SENSORS IN IOT (INTERNET OF THINGS)

Sensors in IoT systems detect physical quantities and convert them into signals that can be processed and interpreted. These signals are transformed into human-readable formats, such as changes in resistance, capacitance, or impedance.

Transducers

- A transducer converts one type of energy into another (e.g., mechanical to electrical energy).
- Used as actuators in various systems.

Sensor Characteristics

1. Static Characteristics

- **Accuracy:** The ability to measure close to the true value, measured by errors.

    - **Absolute Error:** Measured value - True value
    - **Relative Error:** Measured value / True value
- **Range:** The minimum and maximum values a sensor can detect.
- **Resolution:** The smallest change a sensor can detect.
- **Precision:** Consistency of measurements under the same conditions.
- **Sensitivity:** How much the output changes for a small input change.
- **Linearity:** How closely the sensor's output matches a straight line.
- **Drift:** Slow changes in measurement over time.
- **Repeatability:** The consistency of measurements taken under the same conditions.

2. Dynamic Characteristics

- Zero-order system: No delay in output, no energy storage.
- First-order system: Gradual output change.

- Second-order system: Oscillating output before stabilization.

Sensor Classification

1. **Passive Sensors:** Cannot independently sense input (e.g., accelerometer, temperature sensors).
2. **Active Sensors:** Independently sense input (e.g., radar, laser altimeter).
3. **Analog Sensors:** Provide continuous output based on the input (e.g., temperature sensor).
4. **Digital Sensors:** Output in binary form with additional electronics for bit conversion (e.g., PIR sensor).
5. **Scalar Sensors:** Measure the magnitude of an input, not direction (e.g., temperature sensor).
6. **Vector Sensors:** Measure both magnitude and direction (e.g., accelerometer, gyroscope).

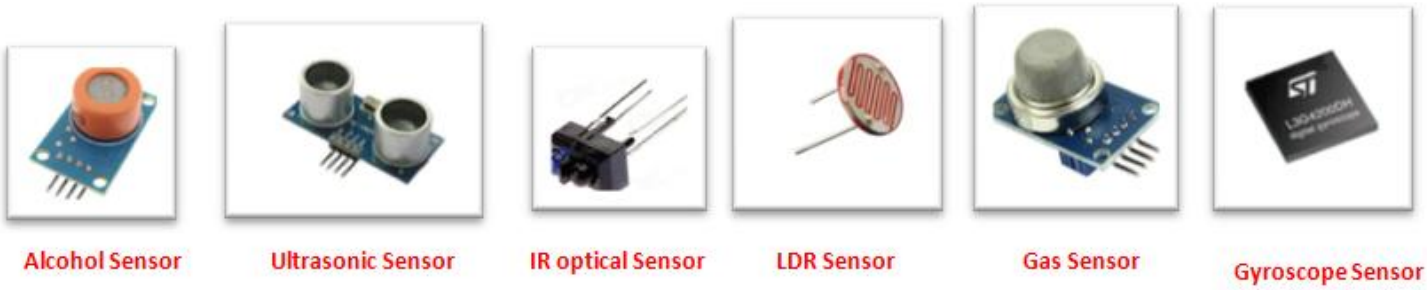
Types of Sensors

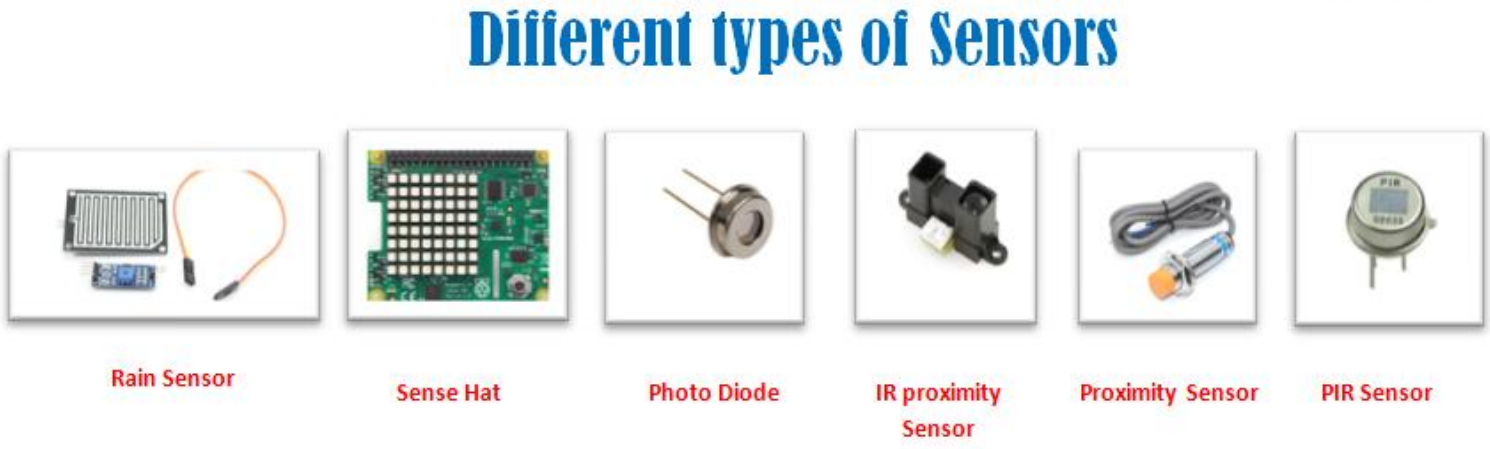
- **Electrical Sensors:** Can be contact or non-contact (e.g., inductive or capacitive sensors).
- **Light Sensors:** Detect light intensity, typically using LDR (Light Dependent Resistor).
- **Touch Sensors:** Detect touch, either resistive or capacitive type.
- **Range Sensors:** Measure distance using non-contact methods (e.g., capacitive, inductive, or energy waves).
- **Mechanical Sensors:** Use mechanical switches for detection.
- **Pneumatic Sensors:** Operate by disturbing air flow.
- **Optical Sensors:** Detect changes in light, often used for proximity sensing.
- **Speed Sensors:** Measure the speed of moving objects (e.g., wind speed sensors, speedometers).

- **Temperature Sensors:** Monitor temperature and provide electrical signals proportional to temperature.
- **PIR Sensors:** Detect motion by measuring infrared light, often used for human motion detection.
- **Ultrasonic Sensors:** Use sound waves to measure distance (similar to radar or sonar).

These sensors play a crucial role in IoT systems, enabling real-time monitoring, automation, and intelligent decision-making.

Common Sensors Used in IoT Devices





2. Pressure Sensor

- Measures pressure (force per unit area) and converts it into an electrical signal.
- **Applications:** Weather forecasting, water leak detection, smartphones, wearables.

3. Proximity Sensor

- Detects the presence of nearby objects without physical contact.
- **Types:** Inductive (metal), Capacitive (plastic/organic), Photoelectric, Ultrasonic.
- **Applications:** Parking sensors in cars, retail, museums, and smartphones.

4. Accelerometer and Gyroscope Sensor

- Accelerometer: Measures linear acceleration (vibration).
- **Gyroscope:** Measures angular position (rotation).
- **Applications:** Drones, smartphones, automobiles, and mobile IoT devices.

5. Infrared (IR) Sensor

- Senses infrared radiation emitted by objects.
- **Applications:** Thermal imagers, gas analyzers, flame monitors, moisture analysis, night vision.

6. Optical Sensor

- Converts light into an electronic signal.
- **Applications:** Cameras, alarm systems, light fixtures, and mining.

7. Gas Sensor

- Detects gases like carbon monoxide and other hazardous gases.
- **Applications:** Gas leak detection, safety systems in homes and industries.

8. Smoke Sensor

- Detects smoke levels and provides alerts.
- **Types:** Optical (photoelectric) and Ionization.
- **Applications:** Smoke detection in homes, voice alerts through Alexa, and notifications on smartphones.

These sensors help gather real-time data and support various IoT applications for monitoring, safety, and automation.