CSE 327
Microprocessor Interfacing and Embedded System

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Ultasonic sensor

What is an ultrasonic sensor?

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.

An ultrasonic sensor uses a **transducer** to send and receive ultrasonic pulses that relay back information about an object's proximity.

High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

Transducer: A device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa.

Ultrasonic sensors are the allrounders in the world of sensors and are suitable for virtually any detection tasks in industrial applications. The objects to be detected can be solid, liquid, granular or in powder form. They reliably detect transparent or high gloss objects as well as objects of changing color. Being extremely tolerant to dirt, the efficiency of ultrasonic sensors comes into its own especially in harsh working environments, as process reliability is not adversely affected by dust, smoke, mist or similar.

How Does an Ultrasonic Sensor Work?

Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. This is similar to how radar measures the time it takes a radio wave to return after hitting an object.

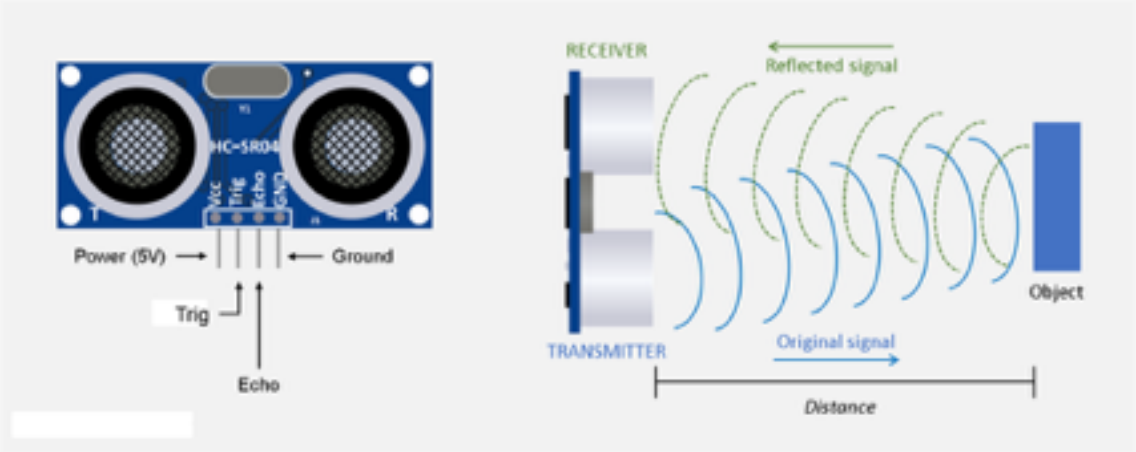
While some sensors use a separate sound emitter and receiver, it's also possible to combine these into one package device, having an ultrasonic element alternate between emitting and receiving signals. This type of sensor can be manufactured in a smaller package than with separate elements, which is convenient for applications where size is at a premium.
If you need to measure the specific distance from your sensor, this can be calculated based on this formula:

Distance = ½ T x C

(T = Time and C = the speed of sound)

At 20°C (68°F), the speed of sound is 343 meters/second (1125 feet/second), but this varies depending on temperature and humidity.

Specially adapted ultrasonic sensors can also be used underwater. The speed of sound, however, is 4.3 times as fast in water as in air, so this calculation must be adjusted significantly.



What are Ultrasonic Sensors Used For?

Robot navigation comes to mind, as well as factory automation. Water-level sensing is another good use, and can be accomplished by positioning one sensor above a water surface. Another aquatic application is to use these sensors to “see” the bottom of a body of water, traveling through the water, but reflecting off the bottom surface below.

Though it might not be immediately obvious, if configured correctly ultrasonic sensors can even measure fluid flow rates. In the simplest case, an emitter and a receiver (separate in this configuration) are aligned with the flow of a fluid. Since sound is traveling through a moving medium, the speed of sound relative to these elements will be increased or decreased by the velocity of the fluid. This can be applied to flow inside pipes by aligning these two elements at an angle to each other, calculating the effective velocity increase based on the trigonometric relations between the two.

Flow rate accuracy can be increased by using data from multiple ultrasonic elements, giving results accurate to within a fraction of a percent.

HC-SR04 Ultrasonic Sensor Pin Configuration

This sensor includes four pins and the pin configuration of this sensor is discussed below.

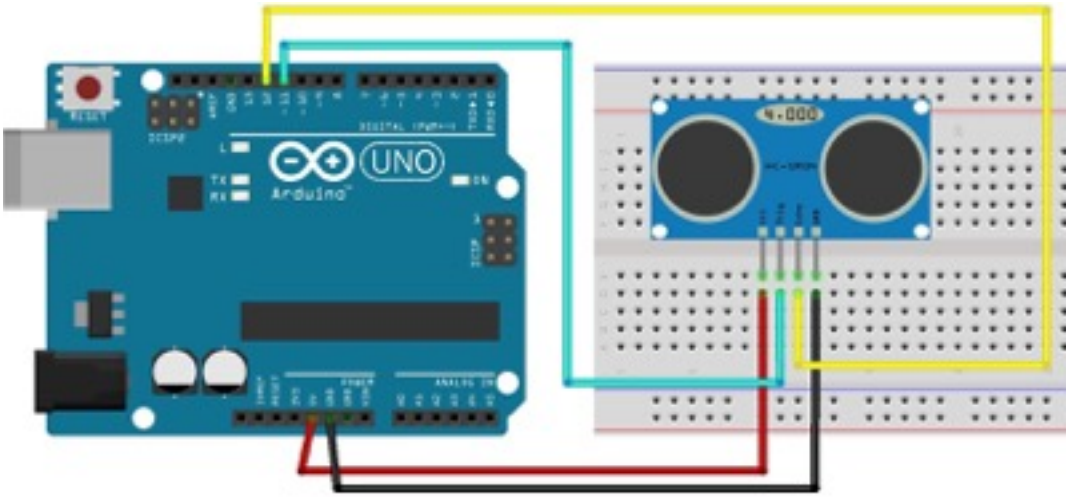
Pin1 (Vcc): This pin provides a +5V power supply to the sensor.

Pin2 (Trigger): This is an input pin, used to initialize measurement by transmitting ultrasonic waves by keeping this pin high for 10us.

Pin3 (Echo): This is an output pin, which goes high for a specific time period and it will be equivalent to the duration of the time for the wave to return back to the sensor.

Pin4 (Ground): This is a GND pin used to connect to the GND of the system.

Incorporating Ultrasonic Sensors into Arduino Projects



Application of multiple Ultrasonic sensors in a Robotic project: