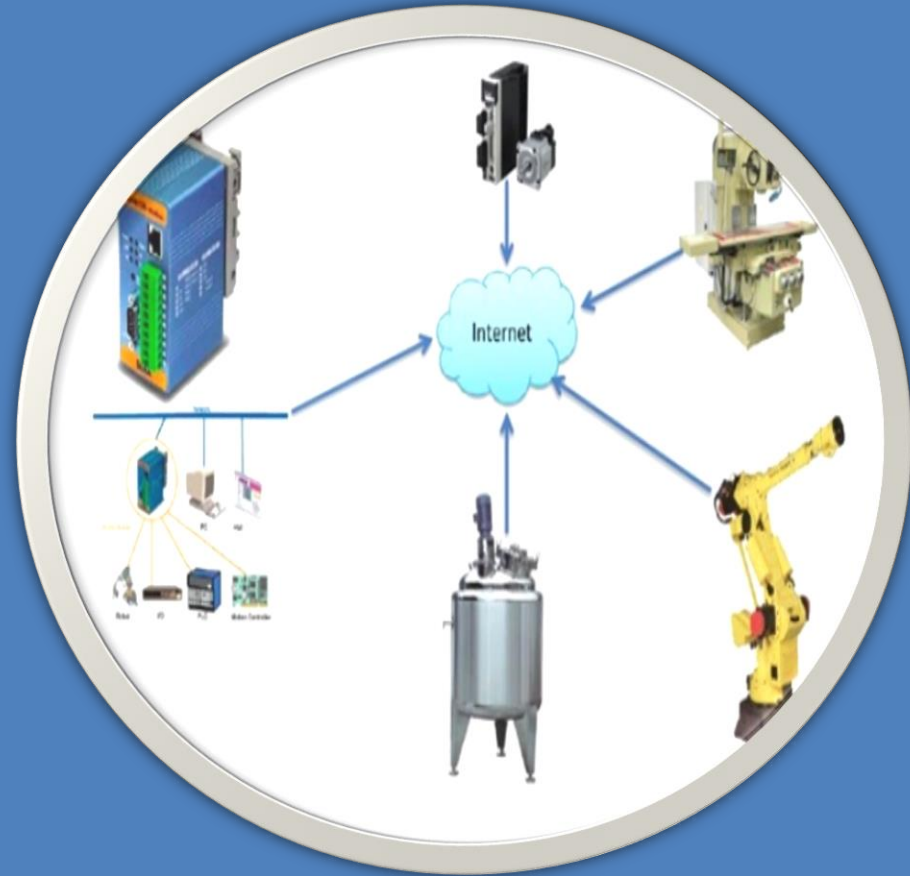


Sensors and Actuators

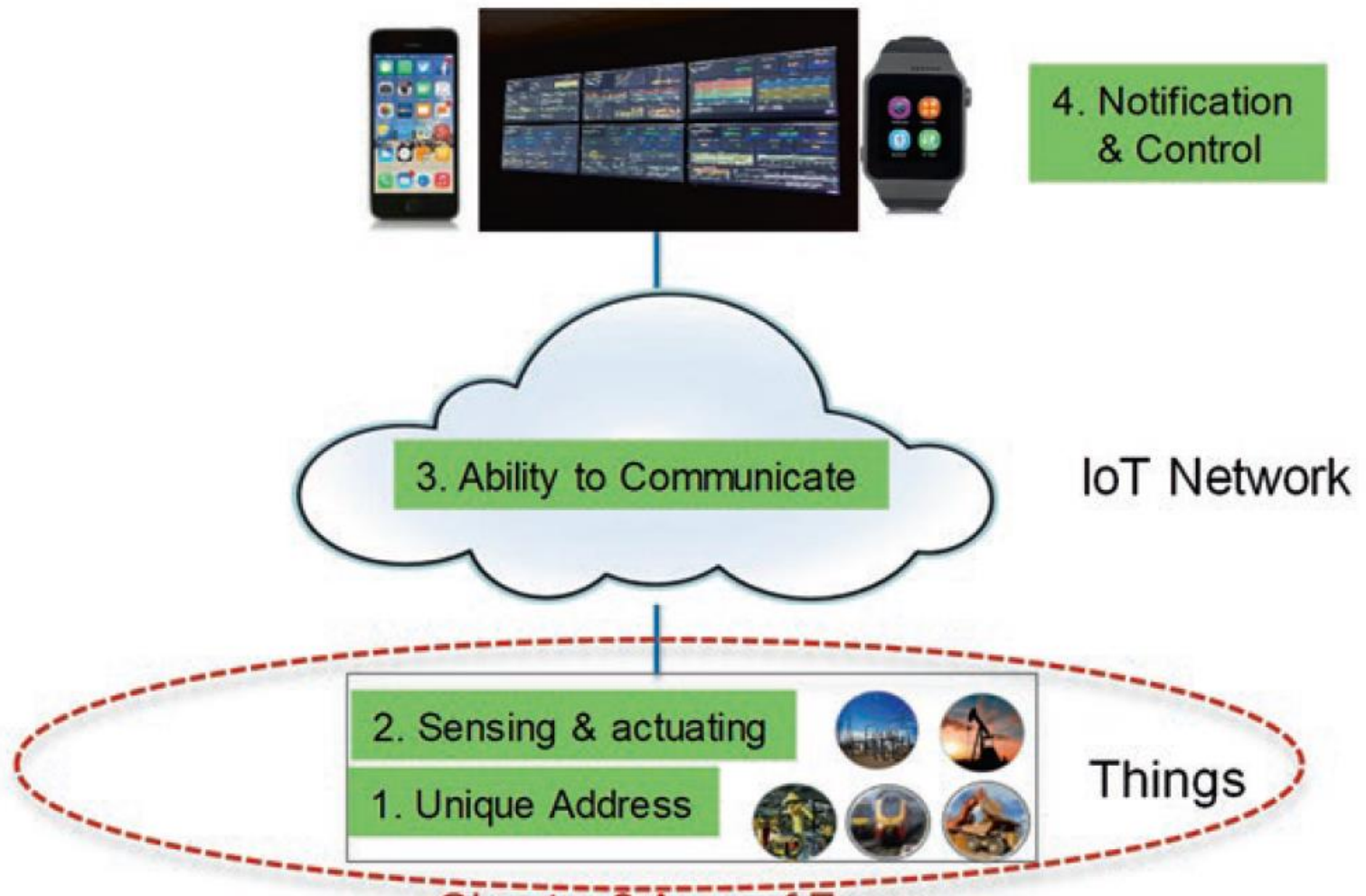
Presented by
Dr. Amany AbdElSamea



Outline

- Sensor definition
- Components of smart sensors
- Sensor types
- Actuators
- Sensor vs. Actuators
- Actuator types

“Thing” in IoT

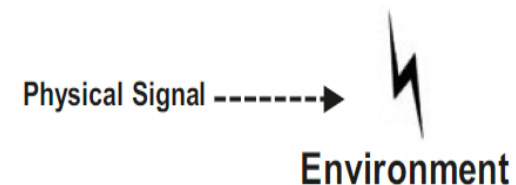
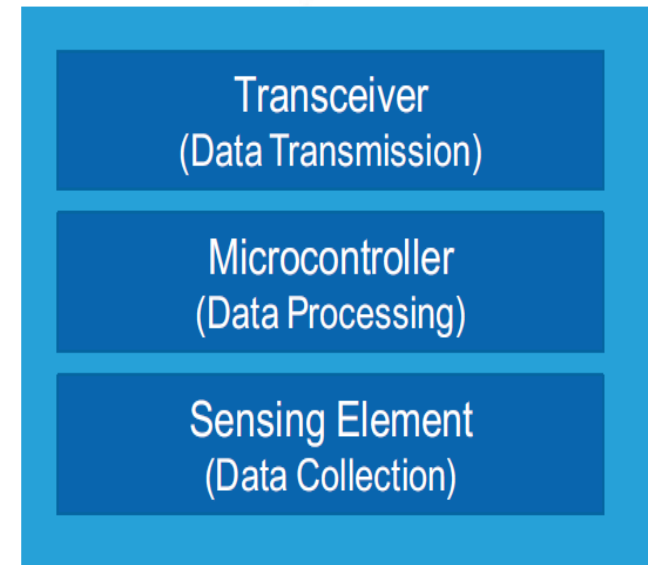
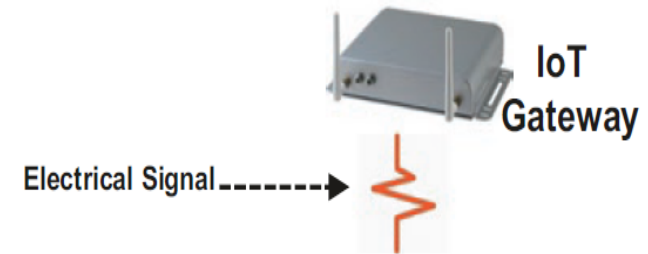


Definition of Sensor

- A sensor is a device (typically electronic) that detects events or changes in its physical environment (e.g., temperature, sound, heat, pressure, flow, magnetism, motion, chemical and biochemical parameters) and provides a corresponding output.
- Most sensors take analog inputs and deliver digital, often electrical, outputs.

Components of Smart Sensors

- Collects and transmits data and only notifies the IoT gateway when very specific conditions are met.
- IoT sensing device requires at least three elements:
 - sensor(s),
 - microcontrollers, and
 - connectivity to send filtered data to IoT gateway or other systems.



Sensor Types

Most common types of sensors include:

1. Temperature Sensors
2. Proximity Sensor
3. Infrared Sensors
4. Ultrasonic Sensors
5. Smoke and Gas Detector
6. Humidity Sensors
7. Motion Detection Sensors
8. Sound Sensors

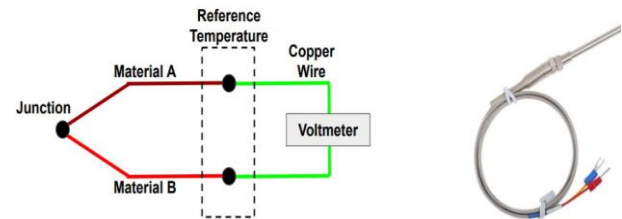
Temperature Sensors

- One of the most common and popular sensors. It measures the changes in the temperature correspond to change in its physical property like resistance or voltage.

There are four types of temperature sensors:

i. Thermocouple Sensors:

- A thermocouple is the most commonly used types of temperature sensors consisting of two different and dissimilar conductors (Hot and Cold junctions) in contact or welded together at one end
- It produces a voltage as a result of the thermoelectric effect (temperature difference).



ii. Resistance Temperature Detector (RTD) Sensors:

- RTD works on the principle that any change in temperature results in a change in the electrical resistance of the conductive material
- Are temperature sensing devices whose resistance changes with temperature.
- Used to measure temperature in laboratory and industrial processes.
- Have developed a reputation for accuracy, repeatability, and stability.



Temperature Sensors

iii. Thermistors:



- Thermistors are thermally sensitive resistors. Similar to RTD, thermistor electrical resistance changes with temperature change
- But thermistors are different from RTD because thermistors use resistive material instead of conductive materials used in RTD
- Therefore change in resistance in the thermistor is higher compared to RTD

iv. Semiconductor Sensors:



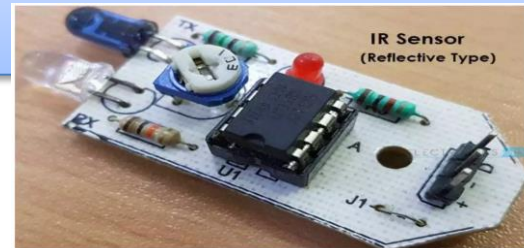
- It consists of temperature-sensitive voltage and current diodes. A voltage or current passing through diodes changes with a temperature change
- Modern semiconductor temp. sensors offer high accuracy and high linearity over an operating range of about 55 °C to +150 °C (–58 to 302 °F).

Proximity Sensor

- A Proximity Sensor is a non-contact type sensor that detects the presence of an object. Proximity Sensors can be implemented using different techniques like Optical (like Infrared or Laser), Ultrasonic, Hall Effect, Capacitive, etc.
- Some of the applications of Proximity Sensors are Mobile Phones, Cars (Parking Sensors), industries (object alignment), Ground Proximity in Aircrafts, etc.



Infrared Sensor



Infrared Sensor (IR Sensor)

- IR Sensors or Infrared Sensor are light based sensor that are used in various applications like Proximity and Object Detection. IR Sensors are used as proximity sensors in almost all mobile phones.
- There are two types of Infrared or IR Sensors: **Transmissive Type and Reflective Type**.
- In **Transmissive Type IR Sensor**, the IR **Transmitter** (usually an **IR LED**) and the **IR Detector** (usually a Photo Diode) are positioned facing each other so that when an object passes between them, the sensor detects the object.
- The other type of IR Sensor is a **Reflective Type IR Sensor**. In this, the **transmitter and the detector** are positioned adjacent to each other facing the object. When an object comes in front of the sensor, the sensor detects the object.
- Different applications where IR Sensor is implemented are Mobile Phones, Robots, Industrial assembly, automobiles etc.

Ultrasonic Sensor

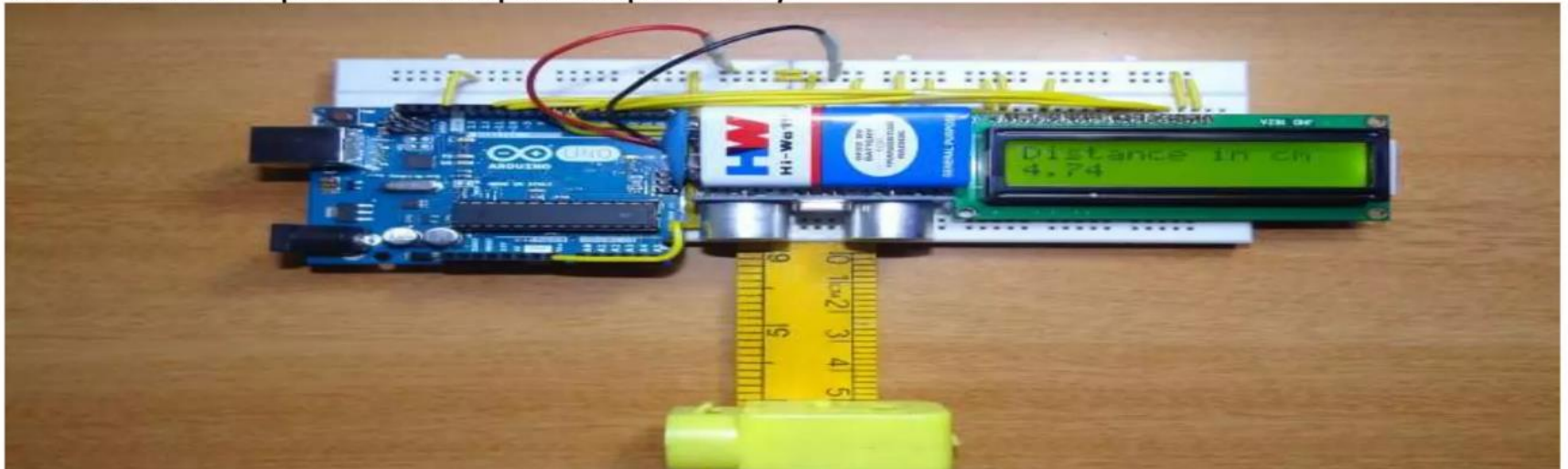
- An Ultrasonic Sensor is a non-contact type device that can be used to measure distance as well as velocity of an object. An Ultrasonic Sensor works based on the properties of the sound waves with frequency greater than that of the human audible range.



Ultrasonic Sensor

Ultrasonic Sensor cont.,

- Ultrasonic means nothing but the range of the frequencies. Its range is greater than audible range (>20 kHz)
- This ultrasonic sensor is *used to calculate the distance between the ultrasonic transmitter and the target and also used to measure the velocity of the target.*
- **Ultrasonic sensor HC-SR04** can be used to measure distance in the range of 2cm-400cm with an accuracy of 3mm.
- The 4 pins of Ultrasonic sensor are Vcc, Gnd, Trig and Echo. Trig is connected to Pin 11 of Arduino and Echo is connected to Pin 10. With respect to Arduino, Pins 10 and 11 are input and output respectively.

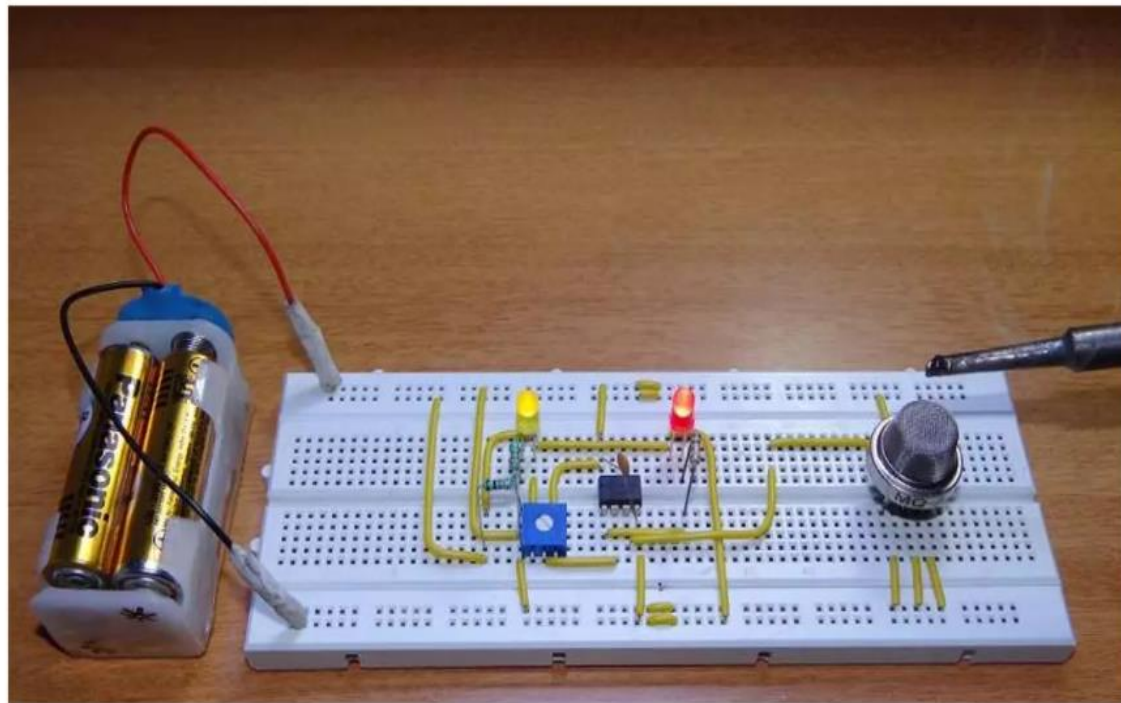


Smoke and Gas Detector

- smoke and gas detector is a gadget that sense gas, smoke and typically it's an indicator of fire. Now a days all security devices using this sensor to passing signal to fire alarm to control panel. Household smoke detector is also known as smoke alarm, most of the device manufacturer using audible or visual alarm system in security devices that detect automatically.

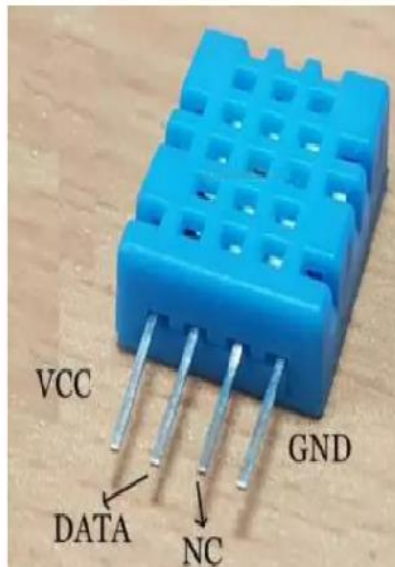


1 = Output
2 = Vcc (positive voltage)
3 = Gnd



Humidity Sensor

- A humidity sensor (or hygrometer) senses, measures and reports both **moisture and air temperature**. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called **relative humidity(RH)**. Relative humidity becomes an important factor when looking for comfort.



Motion Detection Sensor

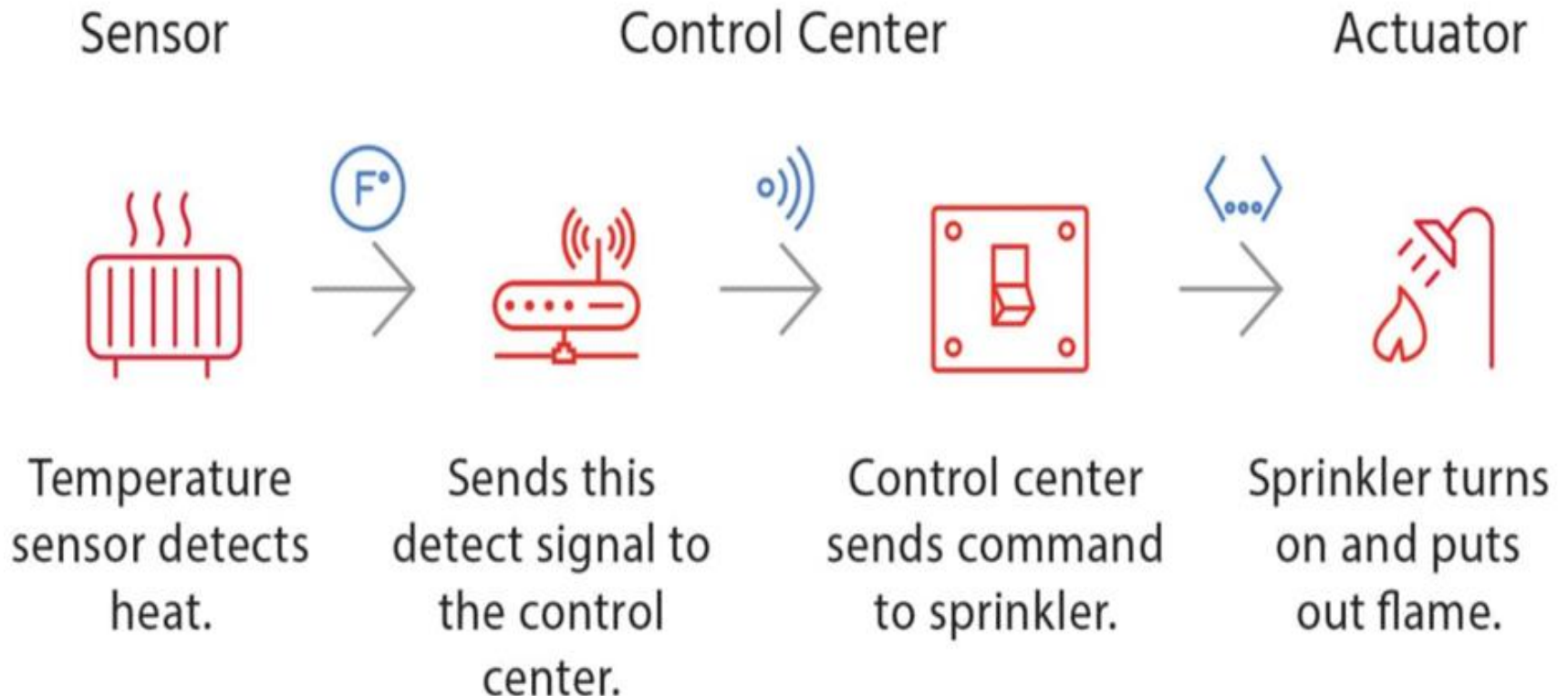
- A motion detector is an electronic device which is used to detect the physical movement (motion) in a given area and it transforms motion into an electric signal; motion of any object or motion of human beings.
- These are primarily used for intrusion detection systems, automatics door control, boom barrier, smart camera (i.e motion based capture/video recording), toll plaza, automatic parking systems, automated sinks/toilet flusher, hand dryers, energy management systems(i.e. Automated Lighting, AC, Fan, Appliances Control) etc.
- **Following are key motion sensor types widely used:**
- **Passive Infrared (PIR):** It Detects body heat (infrared energy) and the most widely used motion sensor in home security systems.
- **Ultrasonic:** Sends out pulses of ultrasonic waves and measures the reflection off a moving object by tracking the speed of sound waves.
- **Microwave:** Sends out radio wave pulses and measures the reflection off a moving object. They cover a larger area than infrared & ultrasonic sensors, but they are vulnerable to electrical interference and more expensive.

Sound Sensor

- The sound sensor is one type of module used to notice the sound. Generally, this module is used to detect the intensity of sound.
- This sensor employs a microphone to provide input to buffer, peak detector and an amplifier. This sensor notices a sound, & processes an o/p voltage signal to a microcontroller. After that, it executes required processing.



Sensor to Actuator Flow



Why Actuators?

- Sensors:
 - sense changes in their surroundings,
 - collect relevant data, and
 - make data available to monitoring systems.
- Collecting and displaying data by a monitoring system is useless unless such data is translated into intelligence that can be used to control an environment.
- Actuators use sensor-collected and analyzed data as well as other types of data intelligence to control IoT systems.
- e.g.: shutting down gas flow when the measured pressure is below a certain threshold.

Sensors vs. Actuators

SENSOR

A device that detects events or changes in the environment and sends that information to other electronic devices

Connected to the input ports of the system

Help to monitor the changes in the environment

Output is an electrical signal

Ex: biosensors, image sensors, motion sensors, chemical sensors

ACTUATOR

A component of a machine that is responsible for moving and controlling mechanism

Connected to the output ports of the system

Helps to control the environment or physical changes

Output is a movement

Ex: electric motors, stepper motors, comb drives, and hydraulic cylinders

Actuator Types

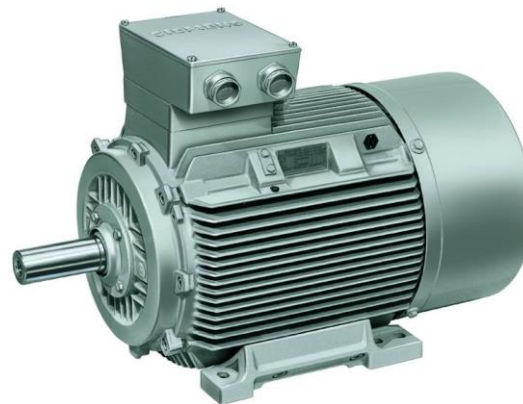
1. Electrical Actuators:

- Electric actuators are devices driven by small motors that convert energy to mechanical torque.
- The created torque is used to control certain equipment that requires multi-turn valves or to control gates.
- Electric actuators are also used in engines to control different valves.
- e.g.: Electric Motors: DC motors, AC motors, Stepper motors.



Electric Motor as Actuator

- An electric motor is an actuator which provides rotatory motion or linear movement.
- Automated systems use motors to rotate microwave oven turntables, washing machine drums, hard disk drives in computers, optical disks in computers and CD and DVD players.
- Electric motor is also used in feed rollers and drums in printers, fans in heating, ventilating and air conditioning systems.



Light Bulbs & LEDs as Actuator

- It is really amazing to know that we can also use light bulbs and LED (Light Emitting Diode) as actuators.
- These bulbs or LEDs can be used as indicators in various systems to show the status of an equipment such as blinking LED as warning of fault in an equipment.



Motorized Pump as Actuator

- A motorized pump forms as actuator that moves gases or liquids.
- Automated systems use pumps to move water in dishwashers, washing machines, water filled heating systems, refrigerants in heat pumps, gases and liquids in industrial processes.
- An automatic blood pressure monitor uses an air pump to inflate its cuff.
- A motorized fan is a low pressure pump for gases.



Buzzer as Actuator

- A buzzer is an audio signaling device that makes a rasping sound.
- Automated systems use buzzers or similar actuators such as bells, beepers or sirens to indicate an event to the user.
- For example, a beeper can make a sound when a microwave oven finishes heating.
- A siren can sound when a fire alarm detects a fire.



Questions