ASME IIT ROORKEE SECTION

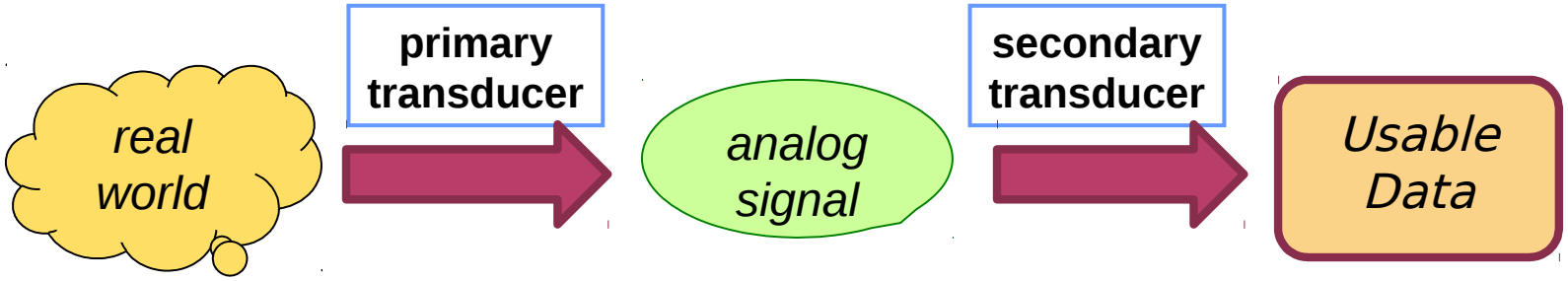
MODELS AND ROBOTICS SECTION

Basic Electronics

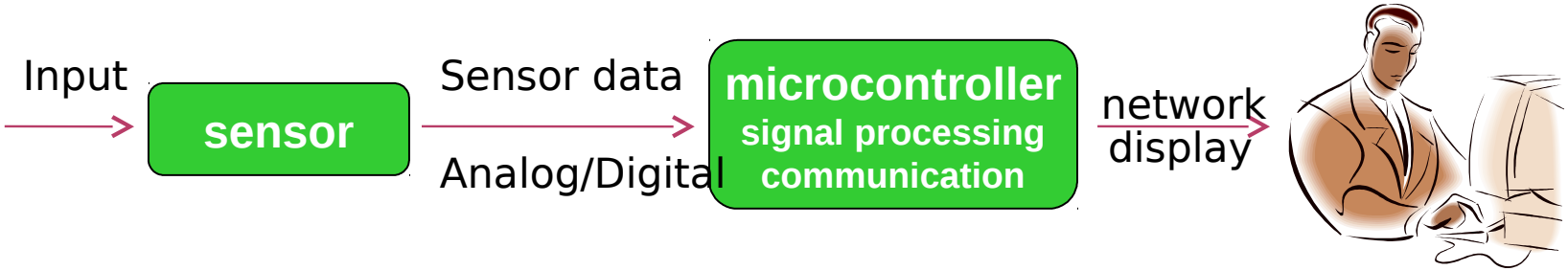
SENSORS

What is a sensor?

- A sensor is an electronic device which acquires any physical quanties and converts it into an electronic signal that can be processed.
- In simple words, it acquires information from “real world”.



- Active element of a sensor is called a transducer.



Transducers

A device which converts one form of energy to another.

When input is a physical quantity and output electrical → Sensor

When input is a electrical and output physical quantity → Actuator

<u>e.g. Piezoelectric:</u>
Force to voltage
Voltage to force

<u>e.g. Sound:</u>
Microphone – Sound to electric signal
Loud Speaker – Electric signal to sound

SENSORS

Light Sensor

Three-axes accelerometer

Ultrasonic Sensor

Bump Sensor

Proximity Sensor

Sharp IR Sensor

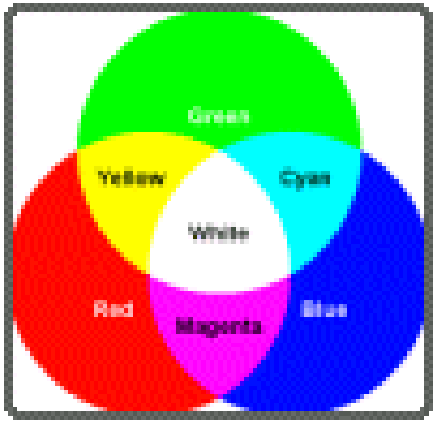
Encoder

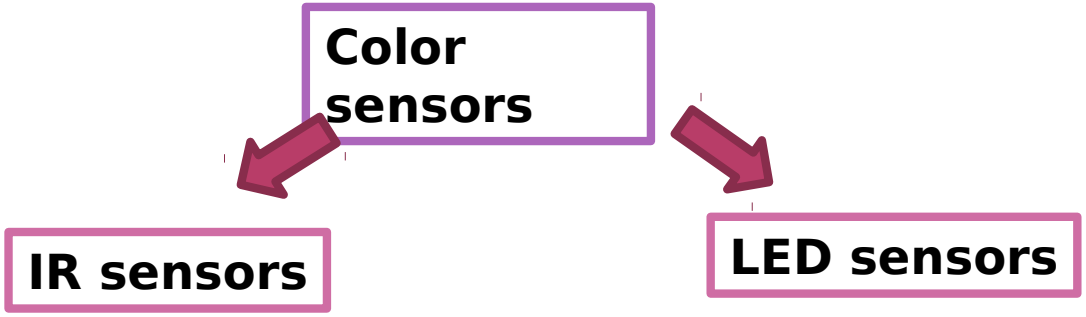
Color Sensors

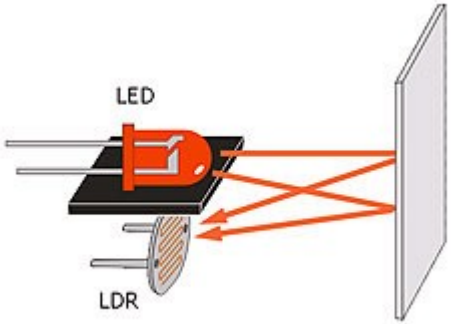
•Light is comprised of several frequencies.

•When light is incident on a surface, some frequencies are absorbed and some are reflected.

•We can see an object because of this reflected light.

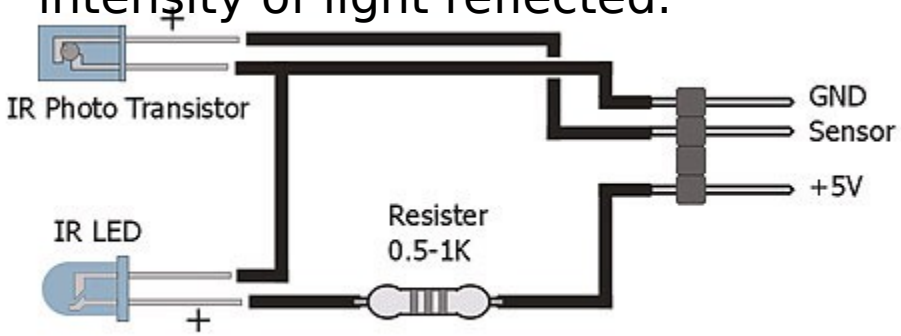






LDR is a light dependant resistor. Instead an IR photo transistor can also be used.

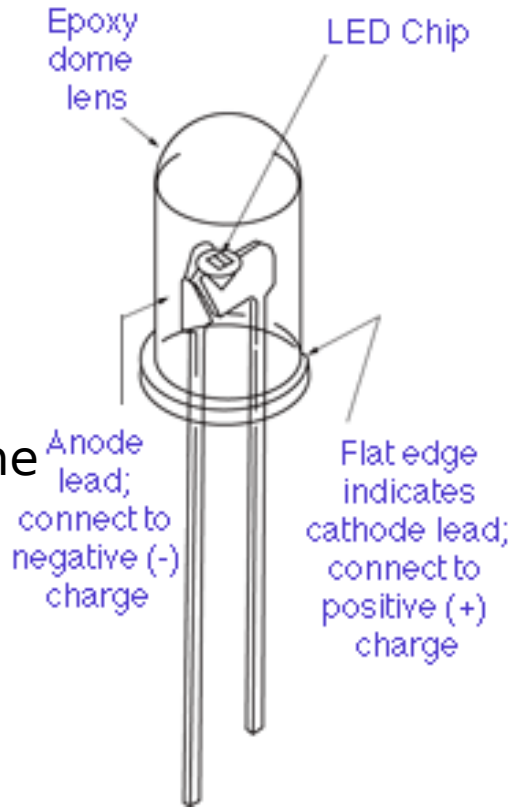
- The IR sensor has two major parts, namely – the LED and the LDR.
- The LED emits IR rays which are reflected by the target surface.
- The reflected light is received by the LDR and converted to voltage signal.
- Higher voltage => Higher intensity of light reflected.



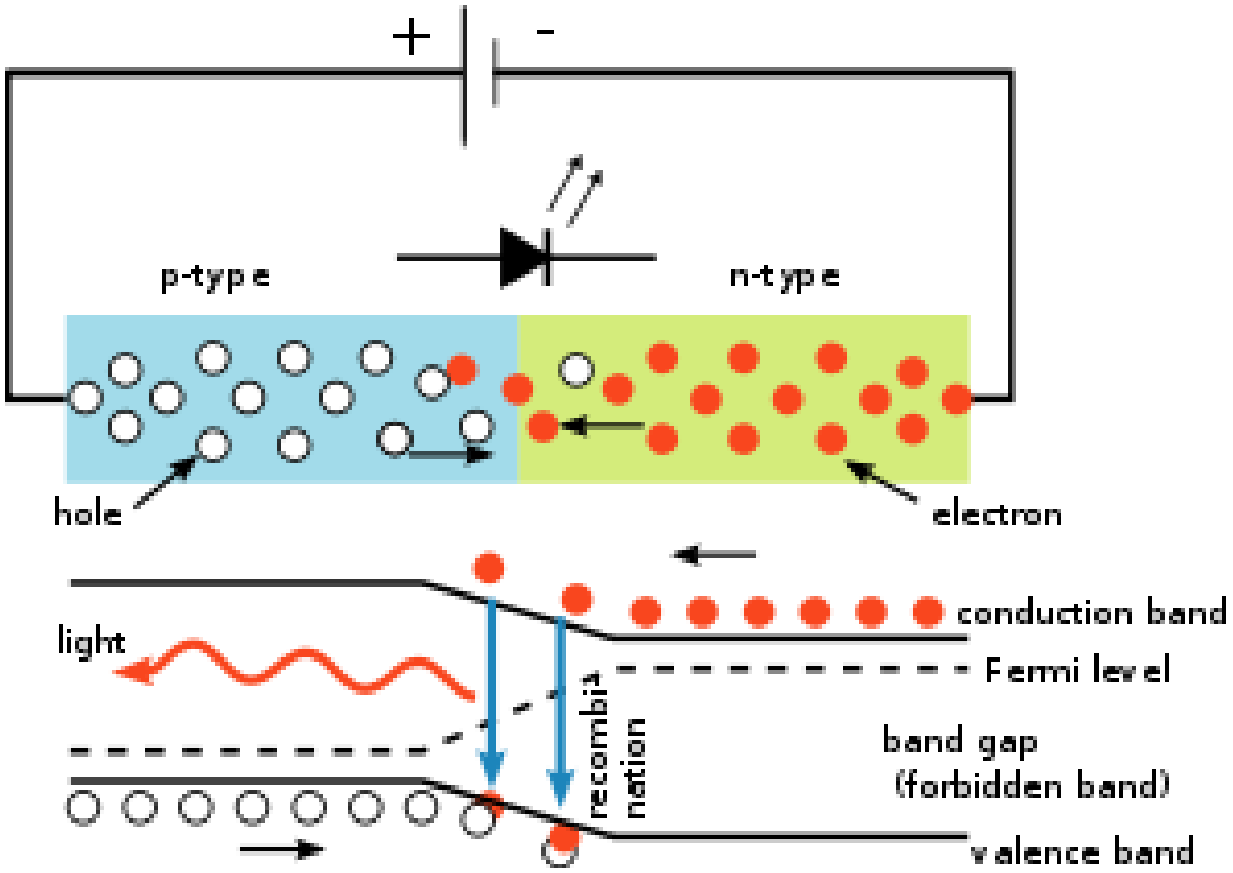
❖ A LED (Light Emitting Diode) is basically a p–n junction diode, which emits light when activated.

❖When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons.

❖This effect is called electroluminescence, and the color of the light is determined by the



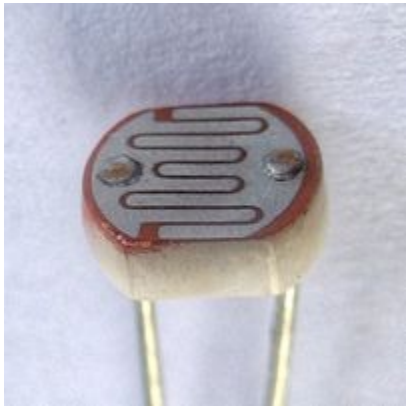
Color	Material
Infrared	Gallium arsenide (GaAs) Aluminium gallium arsenide (AlGaAs)
Red	Gallium(III) phosphide (GaP)
Blue	Zinc selenide (ZnSe), Indium gallium nitride (InGaN)
Ultraviolet	Diamond (235nm), Boron nitride(215nm), Aluminium nitride(AlN)(210nm)



•The LED consists of a chip of semiconducting material doped with impurities to create a p-n junction.
•Charge-carriers—electrons and holes—flow into the junction from electrodes with different voltages.
•When an electron meets a hole, it falls into a lower energy level and releases energy in the form of a photon.

Infrared phototransistors are almost like standard NPN transistors. NPN transistors require a current at the base to allow a large current to flow from the collector to the emitter. The infrared phototransistor operates on the same principle, however the small current is created by infrared light.

A **photoresistor** or **light-dependent resistor (LDR)** is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it
exhibits photoconductivity.

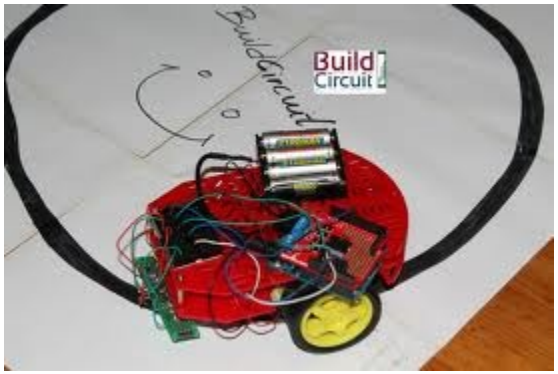


LED Sensors

- Works on same principle as IR sensors but coloured LEDs used.
- Can differentiate better among objects of two different colours but same intensity.

Applications

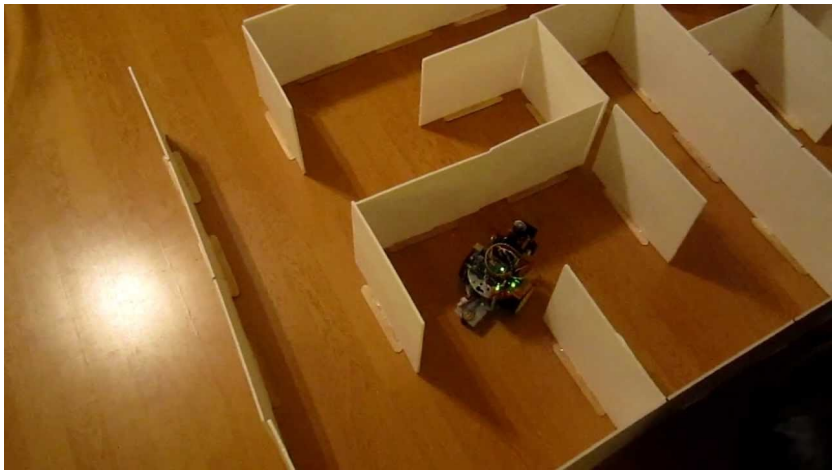
Rubik’s cube solver



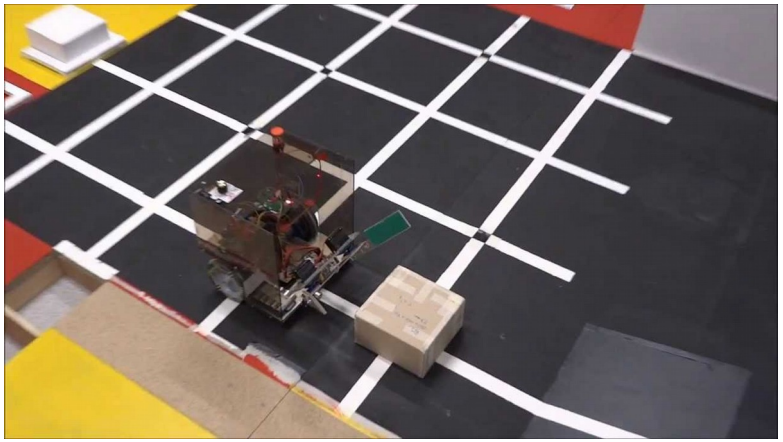
Line follower

Pick and place

Distance Sensors

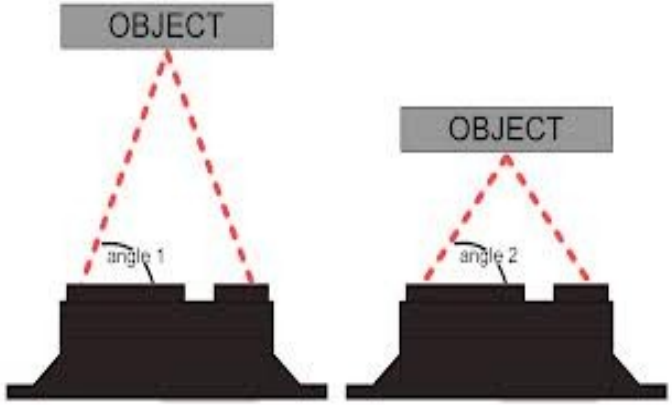


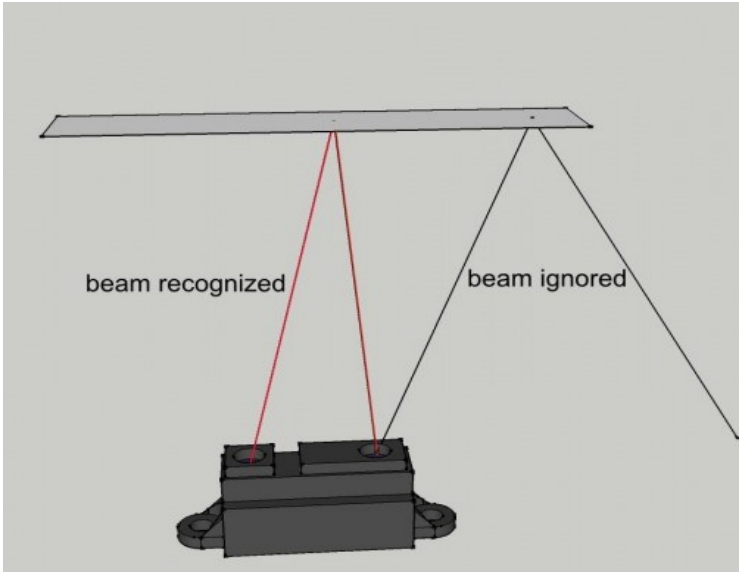
While making a robot to deal with obstacles or other objects, often we have to make use of distance sensors.



Sharp Sensors

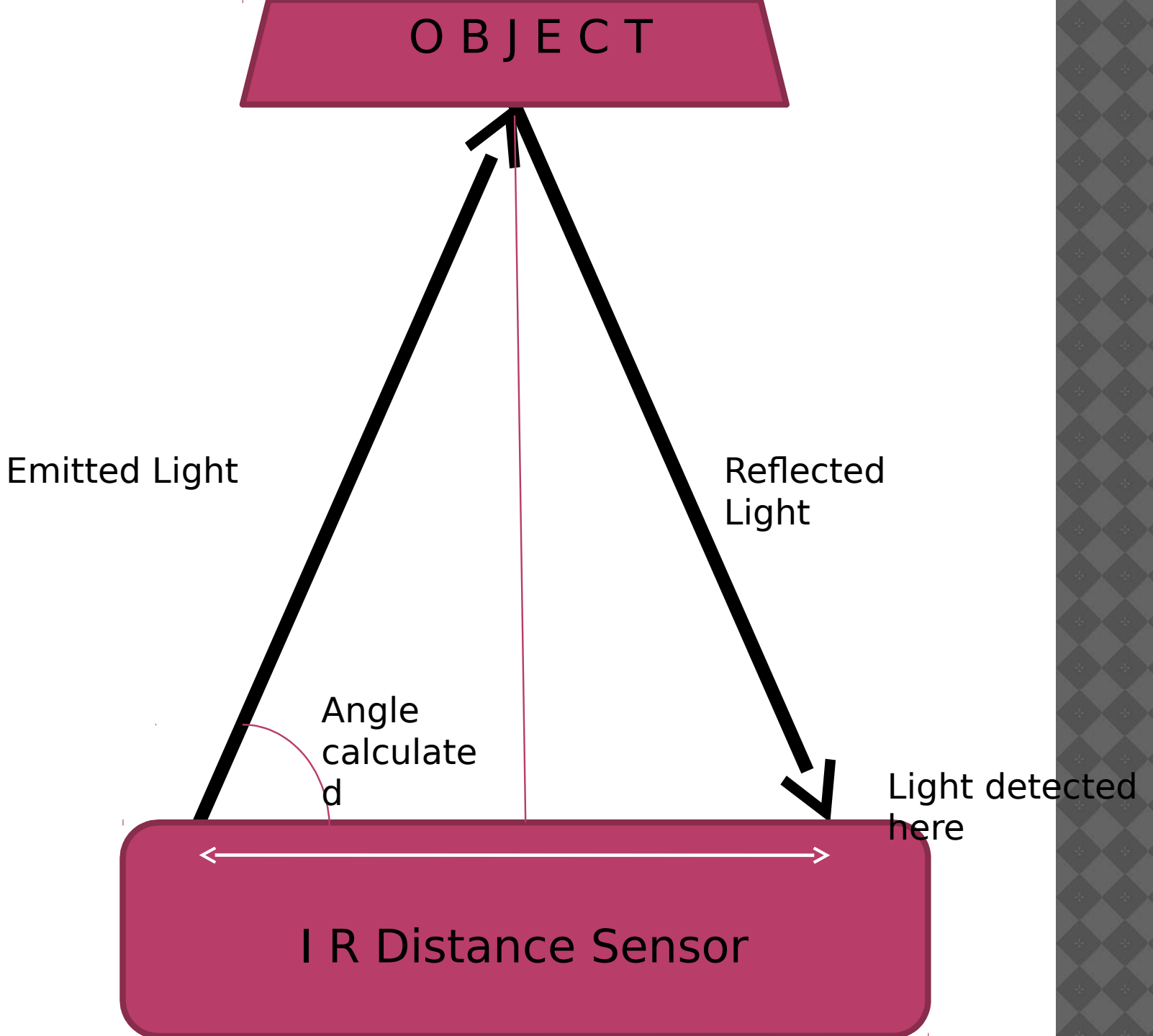
- Analog distance sensor that uses infrared to detect an object's distance.
- Uses triangulation method
- The further the object is away from the sensor, the steeper the angle will be.





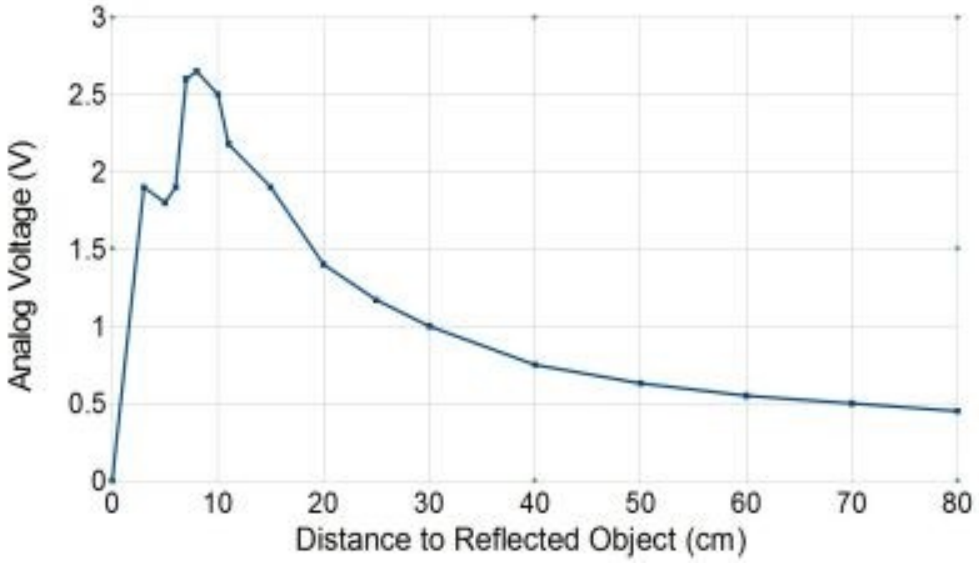
•In order to triangulare, a pulse of IR light is emitted by the emitter.

•The light travels out into the field of view and either hits an object or just keeps on going. In the case of no object, the light is never reflected, and the


O B J E C T
Emitted Light
Reflected Light
Angle calculated
Light detected here
I R Distance Sensor

✓ If the light reflects off an object, it returns to the detector and creates a triangle between the point of reflection, the emitter and the detector.

✓The incident angle of the reflected light varies based on the distance to the object.



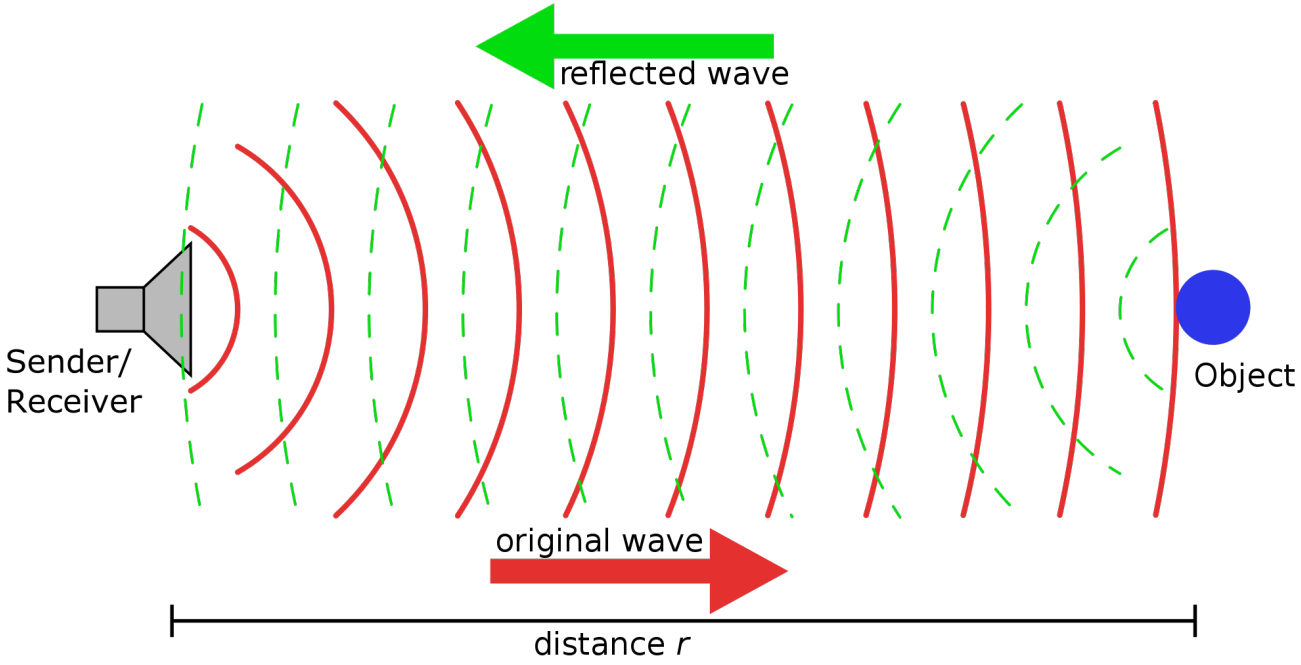
✓ The receiver portion of the IR rangers is a precision lens that transmits reflected light onto various portions of the enclosed linear CCD array based on the incident angle of the reflected light.

✓The CCD array can then determine the incident angle, and thus calculate the distance to the object.

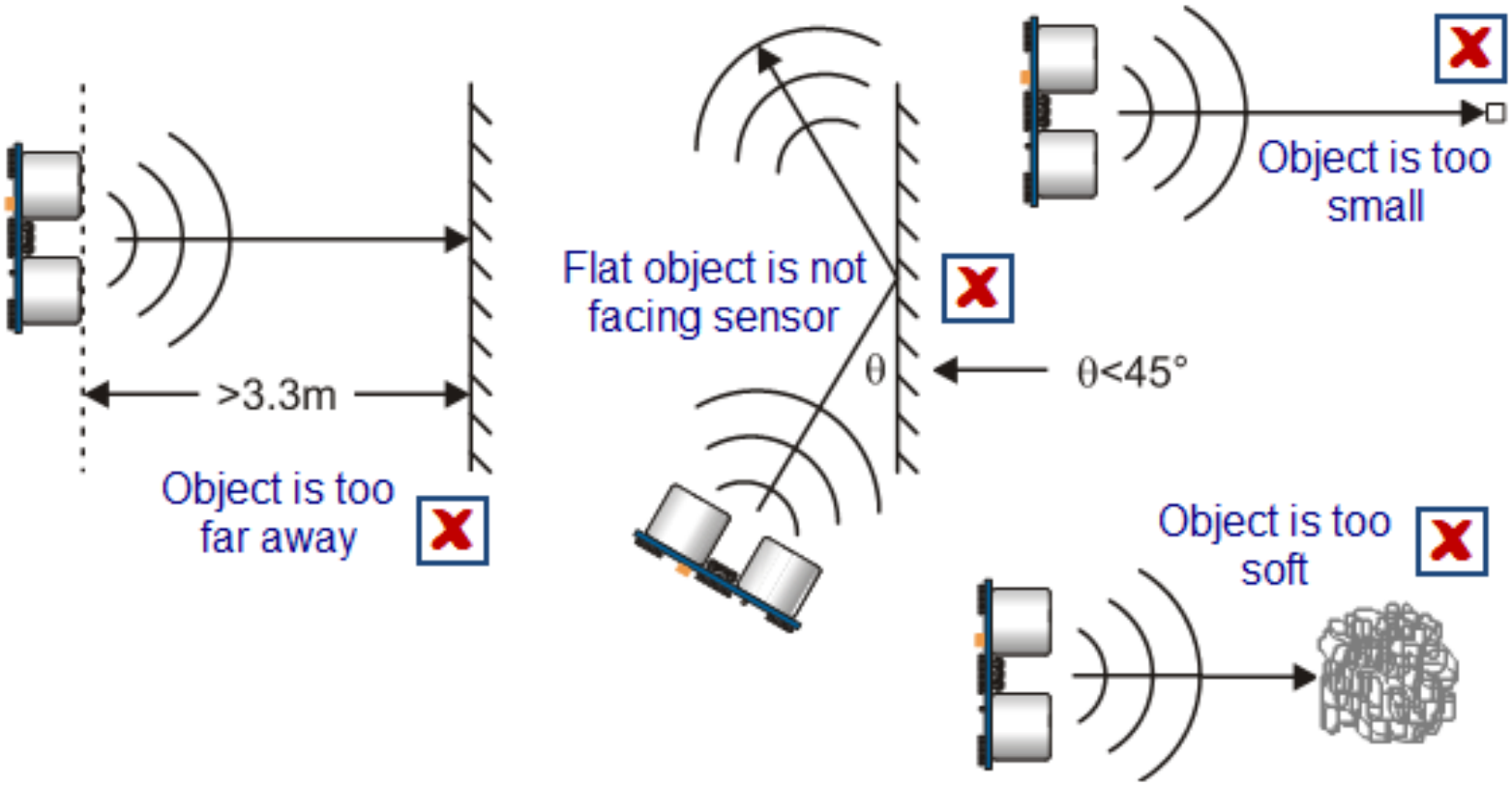
Ultrasonic Sensors

- Sends high frequency sound waves whose echo is received by the receiver.

- The time interval between sending the signal and receiving echo is calculated by using a clock pulse.



When this sensor fails?



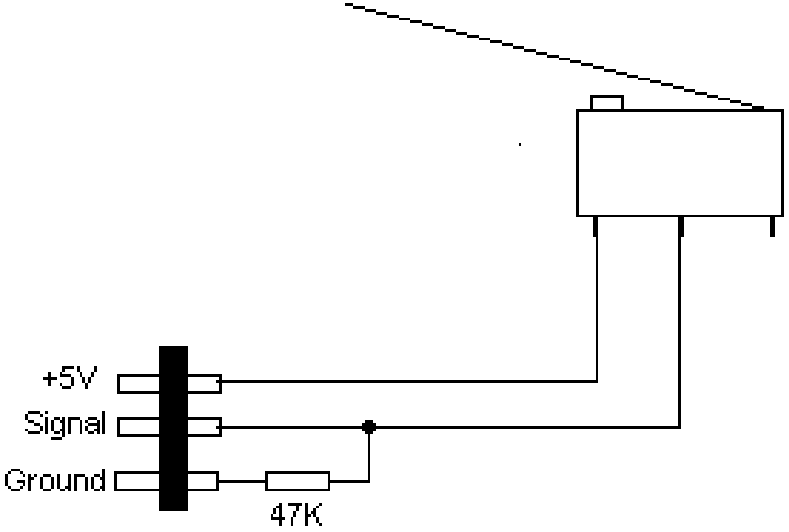
arp Sensor vs Ultrasonic sensor

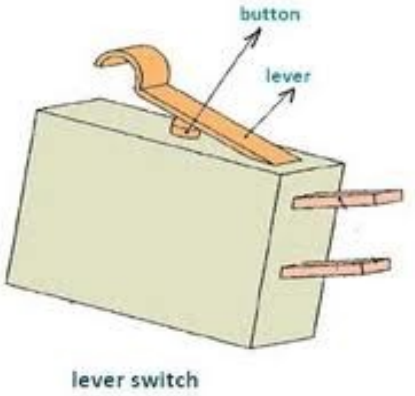
Sharp Sensor	Ultrasonic sensor
Works on the triangulation method i.e. angle of the light calculated.	Works by using a clock pulse and counting the time pulses between the sent and received signals.
Gives an analog output that needs to be converted to digital by *Analog To Digital Converter.*	Gives a digital output.
Cannot be used outside in bright sunlight.	Can be used both inside and outside.
Since light does not reflect the same way off every surface, the IR sensor reading will not beuniform even if the range is the same.	It can give accurate distance of the obstacle no matter what color or texture the obstacle has.

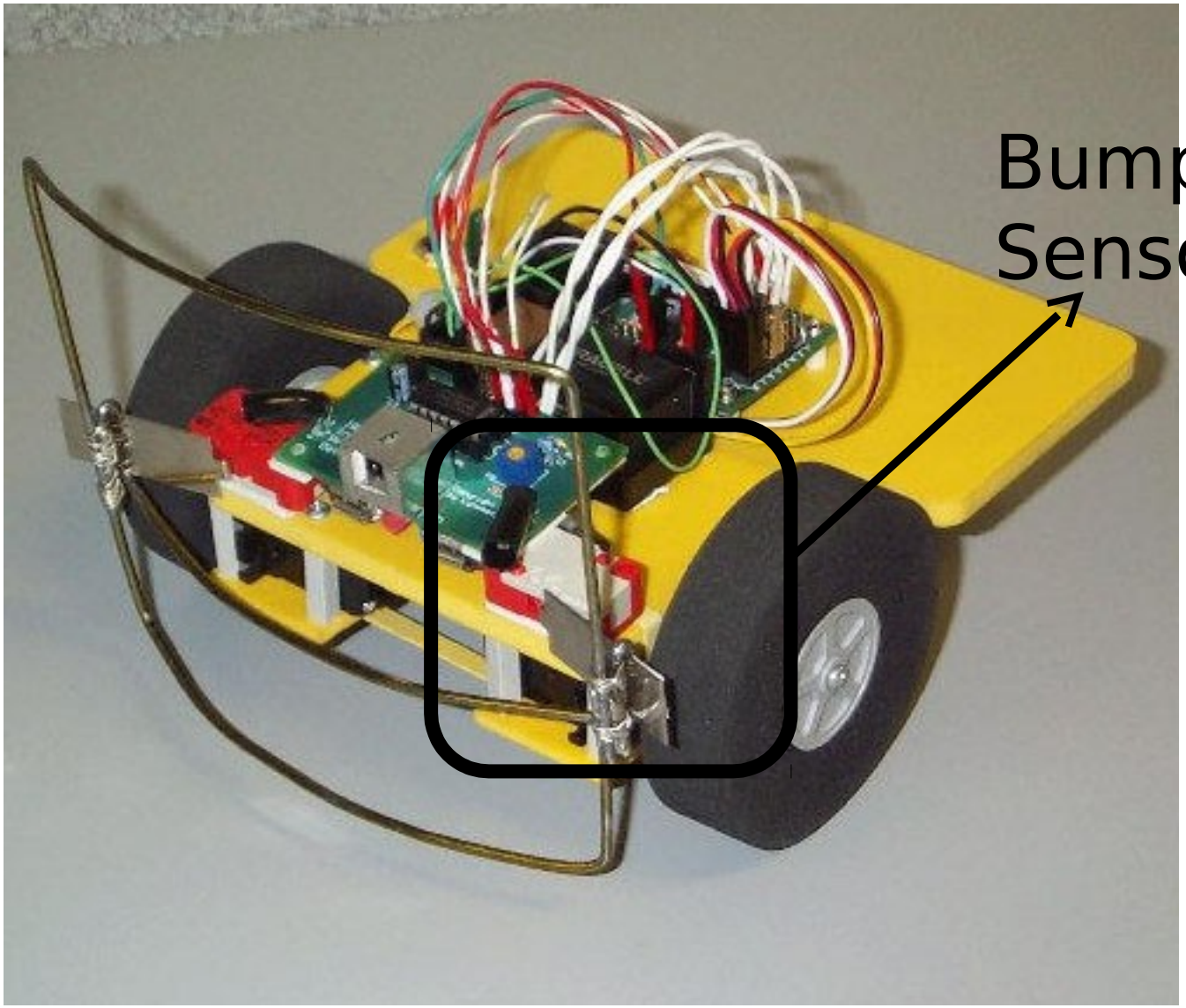
Bump Sensor

◊Like buttons or switches, bump sensors pull high on a logic pin when pressed.

◊On being pressed the circuit is completed, hence we get a signal.

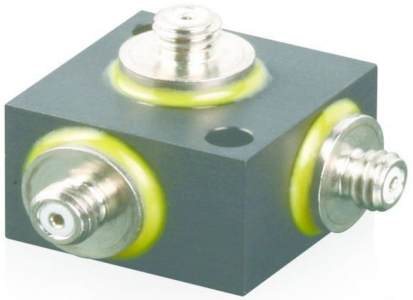


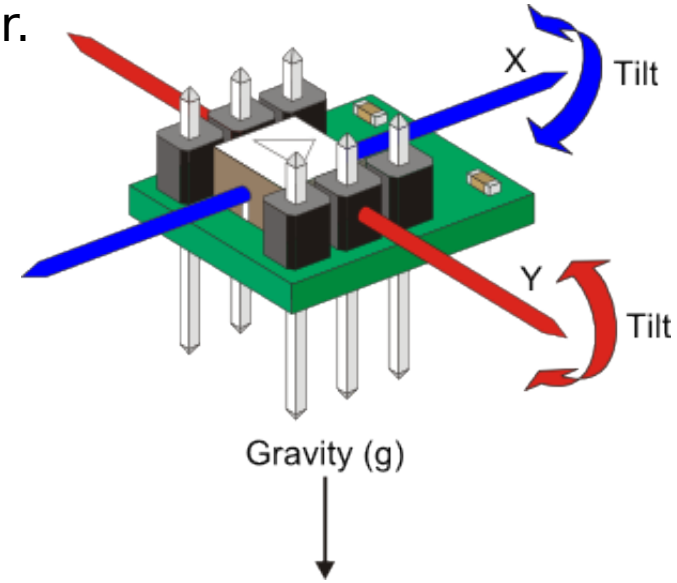


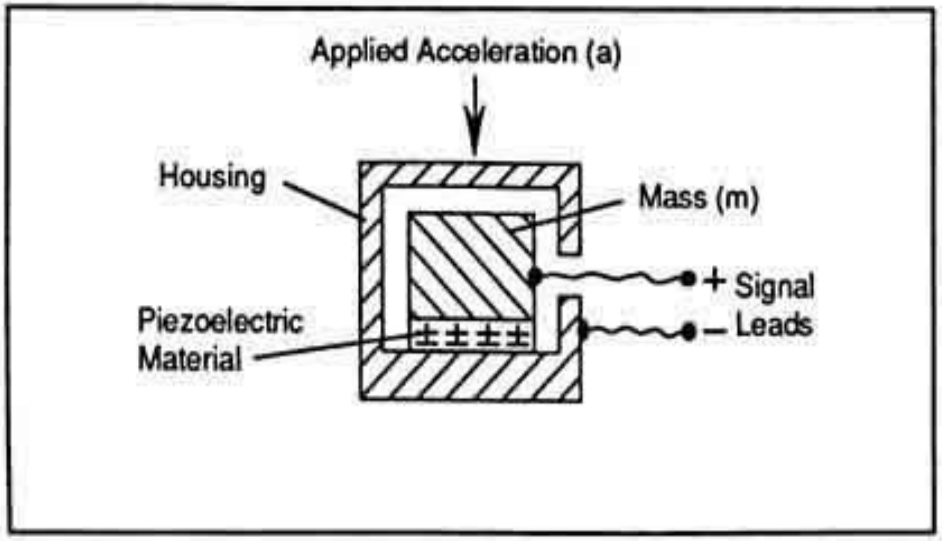

Bump
Sensor

Accelerometer

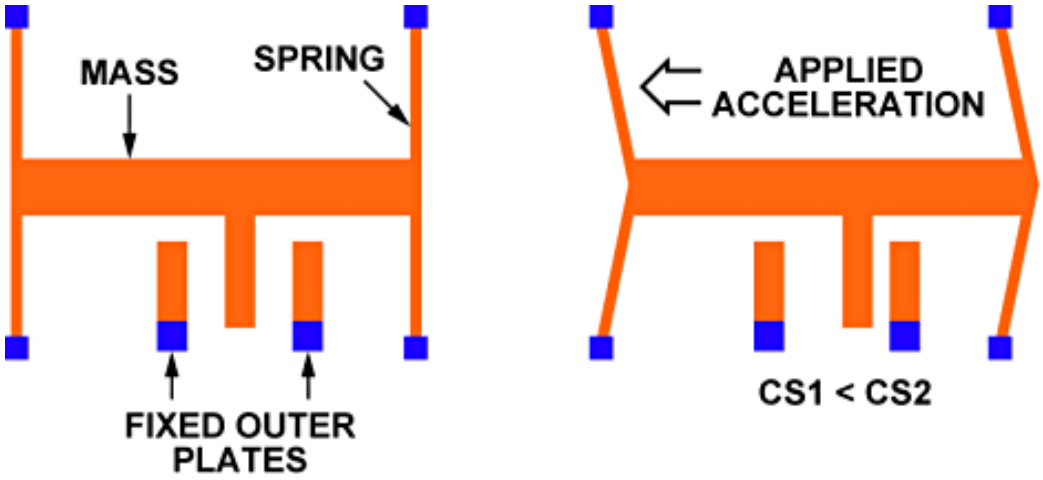
- Used for measuring acceleration of a body.
- It can also measure inclination of a body with respect to earth.
- Finds many applications in self balancing robots, alarm systems, human motion monitoring, levelling sensor, inclinometer.



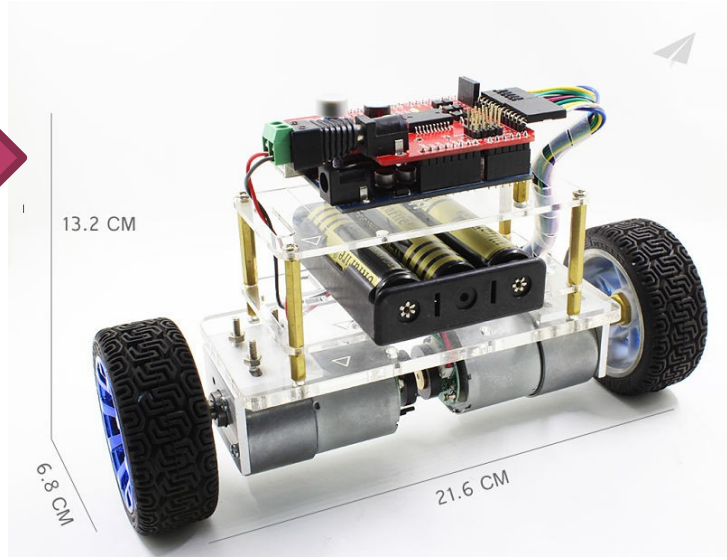


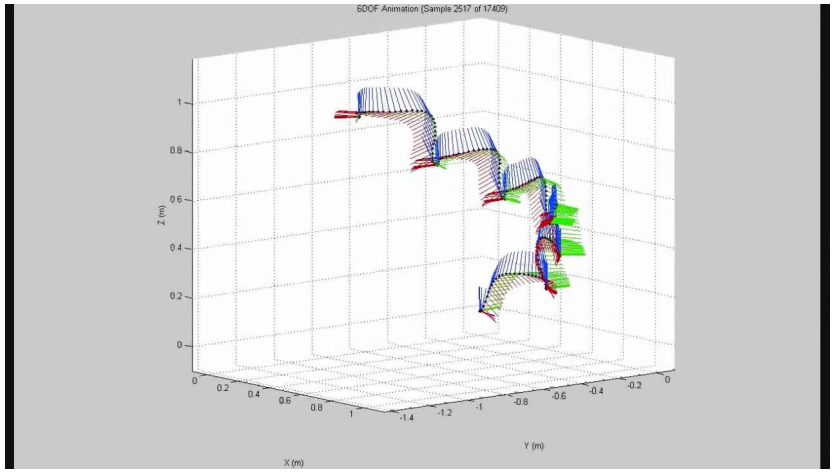


It comprises of a mechanical sensing element and converts the signal from the mechanical to the electrical domain.



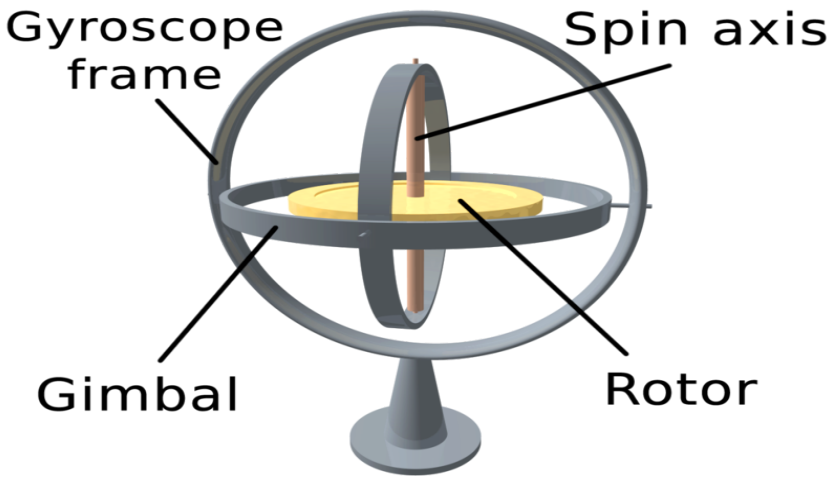
Accelerometer





Gyroscope

A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum.



Mechanically, a gyroscope is a spinning wheel or disc in which the axle is free to assume any orientation.

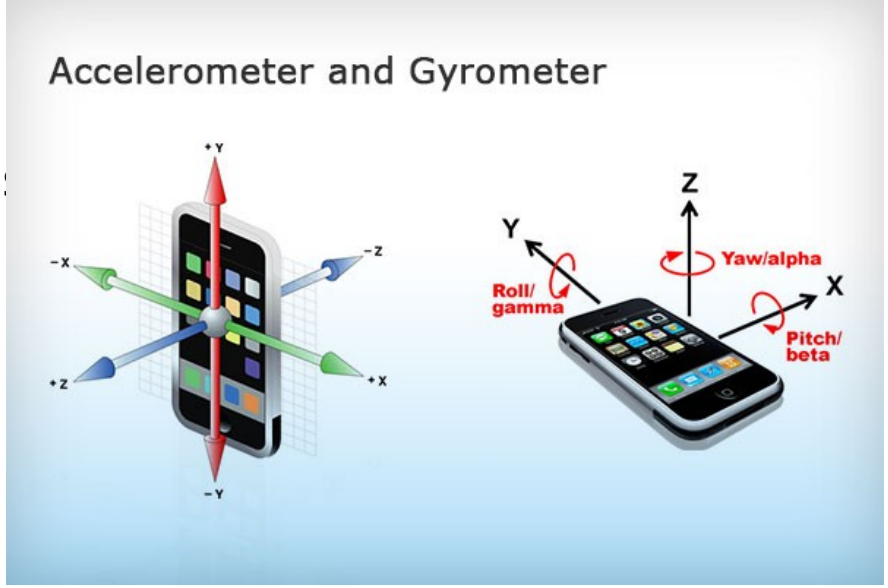
Gyrometer

•A Gyrometer (or gyroscope) is a device for measuring orientation along one or several axis.

•It measures the rotation of the robot on the vertical axis to determine its orientation with respect to the arena.

•A Gyrometer can be used for several purposes like:

- ❑Racing cars
- ❑Balancing
- ❑Anti roll stabilizers
- ❑Ship stabilizer
- ❑Computer pointing devices

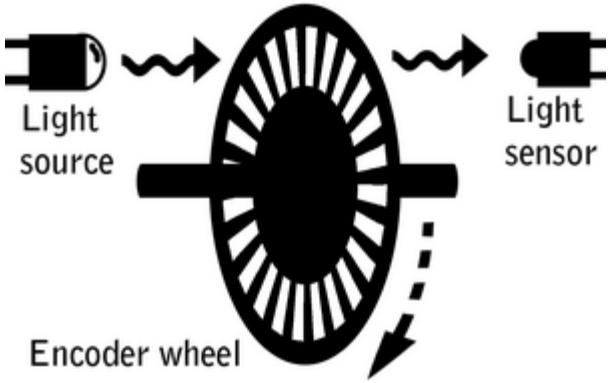


Encoder

- The encoder is a sensor attached to a rotating object to determine displacement, velocity, or acceleration of a rotating sensor.

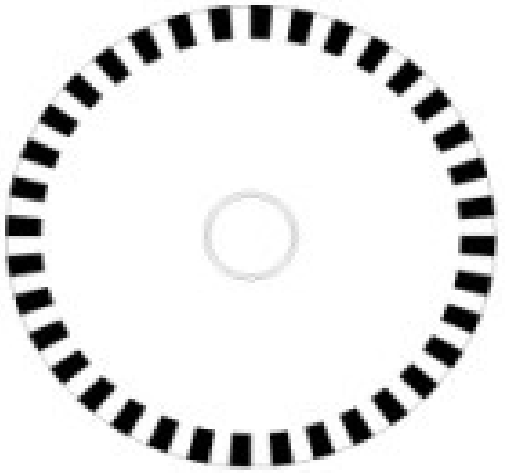
- As it does not take skidding into consideration, there may be inaccurate readings.

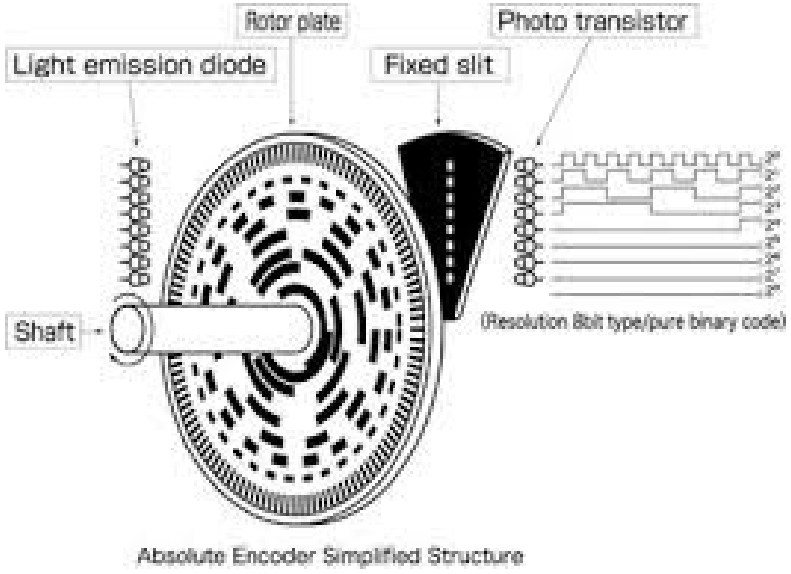
- It should be very precise as even a small error of few degrees in encoders multiplies over large distances.



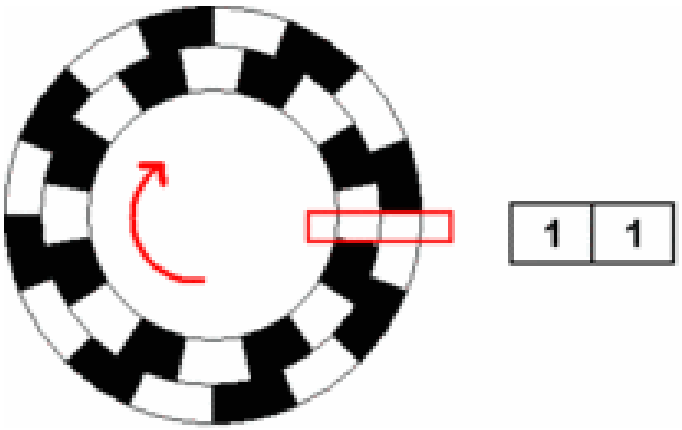
Encoder: Working

- A Line pattern on glass or plastic disc is made
- As these patterns are read a pulse is counted
- The signals is analysed by counting up or down with each pulse and stored in digital count.



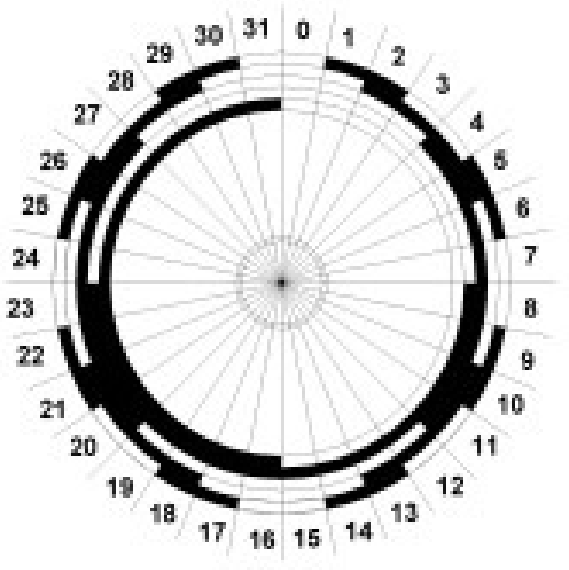


Absolute Encoder Simplified Structure



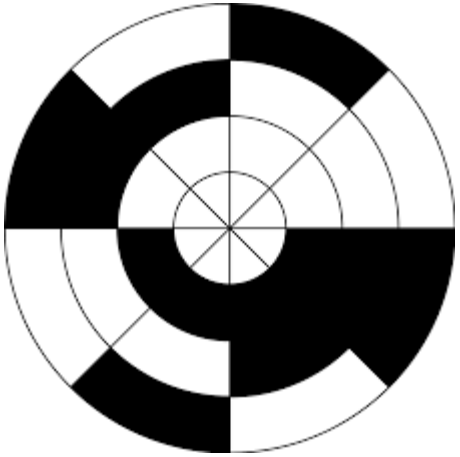
Absolute Measuring System

- Every position of the measurement is identified by a definite code on a glass or plastic disc.



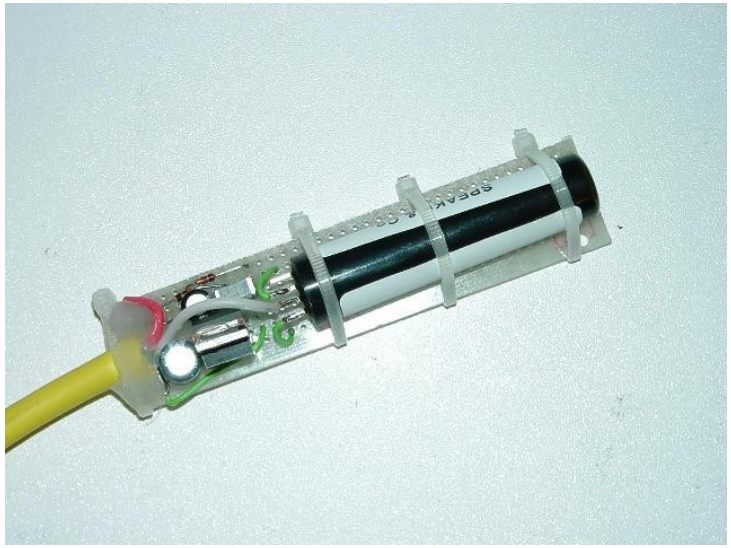
- The code is in the form of light and dark regions within different tracks.

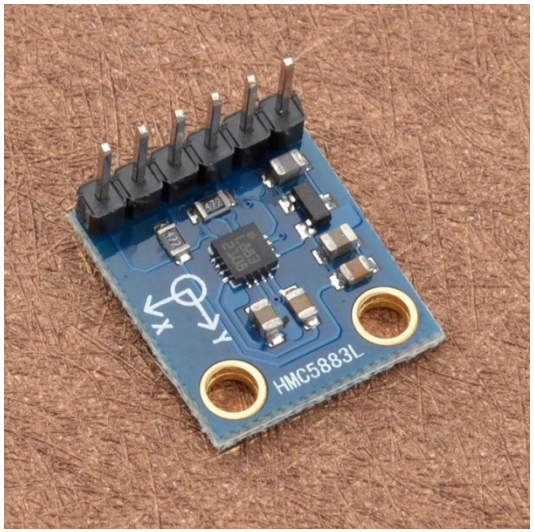
- This combination relates to an absolute numerical value.



Magnetometer

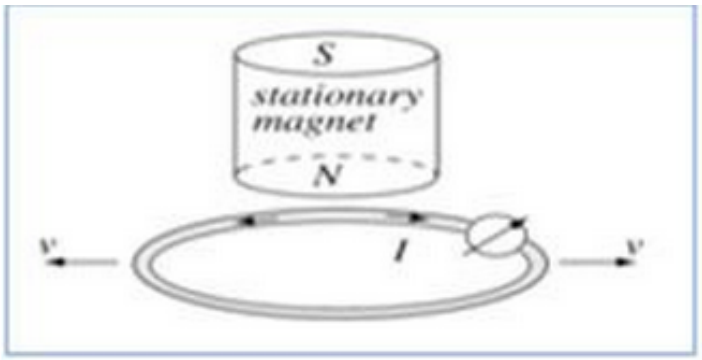
The magnetometer is a sensor that measure magnetic fields. It basically acts as a compass having three degree of Freedom.





Coil Magnetometer

- It basically measures the rate of change of flux through a coil while entering a magnetic field and then integrating the rate of change of magnetic field to obtain the net magnetic field at the point where



$E = -N \cdot d\phi/dt, \qquad \phi = \int \mu o * \mu r * B * A * \sin\theta \; ds$

Where, B = Flux Density
A= Area of the coil
θ = Angle between the two

Queries???