ENGR 3421: ROBOTICS I

Ultrasonic Distance Sensor

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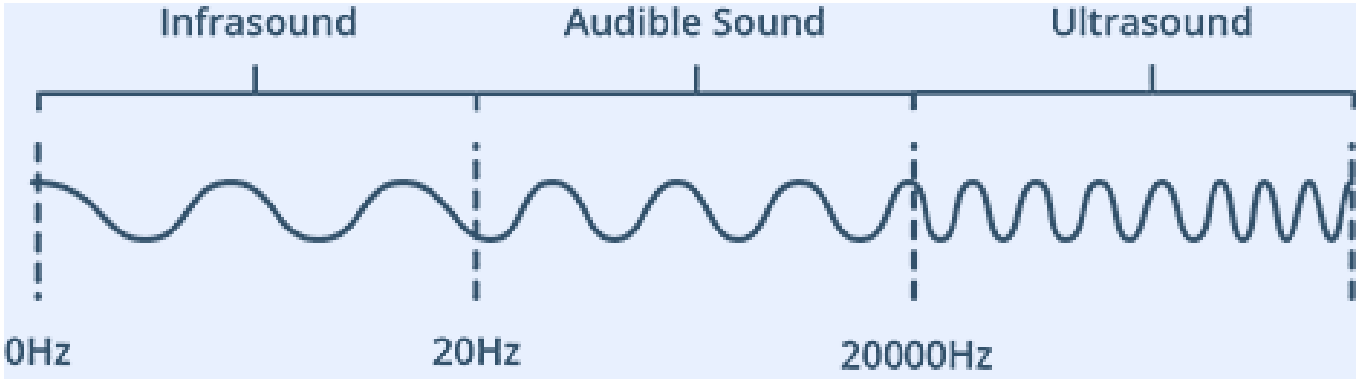
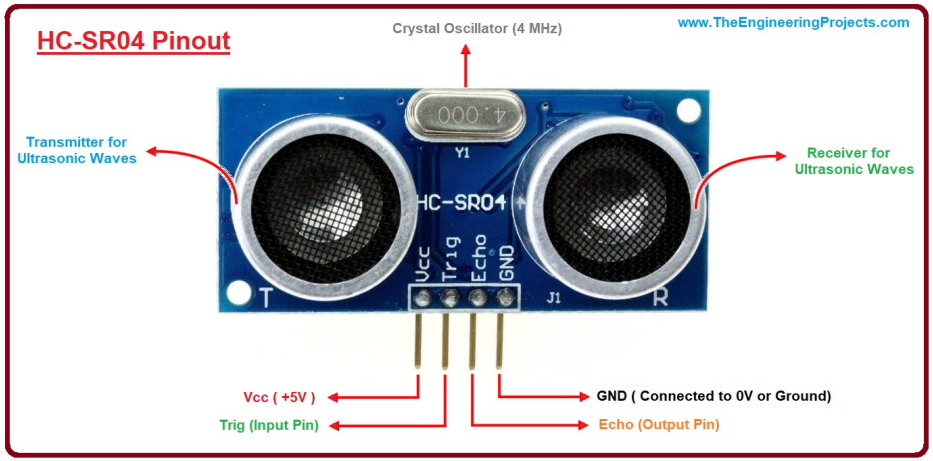
Ultrasound

Ultrasound is high-pitched sound waves with frequencies higher than the audible limit of human hearing.

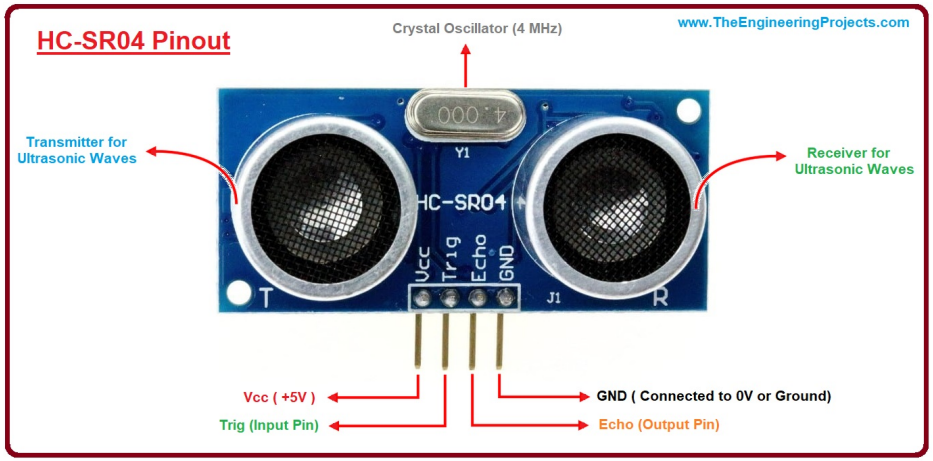


HC-SR04 Ultrasonic Distance Sensor



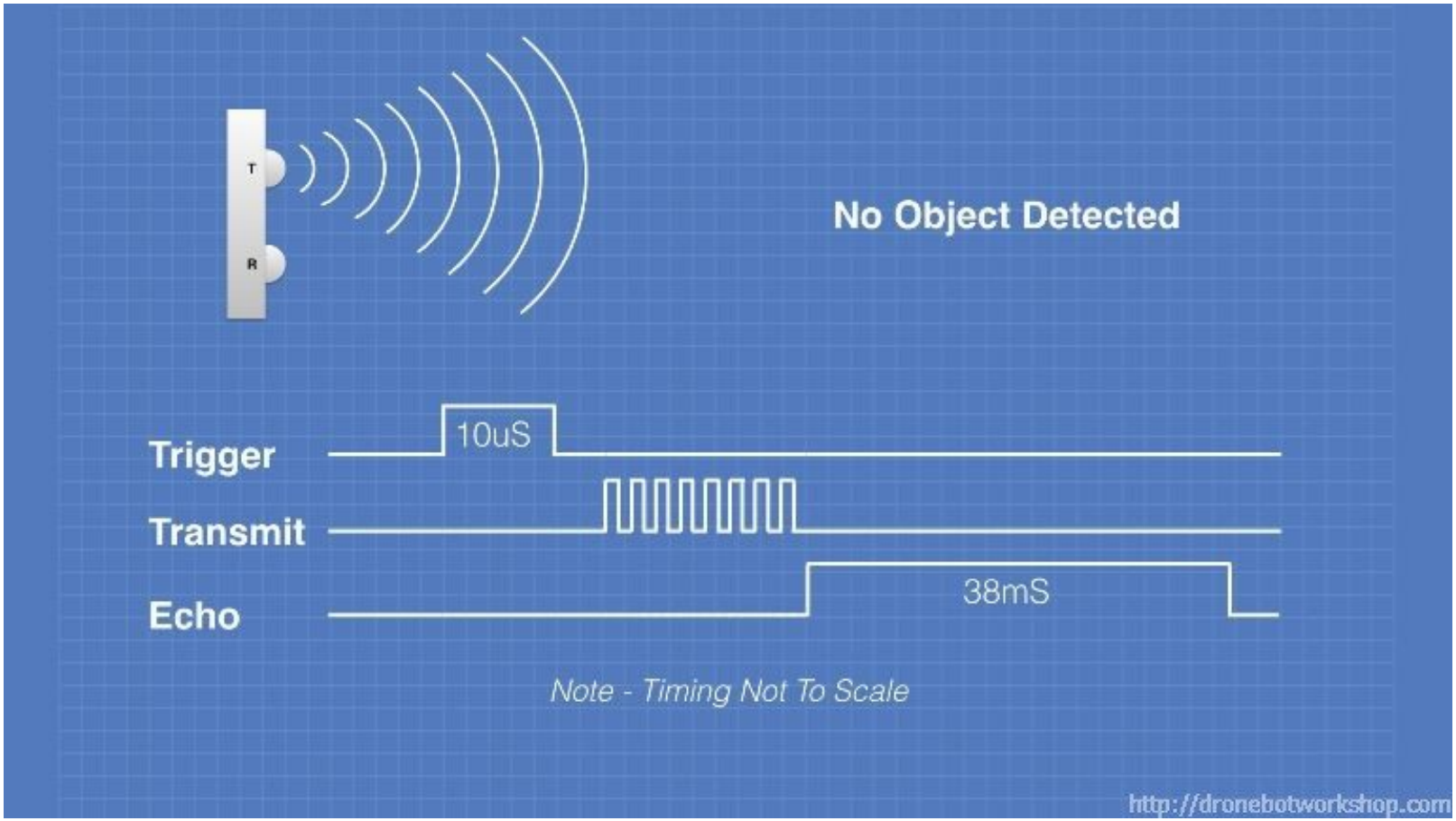
- Consists of two ultrasonic transducers: a transmitter and a receiver.
- The transmitter converts electrical signal into 40 KHz ultrasonic sound pulses.
- The receiver listens for the transmitted pulses.
- If receives the pulses back, produces an output pulse to determine the distance.

HC-SR04

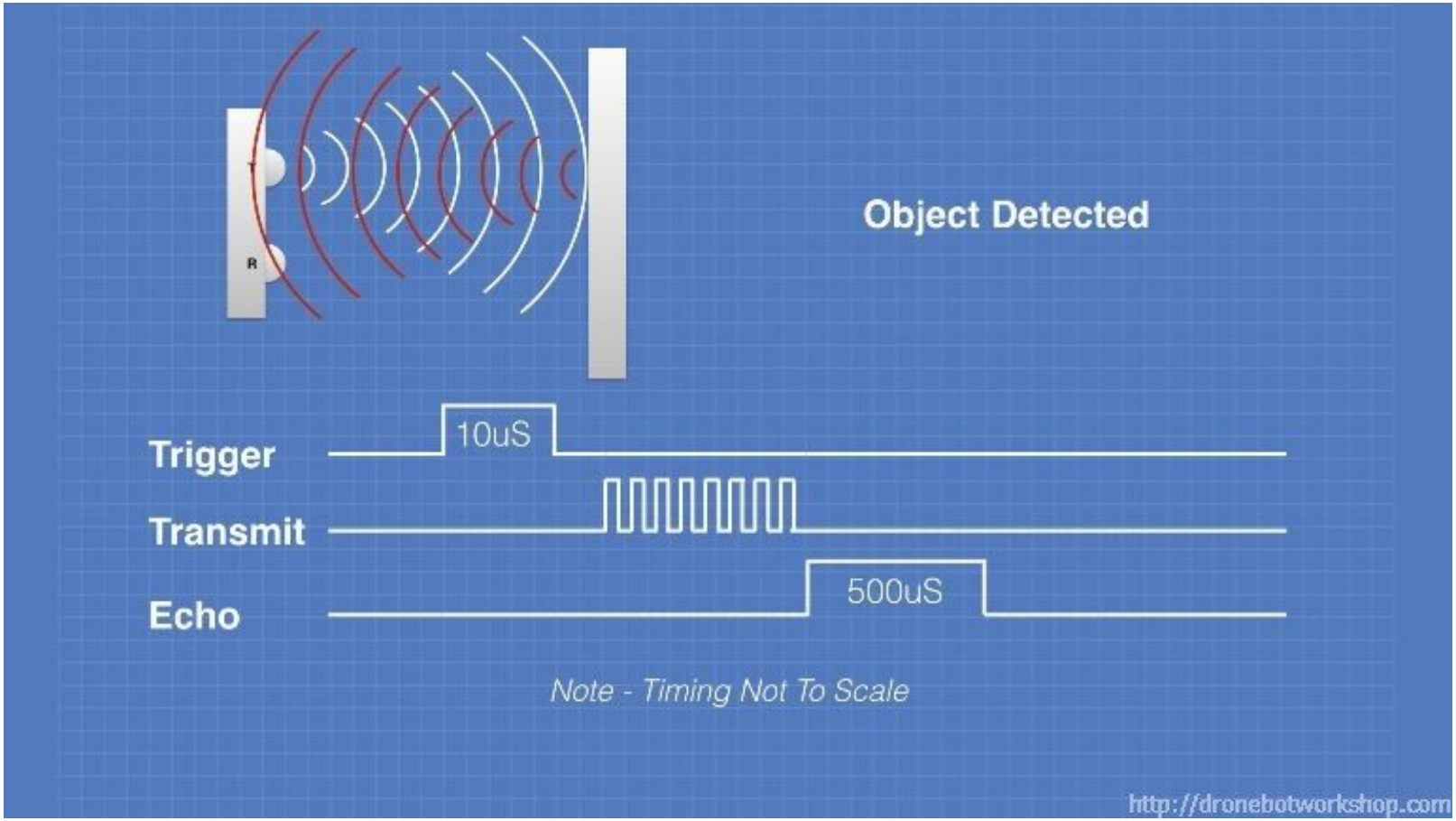


Operating Voltage	5 V
Operating Current	15 mA
Ultrasound Frequency	40 kHz
Max Range	4 m
Min Range	2 cm
Ranging Accuracy	3 mm
Measuring Angle	15 degree

HC-SR04 - No Object Detected



HC-SR04 - Object Detected



$$distance = \frac{Speed \times Time}{2} = 0.034 cm/\mu s \times 500 \mu s \times 0.5$$

HC-SR04 Workflow

1. A 5 volt pulse of at least 10 μS (10 microseconds) in duration is applied to the Trigger pin.
2. The HC-SR04 responds by transmitting a burst of eight pulses at 40 KHz. This 8-pulse pattern makes the "ultrasonic signature" from the device unique, allowing the receiver to discriminate between the transmitted pattern and the ultrasonic background noise.
3. The eight ultrasonic pulses travel through the air away from the transmitter. Meanwhile the Echo pin goes high to start forming the beginning of the echo-back signal.
4. If the pulse in NOT reflected back then the Echo signal will timeout after 38 mS (38 milliseconds) and return low. This produces a 38 mS pulse that indicates no obstruction within the range of the sensor.
5. If the pulse IS reflected back the Echo pin goes low when the signal is received. This produces a pulse whose width varies between 150 uS to 25 mS, depending upon the time it took for the signal to be received.
6. The width of the received pulse is used to calculate the distance to the reflected object. Remember that the pulse indicates the time it took for the signal to be sent out and reflected back so to get the distance you'll need to divide your result in half.

HC-SR04 Limitations

- Object too far.
- Object too small.
- Object with soft irregular surface.
- Effect of temperature and humidity. A more accurate distance calculation:
  $Speed(m/s) = 331.4 + (0.606 * Temp) + (0.0124 * Humidity)$
- Ultrasound may annoying to animals. Please consider your furry friends (Check the hearing range list).

Voltage Divider