

## UNIT-III

**SENSORS AND ACTUATORS:** Introduction, Sensor, Types of Sensors, Actuators, classification of Actuators.

**TECHNOLOGIES USED IN IoT:** Bluetooth, Bluetooth Low Energy (BLE), WiFi, LiFi, Cellular Networks, Z-Wave, X-10, Sig fox, ZigBee, LoRaWAN, 6LowPAN, 5-G, LPWAN, RFID and NFC, WSN.

**COMMUNICATION PROTOCOLS:** CoAP, MQTT, XMPP, DDS, AMQP, REST, HTTP

Text book: Yashavant Kanetkar, Shrirang Korde, 21 IOT Experiments, 1st Edition, BPB Publications, 2018



Temperature sensor



Push button



LED



DC MOTOR



Light sensor



potentiometer



BUZZER



**Position sensor:**

Measures the position of an object; the position measurement can be either in absolute terms or in relative terms. Position sensors can be linear, angular, or multi-axis.

**Occupancy and motion:**

Occupancy sensors detect the presence of people and animals in a surveillance area, while motion sensors detect movement of people and objects.

The difference between the 2 is that occupancy sensors will generate a signal even when a person is stationary, while a motion sensor will not.

Eg: Radar



Position and speed sensor



Occupancy sensor



Motion sensor

## Velocity and Acceleration:

Velocity(speed of motion) sensors may be linear or angular, indicating how fast an object moves along a straight line or how fast it rotates.

## Force:

Force sensors detect whether a physical force is applied and whether the magnitude of force is beyond a threshold.  
Eg: force gauge, viscometer, tactile sensor(touch sensor).



Velocity sensor



Accelerometer



Force sensor

## **Pressure:**

Pressure sensors are related to force sensors and measure the force applied by liquids or gases. Pressure is measured in terms of force per unit area. These sensors make it possible to create IoT systems that monitor systems and devices that are pressure propelled.

With any deviation from standard pressure range, the device notifies the system administrator about any problems that should be fixed.

Eg: barometer, bourdon gauge, piezometer.

## **Flow:**

Flow sensors detect the rate of fluid flow. They measure the volume (mass flow) or rate(flow velocity) of fluid that has passed through a system in a given period of time.

Eg: anemometer, mass flow sensor, water meter



Pressure sensor



Flow sensor

### **Acoustic :**

Acoustic sensors measure sound levels and convert that information into digital or analog data signals.

Eg: microphone, geophone, hydrophone

### **Humidity:**

Humidity is defined as the amount of water present in the surrounding air. Humidity sensors detect humidity (amount of water vapor) in the air or a mass. Humidity sensor is one of the most important devices that has been widely in consumer, industrial, biomedical and environmental applications for measuring and monitoring humidity.

Eg: hygrometer, humistor, soil moisture sensor.



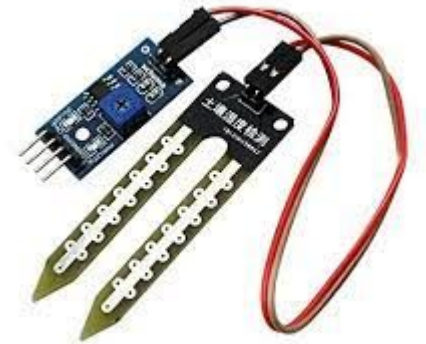
Acoustic sensor



Microphone and  
sound sensor



Humidity sensor



Soil and moisture sensor

## Light :

Light sensors detect the presence of light(visible or invisible)

Eg: Infrared sensor, Photodetector, flame detector.



Light sensor

## Radiation:

Radiation sensors detect radiation in the environment. Radiation can be sensed by scintillating or ionization detection.

Eg: scintillator, Neutron detector.



Sodium scintillator

## Temperature:

Temperature sensor measure the amount of heat or cold that is present in a system.

2 types: contact- need to be in physical contact with the object being sensed.

Non contact- do not need physical contact

Eg: thermometer, calorimeter, temperature gauge.



### Chemical:

Chemical sensors measure the concentration of chemicals in a system. Chemical sensors are applied in a number of different industries. Their goal is to indicate changes in liquid or to find out air chemical changes. They play an important role in bigger cities, where it is necessary to track changes and protect the population. Eg: breathalyzer, smoke detector.

### Image:

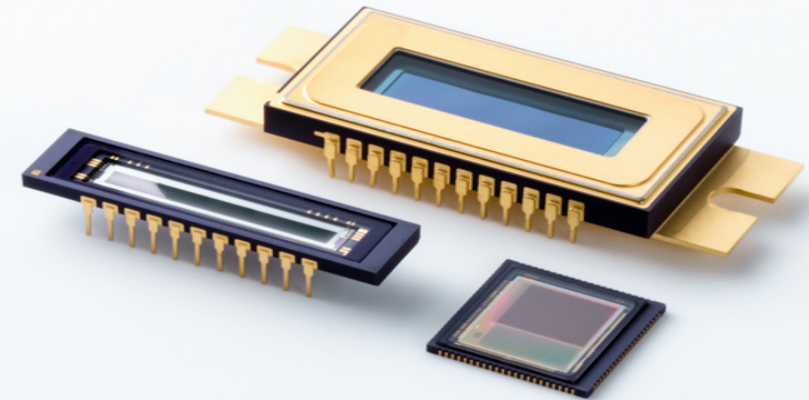
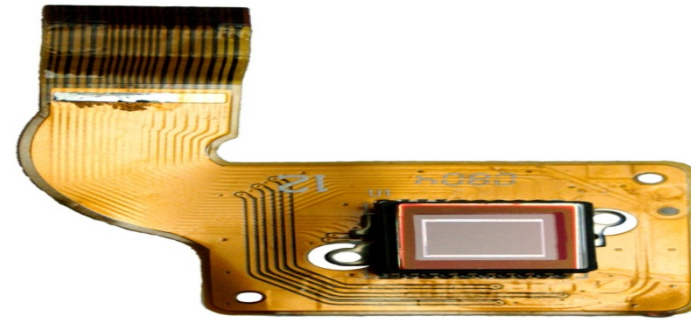
Image sensors are instruments which are used to convert optical image into electronic signals for displaying or storing files electronically. The major use of image sensor is found in digital camera and modules, medical imaging and night vision equipment, thermal imaging devices, radar, sonar media house, biometric etc





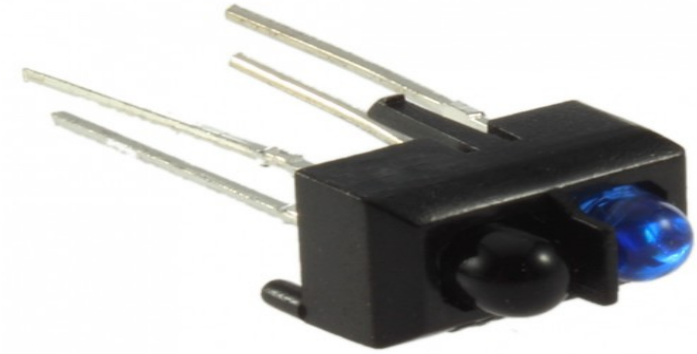
# Image Sensor

Image sensors are instruments which are used to convert optical images into electronic signals for displaying or storing files electronically. The major use of image sensor is found in digital camera & modules, medical imaging and night vision equipment, thermal imaging devices, radar, sonar, media house, biometric etc



# Optical Sensor

Optical sensors measure the physical quantity of light rays and convert it into an electrical signal which can be easily read by a user or an electronic instrument/device. It is called an optical sensor. For example, Photodetector, Fiber Optics, Pyrometer, etc.



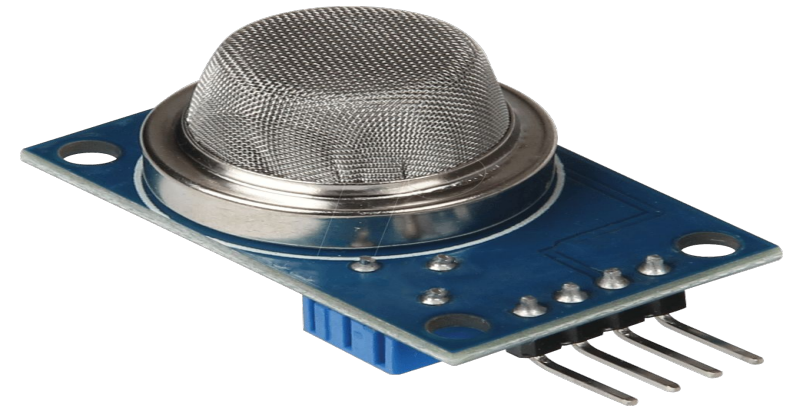
IR optical sensor



Photo detector Sensor

# Gas Sensor

Gas sensor plays a major role in detecting the gas leakage. These gas sensors are classified into various types based on the type of gas that to be detected. They are used in numerous industries such as manufacturing, agriculture and health and used for air quality monitoring, detection of toxic or combustile gas, hazardous gas monitoring in coal mines, oil & gas industries, chemical laboratory research



GAS sensor

# Ultrasonic Sensor

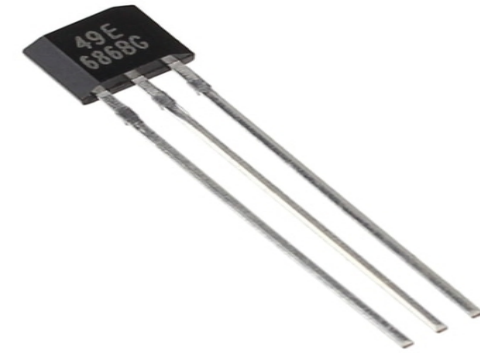
Ultrasonic means the range of the frequencies. Its range is greater than audible range ( $>20$  kHz) so even it is switched on you can't sense these sound signals. Only specific speakers and receivers can sense those ultrasonic waves. It is used to detect the presence or to measure the distance of targets similar to radar or sonar.



Ultrasonic sensor

# Hall Sensor

Hall Sensor is the sensor which works on the Hall Effect. It can be defined as when a magnetic field is brought close to the current carrying conductor then a potential difference is developed across the given conductor. Using this property a Hall sensor is used to detect the magnetic field and gives output in terms of voltage



Hall sensor

# Infrared Sensor

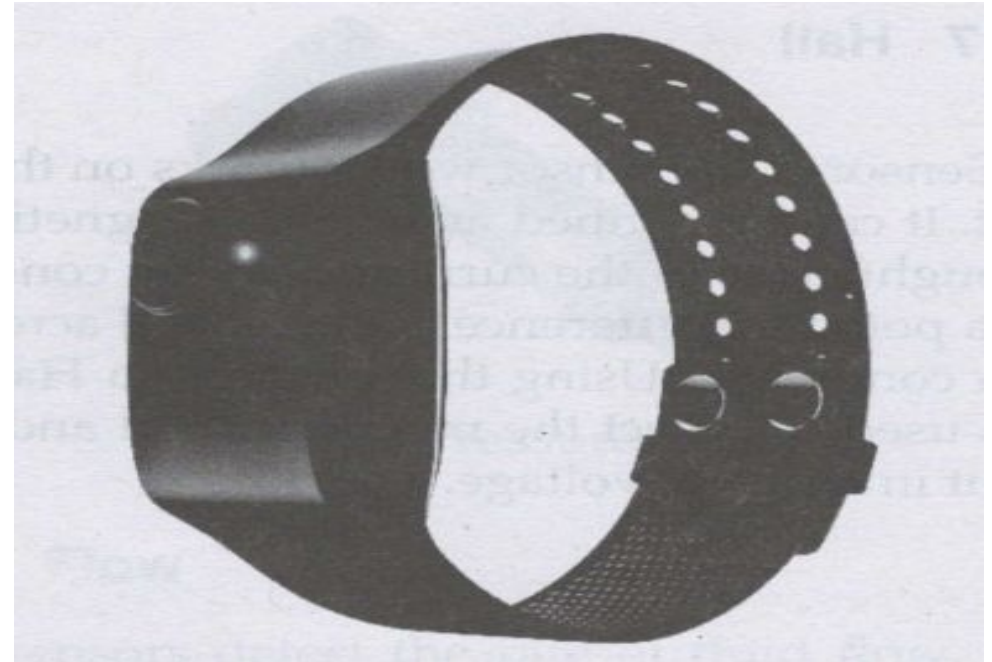
An infrared sensor is a sensor which is used to sense certain characteristics of its surroundings by either emitting or detecting infrared radiation. It is also capable of measuring the heat being emitted by the objects. They are now used in a variety of IoT projects, especially in Healthcare as they make monitoring of blood flow and blood pressure simple. They are even used in a wide array of regular smart devices such as smartwatches and smartphones as well .



Infrared sensor

# Bio Sensor

A Biosensor is an analytical device that detects changes in Biological processes and converts them into an electrical signal. Biosensors detect various biological elements such as organisms, tissues, cells, enzymes, antibodies, and nucleic acids. The main area of interest of Biosensor is the Medicine, Clinical and Diagnostics applications. Electrochemical based Biosensors are commonly used in biochemical labs and clinics to monitor and measure glucose levels as well as lactic acid. Glucometers are a type of Biosensors, which measure the concentration of glucose in blood. Apart from the desired medicine and health based applications, Biosensors have also found critical applications in several other fields like industrial processing, agriculture, food processing, pollution control etc



Bio sensor

# Micro and Nano Sensors

Microsensors (sometimes also called MEMS) are the miniaturized version of the conventional macrosensors with improved performance and reduced cost. Silicon micromachining technology has helped the development of many microsensors and continues to be one of the most active research and development topics in this area .



## IR LED

It is also called as IR Transmitter. It is used to emit Infrared rays. The range of these frequencies are greater than the microwave frequencies. The rays generated by an infrared LED can be sensed by Photodiode. The pair of IR LED and photodiode is called IR Sensor.



IR LED

# Photo Diode (Light Sensor)

It is a semiconductor device which is used to detect the light rays and mostly used as IR

Receiver. Using a photodiode you can build a basic automatic street lamp which glows when the sunlight intensity decreases.

**Photo Diode**



## LDR (Light Dependent Resistor)

It is the resistor that depends upon the light intensity. It works on the principle of photoconductivity which means the conduction due to the light. When light falls on the LDR, its resistance decreases and acts similar to a conductor.



LDR

# Thermistor (Temperature Sensor)

It is a temperature sensitive resistor that changes its physical resistance with the change in temperature. When the temperature increases the resistance decreases. So, the thermistor's resistance can be varied with the rise in temperature which causes more current flow through it. This change in current flow can be used to determine the amount of change in temperature.



Thermistor

# Thermocouple (Temperature Sensor)

These are voltage devices that indicate temperature measuring with a change in voltage. As temperature goes up, the output voltage of the thermocouple rises.

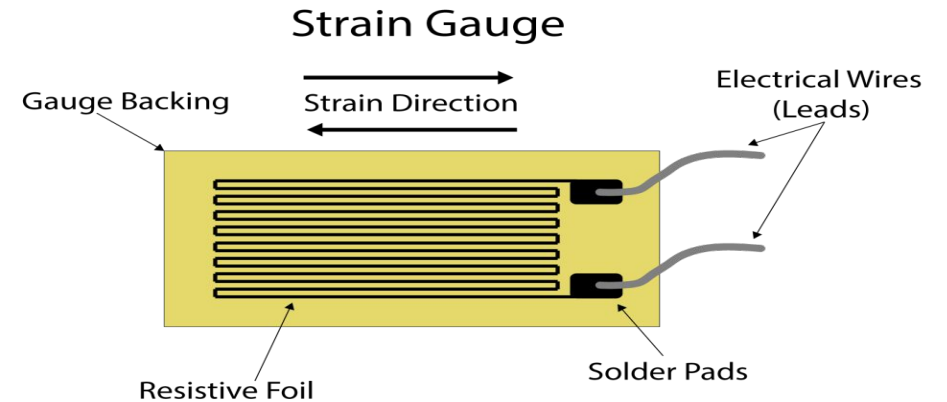


Thermocouple

# Strain Gauge (Pressure/ Force Sensor)

A strain gauge is used to detect pressure when a load is applied. It works on the principle of resistance, as the resistance is directly proportional to the length of the wire and is inversely

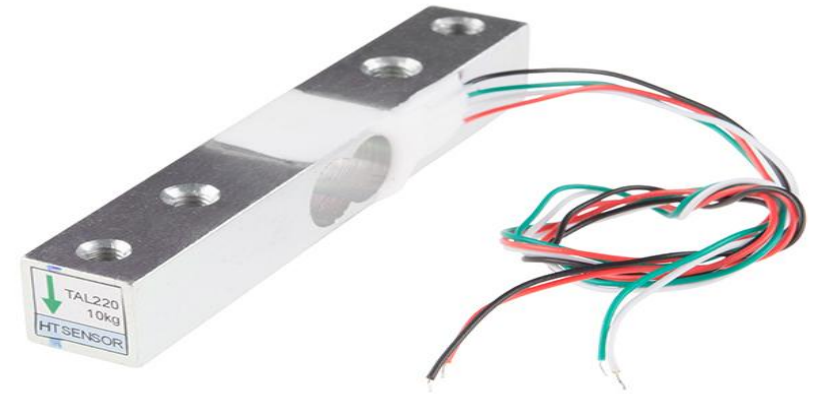
Sensors; Actuators and proportional to its cross-sectional area. The same principle is applied here to measure the load.



Strain Guage

## Load Cell (Weight Sensor)

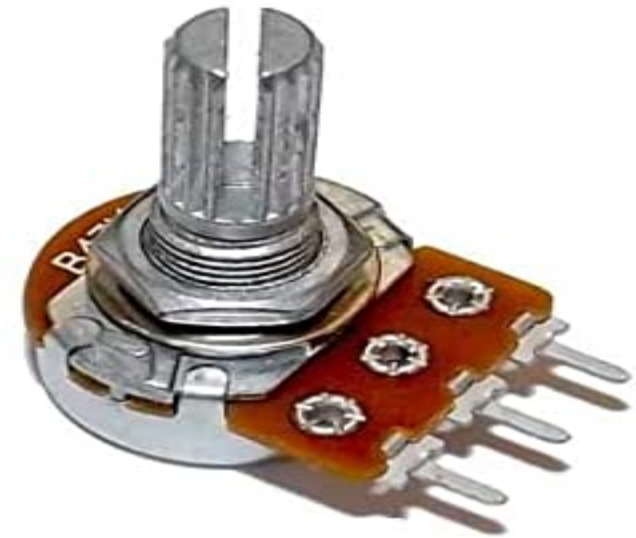
Load cells are similar to strain gauges which measure the physical quantity like force and give the output in form of electrical signals. When some tension is applied on the load cell its structure varies causing the change in resistance



Load Cell

# Potentiometer

A potentiometer is used to detect the position. It generally has various ranges of resistors connected to different poles of the switch. A potentiometer can be either rotary or linear type



Potential meter



# Encoder

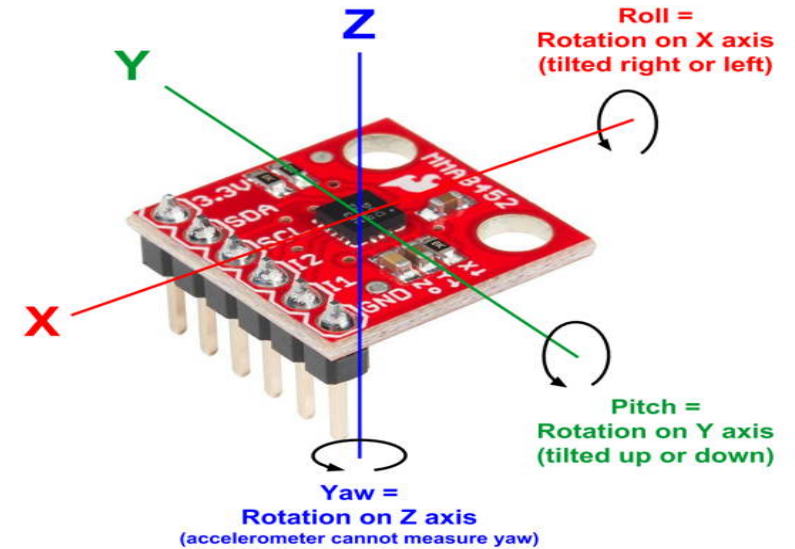
To detect the change in the position an encoder can also be used. It has a circular rotatable disk-like structure with specific openings in between such that when the IR rays or light rays pass through it only a few light rays get detected



Wheel Encoder

# Accelerometer (Tilt Sensor)

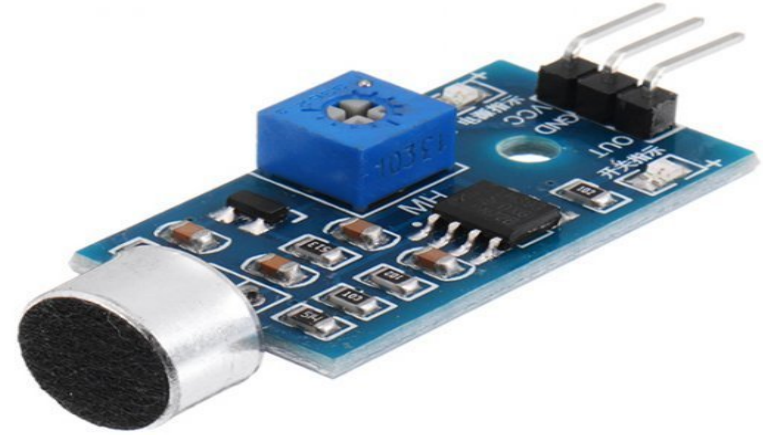
An accelerometer sensor can sense the tilt or movement of it in a particular direction. It works based on the acceleration force caused due to the earth's gravity.



Accelerometer

# Microphone (Sound Sensor)

Microphone can be seen on all the smartphones or mobiles. It can detect the audio signal and convert them into small voltage (mV) electrical signals. A microphone can be of many types like condenser microphone, crystal microphone, carbon microphone etc., each type of microphone work on the properties like capacitance, piezoelectric effect, resistance respectively.



Microphone Sound Sensor

# Proximity sensor

A device that detects the presence or absence of a nearby object, or properties of that object, and converts it into signal which can be easily read by user or a simple electronic instrument without getting in contact with them.



Proximity Sensor

# Photoelectric Sensors

Photoelectric sensor is made up of light-sensitive parts and uses a beam of light to detect the presence or absence of an object. It is an ideal alternative of inductive sensors. And used for long distance sensing or to sense non-metal object.

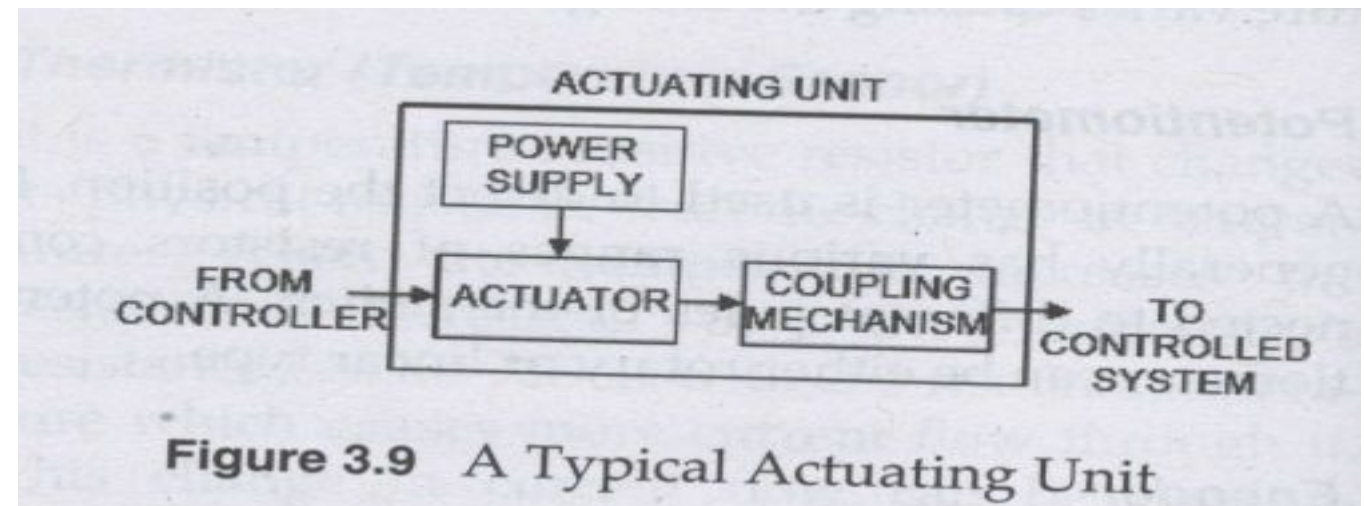
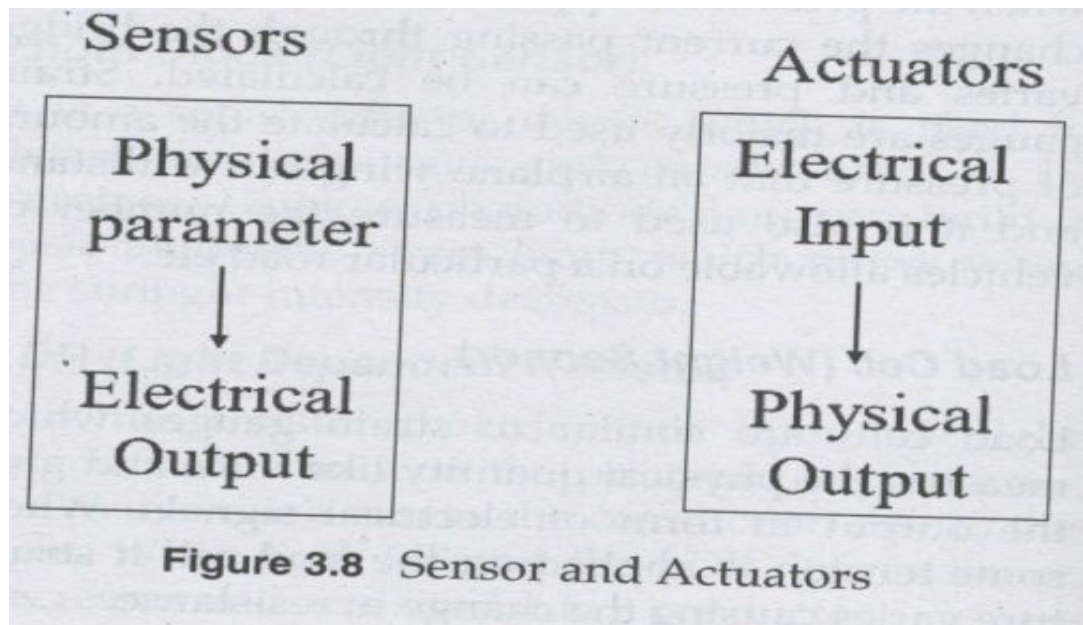


Photo Electric Sensor

# Actuators

- Actuators convert information or energy from sensors into action by transmitting it to another power mechanism or system. No human intervention need be involved in the decision making process.

**An actuator is a device that converts an input energy into motion or mechanical energy**



# CLASSIFICATION OF ACTUATORS

- Actuators can be classified based on the type of energy. They are essentially of Electrical, Electromechanical, Electromagnetic, Hydraulic, or Pneumatic type. The new generations of actuators include Smart Material Actuators, Micro-actuators, and Nanoactuators



# Electrical Actuators