ENGR 4421:Robotics II

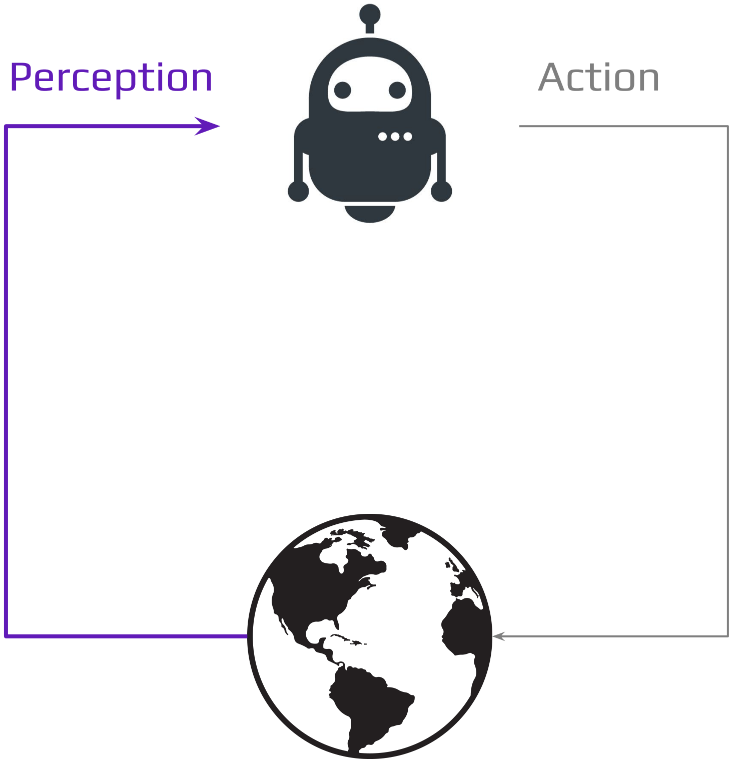
Ultrasonic Distance Sensor

09/29/2022

Outline

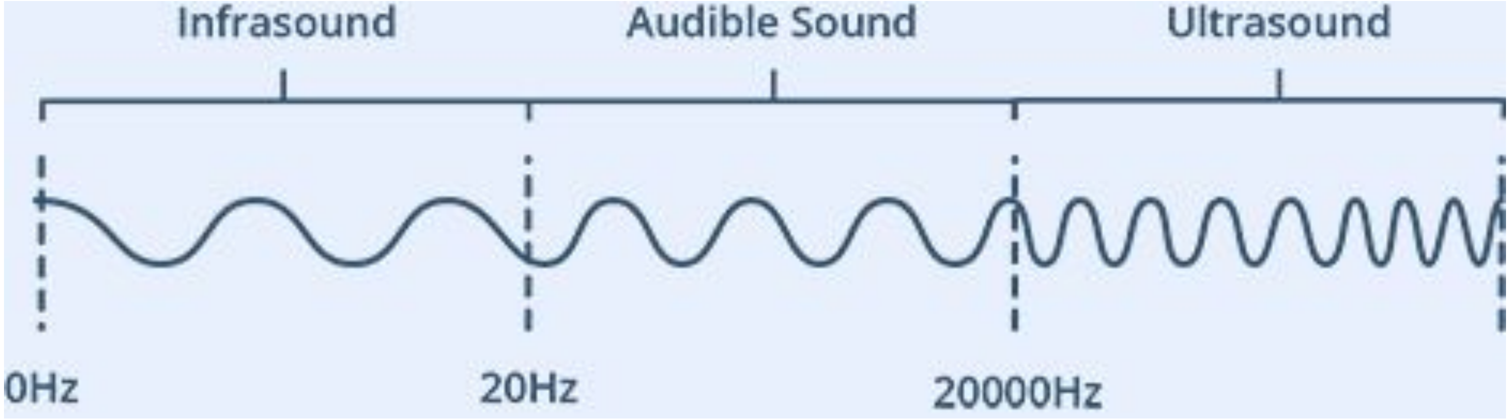
- Ultrasound
- HC-SR04

What does A Robot Do

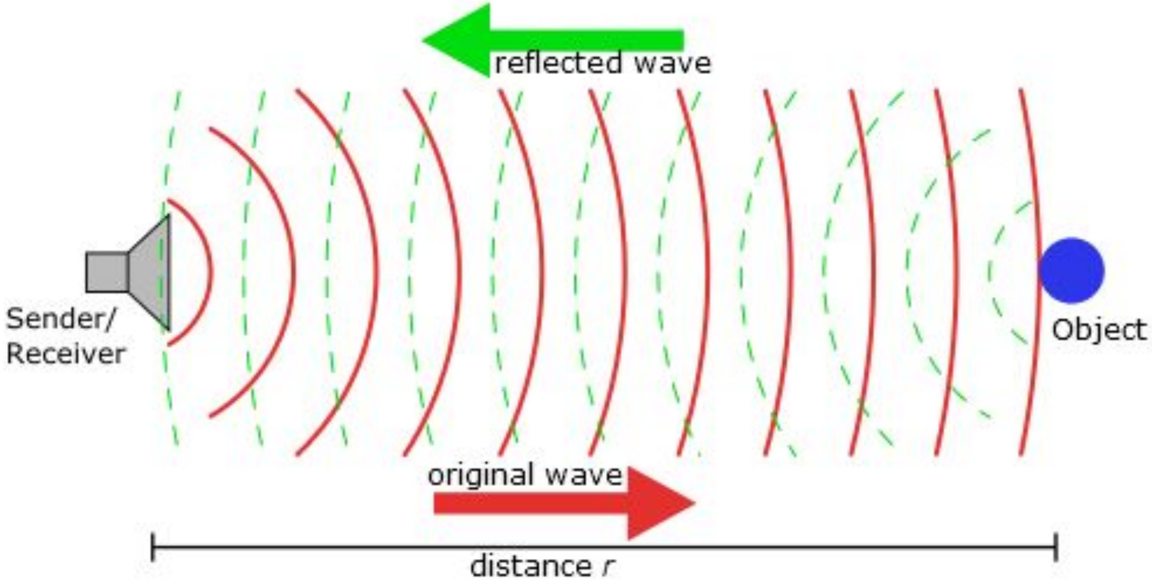


Ultrasound

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



Ultrasound Distance Sensing

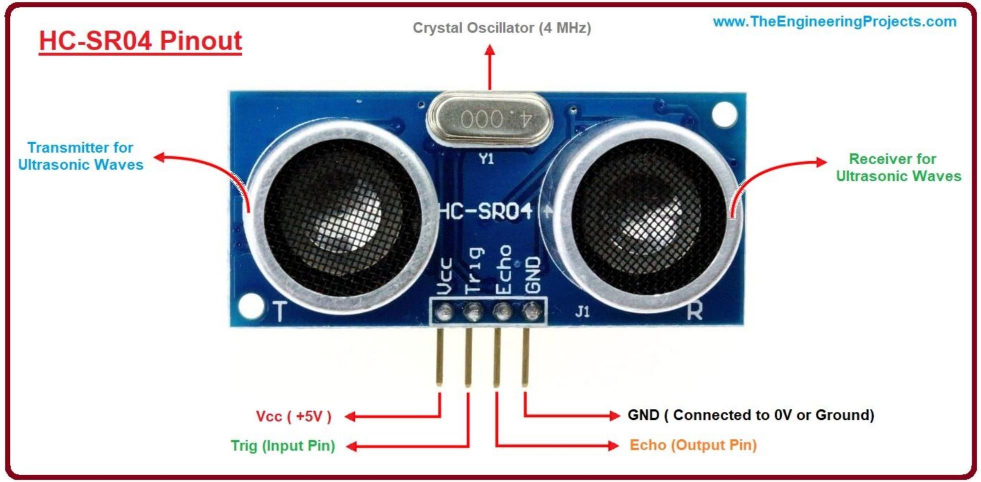


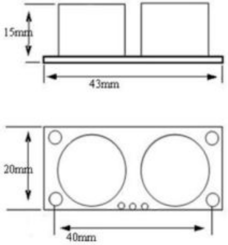
$$\text{distance} = \frac{\text{speed} \times \text{time}}{2}$$

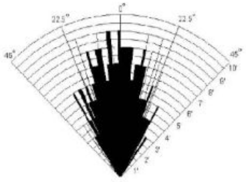
HC-SR04 Ultrasonic Distance Sensor

- Consists of a transmitter and a receiver.
- Transmitter broadcasts ultrasound at 40kHz.
- Receiver listens to the transmitted ultrasonic waves.

HC-SR04 Ultrasonic Distance Sensor


HC-SR04 Pinout
Crystal Oscillator (4 MHz)
www.TheEngineeringProjects.com
Transmitter for Ultrasonic Waves
Receiver for Ultrasonic Waves
4.000
Y1
HC-SR04
Vcc
Trig
Echo
GND
T
J1
R
Vcc (+5V)
Trig (Input Pin)
GND (Connected to 0V or Ground)
Echo (Output Pin)

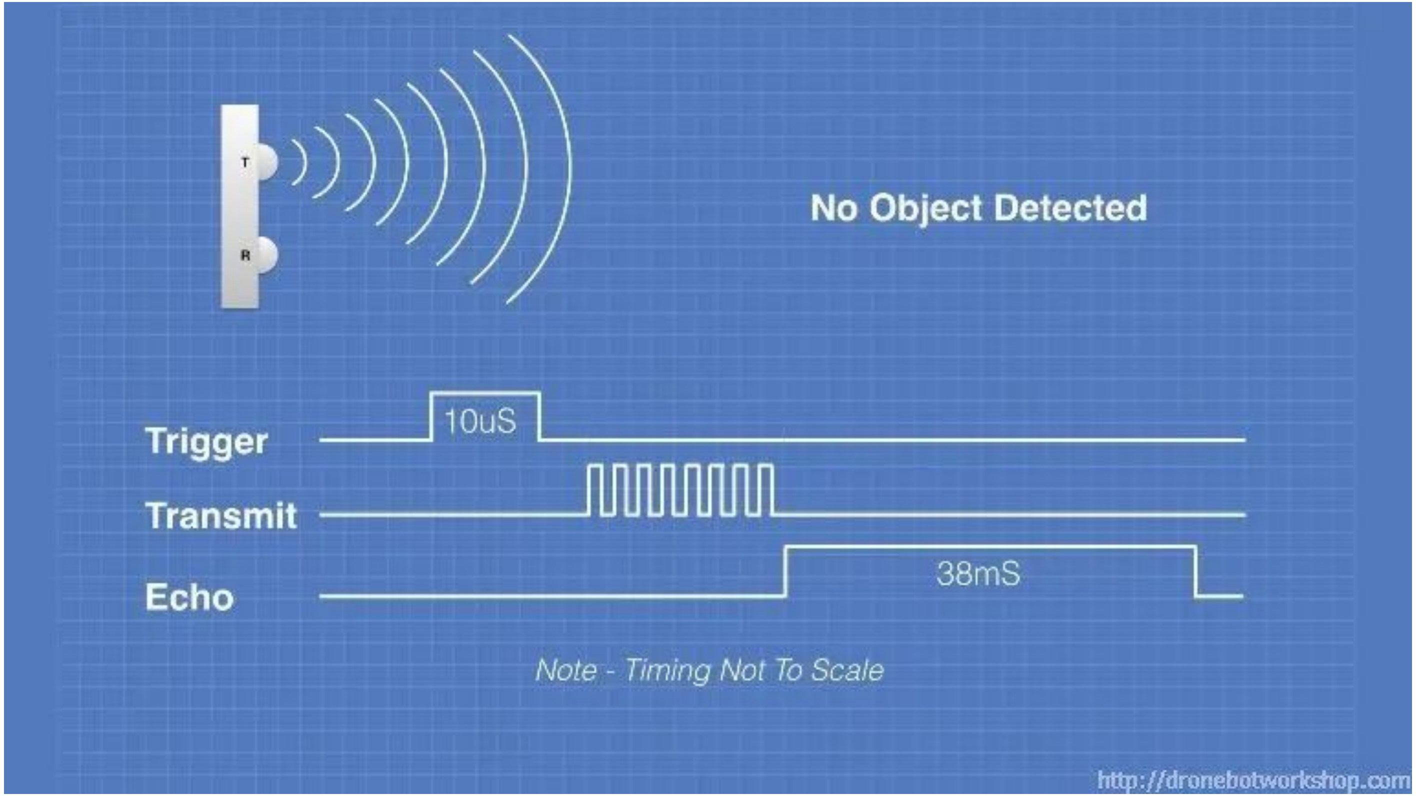




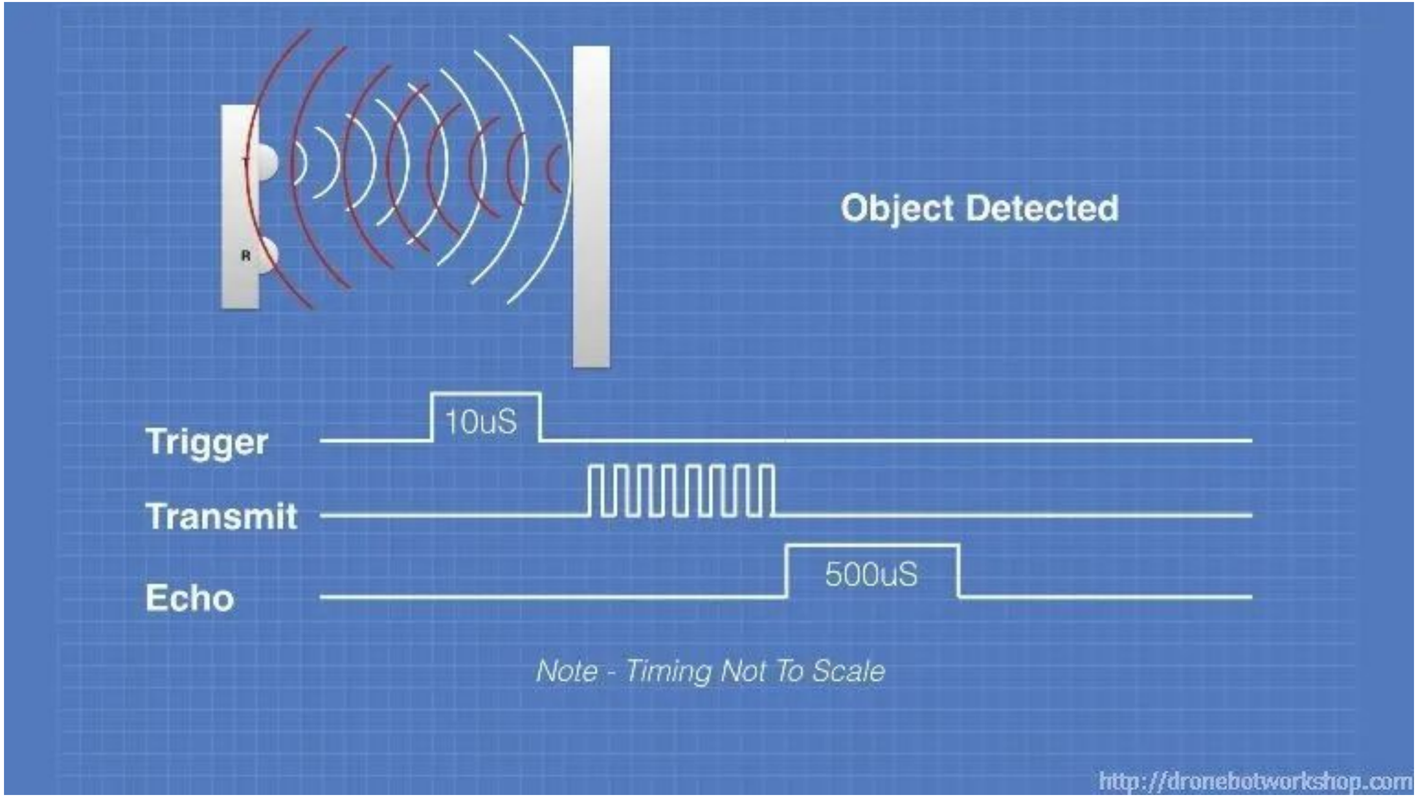
Practical test of performance,
Best in 30 degree angle

Operating Voltage	5V
Operating Current	15mA
Ultrasound Frequency	40kHz
Max. Linear Range	4 m
Min. Linear Range	0.02 m
Measuring Angle	15 deg
Measuring Accuracy	3 mm

HC-SR04 Detection



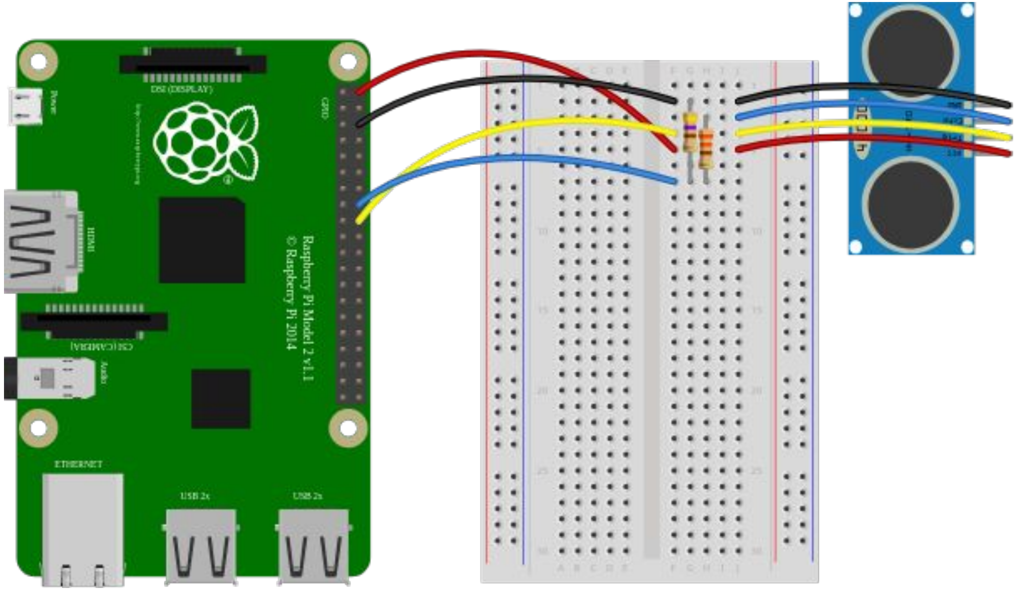
HC-SR04 Detection

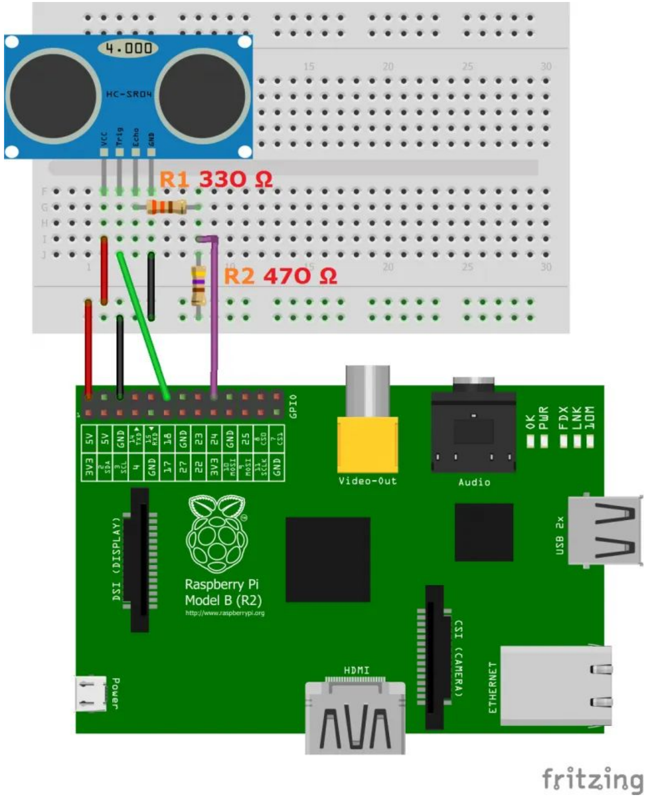


HC-SR04 Workflow

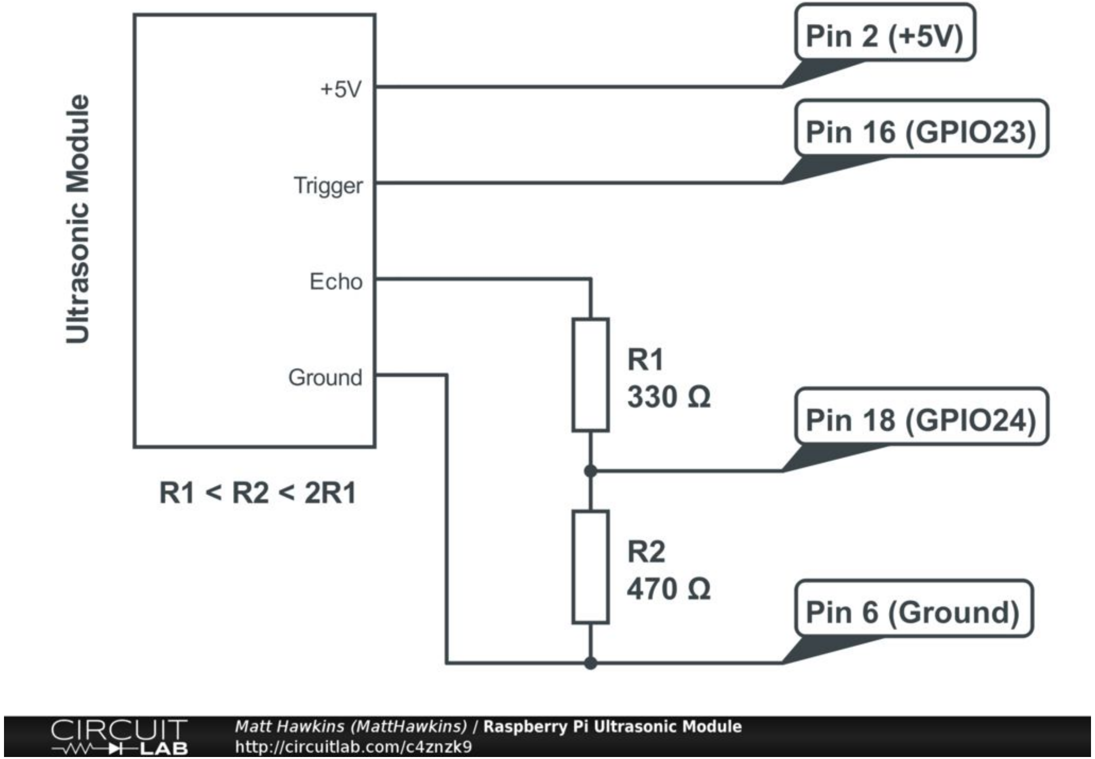
1. Send a 10 microseconds pulse at 5 volt to the “Trigger” pin.
2. The transmitter bursts of 8 pulses at 40 KHz. This 8-pulse pattern makes the “ultrasonic signature” from the device unique, allowing the receiver to discriminate between the transmitted pattern and the ultrasonic background noise.
3. As soon as the 8-pulse ultrasonic wave is transmitted, the “Echo” pin goes high.
4. If the receiver DOES NOT hear the 8-pulse signal. The “Echo” pin goes low after 38 milliseconds.
5. If the 8-pulse signal is received before the Echo signal timed out, the “Echo” pin goes low immediately. This produces a pulse whose width varies between 150 uS to 25 mS.
6. The width of the received pulse is used to calculate the distance to the reflected object.

HC-SR04 Wiring





Voltage Divider



gpiozero Examples

```python
from gpiozero import DistanceSensor
from time import sleep

sensor = DistanceSensor(23, 24)

while True:
    print('Distance to nearest object is', sensor.distance, 'm')
    sleep(1)
```

```python
from gpiozero import DistanceSensor, LED
from signal import pause

sensor = DistanceSensor(23, 24, max_distance=1, threshold_distance=0.2)
led = LED(16)

sensor.when_in_range = led.on
sensor.when_out_of_range = led.off

pause()
```