Engineering Design-II
(UTA 014)
Buggy Lab

Dr. Divya Sharma

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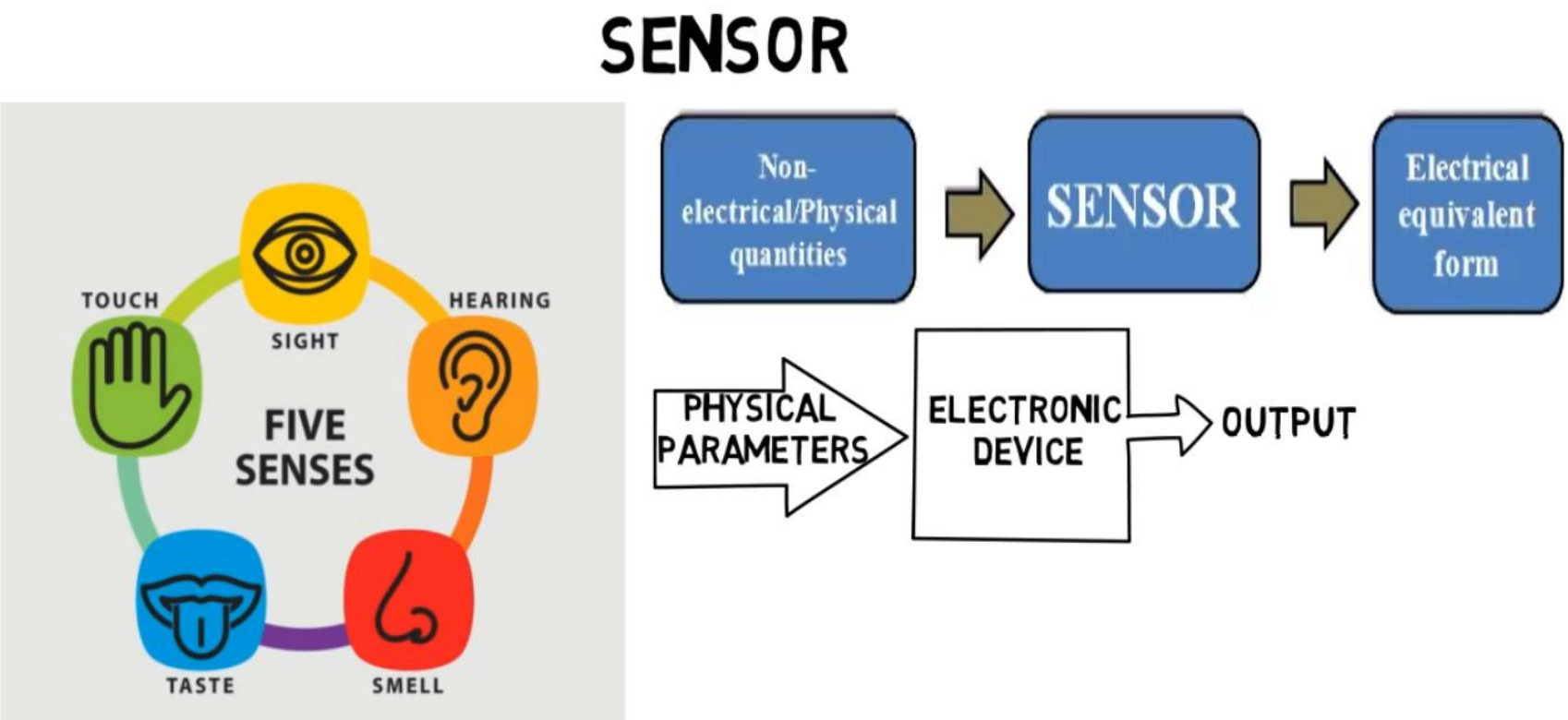
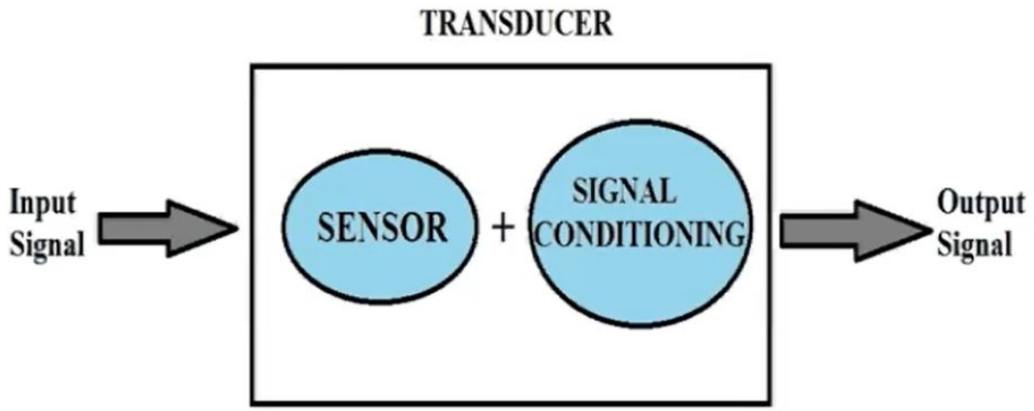
What is Sensor?

- A sensor is a device which converts physical quantities into electrical form or converts non-electrical quantities into electrical equivalent.



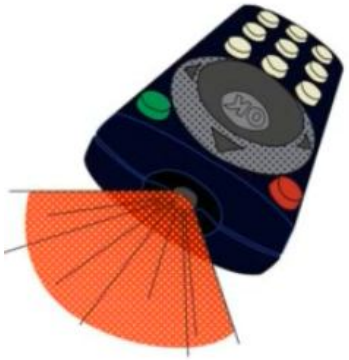
Sensor Vs. Transducer

- A sensor used in conjunction with signal conditioning is called as a transducer.
- Signal conditioning circuit performs:
  1. Amplification
  2. Filtering
  3. Frequency response matching
  4. Grounding/Isolation etc.



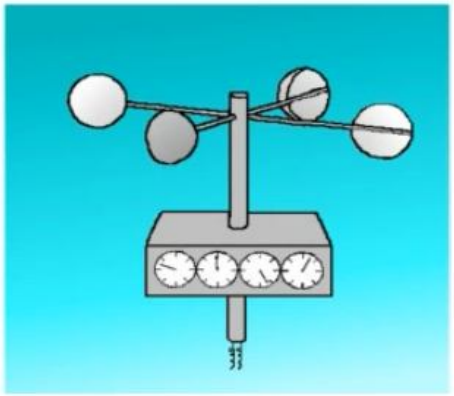
Types & application of sensor

IR SENSOR



An infrared sensor is used to sense certain characteristics of its surroundings by either emitting or detecting infrared radiation using remote control.

WIND SENSOR



Wind Sensor: detects speed of blowing winds through anemometer.

WEIGHT SENSOR

Weight sensor or Load cells are similar to strain gauges which measure the physical quantity like weight and give the output in form of electrical signals using weighing machine.

Types & application of sensor

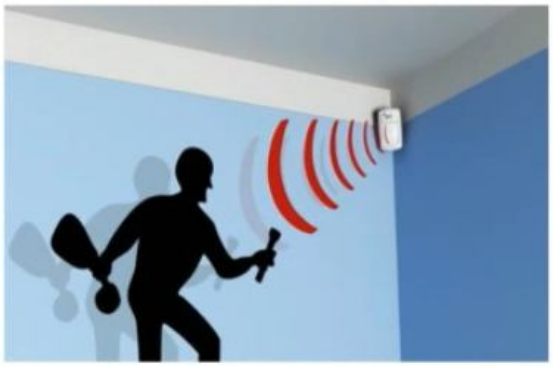
RADAR SENSOR

Radar Sensor: It uses Frequency modulation CW technique to detect moving targets near accelerator

CAPACITIVE SENSOR

Capacitive proximity sensors are non-contact devices that can detect the presence or absence of virtually any object regardless of material.
e.g. human interface with PC, tablet , mobile

MOTION SENSOR



A **motion detector** is an electronic device which is used to detect the physical movement (motion) in a given area and it transforms motion into an electric signal. E.g. Burglar Alarm in Smart Automated home control system..

Types of sensors

PHOTO SENSOR

SPEED SENSOR

OPTICAL SENSOR

Photo sensor: Semiconductor device, Opto-detector convert light into electrical/Digital Signal. Barcode scanning in store.

Speed Sensor: speed sensor measures rotational speed of a shaft e.g. tachometer in automobile aircraft

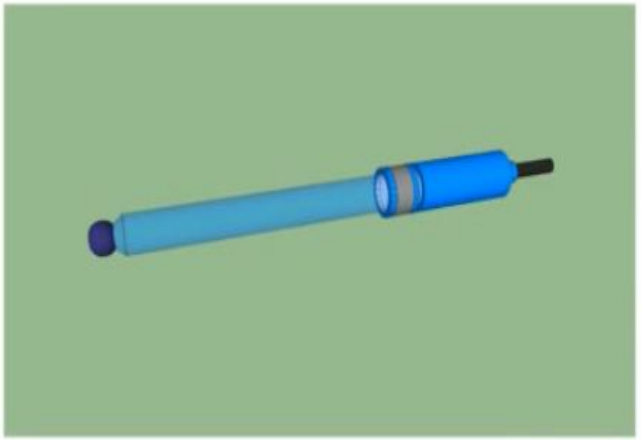
Optical sensor measures light rays and convert it into electrical signal which can be easily readable by user using optical mouse

Types of sensors

SMOKE SENSOR

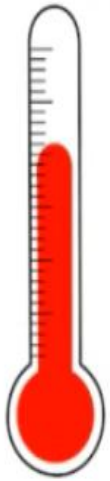
A smoke sensor is a device that senses smoke and it's level. e.g. fire alarm

CHEMICAL SENSOR

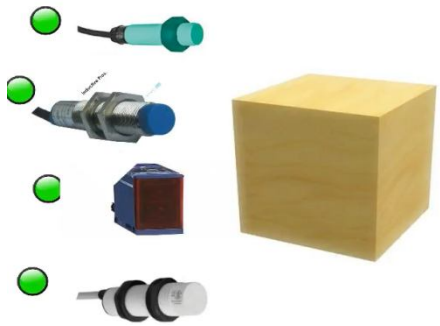


Chemical sensors Their goal is to indicate changes in liquid or to find out chemical changes. E.g. PH sensor, measures H+ ion in water solution indicating its alkalinity.

TEMPERATURE SENSOR



Temperature sensor is a device, used to measure amount of heat energy that allows to detect a physical change in temperature from a particular source. e.g. thermometer

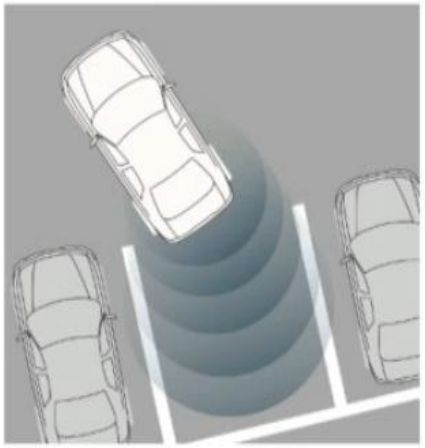


Types of sensors

ACCELEROMETER SENSOR

Accelerometer sensor is used to measure the acceleration experienced by an object due to inertial forces and converts the mechanical motion into an electrical output.
e.g. in mobile, adapting orientation change

PROXIMITY SENSOR



Proximity Sensor: It is able to detect nearby objects with the help of emitting electromagnetic field without any physical contact. E.g. car measures distance at parking

ENVIRONMENTAL SENSOR

Environmental sensor, senses say humidity sensor gives data for weather monitoring station.

Types of sensors

MAGNETIC SENSOR

Magnetic Sensor: It detects the presence of a permanent magnet. E.g. in metal detector

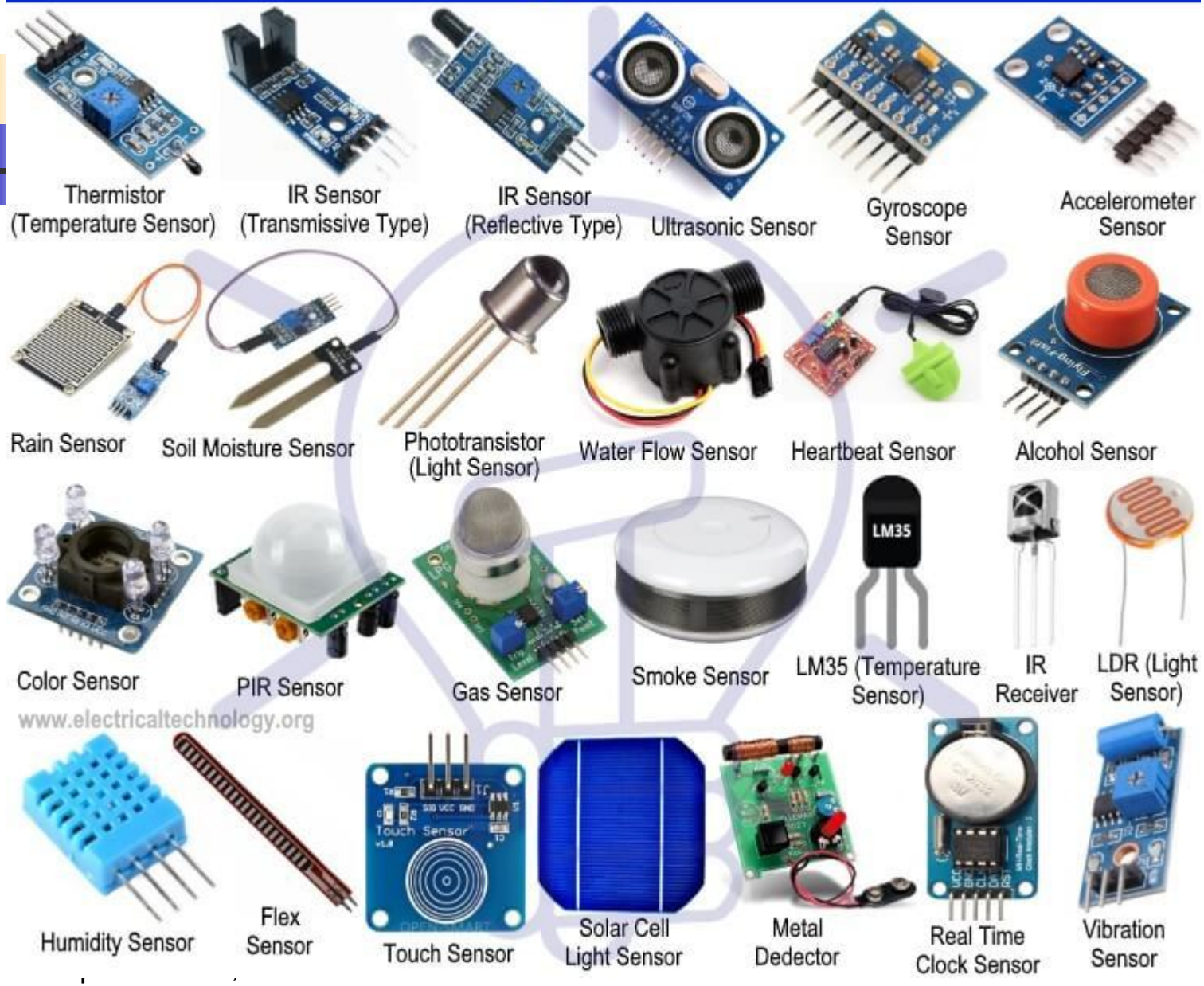
LEVEL & POSITION SENSOR

Level & Position Sensor : It detect the object movements and converts them into signals suitable for processing, transmission, or control.
e.g. reed sensor in washing machine, to detect door is open or closed. To detect water level.

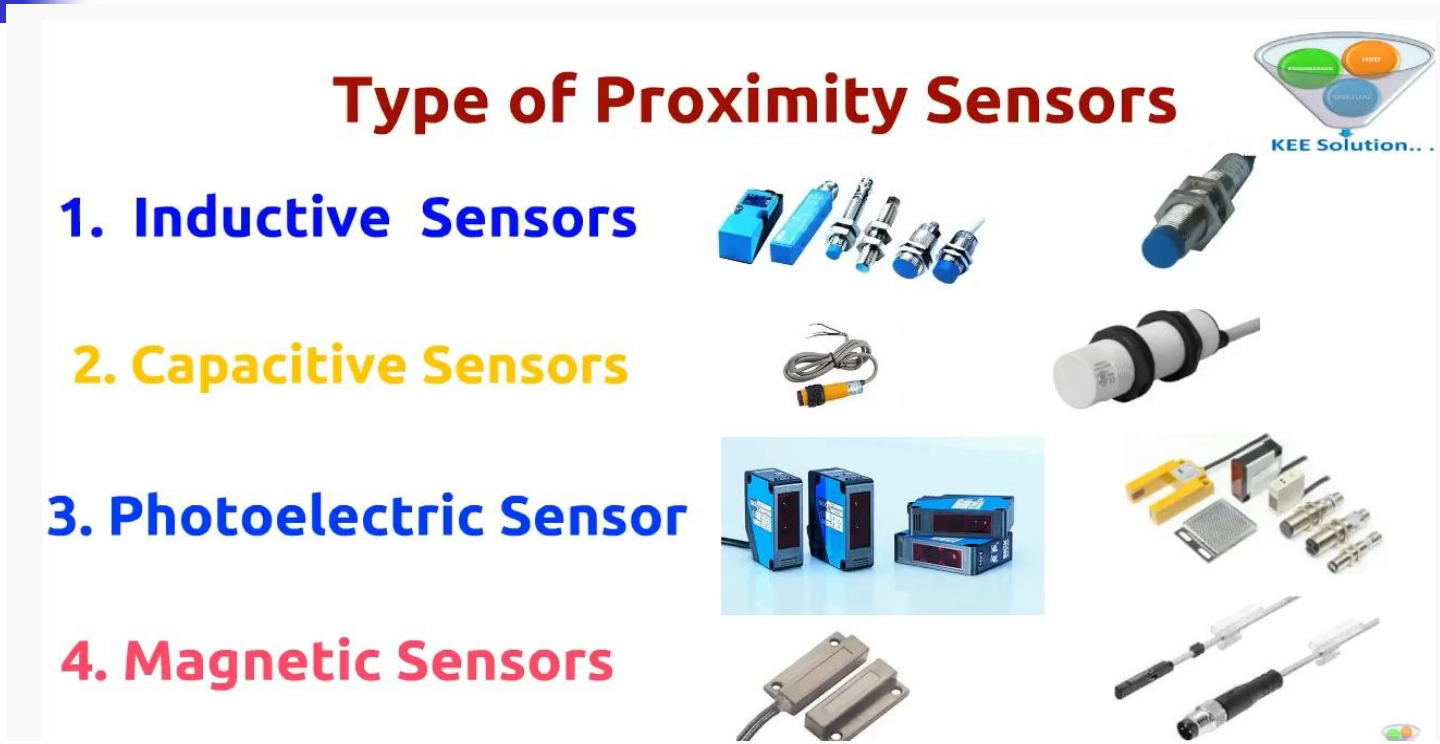
PIEZOELECTRIC SENSOR

Piezoelectric sensor uses the piezoelectric effect to measure changes in **pressure**, acceleration, strain, or force by converting them to an electrical charge using microphone, speaker.

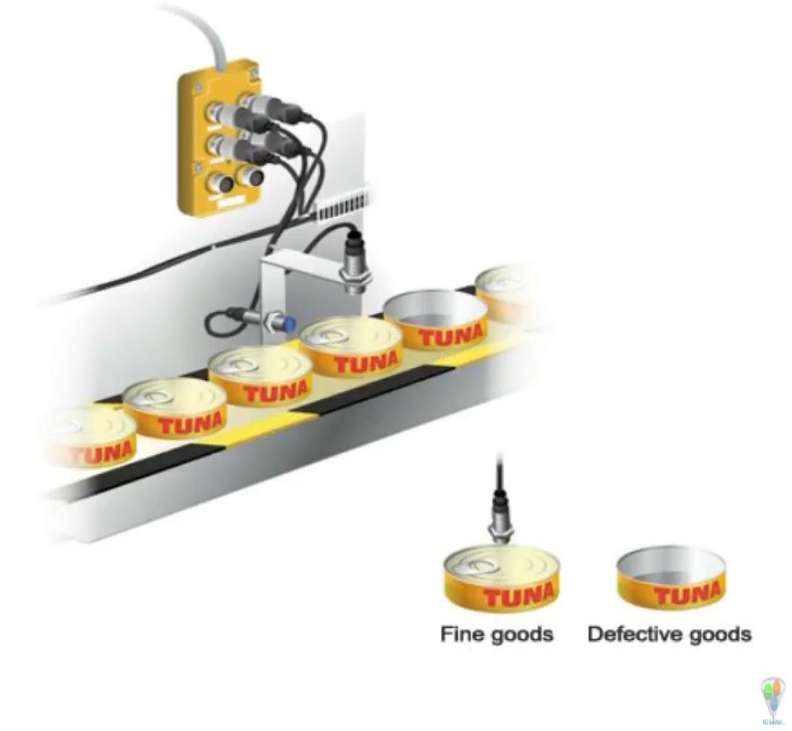
Different Types of Sensors



Types of proximity sensor

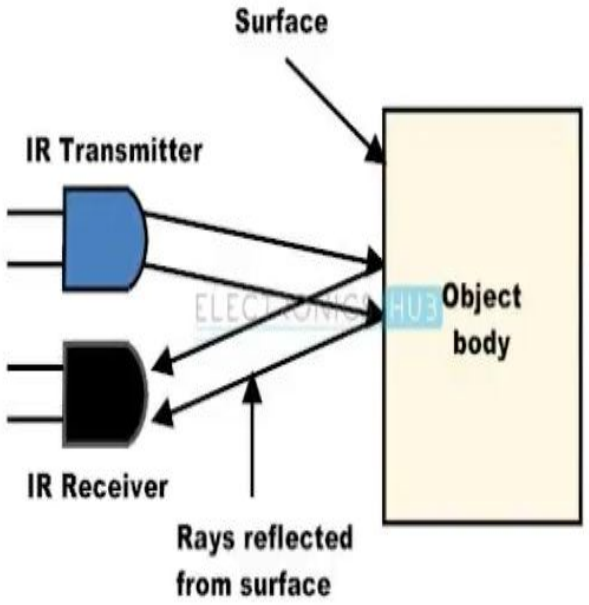


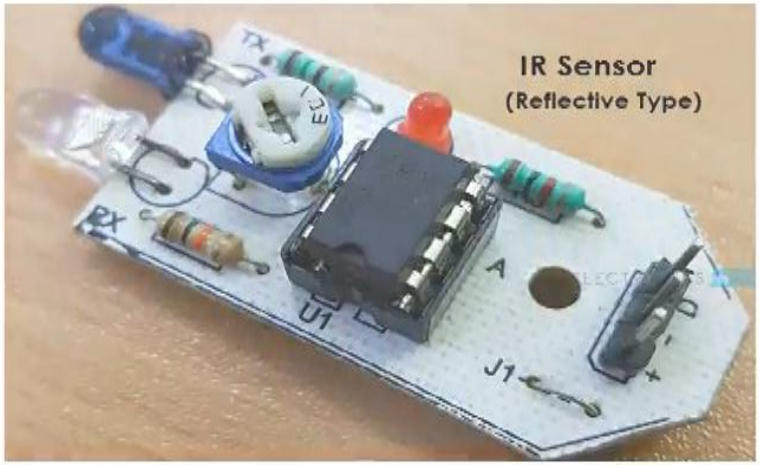
Application of proximity sensor



IR Sensor

Infrared Sensor (IR- Use Transparen objects like-Glass)





IR Sensor

When we look into electromagnetic spectrum, infrared region is divided into three regions as Near Infrared, mid Infrared and far Infrared region. Infrared spectrum has a higher frequency range than microwave and lesser frequency than visible light.

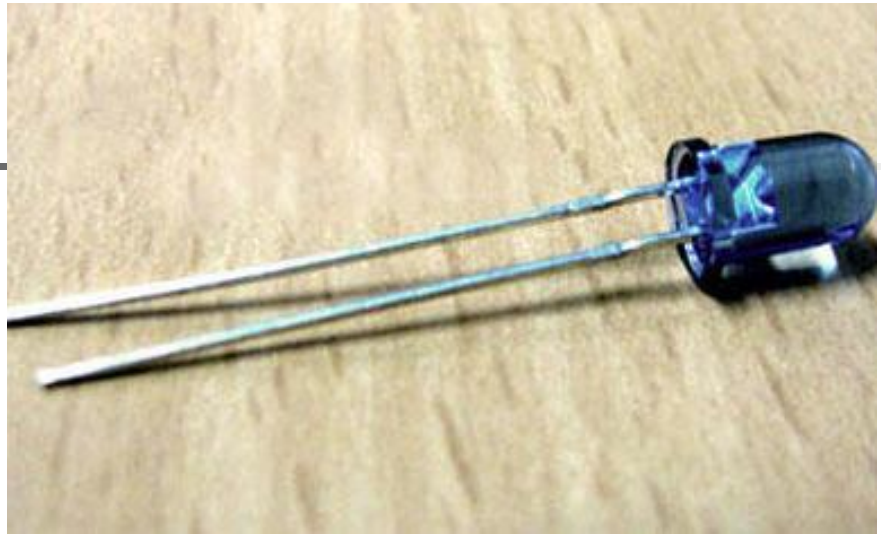
An infrared sensor is used for emitting and detecting IR radiation. By this principle, IR sensor can be used as Obstacle detector. There are two types of IR sensors as Active and Passive IR sensors.

Active vs. passive IR Sensor

Passive IR sensor: When sensor does not use any IR source to detect the emitted energy from the obstacles it acts as a Passive IR sensor. Examples like thermocouple, pyro electric detector and bolometers comes under passive sensors.

Active IR sensor: When are there two components which acts as IR source and IR detector it is called as Active sensor. LED or laser diode act as IR source. Photodiode or phototransistors acts as IR detector.

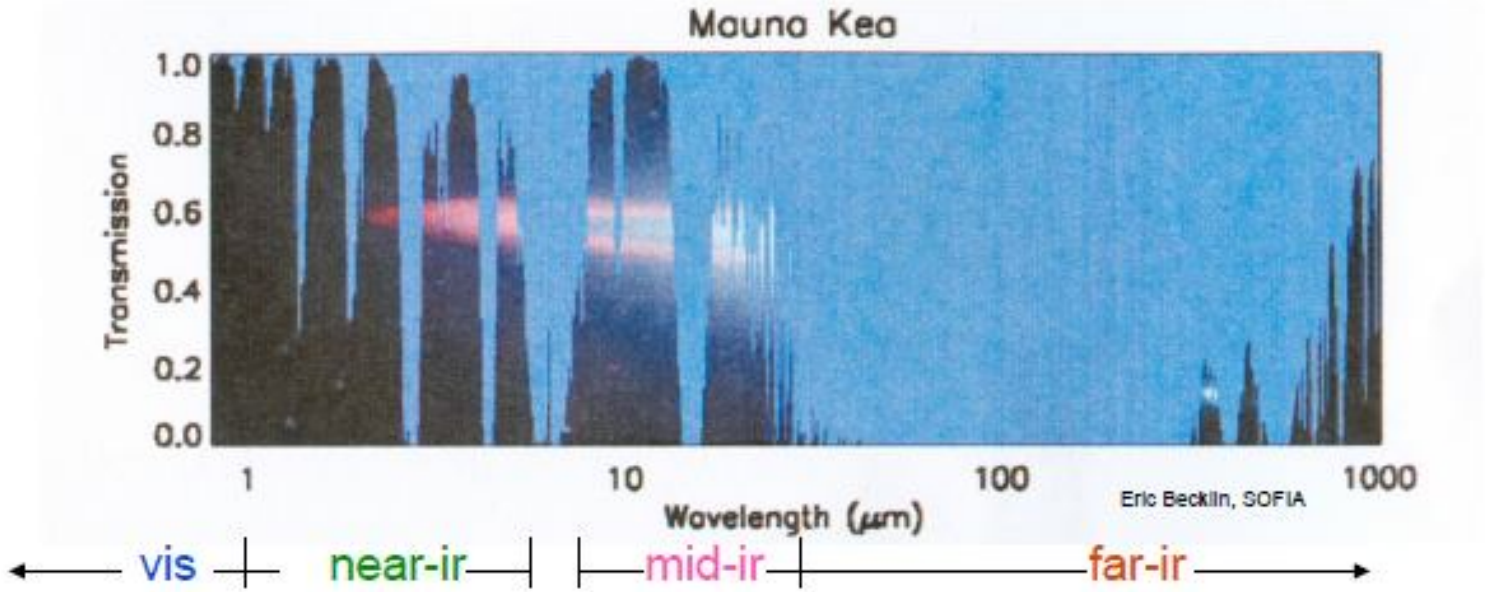
IR Sensors



Infrared radiation is the portion of electromagnetic spectrum having wavelengths longer than visible light wavelengths, but smaller than microwaves, i.e., the region roughly from 0.75μm to 1000 μm is the infrared region.

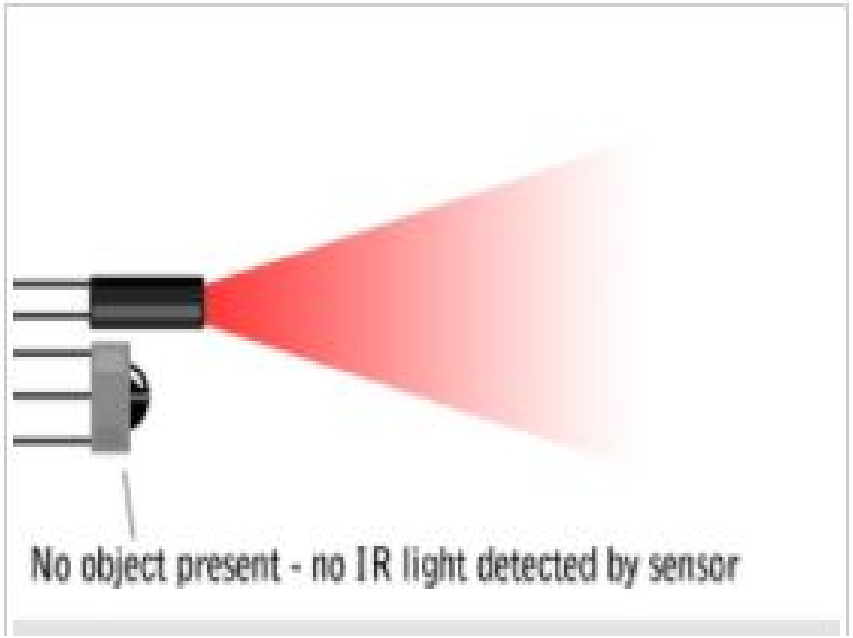
Infrared waves are invisible to human eyes. The wavelength region of 0.75μm to 3 μm is called near infrared, the region from 3 μm to 6 μm is called mid infrared and the region higher than 6 μm is called far infrared.

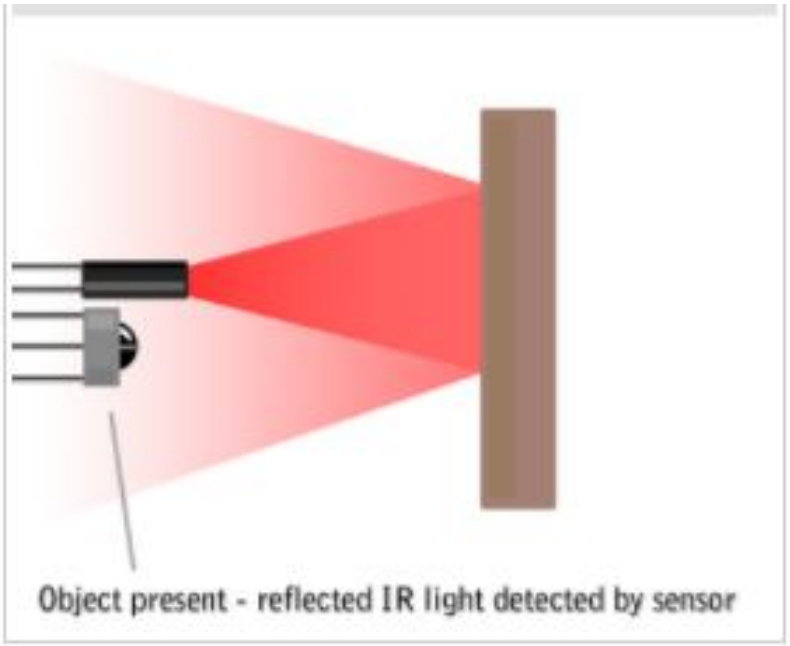
Define infrared by detectors/atmosphere



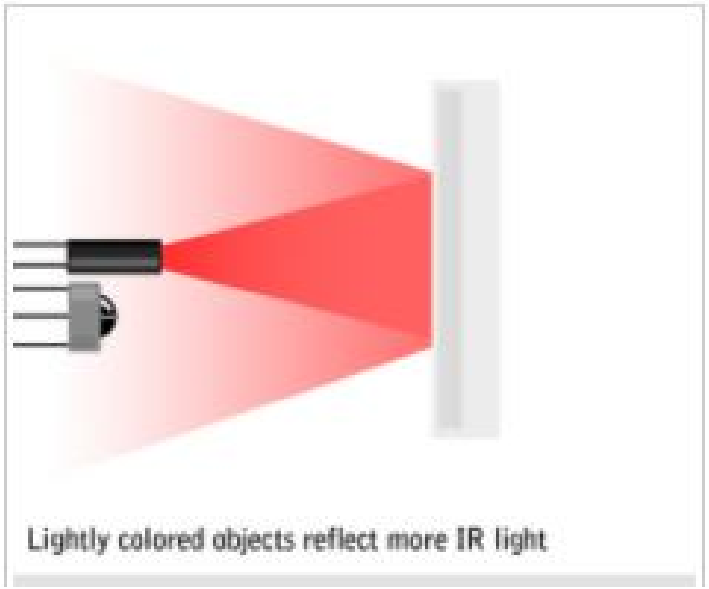
- "visible": 0.3 – 1.0 μm; CCDs
- Near-IR: 1.0 – 5.2 μm; InSb, H_2O absorption
- Mid-IR : 8 – 25 μm; Si:As, H_2O absorption
- Far-IR: 25 – 1000 μm; airborne, space

Principle of operation

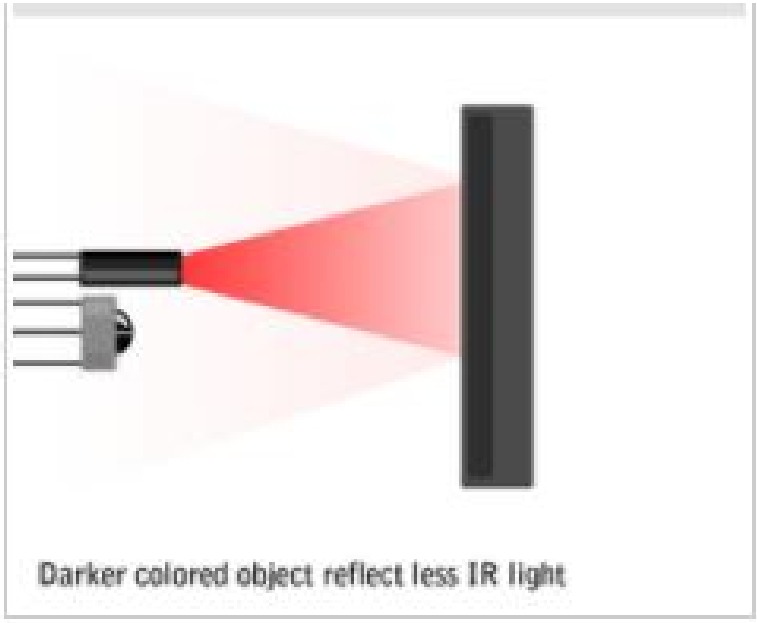




Detecting brightness

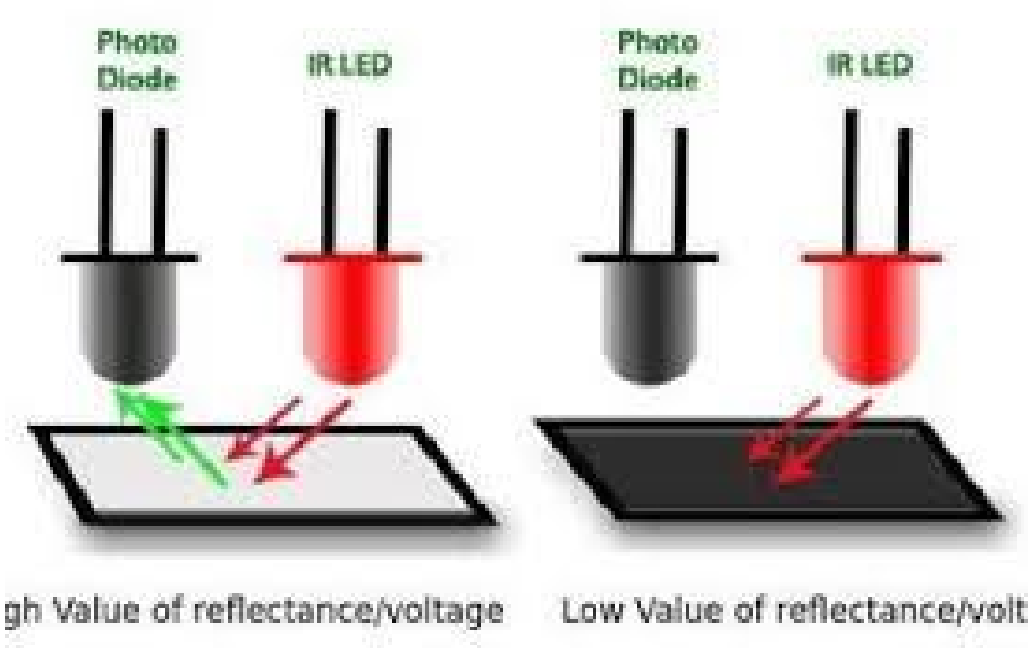


Lightly colored objects reflect more IR light

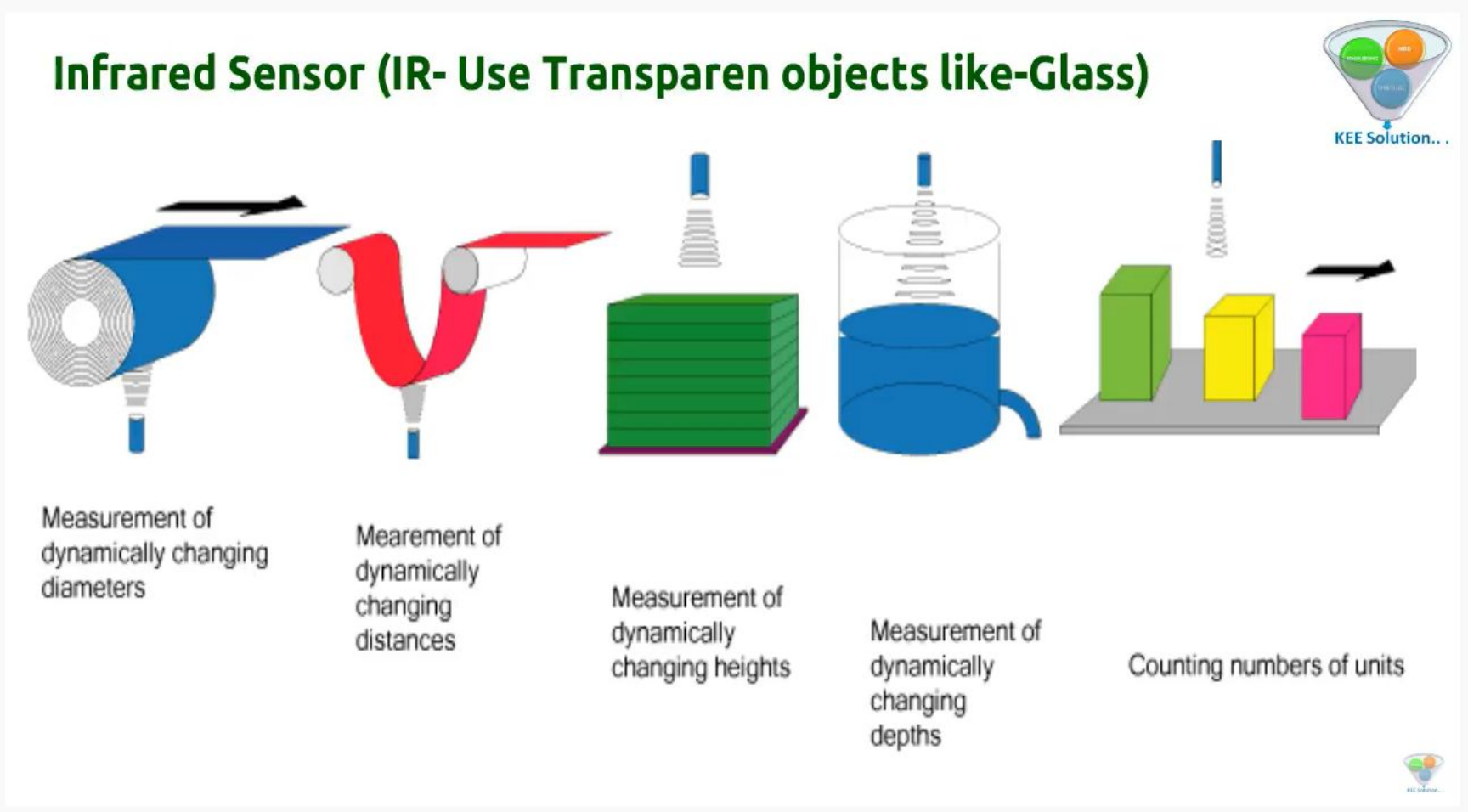


Darker colored object reflect less IR light

Principle of operation



Application of IR Sensor



Application of IR Sensor

IR TV remote: These days IR based TV remotes are used at home and theaters. They use infrared light as source for communication. TV remote consists of buttons and PCB. PCB consists of electrical circuit which is used to sense or detect the button that is pressed. Once the button is pressed, the signal is transmitted in form or Morse code. Transistors are used for amplification of the signal. Finally, it reaches the IR LED. The end of circuit board will be connected to IR LED. A sensor is placed on the receiving end of TV. IR LED will emit IR light and the sensor senses it.

IR Imaging devices: IR sensors are used to image objects. They are used in Thermography cameras, which are used as Noninvasive imaging technique.

Ultrasonic sensors

Introduction

Ultrasonic sensors "are based on the measurement of the properties of acoustic waves with frequencies above the human audible range," often at roughly 40 kHz [1)]. They typically operate by generating a high-frequency pulse of sound, and then receiving and evaluating the properties of the echo pulse.

Three different properties of the received echo pulse may be evaluated, for different sensing purposes. They are:

- Time of flight (for sensing distance)
- Doppler shift (for sensing velocity)
- Amplitude attenuation (for sensing distance, directionality, or attenuation coefficient)

Ultrasonic sensors

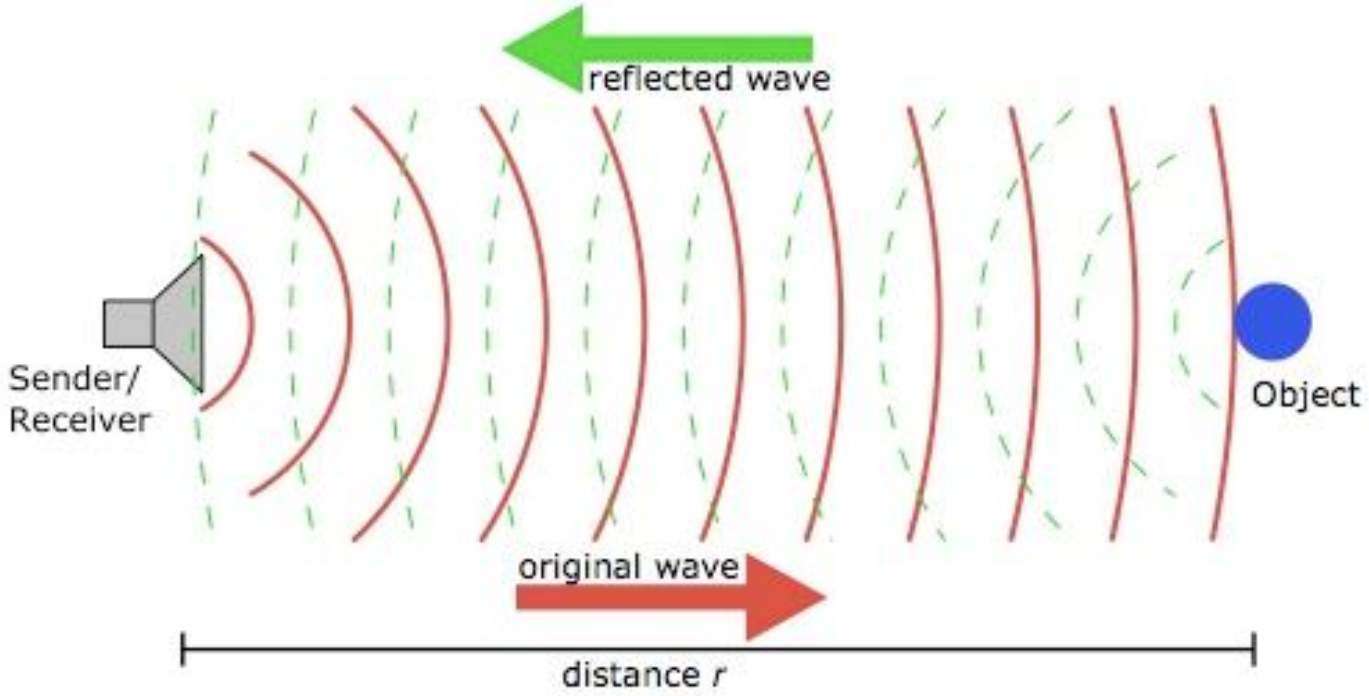
- ✓ Ultrasonic sensors are used to measure distance or travel time using ultrasonic waves. A source will be used to emit ultrasonic wave.
- ✓ After wave hits the target, the waves are reflected and the detector collects the signal.
- ✓ The travel time between the transmitted wave and reflected wave is measured using Ultrasonic sensor.
- ✓ Optical sensors use two different element for transmitter and receiver. Whereas ultrasonic sensor uses single element for transmission and reception.

Mode of operation

1A. Reflection Mode

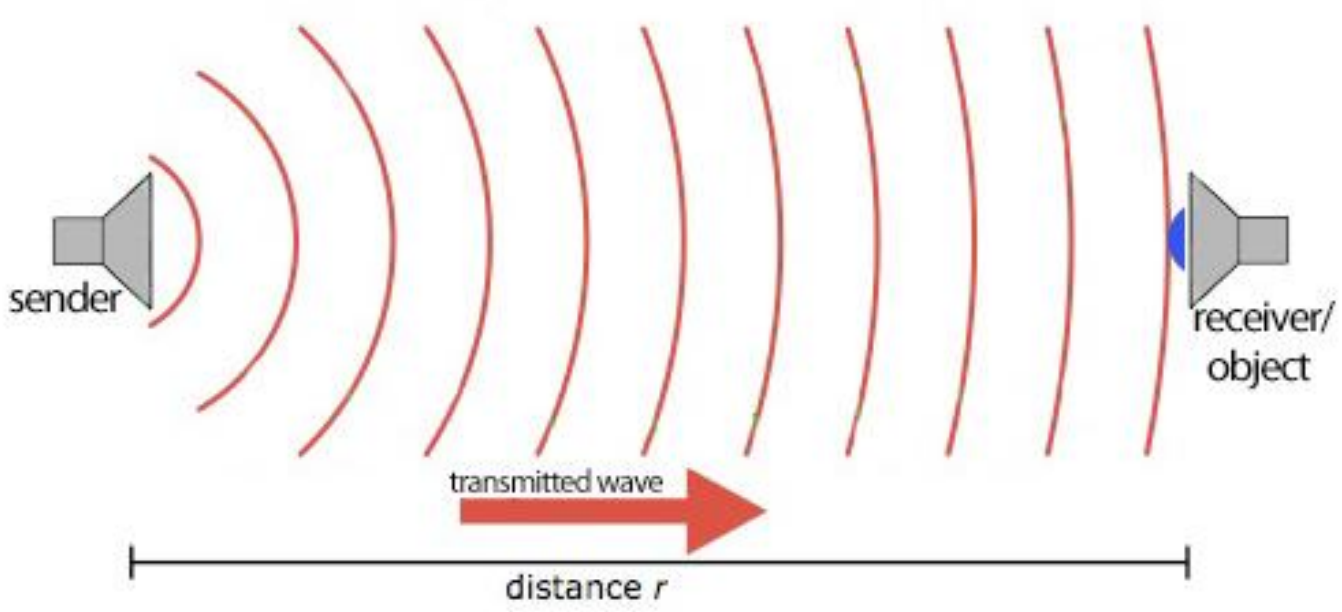
In reflection mode (also known as "echo ranging"), an ultrasonic transmitter emits a short burst of sound in a particular direction. The pulse bounces off a target and returns to the receiver after a time interval **t**. The receiver records the length of this time interval, and calculates the distance travelled **r** based on the speed of sound **c**:

r = c * t



1B. Direct Measurement Mode

In this mode of operation the transmitter and receiver are two separate units that move relative to each other. For example, the receiver can be fixed to a target that moves relative to a stationary transmitter, or vice-versa.



Ultrasonic sensor

- ✓ The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do.
- ✓ It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package.
- ✓ From 2cm to 400 cm or 1” to 13 feet.
- ✓ Its operation is not affected by sunlight or black material like Sharp rangefinders

Application of Ultrasonic Sensor

- Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.
- Used to measure the distance within a wide range of 2cm to 400cm
- Can be used to map the objects surrounding the sensor by rotating it
- Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water

Criterion to choose a sensor

- There are certain features which have to be considered when we choose a sensor. They are as given below:
- Accuracy – should be High
- Stability - maintain under abnormal condition
- Environmental condition - usually has limits for temperature & humidity
- Range - Measurement limit of sensor
- Calibration - Essential for most of the measuring devices as the readings changes with time
- Resolution - Smallest increment detected by the sensor
- Cost - Should be Low
- Power Consumptions - Low
- Repeatability - The reading that varies is repeatedly measured under the same environment

Criterion to choose a sensor

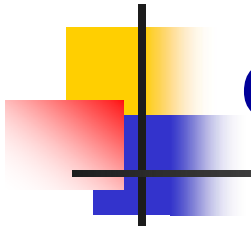
Sensitivity: Defined as input parameter change required to produce standardized output change. (High 110V/W)

Precision: Degree of reproducibility of measurement

Accuracy: Maximum difference between actual value and indicated value

Linearity: Extent to which actual measured curve is departed from ideal curve

Response time: Sensor don’t change output state immediately after input parameter change. (good, 40 ms)



Criterion to choose a sensor

Hysteresis: A sensor should be capable of following the changes of the input parameter regardless of which direction the change is made; hysteresis is the measure of this property.

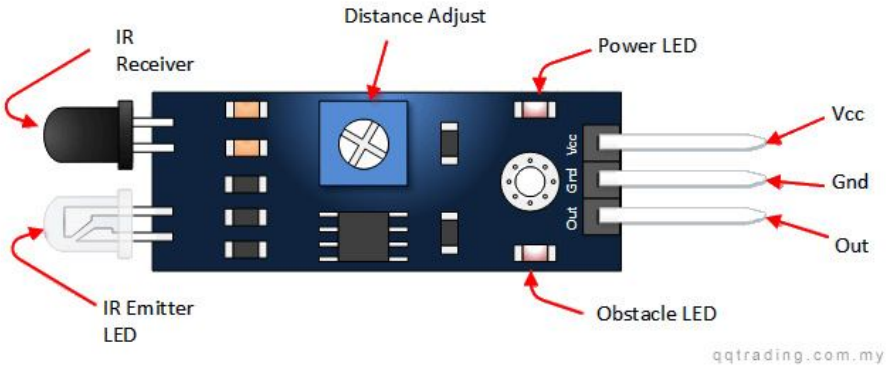
Settling time : the time for the sensor to reach a stable output once it is turned on.

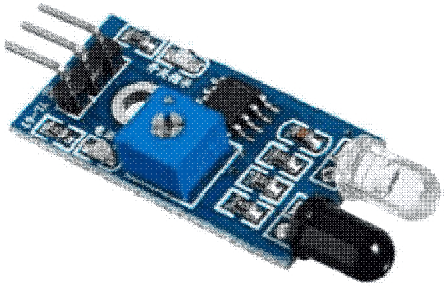
Drift: This is the low frequency change in a sensor with time. It is often associated with electronic aging of components. Drift generally decreases with the age of a sensor.

SNR: Signal to noise ratio high.

Technical specification of sensors

Proximity IR Obstacle Detaction Sensor Module FC-51





Features:

•There is an obstacle, the green indicator light on the circuit board

•Digital output signal

•Detection distance: 2 ~ 30cm

•Detection angle: 35 ° Degree

•Comparator chip: LM393

•Adjustable detection distance range via potentiometer:

- Clockwise: Increase detection distance
- Counter-clockwise: Reduce detection distance

Specifications:

•Working voltage: 3 - 5V DC

•Output type: Digital switching output (0 and 1)

•3mm screw holes for easy mounting

•Board size: 3.2 x 1.4cm

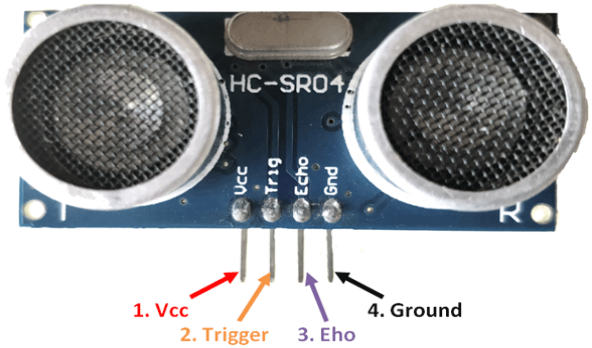
•Cost: 100 Rs

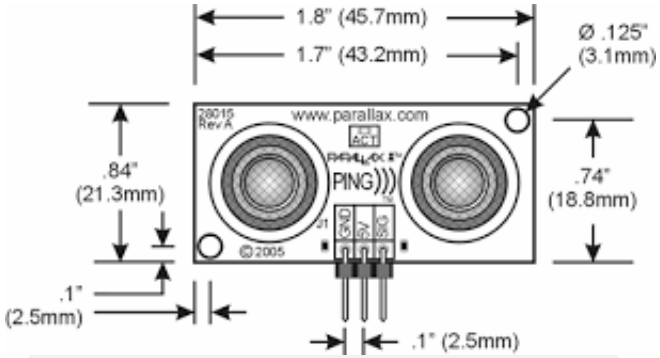
INFRA RED SENSOR SMTIR9901/02

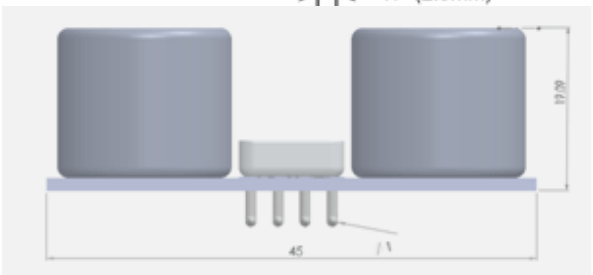
Specifications

Parameter	typical	units
Number of thermojunctions	100	
Active area	0,5	mm^2
Die size	2,2 x 2,2	mm^2
Resistance of thermopile (Rth)	50±15	KΩ
Sensitivity	110±20	V/W [1])
Temp. Coeff. Of sensitivity	-0,52±0,08	%/K
Specific Detectivity	2,1 *10E8	cm.Hz½/W [1])
noise equivalent power	0,35	nW [1])
Noise voltage	37	nV/Hz½
Time constant	40±10	ms (63%)
Temperature range (sensor)	-20 - + 100	°C
Storage temperature	-40 - +100	°C
Filter (high pass)	5,5	µm
[1]) at 500 K dc		
Reference Thermistor (SMTIR9902 only)		
Resistance	1,000 ±0,004	KΩ (@ 0 °C

Technical specification:HC-SR04







- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz
- Easy to use 4-pin breakout.
- Ranging accuracy: ±3cm (incremental towards maximum range).
- Separate inputs for trigger and received Echo.
- COST: Approx.: 150Rs

Thanks !