

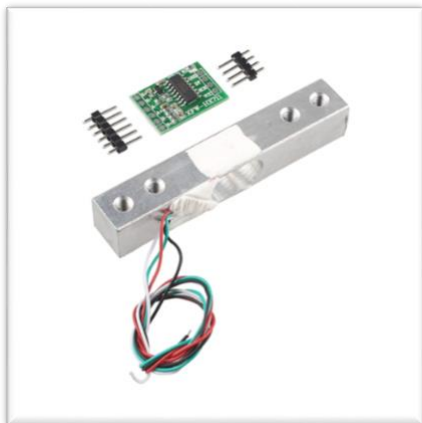
SENSORS AND ACTUATORS

Assignment

INDUSTRIAL SENSORS

An industrial sensor is a device used in industries to detect, measure, and monitor physical quantities such as temperature, pressure, flow, level, speed, or position, and convert them into electrical signals that can be read by a control system like a PLC (Programmable Logic Controller).

Load cell sensor



A load cell is a force or weight measuring sensor that converts the applied load (force, weight, or pressure) into an electrical signal.

Working principle

- The load cell works on the strain gauge principle.

- When a load or force is applied to the sensor, it causes tiny deformation (strain) in the metal body.
- Strain gauges attached to the body change their electrical resistance due to this deformation.
- This change in resistance is converted into an electrical voltage signal, proportional to the applied force or weight.

Types of load cell

1. Strain Gauge Load Cell Most common type; used in weighing systems.
2. Hydraulic Load Cell Uses fluid pressure to measure load.
3. Pneumatic Load Cell Uses air pressure; good for clean environments.
4. Capacitive Load Cell Measures change in capacitance due to deformation.

Advantages

- High accuracy and reliability
- Wide measurement range
- Suitable for dynamic and static loads
- Compact and durable

Ultrasonic sensor



An ultrasonic sensor is a device that measures distance or detects objects by using ultrasonic sound waves (sound waves above the human hearing range, i.e., above 20 kHz).

Working principle

- The sensor sends out ultrasonic sound waves from a transmitter (Tx).
- These sound waves hit an object and reflect back to the sensor's receiver (Rx).
- The time taken for the sound wave to travel to the object and return is measured.

Advantages

- Non-contact measurement
- Works in dark or dusty environments
- High accuracy and reliability
- Safe and low-cost

Proximity sensor



A proximity sensor is an electronic sensor that detects the presence or absence of an object or its distance without any physical contact.

It works by emitting an electromagnetic or optical field and observing changes in that field when an object comes close.

Working principle

The sensor generates a field or signal (magnetic, electric, or optical).

When an object enters this field, it disturbs the signal.

The sensor's circuit detects the change and sends an output signal (ON/OFF or analog value) to the controller.

Advantages

- Non-contact operation (no wear and tear)
- High switching speed
- Reliable in dusty or wet environments
- Long lifespan and low maintenance

Flow sensor



A flow sensor (or flow meter) is a device that measures the rate of flow of a liquid or gas in a pipe or system.

It converts the movement of the fluid into an electrical signal that can be read, recorded, or used for control in industrial processes.

Working principle

1. The fluid (liquid or gas) flows through the sensor.
2. The movement of the fluid is detected by a mechanical, thermal, or electromagnetic method.
3. The sensor converts this flow into an electrical signal proportional to the flow rate.
4. The flow rate is usually expressed in liters per minute (L/min) or cubic meters per hour (m^3/h).

Advantages

- Accurate and continuous flow measurement
- Helps in process automation and control
- Detects leaks or blockages in pipelines
- Non-contact types (like ultrasonic) are maintenance-free

PH sensor

A pH sensor is a device that measures the hydrogen ion concentration (H^+) in a solution to determine its acidity or alkalinity, expressed as pH value.

Ph scale:

The pH scale ranges from 0 to 14:

pH < 7 → Acidic

pH = 7 → Neutral

pH > 7 → Alkaline (Basic)

Working principle

The pH sensor works on the electrochemical principle.

It has two electrodes:

1. Glass Electrode (measuring electrode): Sensitive to H^+ ions.
2. Reference Electrode: Provides a stable reference voltage.

When both electrodes are dipped into the solution, a voltage difference is created between them.

This voltage depends on the H^+ ion concentration in the solution.

The pH meter converts this voltage into a pH value using the Nernst equation.

Advantages

- Accurate and reliable pH measurement
- Easy to use and portable
- Provides continuous monitoring (in process industries)

