BYJ-48 Stepper Motor

The Arduino Uno is an open-source microcontroller which is programmable with the Arduino IDE. We utilize this board as our main driver for our prototype to power and control our motor circuit and sensor.



## HC-SR04 Enabler Code // 28BYJ-48 Stepper

```
int trigPin = 11;    // Trigger
int echoPin = 12;    // Echo
long duration, cm, inches;

void setup() {
  //Serial Port begin
  Serial.begin (9600);
  //Define inputs and outputs
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
}

void loop() {
  // The sensor is triggered by a HIGH pulse of 10 or more microseconds.
  // Give a short LOW pulse beforehand to ensure a clean HIGH pulse:
  digitalWrite(trigPin, LOW);
  delayMicroseconds(5);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Read the signal from the sensor: a HIGH pulse whose
  // duration is the time (in microseconds) from the sending
  // of the ping to the reception of its echo off of an object.
  pinMode(echoPin, INPUT);
  duration = pulseIn(echoPin, HIGH);

  // Convert the time into a distance
  cm = (duration/2) / 29.1;     // Divide by 29.1 or multiply by 0.0343
  inches = (duration/2) / 74;   // Divide by 74 or multiply by 0.0135

  Serial.print(inches);
  Serial.print("in, ");
  Serial.print(cm);
  Serial.print("cm");
```

```
#define STEPPER_PIN_1 9
#define STEPPER_PIN_2 10
#define STEPPER_PIN_3 11
#define STEPPER_PIN_4 12
int step_number = 0;
void setup() {
pinMode(STEPPER_PIN_1, OUTPUT);
pinMode(STEPPER_PIN_2, OUTPUT);
pinMode(STEPPER_PIN_3, OUTPUT);
pinMode(STEPPER_PIN_4, OUTPUT);
}

void loop() {

  Serial.flush();
  delay(2);

}


void OneStep(int dir){
  if(dir){
switch(step_number){
  case 0:
  digitalWrite(STEPPER_PIN_1, HIGH);
  digitalWrite(STEPPER_PIN_2, LOW);
  digitalWrite(STEPPER_PIN_3, LOW);
  digitalWrite(STEPPER_PIN_4, LOW);
  break;
  case 1:
  digitalWrite(STEPPER_PIN_1, LOW);
  digitalWrite(STEPPER_PIN_2, HIGH);
  digitalWrite(STEPPER_PIN_3, LOW);
  digitalWrite(STEPPER_PIN_4, LOW);
  break;
  case 2:
  digitalWrite(STEPPER_PIN_1, LOW);
  digitalWrite(STEPPER_PIN_2, LOW);
  digitalWrite(STEPPER_PIN_3, HIGH);
  digitalWrite(STEPPER_PIN_4, LOW);
  break;
  case 3:
  digitalWrite(STEPPER_PIN_1, LOW);
  digitalWrite(STEPPER_PIN_2, LOW);
  digitalWrite(STEPPER_PIN_3, LOW);
  digitalWrite(STEPPER_PIN_4, HIGH);
  break;
}
}
step_number++;
  if(step_number > 3){
    step_number = 0;
  }
}
}else{
  switch(step_number){
case 0:
digitalWrite(STEPPER_PIN_1, LOW);
digitalWrite(STEPPER_PIN_2, LOW);
digitalWrite(STEPPER_PIN_3, LOW);
digitalWrite(STEPPER_PIN_4, HIGH);
break;
case 1:
digitalWrite(STEPPER_PIN_1, LOW);
digitalWrite(STEPPER_PIN_2, LOW);
digitalWrite(STEPPER_PIN_3, HIGH);
digitalWrite(STEPPER_PIN_4, LOW);
break;
case 2:
digitalWrite(STEPPER_PIN_1, LOW);
digitalWrite(STEPPER_PIN_2, HIGH);
digitalWrite(STEPPER_PIN_3, LOW);
digitalWrite(STEPPER_PIN_4, LOW);
break;
case 3:
digitalWrite(STEPPER_PIN_1, HIGH);
digitalWrite(STEPPER_PIN_2, LOW);
digitalWrite(STEPPER_PIN_3, LOW);
digitalWrite(STEPPER_PIN_4, LOW);

}
}
step_number++;
  if(step_number > 3){
    step_number = 0;
  }
}
}
```

**28BYJ-48 Stepper-** a stepper motor which is controlled by a series of electromagnetic coils when fed a current or not, creating magnetic fields causing the motor to rotate.

**Arduino Uno-** is an open-source microcontroller which is programmable with the Arduino IDE

**HC-SR04 -** Contains two ultrasonic transducers, one is the transmitter of the sound waves and the other is the receiver

We would like to thank our Faculty Supervisor, Professor Mikhail Gouzman. We truly regret that we were not able to complete our project and complete our mentorship from Professor Gouzman due to the ongoing pandemic of COVID-19. We thank you for reading over our poster and considering our final design project.

## The A-Team