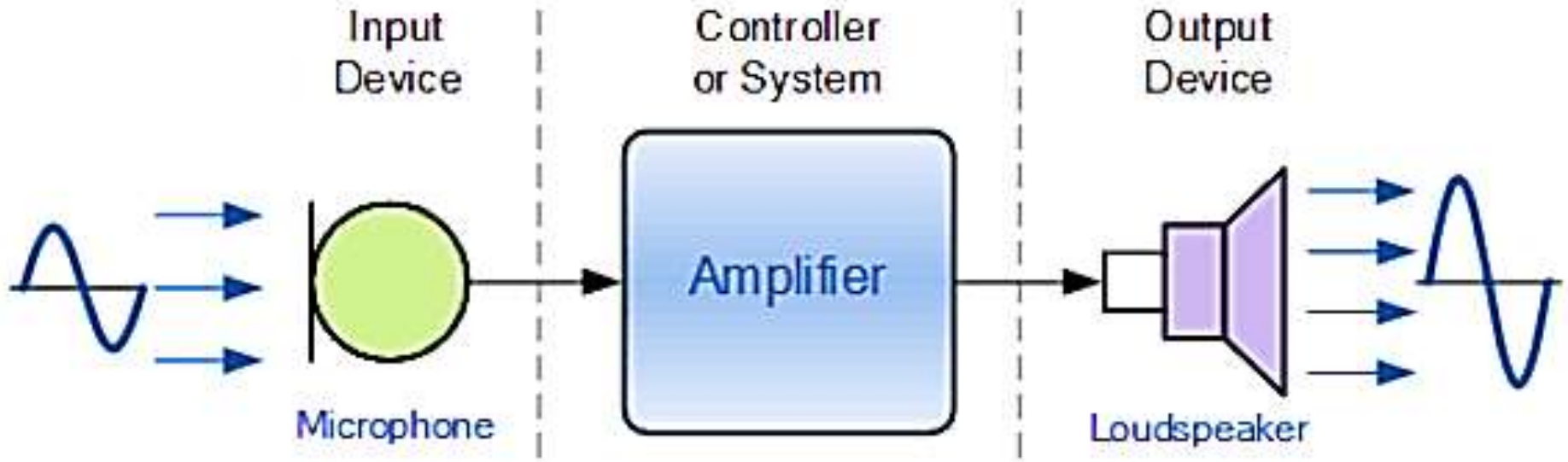
UNIT-V Chapter-II

Introduction to Sensors

Introduction

- An electrical (or electronic sensor) sensor is a device that detects a physical parameter of interest (e.g. heat, light, sound) and converts it into electrical signal that can be measured and used by an electrical or electronic system.
- The detected quantity is usually a form of energy that is analog (continuous) in nature and is converted into electrical energy using a transducer (e.g. a microphone is a transducer that converts sound energy into electrical energy).



- Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base.
- Applications include cars, machines, aerospace, medicine, manufacturing and robotics.

Humans are equipped with 5 different types of sensors

Detects light

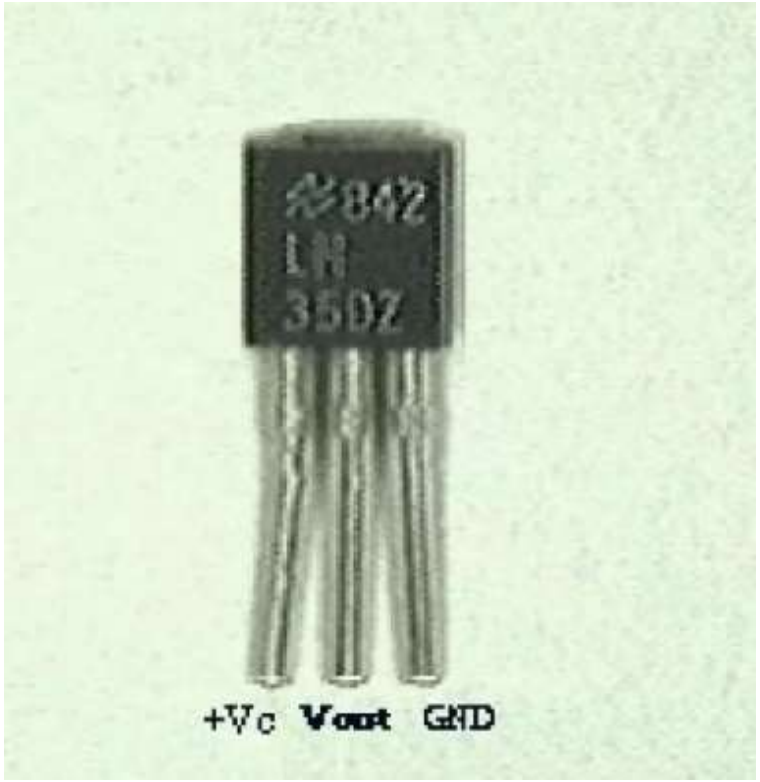
Detects certain chemicals

Detects pressure & temperature

Detects sound

Temperature sensors

- A temperature sensor is a device that detects and measures the degree of hotness or coldness and converts it into an electrical signal.



- The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).

A typical disc thermistor

A threaded thermistor

Working:

The working of a temperature meter depends upon the voltage across the diode. The temperature change is directly proportional to the diode's resistance. The cooler the temperature, the lesser the resistance, and vice versa. The resistance across the diode is measured and converted into readable units of temperature (Fahrenheit, Celsius, Centigrade, etc.) and displayed in numeric form over readout units.

Application:

Temperature sensors have a wide range of applications

- Temperature sensors are utilized in our daily lives. Ex: A thermometer, domestic water heaters, refrigerators, or microwaves.
- Used in the geotechnical monitoring field. In this field, these temperature sensors are utilized in the measuring of internal temperatures of structures such as huge concrete dams, bridges, power plants. boreholes, soil, and buildings.

Displacement sensors

- A Displacement Sensor is a device that measures the distance between the sensor and an object by detecting the amount of displacement through a variety of elements and converting it into a distance
- Displacement sensors are widely used. Some of the most common industries for displacement sensors are; Motorsport, automotive, industrial applications, agriculture, aerospace, robotics and many more.
- Working: They measure displacement by converting movement into electromagnetic, electrostatic or magneto electric signals which can be converted into a readable format for the user.

Application:

- Displacement sensors are often used for shifts in position, measuring gaps or changes in gaps, monitoring and measuring expansions and contractions of objects, measuring inclines etc.
- Some example applications using position sensors are;
  - Automotive and Motorsport – in this industry, displacement sensors can be used for steering systems on agricultural machinery, electric cart throttle control, the suspension on bikes and many other applications.
  - Factory Automation – displacement sensors can be used for conveyor speed measurement, labelling machines and control, printing processes and packaging.
  - Medical Applications – displacement sensors are used on medical pieces of machinery such as MRI or oncology machines.
  - Security Applications - displacement sensors can be used in security applications, for example, monitoring the angle of a CCTV camera.
  - Other applications – displacement sensors can also be used for; elevator position, special effects in film and TV and other transportation devices, various renewable energy applications, baking machines, paper mills and many others

Piezoelectric Sensor

- A piezoelectric sensor measures changes in pressure, acceleration, temperature, strain, or force by converting them into an electrical charge.
- It works using the piezoelectric effect, where certain materials generate an electric charge when mechanically stressed.
- There are various types of piezoelectric sensors, such as those used for measuring vibration, detecting impact, or monitoring pressure changes.
- These sensors are highly sensitive and can detect even minor changes in the environment.

Working

- When pressure or acceleration is applied to the PZT material, an equivalent amount of electrical charge gets generated across the crystal faces.
- Electrical charge will be proportional to the applied pressure. Piezoelectric sensor cannot be used to measure static pressure.
- At the constant pressure, the output signal will be zero.

- Working of a Piezoelectric Sensor can be summarized as,

1. In a piezoelectric crystal the charges are exactly balanced in unsymmetrical arrangement also.
2. The effect of the charges cancels out with each other and hence no net charge will be found on the crystal faces.
3. When the crystal is squeezed, the charge in the crystal becomes unbalanced.
4. Hence, from now on the effect of charge does not cancel with each other which make net positive and negative charge to appear on the opposite faces of the crystal.
5. Therefore, by squeezing the crystal, voltage is produced across the opposite face and this is known as piezoelectricity

Applications of Piezoelectric Sensors:

- They are used to measure dynamic pressure. Dynamic pressure measurements include turbulence, engine combustion, etc.
- In Industrial Applications piezoelectric sensor is used in engine knock sensors, pressure sensors, Sonar Equipment, etc.
- Piezoelectric actuators are applied in Diesel fuel injectors, optical adjustment, Ultrasonic cleaning and welding.
- Sensor is used in electrical appliances like dot matrix printer, inkjet printer, Piezo speaker, buzzers, humidifiers, etc.
- In musical instruments like Instrument pickups and microphone.