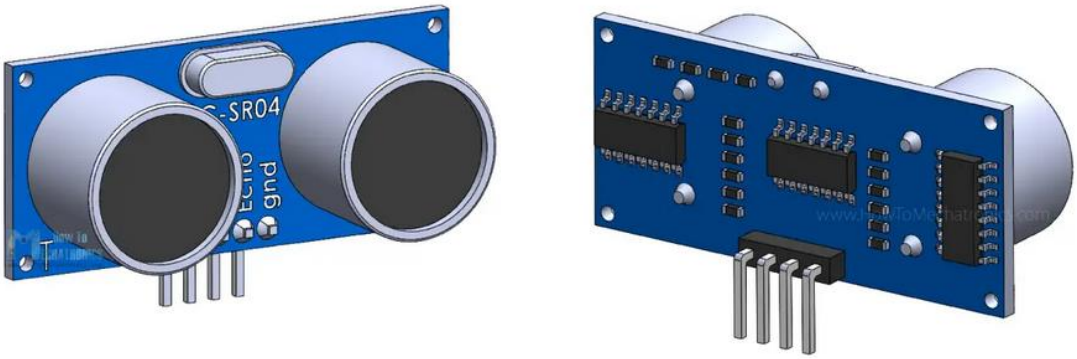
ULTRASONIC RANGE FINDER(DISTANCE)



SENSOR : HC-SR04

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WHAT IS AN ULTRASONIC SENSOR?

The ultrasonic sensor is an electronic device used to measure distances. Because, measuring distance is an essential factor in many applications such as robotic control, vehicle detection etc. Sensors such as optical and sound are the most helpful.

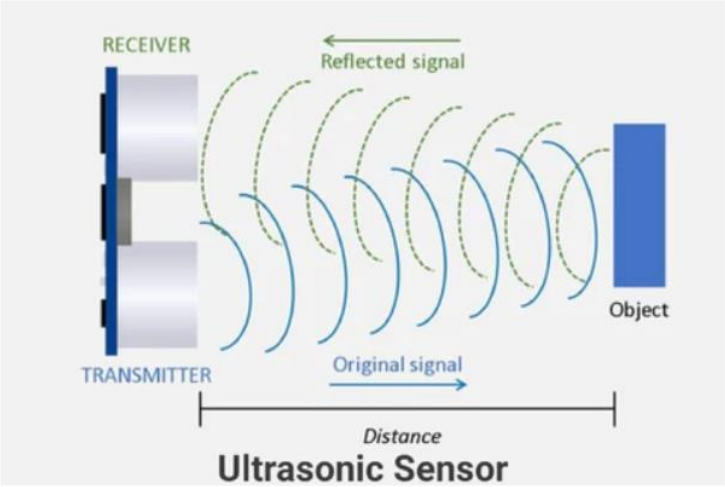
Ultrasonic sensors are used as proximity sensors. They can be found in parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems and manufacturing engineering. Compared to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are less susceptible to interference from smoke, gases, and other airborne particles (although the physical component is subject to variables such as heat).

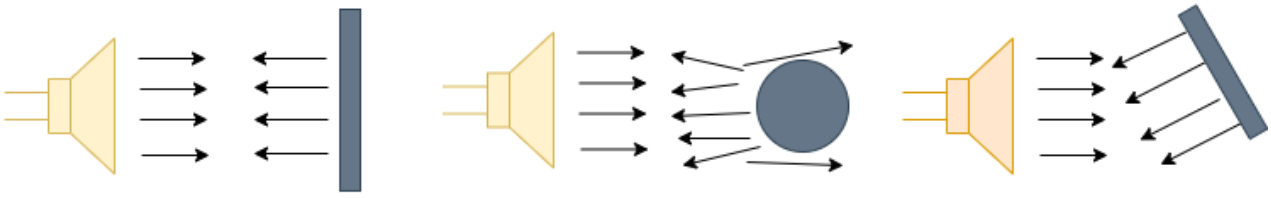
Ultrasonic sensors are also used as level sensors to detect, monitor, and control liquid levels in closed vessels (such as chemical plant drums). Most notably, ultrasound technology has enabled the medical industry to image internal organs, identify tumours, and ensure the health of babies in the womb.

PRINCIPLE OF ULTRASONIC SENSOR

The principle of ultrasonic rangefinders is to measure the time it takes
the signal sent by a transmitter and propagated back to the receiver. As the name implies ultrasonic sensor operates on ultrasonic frequencies. Frequencies beyond our hearing range are known as ultrasonic frequencies. Those frequencies are above 20k Hertz.

They are the all-rounders of sensor technology and can be used in any industrial application. There are several types of objects that can be detected, including solids, liquids, granules, and powders. They reliably detect transparent or glossy objects, as well as objects whose colors change.

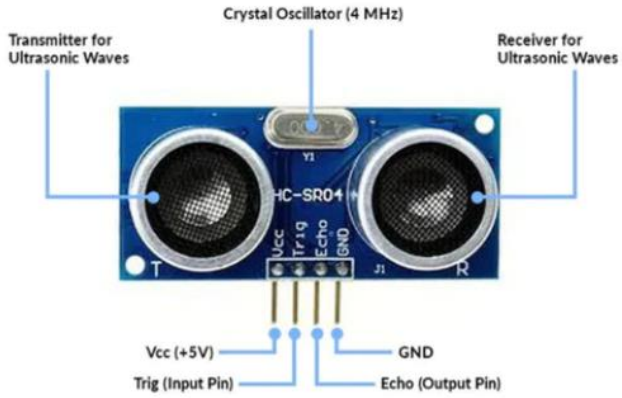




HOW ARE ULTRASONIC SENSORS USED?

With microcontroller platforms like the Raspberry Pi, ARM, PIC, Arduino, Beagle Board, and many more, our ultrasonic proximity level and distance sensors are often employed. Ultrasonic sensors will send sound waves in the direction of the target and calculate its distance by timing how long it takes for the waves to bounce back to the sensor. In addition, to collision avoidance systems also employ ultrasonic sensors.

Here, implemented ultrasonic sensor with Arduino. Before interfacing let us see the pinout of the ultrasonic sensor,



FOUR PINS IN THE ULTRASONIC SENSOR

Vcc	power supply +5 V
Gnd	Common ground
Trigger pin	To start the sensor
Eco pin	Receive the signal

HOW ULTRASONIC SENSOR WORKS?

An ultrasonic sensor is an electronic device that measures the distance to an object by emitting ultrasonic waves and converting the reflected sound into electrical signals. Ultrasound travels faster than audible sound (that is, sound that humans can hear). An ultrasonic sensor consists of two main components: a transmitter (which uses a piezoelectric crystal to emit sound) and a receiver.

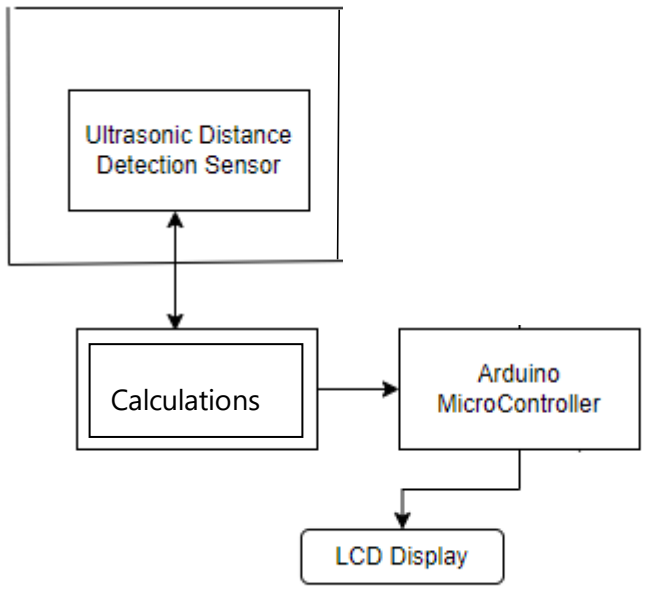
While some sensors use separate sound emitters and receivers, it is also feasible to merge both functions into a single device by using an ultrasonic element to switch between sending and receiving signals in a continuous cycle. The transmitter of the module transmits an ultrasonic sound. This sound will be reflected if an object is present in front of the ultrasonic sensor. The reflected sound is received by the receiver present in the same module. An ultrasonic signal is propagated by a wave at an angle of 30°. The above-depicted Figure illustrates how the ultrasonic signal propagates from the transmitter. Measuring angles should be at least 15° for maximum accuracy. In this case, external objects that fall under this measurement angle interfere with determining the distance to the desired object.

The distance is determined by measuring the travel time of ultrasonic sound and its speed.

Distance = Time x Speed of sound / 2

PICTURES OF THE PROJECT

CIRCUIT WORKING



Components USED:

1. Arduino Uno
2. Ultrasonic Sensor HC-SR04
3. PLASTIC BOX
4. Jumper Wires
5. LED
6. Resistor 220 ohm

Advantages and Disadvantages of Ultrasonic Sensor

In most of the domains, ultrasonic sensors are widely employed because of their advantages which are as follows:

Advantages

- These devices are not impacted by the target's color.
- The device shows flexibility in its distance measurement range where it holds the capability of measuring in the range of a few centimeters to five meters.
- It provides consistent outcomes and shows high reliability.
- High precision device.
- The measurements can be made every second thus showing rapid refresh rates.

Disadvantages

Even though ultrasonic sensors employ versatile technology, there are a few limitations to be considered and those are:

- As sound speed is based on humidity and temperature, environmental circumstances might show an impact on the accuracy while measuring the distance.
- For minimal and embedded projects, ultrasonic sensors seem to be a not good option because these devices are large to integrate with small projects.
- These sensors will not function in a vacuum.
- The sensors will get dirt, wet and frozen which results in errors while measuring or the functionality gets impacted.

APPLICATIONS OF ULTRASONIC SENSOR

ULTRASONIC ANEMOMETERS:

Anemometers are often used in weather stations because they efficiently detect wind speed and direction. 2D anemometers can only measure the horizontal component of wind speed and direction, while 3D anemometers can also measure the vertical component of wind.

Ultrasonic anemometers can not only measure wind speed and direction, but also temperature. This is because the ultrasonic velocity is affected by temperature changes independently of pressure changes. Temperature is calculated by measuring the ultrasonic velocity change.

TIDE GAUGE:

It is used to monitor sea levels and detects tides, storm surges, tsunamis, swells and other coastal processes. Tide gauges can detect water levels in real-time using ultrasonic sensors. Meters are often linked to an online database where records are kept, and the system can trigger alarms if dangerous situations occur.

TANK LEVEL:

Measuring the liquid level in a tank is like a level meter. However, in this case, the fluid may be freshwater, corrosive chemicals, or flammable fluids. In contrast to optical sensors and float switches, ultrasonic sensors are not in contact with liquids, which means less corrosion.

WEB-GUIDING SYSTEMS:

The purpose is to make sure the material is placed correctly. If the material is misaligned, the system mechanically moves the material back into the machine path. Ultrasonic sensors are well suited for web guiding, as the process requires non-contact, fast and efficient functionality.

UAV NAVIGATION:

Unmanned Aerial Vehicles (UAVs) (or drones) typically use ultrasonic sensors to monitor objects in their flight path and the UAV's distance from the ground. By automatically detecting safe distances, aircraft can avoid collisions. In addition, since the flight path changes in an instant, drone collision can be prevented by detecting the distance with ultrasonic waves.

LIMITATIONS OF ULTRASONIC SENSORS

Ultrasonic sensors like the HC-SR04 can efficiently measure distances up to 400cm with a tight tolerance of 3mm. However, if the target is positioned in such a way that the ultrasonic signal is deflected rather than reflected to the ultrasonic sensor, the calculated distance may be incorrect. In some cases, the object is too small to detect enough reflected ultrasound signals to accurately measure distance. Additionally, objects such as fabrics and carpets can absorb acoustic signals. If the signal is absorbed at the edge of the target, it cannot be reflected to the sensor, so range cannot be measured.