

1. **Temperature Sensor**
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1) Temperature Sensor

A Temperature Sensor is a device which is used to measure heat or temperature on the operating machine part. Temperature sensing is performed by gadget called Thermocouple. A thermocouple is a temperature-measuring device consisting of two dissimilar conductors that contact each other at one or more points. It produces a voltage when the temperature of one of the points differs from the reference temperature at other parts of the circuit.



Sub-types of the Temperature Sensors are:

- a. Thermocouples: These are voltage devices that indicate temperature measuring with a change in voltage. As temperature goes up, the output voltage of the thermocouple rises.

- b. Resistor temperature detectors (RTD): The resistance of the device is directly proportional to the temperature, increase in a positive direction when the temperature rises resistance going up.

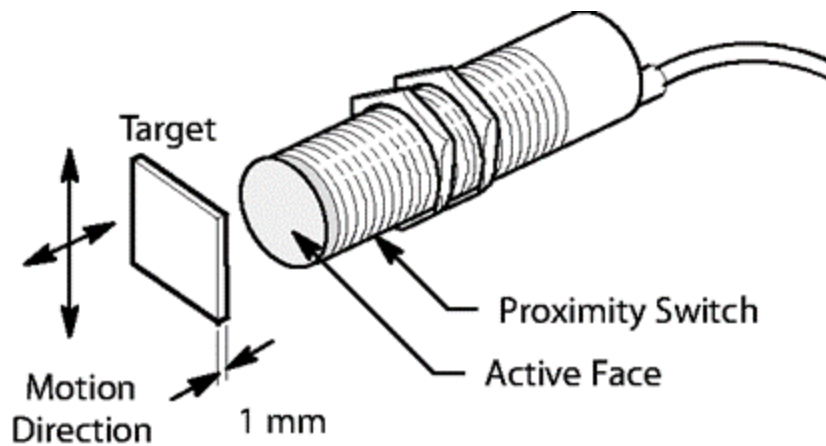
- c. Thermistors: It is a temperature sensitive resistor that changes its physical resistance with the change in temperature.

- d. IC (Semiconductor): They are linear devices where the conductivity of the semiconductor increases linearly and it takes advantage of the variable resistance properties of semiconductor materials. It can provide a direct temperature reading in digital form, especially at low temperatures.

- e. Infrared sensors: It detects temperature by intercepting a portion of emitted infrared energy of the object or substance, and sensing its intensity, can be used to measure temperature of solids and liquids only, Not possible to use it on gases because of their transparent nature.

2) Proximity Sensor

Proximity sensor is using to detect the motion and very common to use in retail shop, through this device retailer will use customer's proximity to any product and same time they can sent the coupons and deals to the customer's mobile or on email. Now a days proximity sensor are using to check the availability or free spaces like parking space, sitting spaces in sports stadium, mall and airports.



a. Inductive Sensors: Inductive proximity sensors are used for non-contact detection to find out the presence of metallic objects using electromagnetic field or a beam of electromagnetic radiation. It can operate at higher speeds than mechanical switches and also seems more reliable because of its robustness.

b. Capacitive Sensors : Capacitive proximity sensors can detect both metallic as well as non-metallic targets. Nearly all other materials are dielectric different from air. It can be used to sense very small objects through a large portion of target. So, generally used in difficult and complicated applications.

c. Photoelectric Sensors : Photoelectric sensor is made up of light-sensitive parts and uses a beam of light to detect the presence or absence of an object. It is an ideal alternative of inductive sensors. And used for long distance sensing or to sense non-metal object.

d. Ultrasonic Sensors: Ultrasonic sensors are also used to detect the presence or to measure the distance of targets similar to radar or sonar. This makes a reliable solution for harsh and demanding conditions.

3) Pressure Sensor

A pressure sensor is a gadget equipped with a pressure-sensitive element that's used to measure the pressure of a liquid or a gas against a diaphragm made of silicon, stainless steel, etc., and converts the measured value into an electrical signal as an output. It's also use to measure the water flow through pipes or tank and notify the concern person when something need to be fixed. Now a days pressure sensor is used in aircraft and vehicles to determine the altitude and force, continuously.



4) Water Quality Sensor

Water quality sensors are mainly used to measure a dozen of the most relevant water quality parameters. Wasp-mote Smart Water is the first water quality-sensing platform to feature autonomous nodes that connect to the Cloud for real-time water control. It's used to measure quality of sea water, river water and etc.



a. Chlorine Residual Sensor: It measures chlorine residual (i.e. free chlorine, monochloramine & total chlorine) in water and most widely used as disinfectant because of its efficiency.

b. Total organic carbon Sensor: TOC sensor is used to measure organic element in water.

c. Turbidity Sensor: Turbidity sensors measure suspended solids in water, typically it is used in river and stream gaging, wastewater and effluent measurement.

d. Conductivity Sensor: Conductivity measurements are carried out in industrial processes primarily to obtain information on total ionic concentrations (i.e. dissolved compounds) in water solutions.

e. pH Sensor: It is used to measure the pH level in the dissolved water, which indicates how acidic or basic (alkaline) it is.

f. Oxygen-Reduction Potential Sensor : The ORP measurement provides insights into the level of oxidation/reduction reactions occurring in the solution.

5) Chemical/Smoke and Gas Sensor

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

Following are most common kind of chemical sensors in use:

Chemical field-effect transistor

Chemiresistor

Electrochemical gas sensor

Fluorescent chloride sensors

Hydrogen sulfide sensor

Nondispersive infrared sensor
pH glass electrode
Potentiometric sensor
Zinc oxide nanorod sensor

Following are some common Gas sensors:

Carbon dioxide sensor
Breathalyzer
Carbon monoxide detector
Catalytic bead sensor
Hydrogen sensor
Air pollution sensor
Nitrogen oxide sensor
Oxygen sensor
Ozone monitor
Electrochemical gas sensor
Gas detector
Hygrometer

Common Type of Smoke Sensors

Smoke sensors detect the presence of Smoke, Gases and Flame surrounding their field. It can be detected either optically or by the physical process or by the use of both the methods.

Optical smoke Sensor (Photoelectric) : Optical smoke sensor used the light scatter principle trigger to occupants.

Ionization smoke Sensor: Ionization smoke sensor works on the principle of ionization, kind of chemistry to detect molecules causing a trigger alarm.

6) Level Sensor

It's used to detect the level of liquids and other fluids and fluidized solids, including granular materials, slurries and powders that exhibit an upper free surface. Level sensors is also using for water waste management and recycling purpose, like it's using to measure water tank levels, petrol fuel gauging, high or low level alarm, liquid assets inventory and irrigation control.



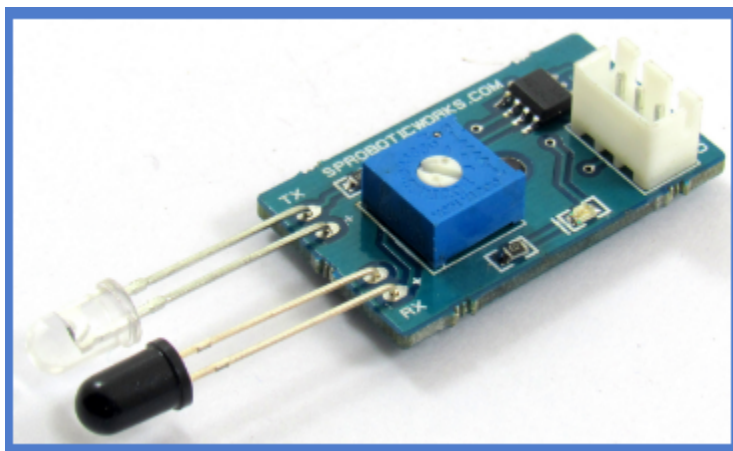
There are two basic level measurement types:

Point level sensors: Point level sensors usually detect the particular specific level and respond to the user if the sensing object is above or below that level. It is integrated into single device to get an alarm or trigger

Continuous level Sensor: Continuous level sensors measure liquid or dry material levels within a specified range and provide outputs which continuously indicate the level. The best example of it is fuel level display in the vehicle.

7) IR Sensor

This smart gadget is used to detect the infrared lights. Infrared sensor visualize the heat leaks in houses, identify environmental chemicals in the environment, and helping doctor to measure patient blood flow. It can be integrated with wearable electronics. A very simple example, all the remotes having IR sensor, it's using to pass the command to respective devices, like TV remote, fan remote, vehicle key remote all having infrared sensor.



8) Ultrasonic Sensor

An Ultrasonic sensor is used to measure the distance between the two object by using sound waves. It's measure distance by sending sound wave at a specific frequency and listen that sound wave house to measure distance. There are two kind of an ultrasonic sensor is, "active ultrasonic sensor" and "passive ultrasonic sensors". An active ultrasonic sensors generates the high frequency sound wave to receive back the ultrasonic sensor for evaluating the echo. But, passive ultrasonic sensors are just used for detecting ultrasonic noise which is present under specific conditions.



9. Image sensors

Image sensors are instruments which are used to convert optical images into electronic signals for displaying or storing files electronically.

The major use of image sensor is found in digital camera & modules, medical imaging and night vision equipment, thermal imaging devices, radar, sonar, media house, Biometric & IRIS devices.

Two main types of sensors are used in: CCD (charge-coupled device) and CMOS (complementary metal-oxide semiconductor) imagers. Although each type of sensor uses different technology to capture images,

Both CCD and CMOS imagers use metal-oxide semiconductors, having the same degree of sensitivity to light, and no inherent quality difference

An average consumer would think that this is a regular camera, but even though this is not far from the truth, image sensors are connected with a wide range of different devices, making their functionality much better.

One of the best-known uses includes the car industry, in which imagery plays a very important role. With these sensors, the system can recognize signs, obstacles and many other things that a driver would generally notice on the road. They play a very important role in IoT industry, as they directly affect the progress of driverless cars.

They are also implemented in improved security systems, where images help capture details about the perpetrator.

In the retail industry, these sensors serve to collect data about customers, helping businesses get a better insight into who is actually visiting their store, race, gender, age are only some of the useful parameters that retail owners get by using these IoT sensors.

10. Motion detection sensors

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

Motion detection plays an important role in the security industry. Businesses utilize these sensors in areas where no movement should be detected at all times, and it is easy to notice anybody's presence with these sensors installed. These are primarily used for intrusion detection systems, Automatic 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.

On the other hand, these sensors can also decipher different types of movements, making them useful in some industries where a customer can communicate with the system by waving a hand or by performing a similar action. For example, someone can wave to a sensor in the retail store to request assistance with making the right purchase decision.

Even though their primary use is correlated with the security industry, as the technology advances, the number of possible applications of these sensors is only going to grow.

Following are key motion sensor types widely used:

a. Passive Infrared (PIR) : It Detects body heat (infrared energy) and the most widely used motion sensor in home security systems.

b. Ultrasonic : Sends out pulses of ultrasonic waves and measures the reflection off a moving object By tracking the speed of sound waves.

c. 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.

11. Accelerometer sensors

Accelerometer is a transducer that is used to measure the physical or measurable acceleration experienced by an object due to inertial forces and converts the mechanical motion into an electrical output. It is defined as rate of change of velocity with respect to time

These sensors are now present in millions of devices, such as smartphones. Their uses involve detection of vibrations, tilting and acceleration in general. This is great for monitoring your driving fleet, or using a smart pedometer. In some instances, it is used as a form of anti-theft protection, as the sensor can send an alert through the system if an object that should remain stationary is moved.

They are widely used in cellular & media devices, vibration measurement, Automotive control and detection, free fall detection, aircraft and aviation industries, movement detection, sports academy/athletes behavior monitoring, consumer electronics, industrial & construction sites etc.

There are various kinds of accelerometers and following are few mainly used in IoT projects:

a. Hall-effect accelerometers : Hall-effect accelerometers are using Hall principle to measure the acceleration, it measures the voltage variations caused by changes in a magnetic field around them.

b. Capacitive accelerometers : Capacitive accelerometers sensing output voltage depends on the distance between two planar surfaces. Capacitive accelerometers are also less prone to noise and variation with temperature.

c. Piezoelectric accelerometers: Piezoelectric sensing principle is working on the piezoelectric effect. Piezo-film based accelerometers are best used to measure vibration, shock, and pressure.

Each accelerometer sensing technology has its own advantages and compromises. Before selecting, it's important to understand the basic differences of the various types and the test requirements.

12. Gyroscope sensors

Gyroscope sensors :

A sensor or device which is used to measure the angular rate or angular velocity is known as Gyro sensors, Angular velocity is simply defined as a measurement of speed of rotation around an axis. It is a device used primarily for navigation and measurement of angular and rotational velocity in 3-axis directions. The most important application is monitoring the orientation of an object.

Their main applications are in Car navigation systems, Game controllers, Cellular & camera devices, consumer electronics, Robotics control, Drone & RC control helicopter or UAV control, Vehicle control/ADAS and many more.

There are several different kinds of gyro sensors which are selected by their working mechanism, output type, power, sensing range and environmental conditions.

- a. Rotary (classical) gyroscopes
- b. Vibrating Structure Gyroscope
- c. Optical Gyroscopes
- d. MEMS(micro-electro-mechanical systems) Gyroscopes

These sensors are always combined with accelerometers. The use of these two sensors simply provides more feedback to the system. With gyroscopic sensors installed, many devices can help athletes improve the efficiency of their movements, as they gain access to the athletes movement during sports activities.

This is only one example of its application, however, as the role of this sensor is to detect rotation or twist, its application is crucial for the automation of some manufacturing processes.

13. Humidity sensors

Humidity is defined as the amount of water vapour in an atmosphere of air or other gases. The most commonly used terms are “Relative Humidity (RH)

These sensors usually follow the use of temperature sensors, as many manufacturing processes require perfect working conditions. Through measuring humidity, you can ensure that the whole process runs smoothly, and when there is any sudden change, action can be taken immediately, as sensors detect the change almost instantaneously. Their applications and use can be found in Industrial & residential domain for heating, ventilating, and air conditioning systems control.

They can also be found in Automotive, museums, industrial spaces and greenhouses , meteorology stations,Paint and coatings industries, hospitals & pharma industries to protect medicines

14. Optical sensors

A sensor which measures the physical quantity of light rays and convert it into electrical signal which can be easily readable by user or an electronic instrument/device is called optical sensor. Optical sensors are loved by IoT experts, as they are practical for measuring different things simultaneously. The technology behind this sensor allows it to monitor electromagnetic energy, which includes, electricity, light and so on.

Due to this fact, these sensors have found use in healthcare, environment monitoring, energy, aerospace and many more industries. With their presence oil companies, pharmaceutical companies and mining companies are in a much better position to track environmental changes while keeping their employees safe.T

Their main use can be found in Ambient light detection, digital optical switches, optical fibres communications,due to Electrical isolation best suited for oil and gas applications, civil and transportation fields, High speed network systems, elevator door control, assembly line part counters and safety systems.

Following are key type of optical sensors:

- a. Photodetector: It uses light sensitive semiconductor materials like photocells,photodiodes or phototransistors to work as photodetector
- b. Fiber Optics : Fibers optics carry no current, So its immune to electrical & electromagnetics interference and even in damaged condition no sparking or shock hazard happens.
- c. Pyrometer : It estimates the temperature of an object by sensing the color of the light and Objects radiate light according to their temperature and produce same colors at same temperature.
- d. Proximity & Infrared : Proximity use light to sense objects nearby and Infrared are used where visible light would be inconvenient.