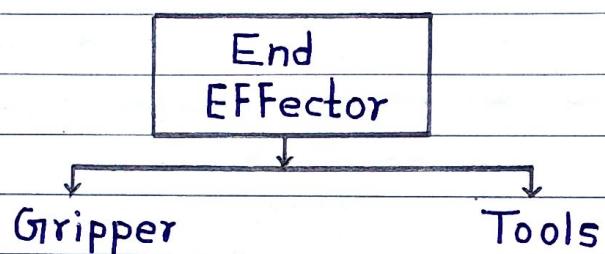


## Robotics

### \* End effector:-

Robot end effector is a device attached to the wrist of a manipulator for the purpose of holding materials, parts, tools to perform a specific task.

Eg:- Grippers, tools, end of arm tooling, welding's equipment.



### o Classification of End effector:-

- 1) According to method used to hold part in the gripper
  - 2) According to special purpose process tools that incorporated in Final gripper design.
  - 3) According to multiple Function capability of gripper
- 
- 1) According to method used to hold part in the gripper :-
    - a) Mechanical pressure gripper
    - b) Vacuum gripper
    - c) Magnetic gripper
  - 2) According to special purpose process tools that incorporated in final gripper design :-
    - a) Drills
    - b) Grinders

- c) Polisher
- d) Paint sprayers
- e) Welding guns and torches

- 3) According to multiple functions capability of the gripper
- 4) Special purpose grippers :-

These grippers may be specialized device like remote centre compliance to insert an external mating component into internal member, inserting a plug into hole.

#### \* Grippers :-

Grippers are the end effectors used for grasp the object during work cycle. A gripper is a device which enables the holding of an objects to be manipulated. Grippers just like a hand. It enables holding , tightening , handling , releasing of object

- Examples :-
  - 1) Vacuum grippers
  - 2) Magnetized grippers
  - 3) Adhesive grippers

#### . Application of Grippers :-

- 1) Material handling
- 2) Palletizing and depalletizing
- 3) Arranging parts on to pallets
- 4) Machine loading and unloading
- 5) Picking and placing of parts on conveyor

## 1) Mechanical Grippers:-

- Mechanical gripper is used as an end effector in a robot for grasping the objects with its mechanically operated fingers.
- In industries two fingers are enough for the holding purpose.
- Mechanical grippers acts as a robot hand. A basic robot hand will have only two or three fingers.

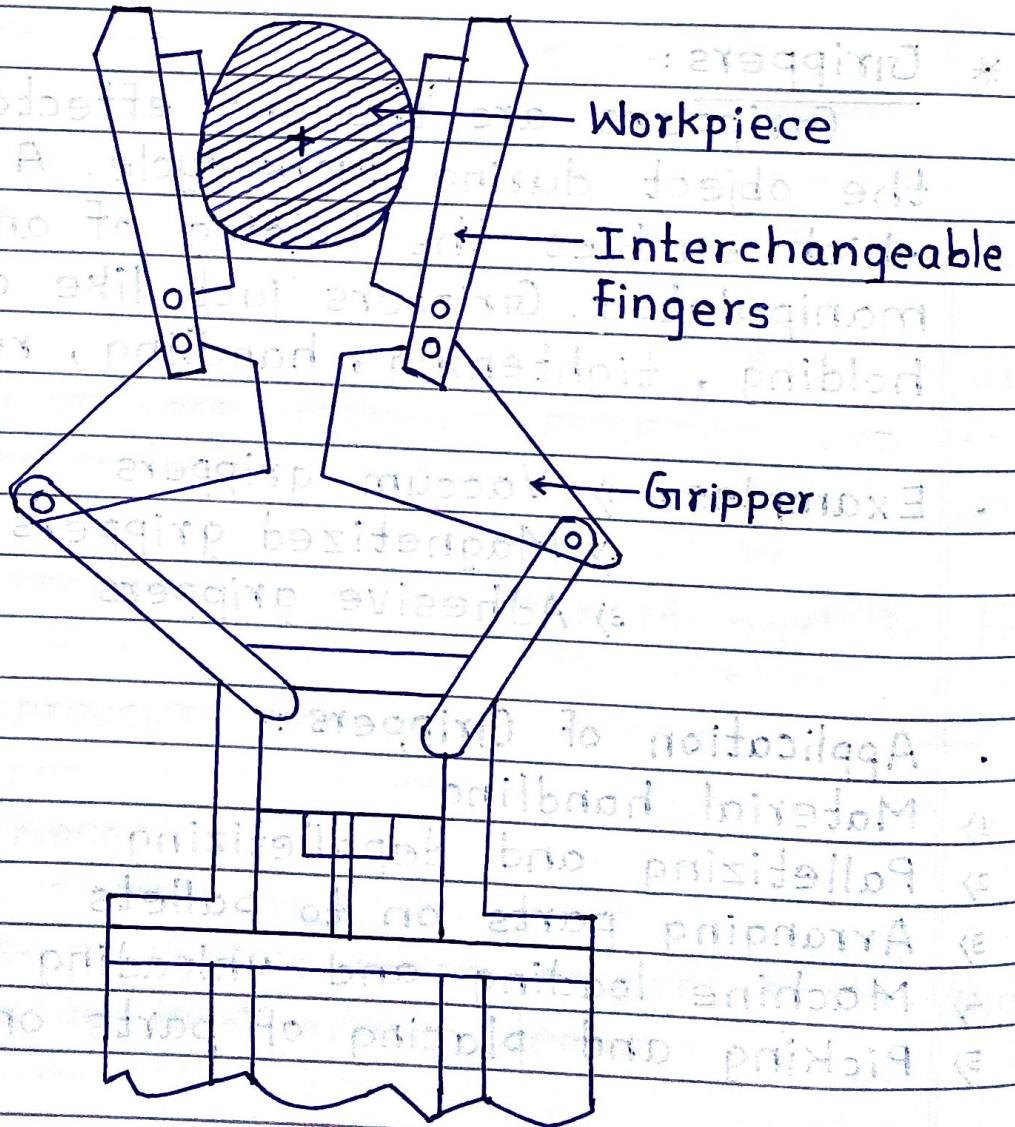
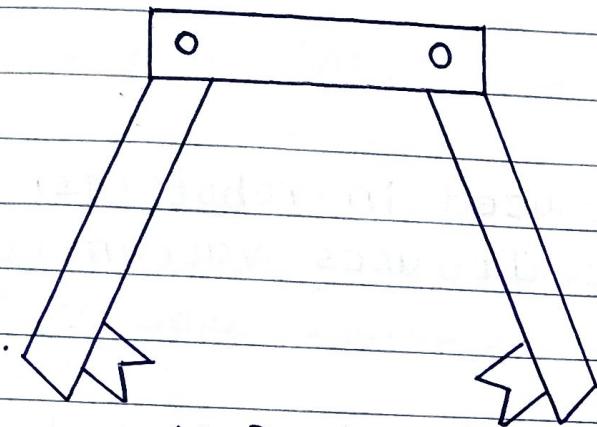
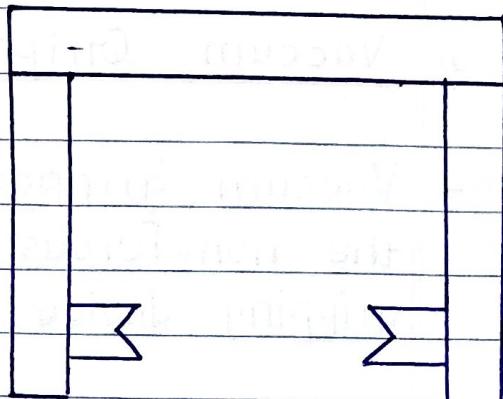


Fig: Mechanical Grippers



(a) Pivot action



(b) slide action

- Features of Mechanical Grippers :-

- i) Simple to use
- ii) Grip using pivoting , linear or translation movement.
- iii) Pneumatic controls can be cost effective & simple to maintain.
- iv) Servo control can be used when a precise controlled gripper movement is required .

- Advantages of Mechanical Grippers :-

- i) Palletizing
- ii) Rotating objects
- iii) Moving small objects
- iv) Moving non uniformly shaped objects
- v) No need For compressed air or other supplementary materials

- This power is given by,

$$P = (I \times N)^2$$

$$25 \times A \times (S_A + S_M)$$

Where, I - Current

N - No. of turns of coil

A - Area of electromagnet

$S_A$  - reluctance of magnetic path

through air

$S_M$  - Reluctance of magnetic path

through metals

#### 4) Adhesive Gripper:-

The grippers in which adhesive substance perform the grasping action for handling the fabrics and other lightweight materials are called as an adhesive grippers.

#### \* Tools as an end effector:-

Various tools such as machine tool means measuring instrument, welding torches, spread painting gun, assembly tools etc are used as an end effector to perform a specific action.

## \* Differentiate between grippers and end effector

Gripper	End Effector
1) A gripper is a device which is mounted on a robot wrist.	1) The end effector means the last link end of the robot. At this endpoint the tools attached.
2) A gripper enable holding, tightening , handling and releasing of an object.	2) A tool enable holding materials , parts , tools to perform a specific task.
3) Gripper just like human hand.	3) End effector just like tool .
4) Grippers can be classified according to power used.	4) End effector are categorized into 2 major types:
1) Mechanical 2) Vacuum 3) Magnetic 4) Adhesive 5) Hydraulic 6) Pneumatic	1) Grippers 2) Tools
5) The common tooling For robot that enables it to perform a task.	5) The special tooling For a robot that enable it to perform required work .

6) Gripper can be used to grasp an object, usually the work part and hold it during a robot work cycle.

7) Grippers are devices that grip an object for moving or placing it within the working range.

8) Grippers are devices often used with pick and place robotics system.

9) Grippers are usually used for single purpose.

10) Essential gripper action is opening or closing its grippers.

6) End of arm tools known as end effectors give robots the ability to pick up parts and handle tools.

7) Using a gripper as end effector gives robots the ability to pick up parts and handle tools.

8) The end effector assembly line robot would typically be welding head or paint spray gun.

9) The end effectors are used for multipurpose.

10) Essential tooling action is machining such as drilling, grinding, spray painting, polishing and welding.

## \* Selection of Grippers :-

- It is based on various factors are as follows

### 1) Object to be handled :-

- In this factor we consider weight and size of an object along with tolerance on part size.
- It also include surface condition and protection of dedicated surface.

### 2) Actuation Method:-

Various actuation method such as magnet, vacuum cup and mechanical grippers used as per the requirement.

### 3) Power and Signal transmission:-

In this factor hydraulic, pneumatic, electrical and mechanical Factors take in the consideration.

### 4) Gripper Force:-

It includes weight of object, speed and acceleration during motion and coefficient of friction between the gripper and object takes in consideration.

### 5) Positioning Factor:-

It includes Length of finger along with the tolerance in part size. The accuracy and also repeatability of material handling takes into consideration.

6) Service condition :-

It includes maintainance and servicability, replaceability of bears components as well as number of actuuations during life cycle of gripper take into consideration.

7) Operating Environment :-

It includes dust, dirt, rays, heat, UV light, various environmental operating condition takes into consideration.

8) Water Protection:-

It includes strength, rigidity, durability, Fatic strength, plastic sheet, air ventilation by fan and use of water resistance material take into consideration.

9) Fabrication Materials:-

It includes strength, rigidity, durability, Fatic strength, cost and ease of fabrications, capability with operating environment takes into consideration.

10) Interface :-

It includes lead times for designs and also compatibility with operating environment. The mounting connection, interface with machine and risk of product design alongwith their effect on gripper design takes into the consideration.

## \* Introduction to Sensors:-

Sensors are one of the most essential part of robot system because they are providing ability to sense, understand and interact with its environment. without sensor robot act blindly and unable to adopt the changes or perform task accurately.

### • Need of sensor in robot system:-

The requirement of various function need sensors For its performance are as follows.

#### 1) Perception of Environment:-

Robots need to gather information about their surrounding which include obstacle, sound, light, temperature, position etc. The various sensors such as cameras, LIDAR & ultrasonic sensor or infrared sensor helps the robot to understand object and working envt.

#### 2) Navigation and Mobility :-

Mobile robot must know their position and movement. Various position sensor such as GPS encoder, gyroscope. It provides Feedback For path planning and obstacle avoidance.

#### 3) Accuracy and Control:-

Encoder sensor provides Feedback signal that helps in maintaining precision, encoder in robotics arm ensure accurate joint angle and movement

#### 4) Safety:-

Collision detect sensor such as ultrasonic sensor and proximity detector prevent the accident. The safety sensors plays the crucial role, robot operates near the human being.

#### 5) Adoptability:-

Robot must adopt to change in environment such as light, temperature, unexpected obstacle. Various sensor provides real time data which helps in adoptive decision making.

#### 6) Automation of task:-

Robots need to make decisions without human input just like robotics vacuum cleaner uses infrared or proximity sensor to detect dirt and obstacles for automatic cleaning.

#### 7) Human Robot Interaction:-

Sensors like microphone, camera or touch sensor allow robot to understand the voice command, gesture or touch input. This into communication between human and robot.

#### \* Selection of Sensors:-

Selection of sensor in robot system is important because wrong sensor may give poor accuracy, cost or fail to perform that task.

- The right sensor must match the robot application, environment and performance requirement.
- The various factors consider for selecting the sensor is as follows:

#### 1) Types of measurement required:-

The distance or obstacles are measured by an infrared or ultrasonic sensor, position and angles measured by encoders and potentiometer. Force and touch sense by tactile or strength gauge sensors. Vision sensed by camera or image sensor.

#### 2) Range and Resolution:-

- Range:- The maximum and minimum limit of the measurement.

Eg:- Ultrasonic sensors measure from cm to several meter but not measured very small distance.

- Resolution:- The smallest change sensor can detect.

Eg:- High resolution encoder is needed for precision robotics arm.

#### 3) Accuracy:-

Some applications such as surgical robots, CNC robotics arm need high accuracy.

#### 4) Response Time / Speed of Response:-

It indicates how fast the sensor can provide data. High speed robot such as drones need fast

sensor while slow robot such as warehouse or domestic robot use slower sensor.

5)

### Environmental Conditions:-

- The various environmental factors such as dust, humidity, lighting, temperature, magnetic Field sensor's performance such as outdoor robots uses GPS or RADAR for location trackings. while factory robot use encoders and cameras with controlled lightning.
- The hazardous environment uses Flame-proof or waterproof sensor for its reliable performance.

6)

### Cost and Availability:-

It indicates balance between budget and performance such as toys robots uses low cost IR sensor while autonomous car uses expensive sensors for its great performance.

7)

### Size, Weight and Power Consumption:-

Small robots such as drones required light weight and low power sensor while industrial robots uses heavier and more powerful sensors.

8)

### Integration and Compatibility:-

Sensors should be easy to interface with a robot controller such as arduino, PLC and micro controller. For proper working

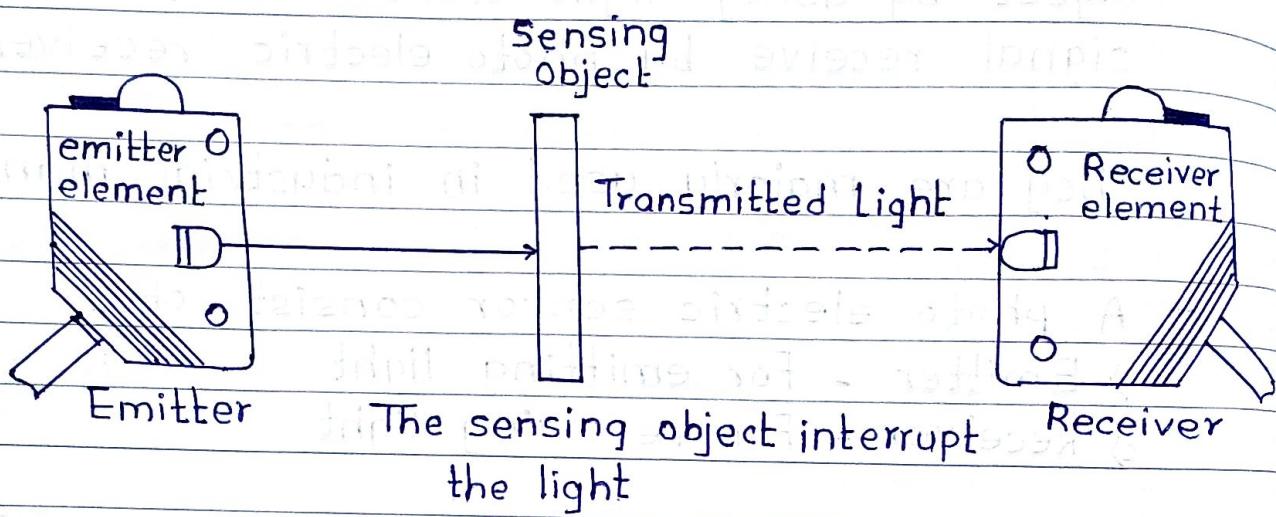
## \* Photo Sensor :-

- A photo electric sensor is a light device used to determine distance, presence and absence of any object by using light transmitter / infrared and signal receive by photo electric receiver.
- They are majorly used in industrial manufacturing.
- A photo electric sensor consist of ...
  - 1) Emitter - For emitting light
  - 2) Receiver - For receiving light
- When emitted light is interrupted or reflected by sensing object . It changes the amount of light that arrives at the receiver.
- The receiver detect this change and convert it into an electrical output.
- They are further classified as ...
  - 1) Beam sensor
  - 2) Reflective sensors
  - 3) Diffuse reflective sensor

### 1] Through Beam Sensor :-

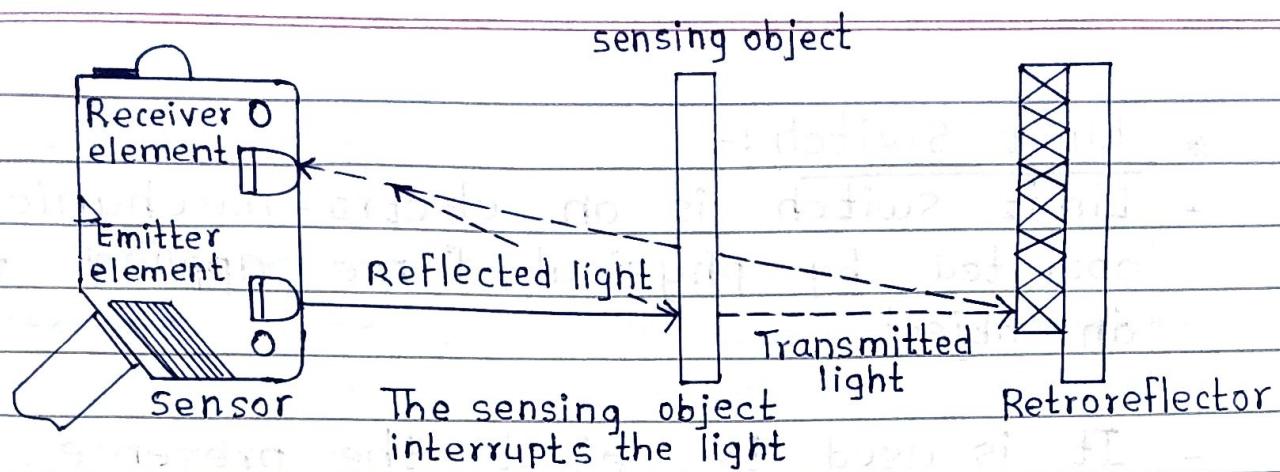
- In through sensor , the emitter and receiver are housed in different cases that are separated from each other .
- Receiver is placed within the line-of-sight of the emitter.

- The emitter transmits light to the receiver only in one direction. If an object interrupts the light, then intensity of the light decreases. So that output voltage or current level changes.



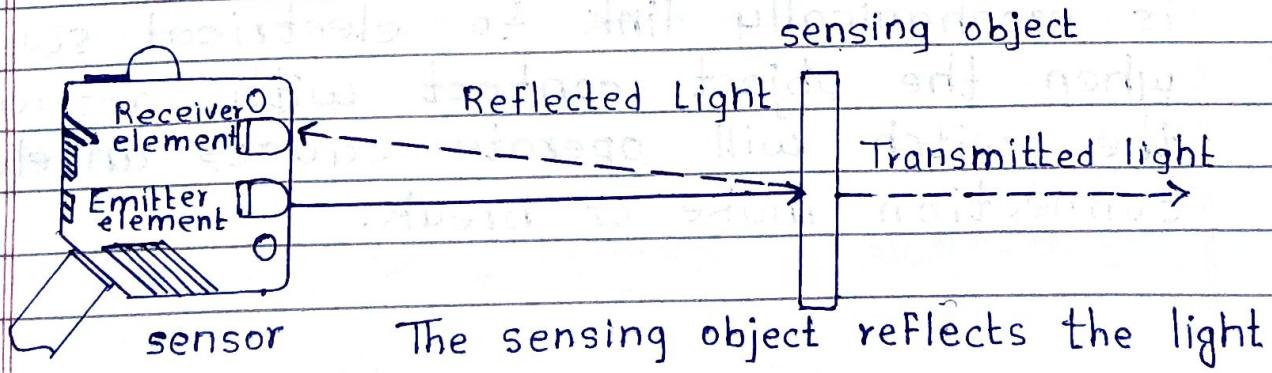
## 2) Retro-Reflective Sensors :-

- In retro-reflective sensor, the emitter & receiver are placed in a single housing. The emitted light from the emitter is reflected back from a reflector to receiver.
- If an object interrupts the reflected light, then it fails to reach the receiver. It indicates the presence of an object.
- The receiver detects the change and act accordingly.
- These are used in applications where the objects can reflect light such as door and gate control systems.
- These are used where space is limited.



### 3) Diffuse Reflective Sensors:-

- The structure of diffuse reflective sensor is same as in reflective sensor, the sensor's emitter and receiver are placed in a single house. But, it doesn't have reflector.
- The emitter emits a beam of light, which is directly reflected by a beam of object.
- The light incident on the object at any angle and it's diffused in all direction, reflected light back.
- When the object is detected within the reflective surface then the sensor acts accordingly.
- The presence of the object is determined by intensity of the reflected light reaching the receiver.
- These are suitable applications where precise alignment of separate emitter and receiver unit is not possible.



### \* Limit Switch :-

- Limit switch is an electro-mechanical device operated by physical force applied to it by an object.
- It is used to detect the presence and absence of an object like in elevators, wall traveller.
- This switches originally used to define the limit of travel of an object and as a result they named as limit switch.

#### o Types of Limit switches:-

There are general 4 types of Limit switches.

- 1) Roller
- 2) Lever
- 3) Plunger
- 4) Whisker

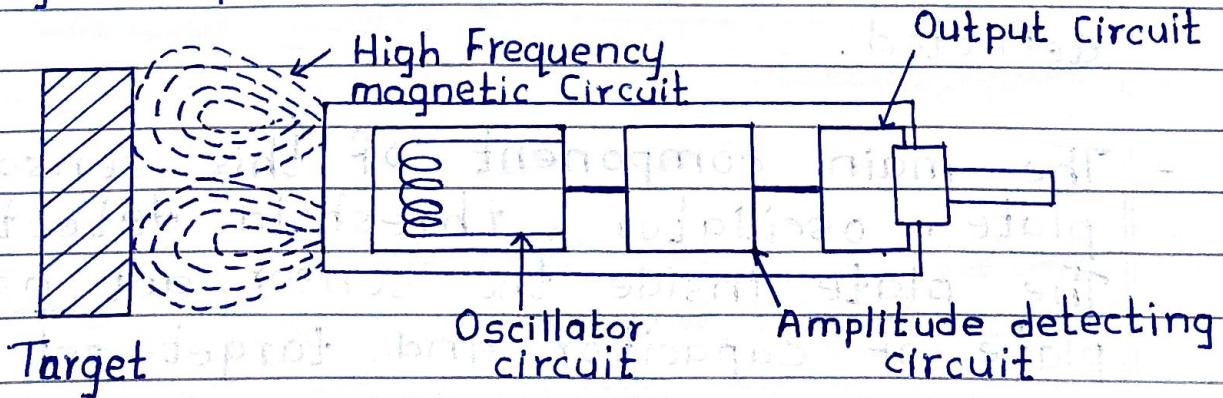
- Depending on the application the limit switches is combination of two types such as lever - roller limit switch.
- Limit switches consist of actuator which is mechanically link to electrical switch. When the object contact with actuator the switch will operate causes an electric connection make or break.

## \* Proximity Sensor:-

- It detect an object when object approaches within detection range and boundary of the sensor.
  - It includes all the sensors that performs a non contact detection in comparison to sensor such as limit switch that detect object by physically contact them.
  - o Types of proximity sensors:-
- On the basis of working of proximity sensor are classified as follows:
- 1) Capacitive proximity sensor
  - 2) Inductive proximity sensor
  - 3) Ultrasonic proximity sensor
  - 4) Optical proximity sensor

### 1) Inductive Proximity Sensor:-

It is proximity sensor which detect a metallic object without physical contact. Their operating principle based on coil and high Frequency oscillation that creates field in a closed surrounding of sensing surface. The operating distance depends on coil size, target shape and materials.



- The main component of proximity sensors are coil, oscillator, detector and
- The operating distances of sensor depend on actuator shape and size along with nature of material.
- The coil generates high frequency magnetic field in front of the phase and when metallic target comes in contact with that metallic field, it absorb some of the energy. Hence the oscillator field is affected the rise or fall of such oscillation is identified by the threshold value due to this object is detected.
- It is very accurate and having high switching area but only detect metallic target.

### Capacitive Sensor:-

It is used for non-contact detection of the metallic or non-metallic objects using its capacitive effect of dielectric materials.

It uses the variation of capacitance between the sensors and object which is to be detected.

- The main component of this sensor are plate, oscillator, threshold detector ckt, The plate inside the sensor act as one plate of capacitor and target act as another.

plate and air acts as a dielectric between the plate.

- This sensor detects any target whose dielectric constant is more than error.

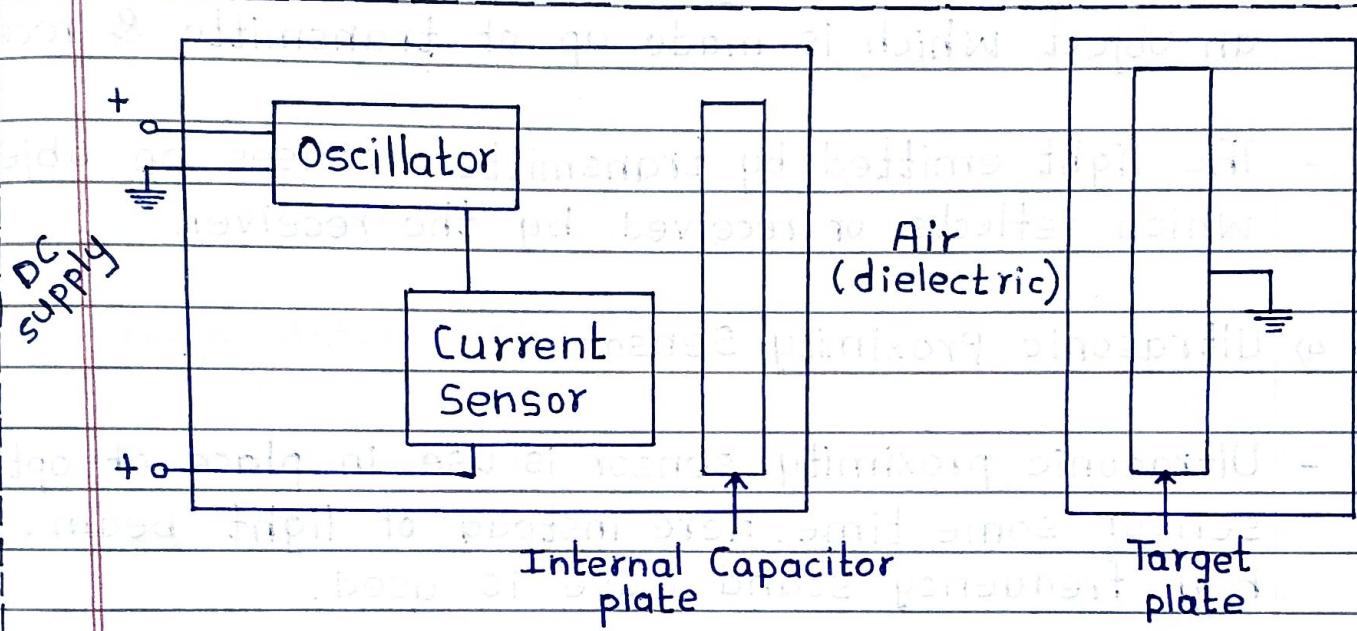


Fig: Capacitive Proximity Sensor

- As the object come close to plate of capacitor, the capacitance increases and as the object moves away the capacitance decreases.
- An electronic circuit inside the sensor begins to oscillates rise to or Fall of such as oscillations is identified by threshold circuit based on this signal object is detected.
- It is low cost and power consuming sensor with high speed performance but less accurate compare to inductive sensor.

### 3) Optical proximity Sensor:-

- The proximity of the object is detected by the action of travelling light.
- This sensor used light sensing element to detects an object which is made up of transmitter & receiver.
- The light emitted by transmitter focuses on objects which reflects or received by the receiver.

### 4) Ultrasonic Proximity Sensor:-

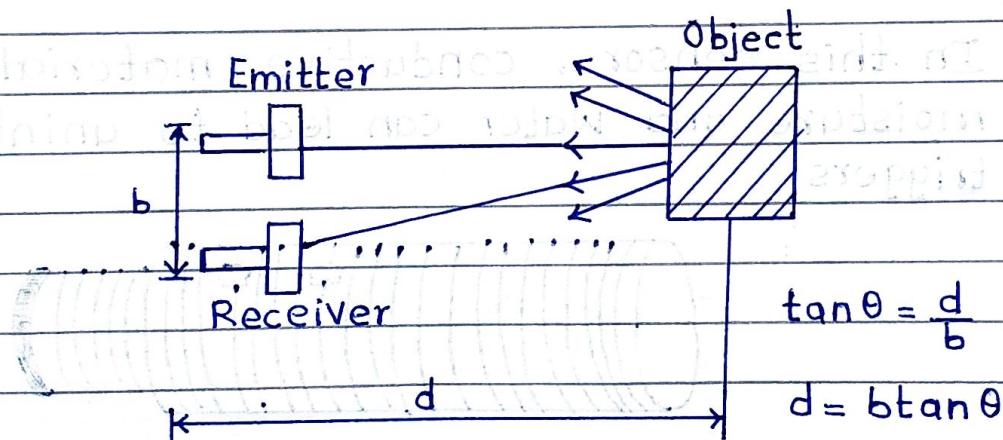
- Ultrasonic proximity sensor is use in place of optical sensor some time. Here instead of light beam, a high frequency sound wave is used.
- This sound wave is above the hearing sound wave known as ultrasonic wave.
- This proximity sensor measures the distance in cm. and inches.

### \* Range Sensor:-

- The distance between the object and distance between robot hand is measured using range sensor i within its range sensor can operate.
- The calculation of object is by visual processing. The range sensor is used in navigation system and avoid obstacle in the path of robot.

- The location and general shape characteristics of part in the worth envelop of robot is done by special applications for the range sensor.
- There are several approaches like triangulation method, structures lightning approaches and time of fight range etc.
- In this cases the race of elimination can be light source, LASER or based on ultrasonic sensor.

### 1) Triangulation Method:-



### \* Touch Sensor:-

- Touch sensor is an electronic sensor that detects physical touch.
- It is small, simple and low cost sensor to replace old mechanical switch used in past.
- This sensor is also known as tactile sensor.

## Types of touch sensor

Resistive

Capacitive

### Capacitive touch sensor

Its major touch based on an electrical disturbance from the change of capacitance.

- Capacitive touch sensor consists of transparent electrode layers on top of glass panel and cover it with a protective coating with printed circuit pattern around router area.

- In this sensor, conductive material such as the moisture and water can lead to unintended or false triggers.

## 2) Resistive touch sensor:-

- It measures touch in response to the pressure applied on the surface.
- Resistive touch sensors constitute a pair of the conductive layers separated by an insulating-material.
- Unlike capacitive touch sensors, resistive touch sensors don't support multi-touch compatibility.