U24EC203

SENSOR AND ACTUATORS

ASSIGNMENT-01

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BTech ECE

2nd Year (A)

Sensors in Automation Industry

1. Inductive Proximity Sensor

Also called: Eddy Current Sensor

Working Principle: Generates an electromagnetic field to detect metallic objects without physical contact.

Output: Digital (ON/OFF)

Applications:

- Position detection
- Counting metallic parts on conveyor belts
- Machine automation

Advantages:

- No wear & tear (non-contact)
- Reliable for metallic detection

Limitations:

- Detects only conductive materials like steel, aluminum

2. Photoelectric Sensor

Also called: Optical Sensor

Working Principle: Uses a light beam (LED/laser) to detect presence, absence, or distance of an object.
Output: Digital (ON/OFF) or Analog (based on received light intensity)

Applications:

- Packaging machines
- Automatic doors
- Object detection in conveyors

Advantages:

- Detects both metallic and non-metallic objects (unlike inductive sensors)

Limitations:

- Performance affected by dust, fog, or ambient light conditions

3. Ultrasonic Sensor

Also called: Sonar Sensor

Working Principle: Emits ultrasonic sound waves and measures echo time to calculate distance.

Output: Analog (typically 4–20 mA or 0–10 V)

Applications:

- Level measurement in tanks
- Distance measurement
- Robotics

Advantages:

- Works with liquids, solids, and granular materials

Limitations:

- Affected by temperature changes and sound-absorbing materials

4. Pressure Sensor

Also called: Pressure Transducer / Pressure Transmitter

Working Principle: Converts applied pressure into an electrical signal (strain gauge or piezoelectric principle).

Output: Analog (4–20 mA, 0–10 V) or Digital (fieldbus/serial protocols)

Applications:

- Monitoring hydraulic systems
- Pneumatic circuits
- Process automation

Advantages:

- Available in a wide pressure range (vacuum to high pressure)

Limitations:

- Needs calibration and protection against pressure spikes

5. Temperature Sensor

Also called: RTD – Resistance Temperature Detector / Thermocouple

Working Principle:

RTD: Resistance changes with temperature
Thermocouple: Generates voltage based on temperature difference

Output: Analog or digital temperature readings

Applications:

Furnaces
HVAC systems
Industrial process control

Advantages:

RTD: High accuracy & stability
Thermocouple: Wider temperature range & faster response

Limitations:

Require proper wiring and compensation circuits for accuracy

Actuators in the Automation Industry

1. Electric Motor

Also called: Servo / Induction / Stepper Motor

Working Principle: Converts electrical energy into rotational mechanical motion using electromagnetic principles.

Types & Uses:

- **Servo motor** → precise position control
- **Induction motor** → continuous operation
- **Stepper motor** → accurate incremental positioning

Applications: Conveyor systems, robotic arms, CNC machines

Advantages:

- Clean, quiet, efficient
- Excellent speed control

Limitations:

- Needs proper motor drives
- Expensive for high-power applications

2. Pneumatic Cylinder

Also called: Air Cylinder

Working Principle: Uses compressed air to create linear motion through piston movement.

Output: Mechanical force (ON/OFF or proportional control)

Applications: Pick-and-place robots, clamping systems, packaging machines

Advantages:

- Fast response, simple design
- Relatively low cost compared to hydraulic systems

Limitations:

- Limited force output
- Requires a compressed air supply system

3. Hydraulic Cylinder

Also called: Linear Hydraulic Actuator

Working Principle: Uses pressurized hydraulic fluid to produce linear motion.

Output: Very high force with possible precise control

Applications: Heavy machinery (excavators, presses, lifting equipment)

Advantages:

Provides much higher force than pneumatics of the same size

Limitations:

Complex system, requires pumps and valves
Risk of fluid leaks, higher maintenance

4. Solenoid Valve

Also called: Electromagnetic Valve

Working Principle: Electromagnetic coil moves a plunger to control fluid or gas flow.

Output: ON/OFF flow control (24V DC or 230V AC)

Applications: Pneumatic control systems, irrigation systems, HVAC

Advantages:

Fast switching speed, reliable
No continuous power needed to hold state

Limitations:

Limited to ON/OFF control (unless proportional type is used)

5. Electric Linear Actuator

Also called: Linear Motor Actuator

Working Principle: Electric motor drives a lead screw or belt mechanism to create linear motion.

Output: Precise position control (often with encoder feedback)

Applications: Adjustable workbenches, medical devices, automated positioning systems

Advantages:

Clean operation (no fluids or compressed air)
High precision

Limitations:

Slower than pneumatic/hydraulic actuators
Limited force capability

Sensors in Healthcare Industry

1. ECG Electrodes

Also called: Biopotential Sensor

Working Principle: Detects electrical activity of the heart via skin-contact electrodes.

Output: Analog voltage signals (in millivolts) representing heart rhythm.

Applications:

- Cardiac monitoring
- Diagnosis of arrhythmias
- ICU monitoring

Advantages:

- Non-invasive
- Continuous monitoring

Limitations:

- Signal quality depends on electrode placement and skin preparation

2. Blood Pressure Sensor

Also called: Cuff + Pressure Transducer

Working Principle: Measures cuff pressure and detects arterial pulsations.

Output: Digital readings of systolic & diastolic pressure (mmHg).

Applications:

- Cardiovascular health assessment
- Clinical diagnosis
- Home BP monitors

Advantages:

- Automated systems reduce human error
- Standard tool in hospitals & clinics

Limitations:

- Accuracy affected by improper cuff size/position

3. Pulse Oximeter

Also called: SpO_2 Sensor

Working Principle: Uses light absorption at red & infrared wavelengths to measure oxygen saturation.

Output: Digital display of oxygen percentage (%) and pulse rate.

Applications:

Surgery monitoring
ICU
Respiratory therapy
Home health devices

Advantages:

Quick, painless, non-invasive

Limitations:

Affected by nail polish, low blood flow, or patient movement

4. Blood Glucose Sensor

Also called: Glucometer Sensor / Electrochemical Sensor

Working Principle: Uses enzymatic electrochemical reaction to measure glucose concentration.

Output: Digital reading in mg/dL or mmol/L.

Applications:

Diabetes management
Continuous glucose monitoring systems (CGMS)

Advantages:

Allows patients to self-monitor blood sugar levels

Limitations:

Requires calibration and proper storage of test strips

5. Body Temperature Sensor

Also called: Thermistor / Infrared Temperature Sensor

Working Principle: Measures temperature via contact resistance change (thermistor) or infrared radiation.

Output: Digital display in °C or °F (accuracy ±0.1°C).

Applications:

- Fever detection
- Hospital patient monitoring
- Epidemic screening

Advantages:

- Non-contact IR sensors reduce infection risk

Limitations:

- Affected by ambient temperature variations