



# Microcontrollers & Applications

Lecture 7.1: Ultrasonic Distance Measurement

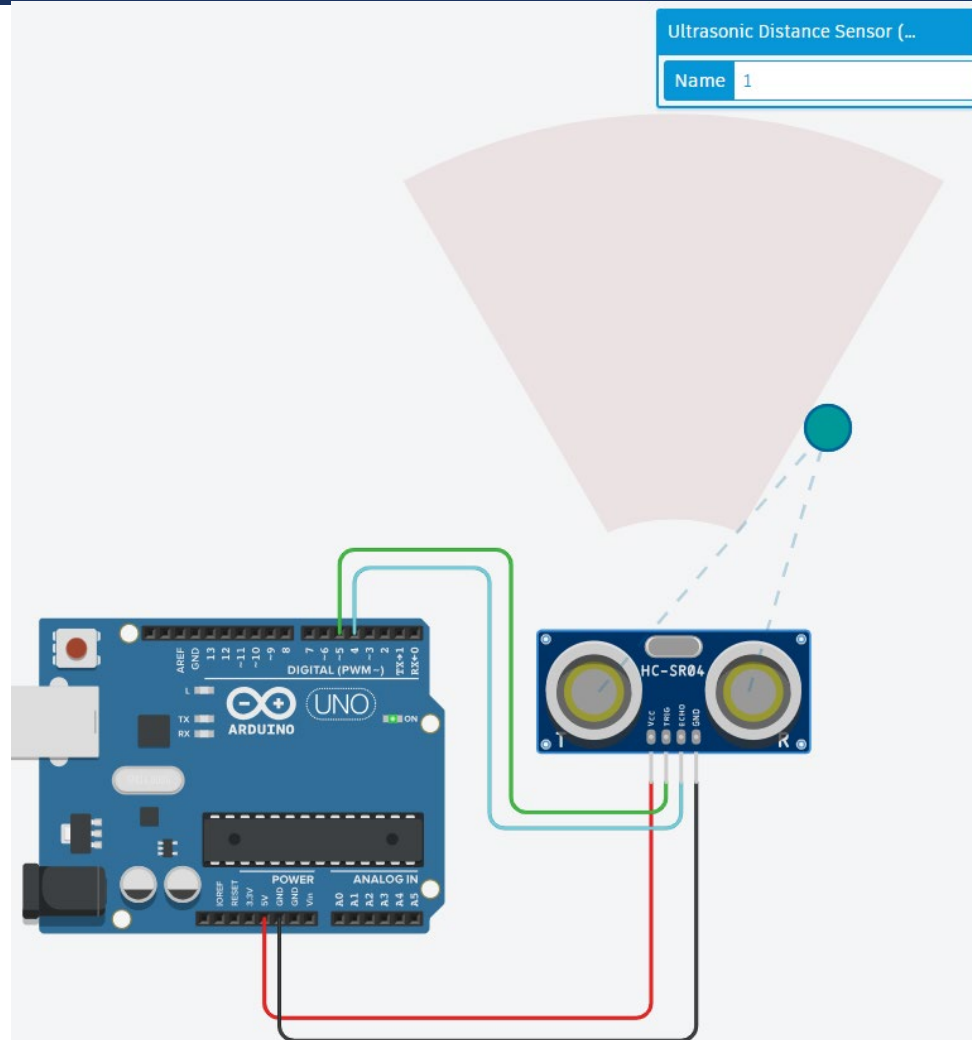
# Ultrasonic Distance Sensor: Structure



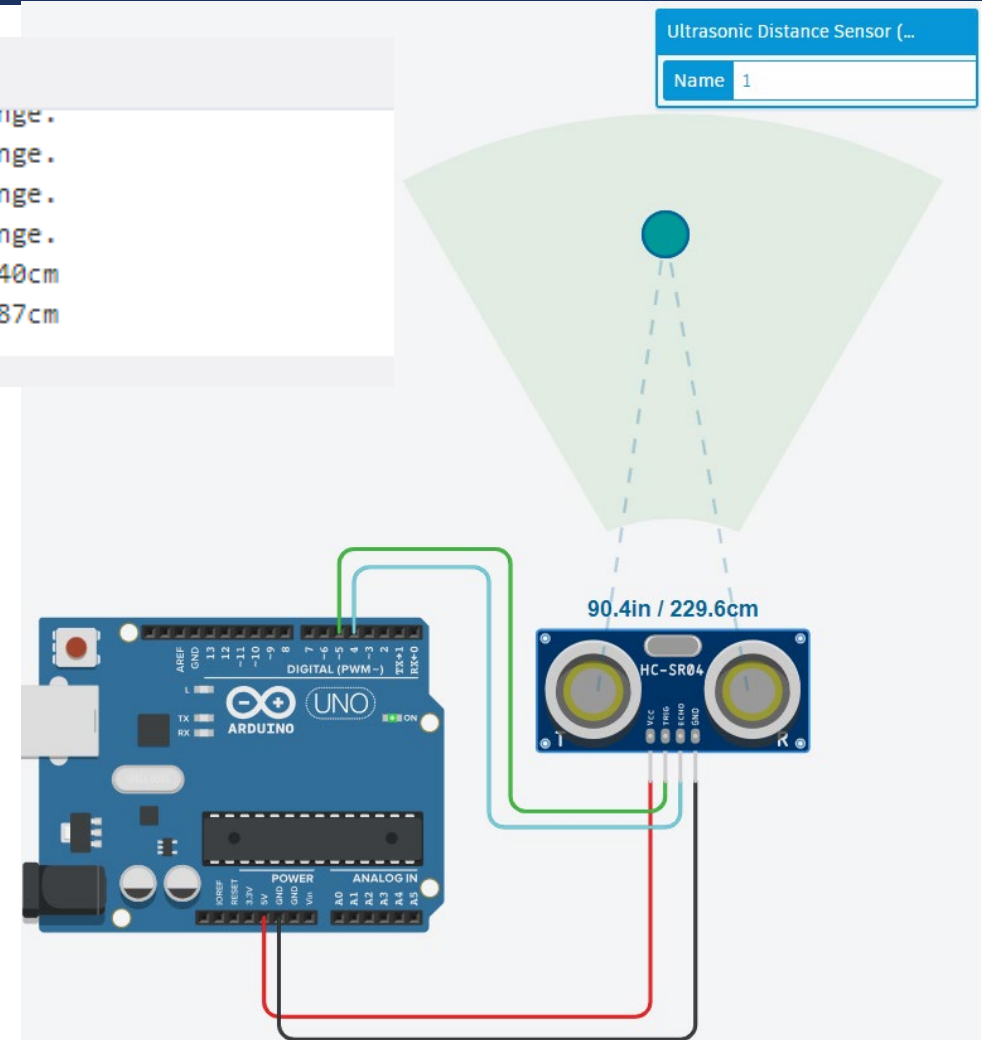
- HC-SR04
- Vcc: +5V
- I<sub>max</sub> < 15 mA
- Distance range: [20 cm, 3.3 m]
- Vision: 15 °
- Principle:
  - TRIG: Silence, Send signal, Stop signal
  - ECHO: Wait using the pulseIn function

$$Distance (cm) = \left(0.03446 \frac{cm}{\mu s}\right) * Time (\mu s) / 2$$

# Ultrasonic Distance Sensor: Arduino Example (1)



```
Serial Monitor  
No object in the range.  
No object in the range.  
No object in the range.  
Nearest object in 140cm  
Nearest object in 187cm
```



# Ultrasonic Distance Sensor: Arduino Example (2)

```
#define TRIG 5
#define ECHO 4

int cm = 0;

long readUltrasonicDistance(int triggerPin, int echoPin) {
  pinMode(triggerPin, OUTPUT); // Clear the trigger
  digitalWrite(triggerPin, LOW);
  delayMicroseconds(2);
  // Sets the trigger pin to HIGH state for 10 microseconds
  digitalWrite(triggerPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(triggerPin, LOW);
  pinMode(echoPin, INPUT);
  // Reads the echo pin until it reaches HIGH in microseconds
  return pulseIn(echoPin, HIGH);
}
```

```
void setup() {
  Serial.begin(9600);
}

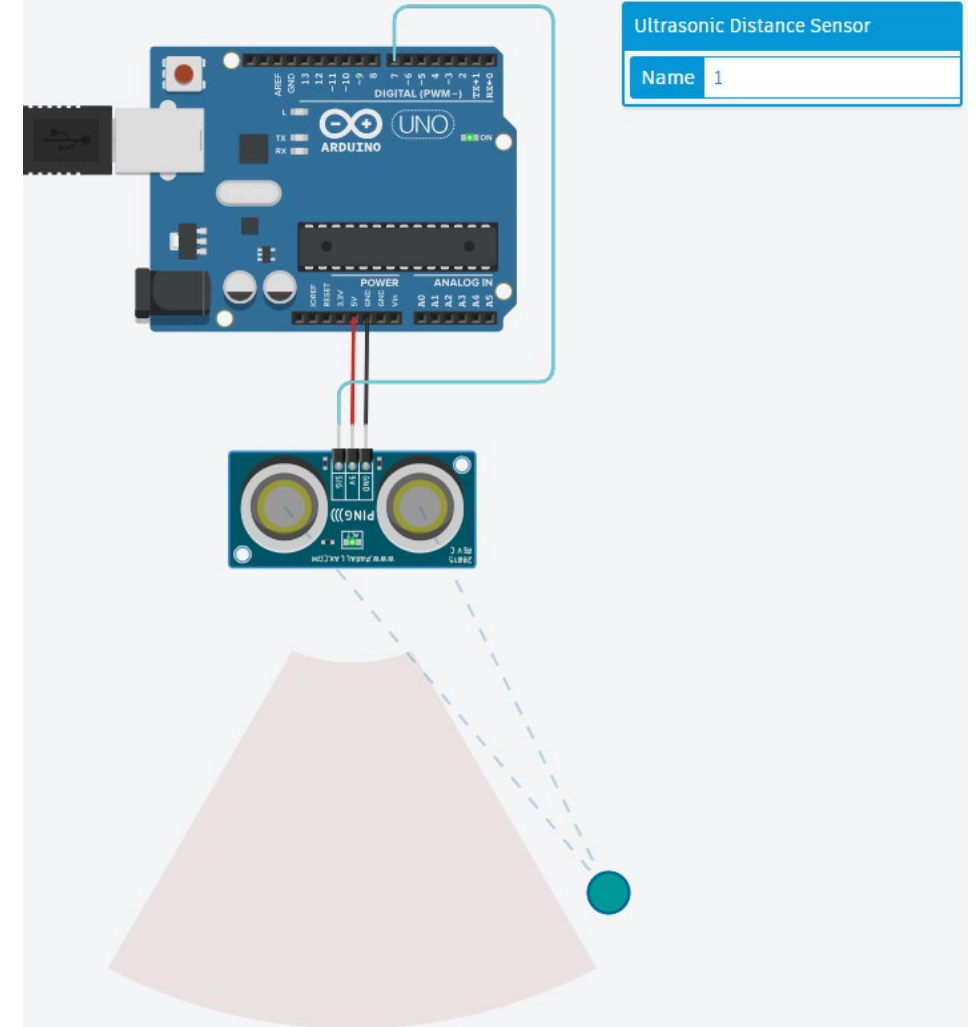
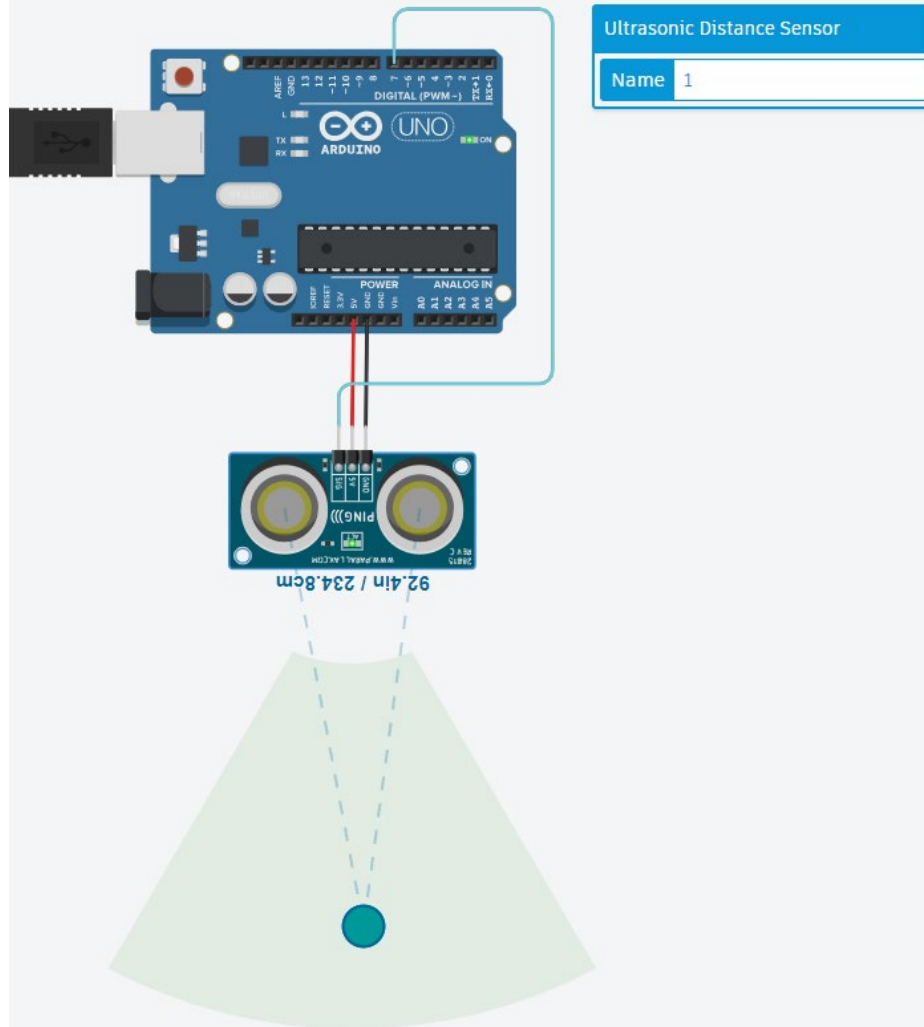
void loop() {
  // measure the ping time in cm
  cm = 0.01723 * readUltrasonicDistance(TRIG, ECHO);
  // convert to inches by dividing by 2.54
  if (cm >20 && cm < 330) {
    Serial.print("Nearest object in ");
    Serial.print(cm);
    Serial.println("cm");
  } else {
    Serial.println("No object in the range.");
  }
  delay(100); // Wait for 100 millisecond(s)
}
```

# Ultrasonic Range Sensor: Structure



- SEN136B5B
- Vcc: +5V
- I<sub>max</sub> < 15 mA
- Distance range: [3 cm, 4 m]
- Vision: 15 °
- Principle:
  - SIG: Silence, Send signal, Stop signal, Wait using the pulseIn function

# Ultrasonic Range Sensor: Arduino Example (1)



## Ultrasonic Range Sensor: Arduino Example (2)

```
#define TRIG 7
#define ECHO 7

int cm = 0;

long readUltrasonicDistance(int triggerPin, int echoPin) {
  pinMode(triggerPin, OUTPUT); // Clear the trigger
  digitalWrite(triggerPin, LOW);
  delayMicroseconds(2);
  // Sets the trigger pin to HIGH state for 10 microseconds
  digitalWrite(triggerPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(triggerPin, LOW);
  pinMode(echoPin, INPUT);
  // Reads the echo pin until it reaches HIGH in microseconds
  return pulseIn(echoPin, HIGH);
}
```

```
void setup() {
  Serial.begin(9600);
}

void loop() {
  // measure the ping time in cm
  cm = 0.01723 * readUltrasonicDistance(TRIG, ECHO);
  // convert to inches by dividing by 2.54
  if (cm > 3 && cm < 400) {
    Serial.print("Nearest object in ");
    Serial.print(cm);
    Serial.println("cm");
  } else {
    Serial.println("No object in the range.");
  }
  delay(100); // Wait for 100 millisecond(s)
}
```

## Car Parking Sensor: Left to Students

Three distance sensors are replaced in back side of a car and three associated LEDs are replaced in front of the user. If a sensor reads a distance of

- $>100$  cm, then the corresponding LED is not lightening
- $\leq 100$  cm, then the corresponding LED is lightening with dimming. For example, the LED is almost not visible if the distance is near 100 cm and the LED is the highly bright if the distance is less than 10 cm, etc.



## Simple RADAR (RAdio Detection And Ranging): Left to Students

A distance sensor is placed on a servo motor. By changing the position of the servo motor, the distance sensor gives whether there is an object or not in its scope with distance. When an object detected, then Arduino should reports the object's distance and angle to the serial port.



Thanks for  
listening 😊

YALÇIN İŞLER

Assoc. Prof.