Instrumentation-Sensors (what)

- Introduction: principles and fundamentals of Process Measurement and Instrumentation
- Pressure Measurement
- Flow Measurement
- Level Measurement
- Temperature Measurement
- **Sensors**

SENSORS

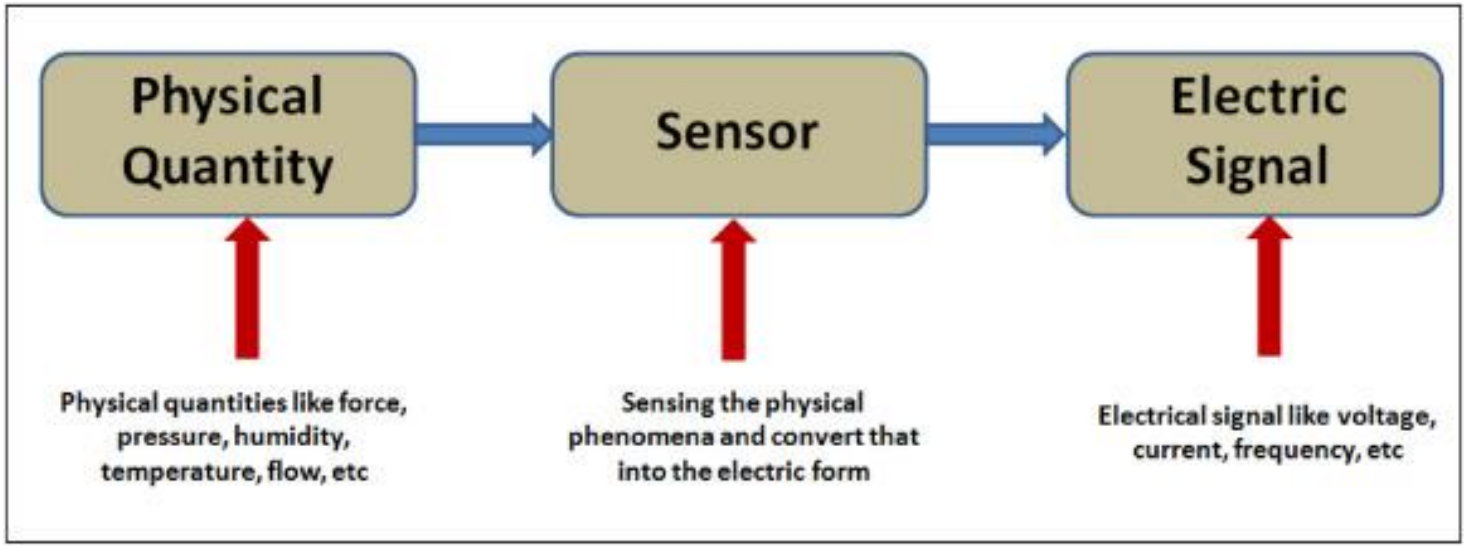
Introduction

Sensor

- Human senses
  - 5 senses

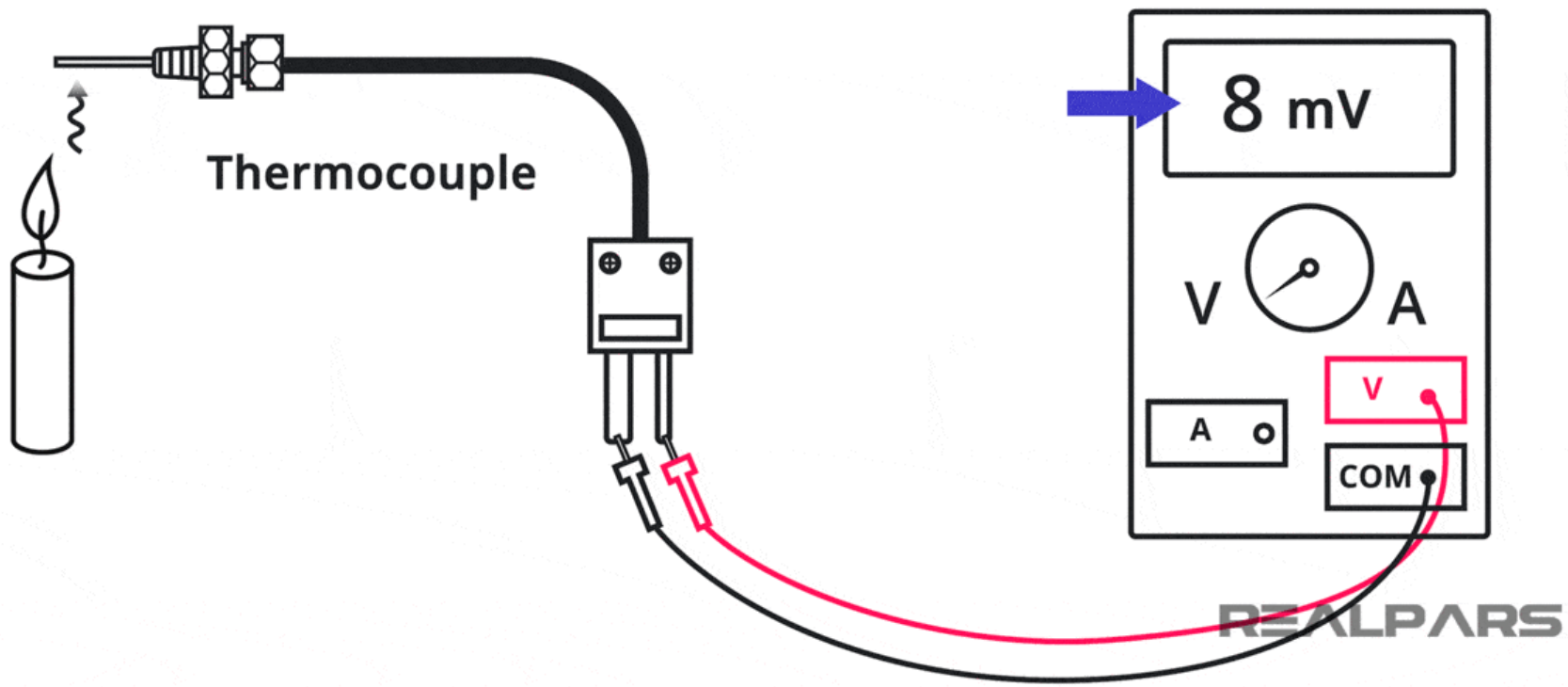
Sensor

- Devices that detect physical parameters and convert them into signals.
- Importance in Process Engineering: Enable monitoring and control of industrial processes, ensuring safety, efficiency, and quality.
- **Key Characteristics:**
  - Accuracy
  - Sensitivity
  - Range
  - Response time



Exemple

Active



Classification of Sensors

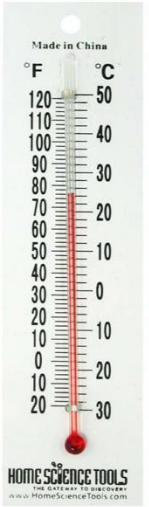
- Mechanical quantities: displacement, Strain, rotation velocity, acceleration, pressure, force/torque, twisting, weight, flow
- Thermal quantities: temperature, heat.
- Electromagnetic/optical quantities: voltage, current, frequency phase; visual/images, light; magnetism.
- Chemical quantities: moisture, pH value

Types of sensor

➢contact type:

These types of sensor are required to be in physical contact with the object being sensed and use conduction to monitor changes in physical state They can be used to detect solids, liquids or gases over a wide range of physical change

e.g. thermometer.

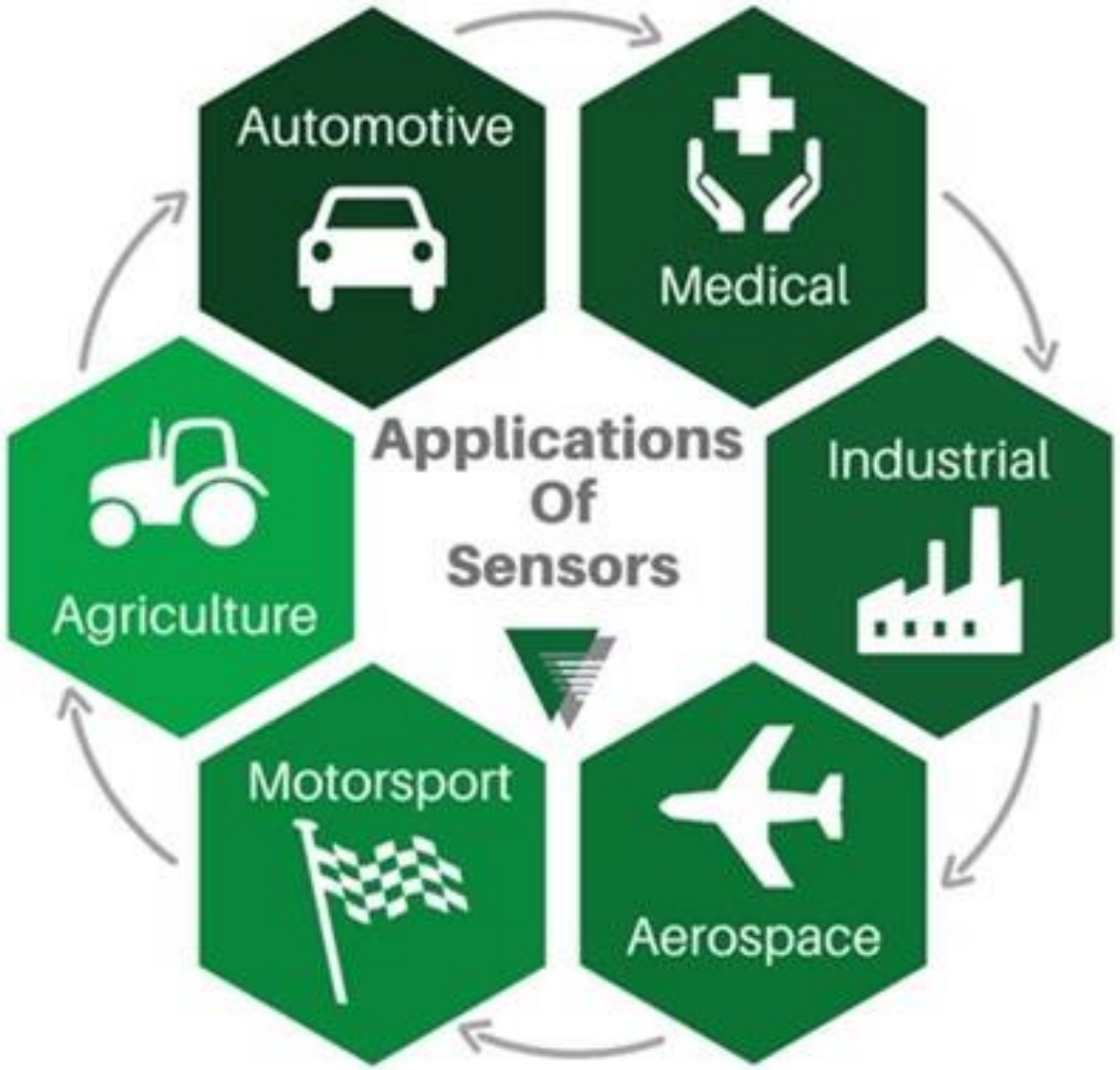


➢Non-contact type:

These types of temperature sensor use convection and radiation to monitor changes like in temperature. They can be used to detect liquids and gases that emit radiant energy as heat rises and cold settles to the bottom in convection currents or detect the radiant energy being transmitted from an object in the form of infra-red radiation (the sun).

e.g. Pyrometer.

Applications of Sensors



Pressure Sensors

- Types of Pressure Sensors:
  - **Manometers:** Simple and traditional devices.
  - **Bourdon Tubes:** Common in industrial settings.
  - **Piezoelectric Sensors:** High sensitivity for dynamic pressure changes.
  - **Capacitive Pressure Sensors:** Precise and used in modern systems.
- **Applications in Process Engineering:**
  - Monitoring gas or liquid pressure in pipelines.
  - Ensuring safety in pressurized systems (e.g., boilers, reactors).

Flow Sensors

- **Principle:** Measure the volume or mass of fluid passing through a system.
- Types of Flow Sensors:
  - **Orifice Plates, Venturi Tubes, and Nozzles:** Utilize pressure difference.
  - **Coriolis Flow Meters:** Measure mass flow rate directly.
  - **Ultrasonic Flow Meters:** Non-intrusive and used for clean fluids.
  - **Electromagnetic Flow Meters:** Suitable for conductive fluids.
- **Applications in Process Engineering:**
  - Monitoring flow rates in chemical processes.
  - Controlling fluid transportation in pipelines.

Level Sensors

- **Purpose:** Detect and measure the height of a liquid or solid in a container.
- Types of Level Sensors:
  - **Float Switches:** Simple mechanical systems.
  - **Ultrasonic Sensors:** Use sound waves for non-contact measurement.
  - **Capacitive Level Sensors:** Ideal for granular solids and liquids.
  - **Radar Level Sensors:** High precision for large tanks.
- **Applications in Process Engineering:**
  - Monitoring storage tanks in refineries.
  - Ensuring optimal levels in chemical reactors.

Temperature Sensors

- Types of Temperature Sensors:
  - **Thermocouples:** Fast response for wide ranges.
  - **Resistance Temperature Detectors (RTDs):** High accuracy and stability.
  - **Infrared Sensors:** Non-contact temperature measurements.
  - **Thermistors:** High sensitivity for small temperature changes.

Applications in Process Engineering:

- Maintaining process temperatures in reactors.
- Monitoring heat exchangers.

Practical Examples and Case Studies

- **Case Study 1:** Using pressure sensors in distillation columns.
- **Case Study 2:** Flow sensors in water treatment plants.
- **Case Study 3:** Level sensors in storage silos.
- **Case Study 4:** Temperature sensors in heat exchangers.