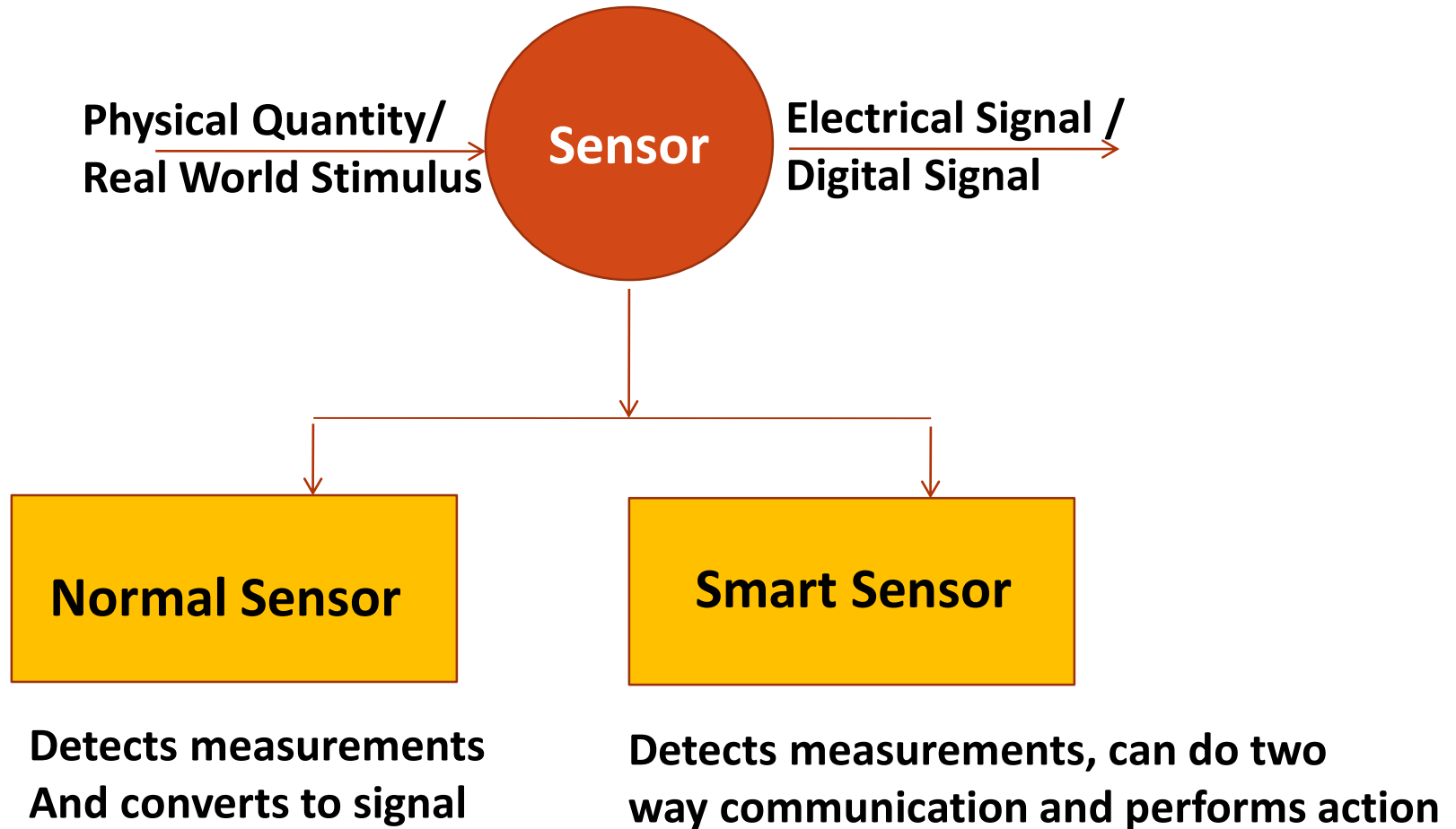# Introduction to Sensor

• We live in an Analog World with Digital means of communication and control Mechanical objects with Electrical signals.

• This is possible because of devices like **sensors and transducers**, which help us in converting data or information from one domain to other.

Introduction to Sensor

Physical Quantity/ Real World Stimulus → **Sensor** → **Electrical Signal / Digital Signal**

Normal Sensor

Detects measurements
And converts to signal

Smart Sensor

Detects measurements, can do two
way communication and performs action

Introduction to Sensor

- A sensor is a device that **detects and responds to some type of input** from the physical environment.

- The input can be **light, heat, motion, moisture, pressure** or any number of other environmental phenomena.

- The output is generally a signal that is converted to a human-readable display at the sensor location or **transmitted electronically** over a network for reading or further processing.

What is a Sensor?

•**Definition** - A device that detects the changes in electrical or physical or other quantities and thereby produces an output as an acknowledgement of change in the quantity is called as a Sensor. Generally, this sensor output will be in the form of electrical or optical signal.
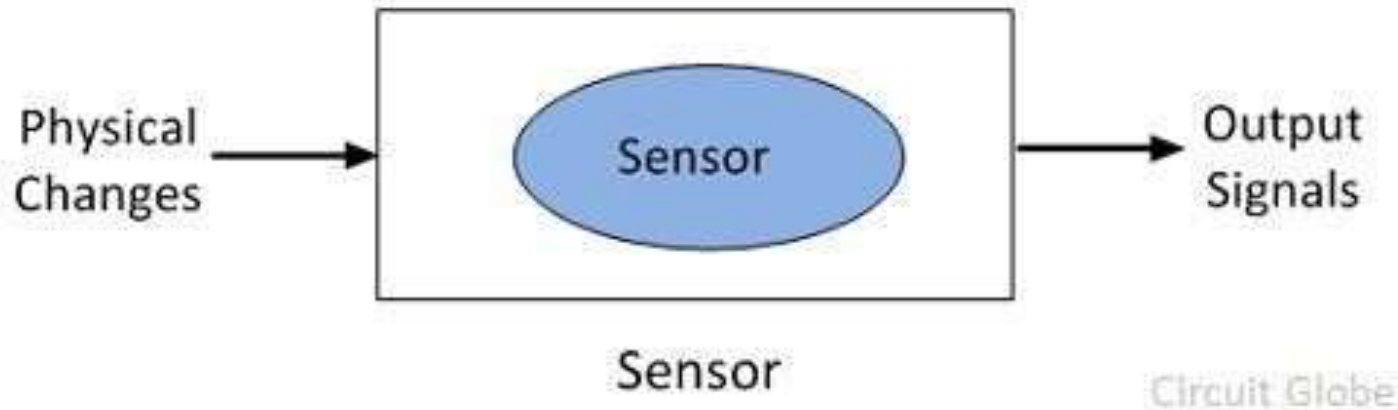

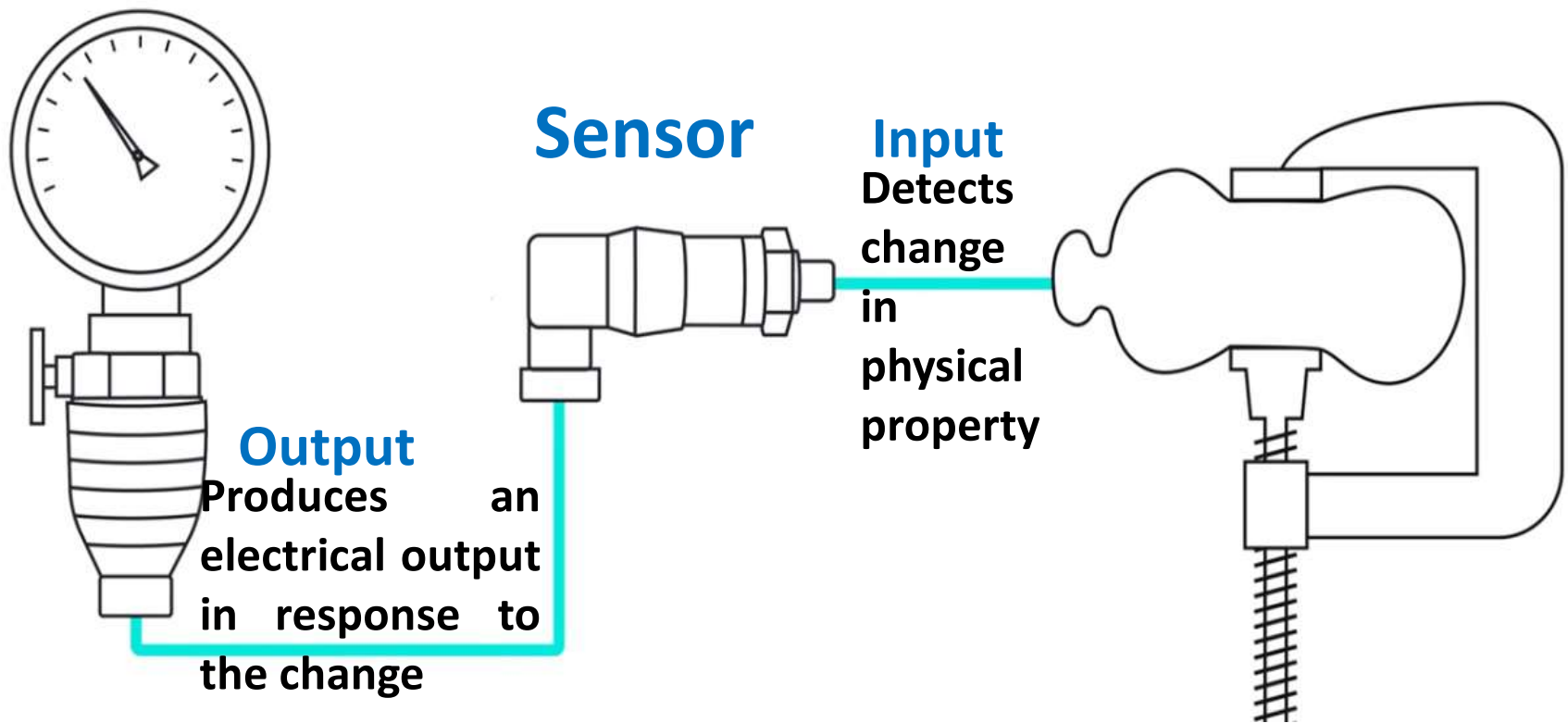**A Sensor is a device which can sense something**

What is a Sensor?

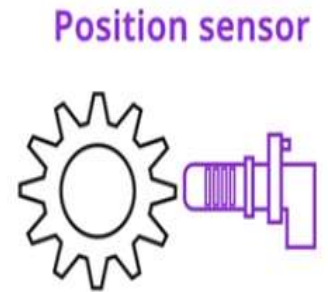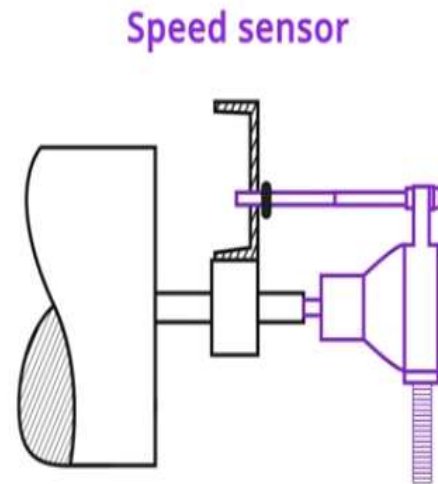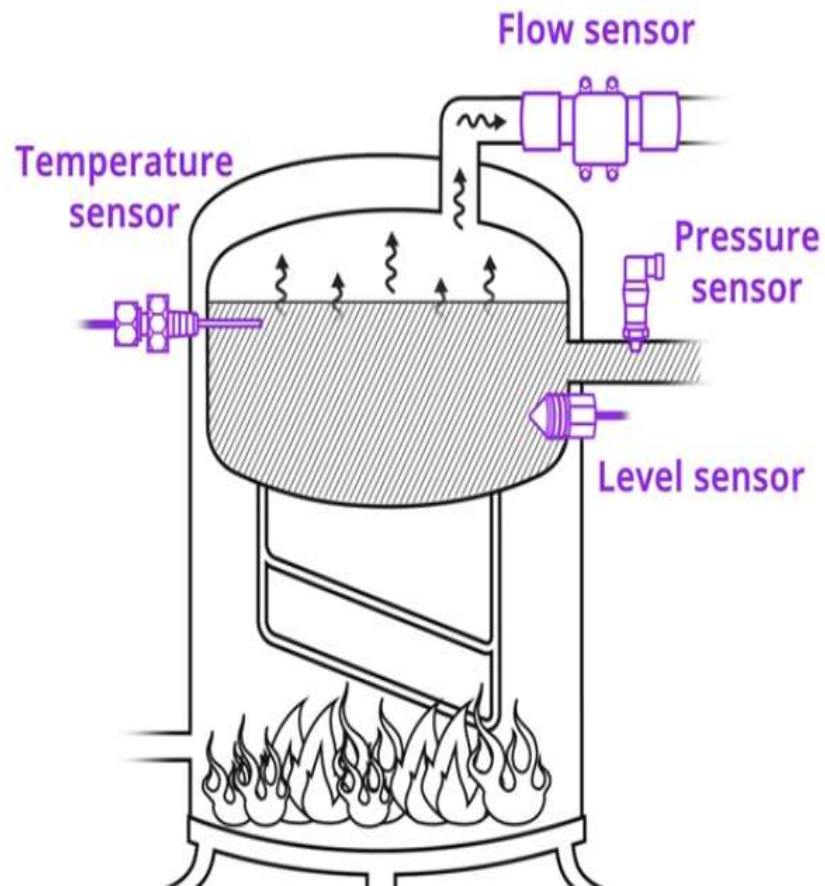## Different types of sensors we use in our routine

- **Touch sensors** in our smartphone
- **IR sensor** used for operating television remote
- **Passive Infrared sensor** used for automatic door opening system of shopping malls
- **LDR sensor** used for outdoor lighting or street lighting system, and so on.

Sensor

Working of a Sensor

Sensor

Input
Detects change in physical property

Output
Produces an electrical output in response to the change

Physical Properties a Sensor can detect

Flow sensor

Temperature sensor

Pressure sensor

Level sensor

Speed sensor

Position sensor

Types of Sensors

Sensors and Actuators

Sensors are devices that perform **input function** in a system as they 'sense' the changes in a quantity. **A sensor converts a physical event into an electrical signal.** The best example of a sensor is mercury thermometer. Here the quantity that is being measured is heat or temperature.

Actuators are devices that work opposite to sensors. **An actuator converts electrical signal into a physical event**. Actuators are used to perform **output function** in a system as they control an external device.
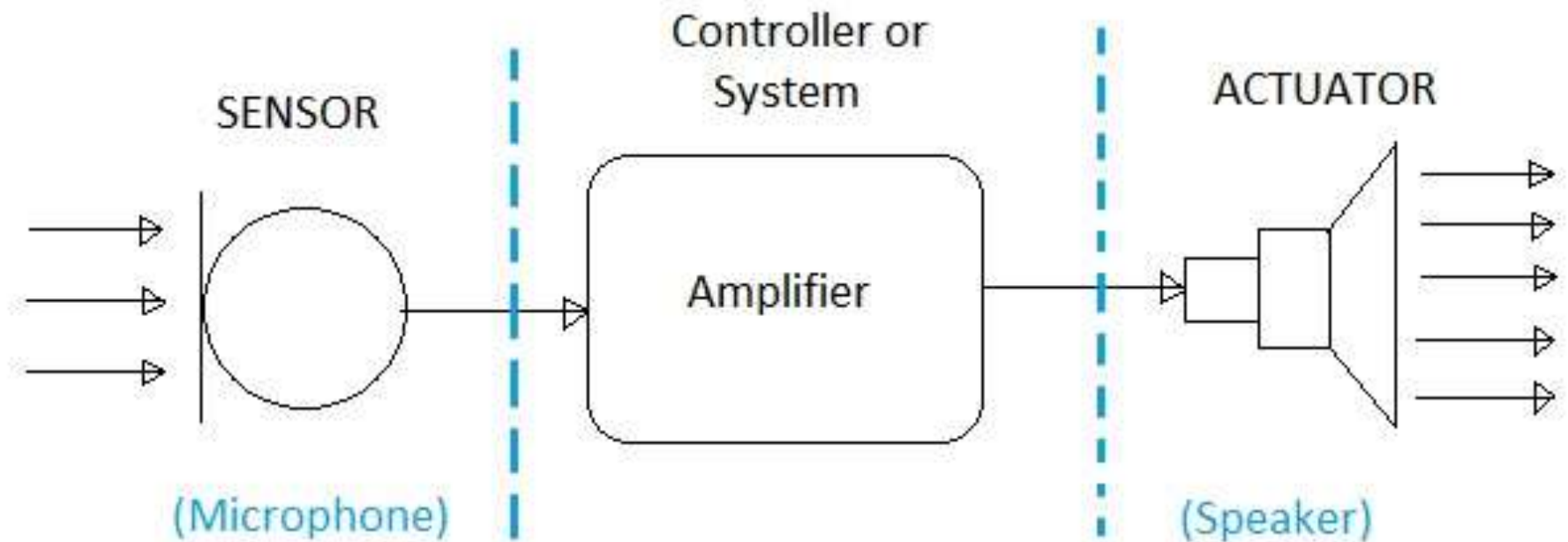
Transducers

Transducers are the devices that convert energy in one form into another form. Generally the energy is in the form of a signal.

•Transducer is a term collectively used for both sensors and actuators.

A simple system using Transducers

A public addressing system is an example of a system using sensors and actuators.

Converts sound signal to less voltage electrical signal

Amplifies the signal to high voltage

Converts electrical signal to sound signals

A simple system using Transducers

•It consists of a microphone, an amplifier and a loudspeaker.

•The **sensor** or the device with input function is a **microphone**. It senses the sound signals and transforms them into electrical signals. The amplifier receives these electrical signals and amplifies their strength.

•The **actuator** or the device with output function is **loudspeaker**. It receives the amplified electrical signals from the amplifier and converts them back into sound signals but with more reach.

Smart Sensors

Smart motion sensor

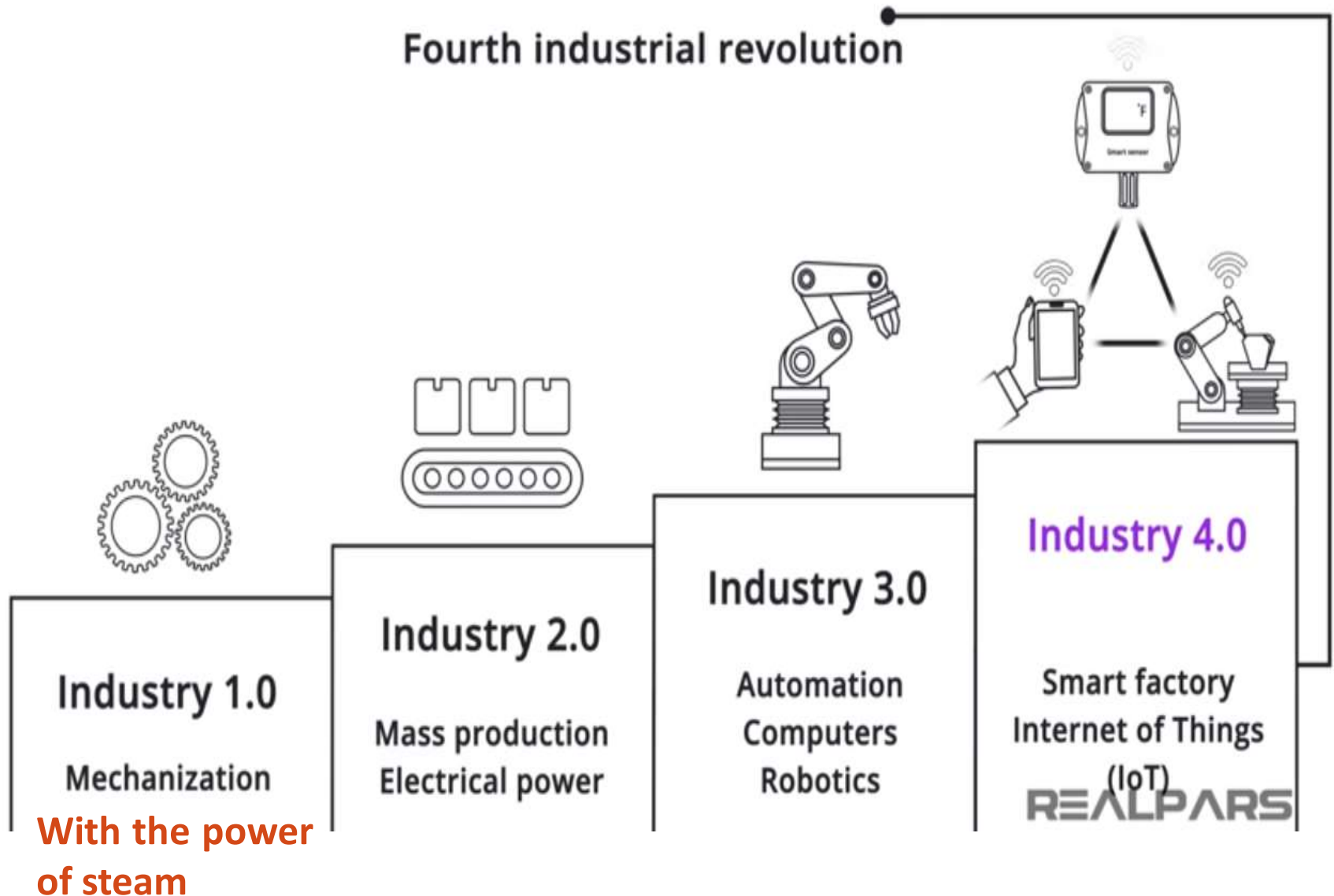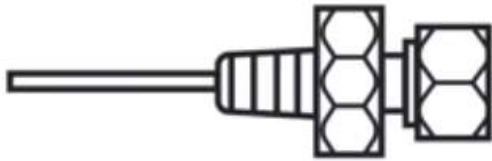Smart thermostat sensor

Smart fuel level sensor

Smart distance sensor
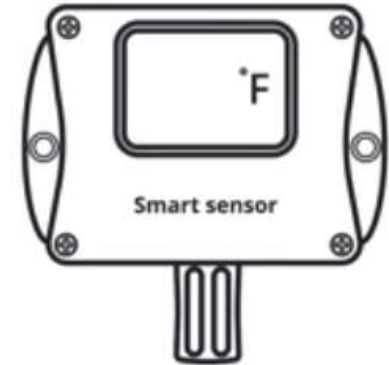
Smart temperature sensor

REALPARS

Smart Sensors in the Smart Factories

Fourth industrial revolution

Industry 1.0

Mechanization

With the power of steam

Industry 2.0

Mass production
Electrical power

Industry 3.0

Automation
Computers
Robotics

Industry 4.0

Smart factory
Internet of Things
(IoT)

REALPARS

Smart Sensors in the Smart Factories

Base temperature
sensor

VS

Smart sensor

°F

Smart temperature
sensor

Base Temperature Sensor (Normal Sensor)

Thermocouple

18 mV

V   A

V

A

COM

REALPARS

Smart Sensors

Cloud

Smart motion sensor

Smart thermostat sensor

Smart fuel level sensor

Smart distance sensor
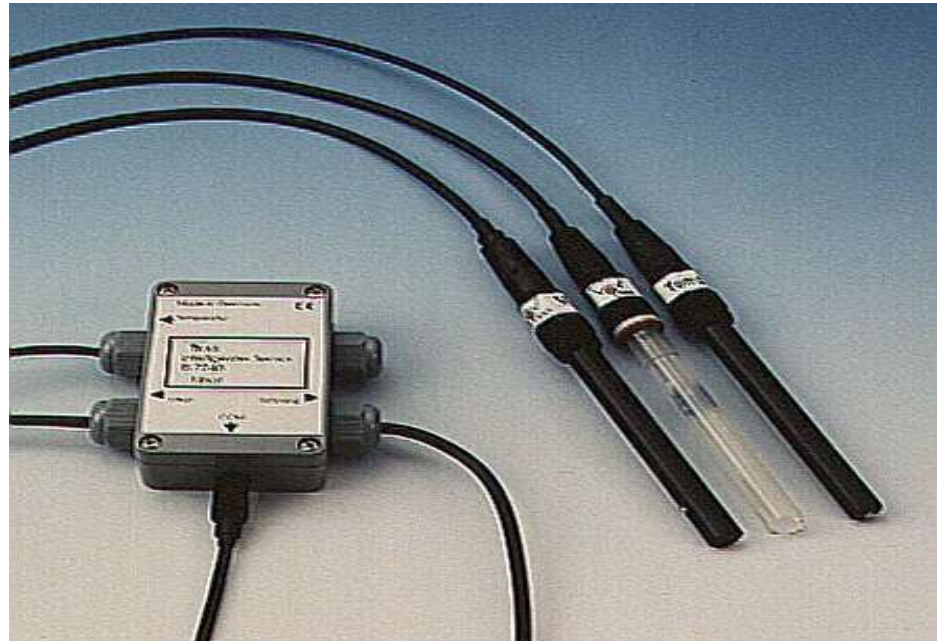
Smart temperature sensor
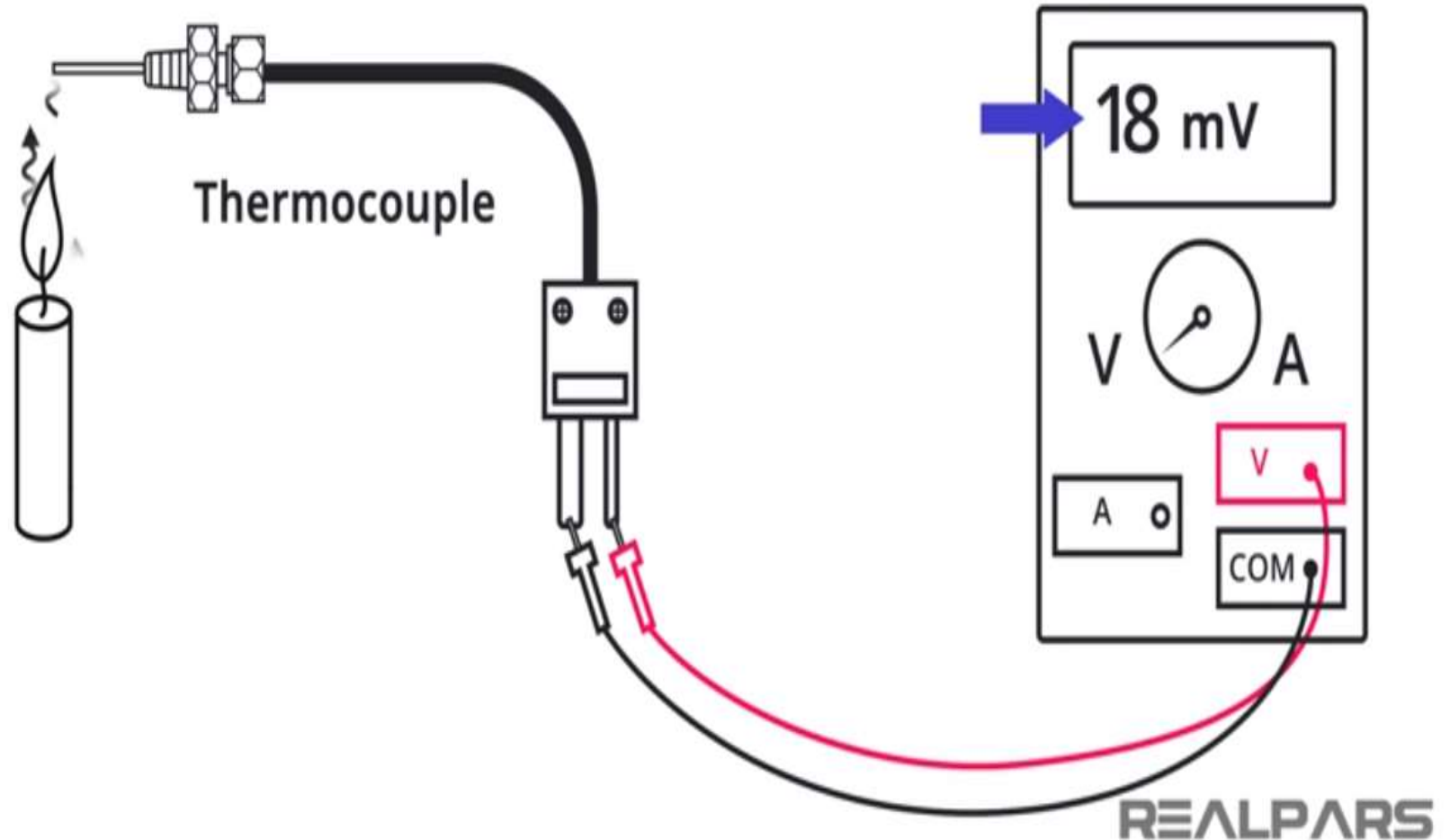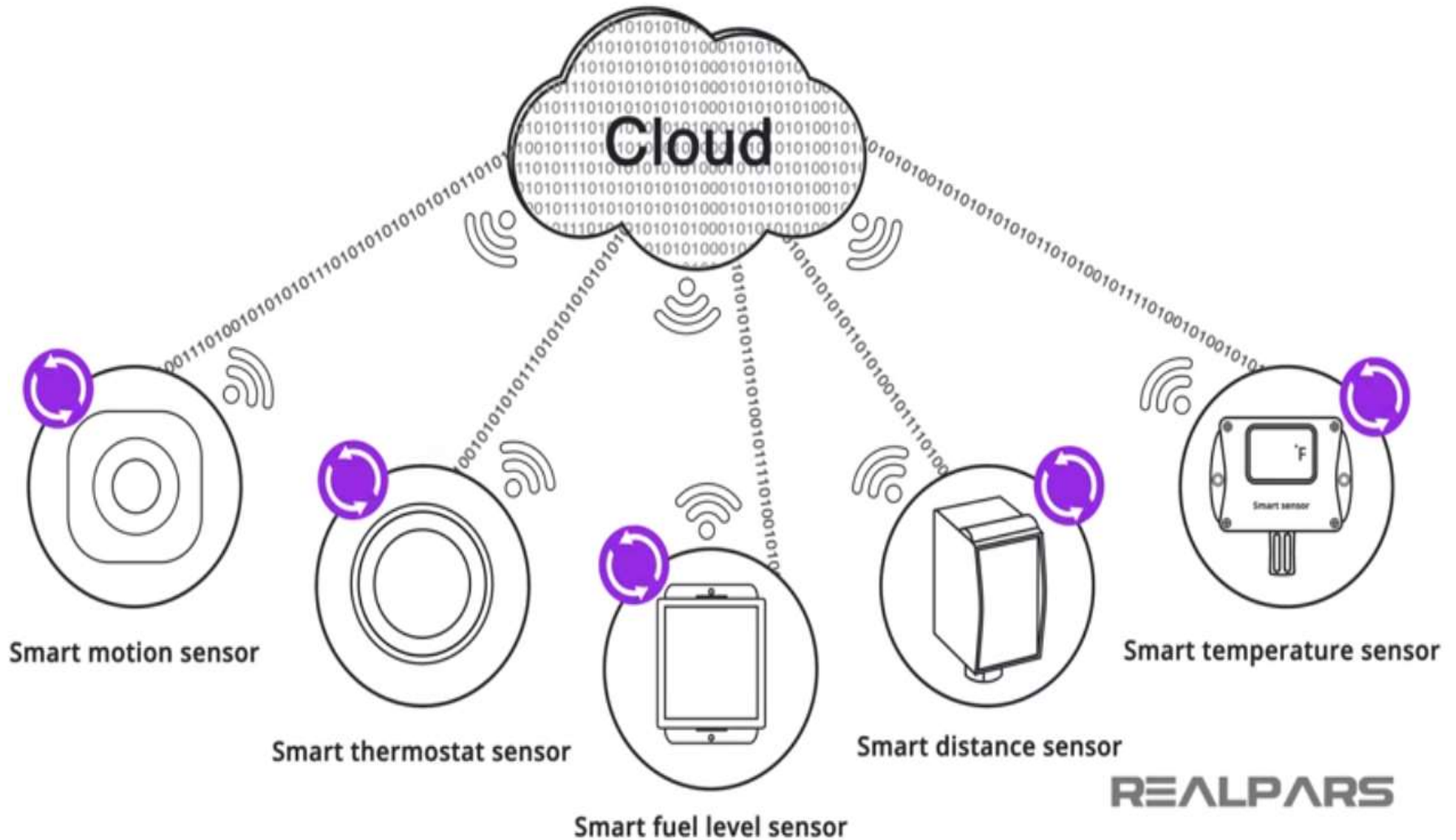
REALPARS

Smart Sensors

•Any gadget which mixes a sensor and a microprocessor is usually called an **Intelligent sensor or a Smart sensor**.
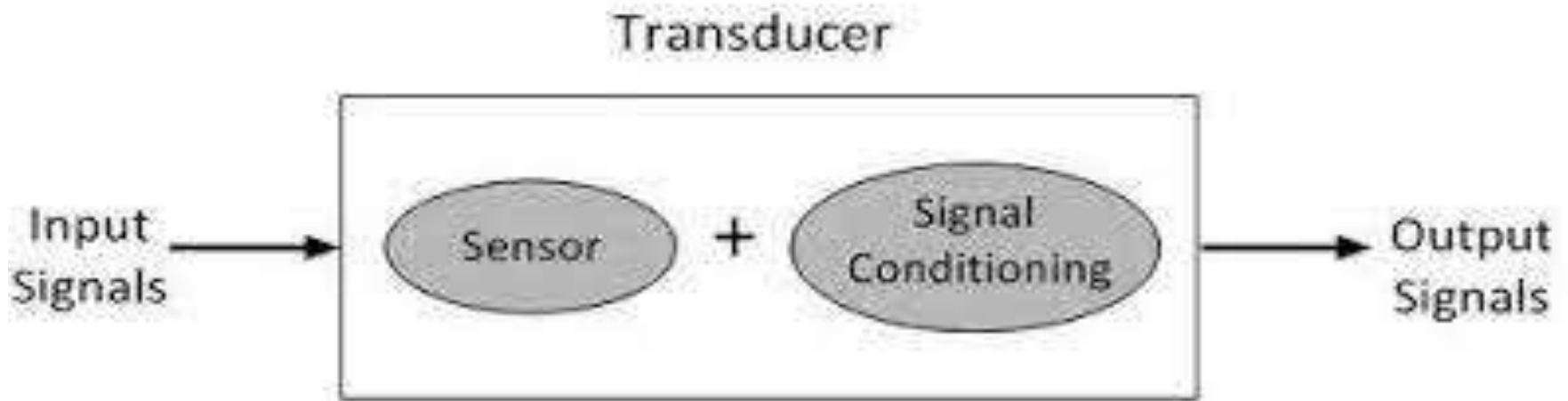
Capable of
•two-way communication
•making decisions
•performing logic functions

Smart Sensors

Definition - A smart sensor is a device that takes input from the physical environment and uses built-in compute resources to perform predefined functions upon detection of specific input and then process data before passing it on.
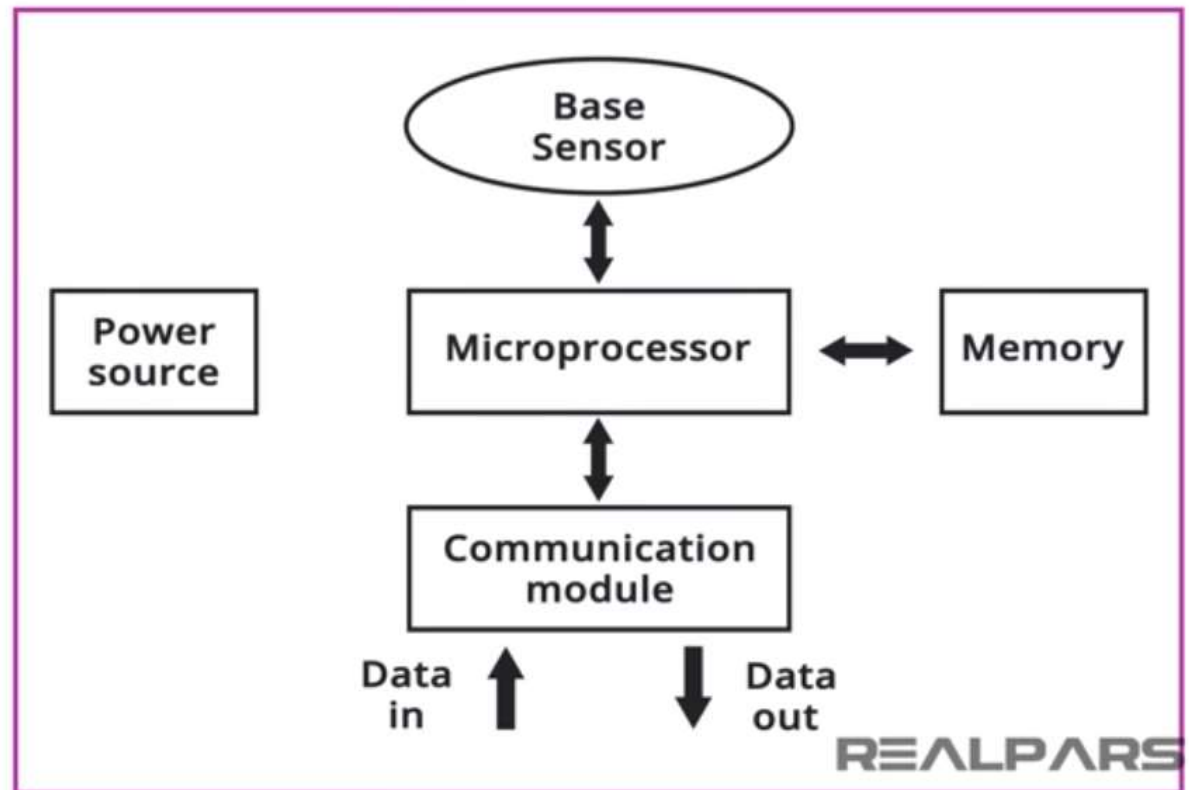
•It is a combination of both sensor and actuator (**A transducer**).

Smart Sensor Architecture
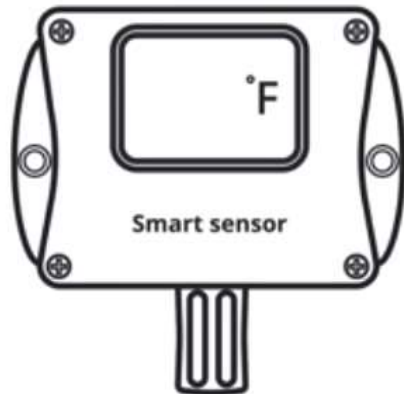
Why Smart Sensors

Smart sensor are capable of variety of functions and options:

- **Self calibration:** Adjust deviation of output of sensor from desired value.

- **Communication:** Broadcast information about its own status.

- **Detect issues :** Like Sensor contamination, Switch failure, Open coils, etc.

- **Multisensing:** A single smart sensor can measure pressure, temperature, humidity, gas flow and Infrared.

- **Cost effective:** less hardware and reduction of repetitive testing make smart sensor cost effective.

Advantages of a Smart Sensor

- These are small in size
- These sensors are very easy to use, design & maintain
- The performance level is higher
- Speed of communication & reliability is higher due to the direct conversion with the processor.
- These sensors can perform self-calibration & self-assessments.
- These sensors can notice issues like switch failures, open coils & sensor contamination.
- These sensors optimize manufacturing processes easily that need changes.
- They can store many systems' data.

Disadvantages of a Smart Sensor

- Smart sensors' reliability is one of the major drawbacks because if they are stolen or get damaged then they can affect a lot of systems badly.
- It needs both sensors & actuators.
- Sensor calibration has to be managed by an external processor.
- High complexity in wired smart sensors, so the cost is also very high

Normal Sensor Vs. Smart Sensor

Normal Sensor	Smart Sensor
A sensor is a device used to detect the physical changing & chemical environment.	The part of a sensor is known as a smart sensor that is used for the computer.
Normal sensor output cannot be used directly because we should convert it into a usable format.	The output of the smart sensor is ready to use.

Normal Sensor Vs. Smart Sensor

Normal Sensor	Smart Sensor
Normal sensors are preferred when an engineer designing a device that requires complete control on sensor input	Smart sensors are generally preferred over base sensors because they include native processing capabilities.
Normal sensors are not expensive because they contain fewer components	Smart sensors are expensive as compared to normal sensors.

Application of Smart Sensor

Optical sensor

Optical sensor is one of the examples of smart sensor, which are used for measuring exposure in cameras, optical angle encoders and optical arrays. Similar examples are load cells silicon based pressure sensors.

Application of Smart Sensor

Integrated Multisensor

This chip contains MOS(Multi Oxide Semiconductor) devices for signal conditioning with on chip sensor. it is developed in university of California.

Application of Smart Sensor in Industries

Structural Monitoring : It is needed to detect damages of industrial infrastructure.