GANPAT UNIVERSITY

U. V. Patel College of Engineering

To study Sensors and Actuators.

2CEIT6PE9: Internet of Things

B.Tech Semester: VI

Computer Engineering/ Information Technology

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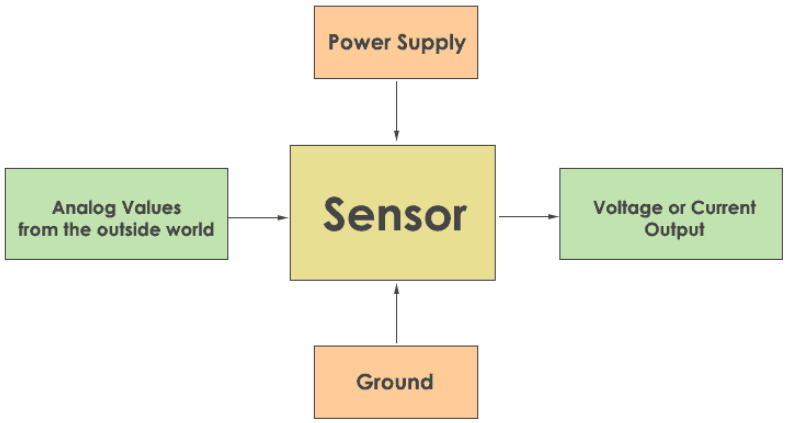
Aim: To study Sensors and Actuators.

- **SENSORS**

A sensor is a transducer that receives and responds to a signal or stimulus from a physical system. It produces a signal, which represents information about the system, which is used by some type of telemetry, information or control system.



Generally speaking, a sensor is a device that is able to detect changes in an environment. By itself, a sensor is useless, but when we use it in an electronic system, it plays a key role. A sensor is able to measure a physical phenomenon (like temperature, pressure, and so on) and transform it into an electric signal. These three features should be at the base of a good sensor :

- It should be sensitive to the phenomenon that it measures
- It should not be sensitive to other physical phenomena
- It should not modify the measured phenomenon during the measurement process

There is a wide range of sensors we can exploit to measure almost all the physical properties around us. A few common sensors that are widely adopted in everyday life include thermometers, pressure sensors, light sensors, accelerometers, gyroscopes, motion sensors, gas sensors and many more. A sensor can be described using several properties, the most important being:

- Range: The maximum and minimum values of the phenomenon that the sensor can measure.
- Sensitivity: The minimum change of the measured parameter that causes a detectable change in output signal.
- Resolution: The minimum change in the phenomenon that the sensor can detect.

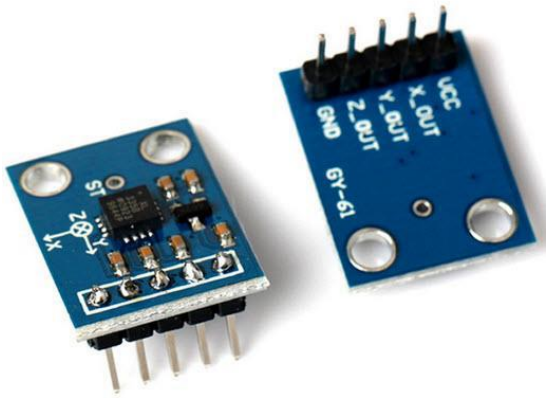
TYPES of Sensors

All sensors used for implementations of IOT application classify in two major category; analog and digital sensors.

- **Accelerometers**

The name itself indicates that these are the type of analog sensors where those can be utilized to detect changes in acceleration applied on the sensor. Acceleration also corresponds to the change in the values of velocity, vibration, position, and tilt by detecting motion. These accelerometers deliver two kinds of data.

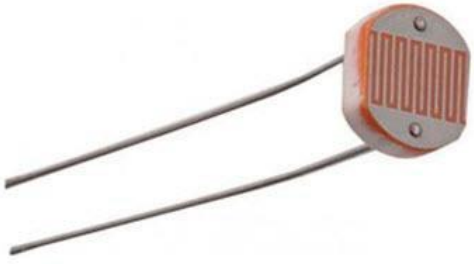
These accelerometers are available as analog and digital sensors, based on the output signal. Analog accelerometer produces a constant variable voltage based on the amount of acceleration applied to the accelerometer.



- **Light Sensors**

Analog sensors that are used for detecting the amount of light striking the sensors are called as light sensors. These analog light sensors are again classified into various types such as photo-resistor, Cadmium Sulfide (CdS), and, photocell.

Light dependent resistor (LDR) can be used as analog light sensor which can be used to switch on and off loads automatically based on the day light incident on the LDR. The resistance of the LDR increases with decrease in light and decreases with increase in light.



- **Sound Sensors**

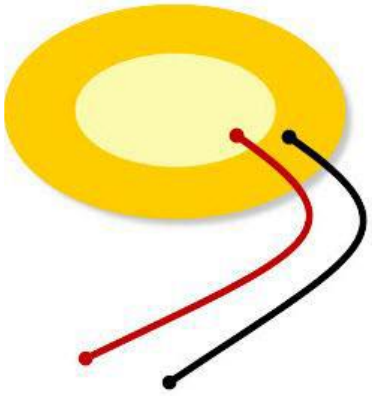
  Apart from building various electronic projects with Arduino (covered in the later section) and more, sound sensors are used in many other day to day applications including:

  - Consumer electronics such as phones, computers, music systems
  - Security and Monitoring systems such as burglar alarms, door alarm, etc.
  - Home automation such as lighting your house by detecting whistle/clap instead of physically turning the light switch
  - Ambient sound recognition and sound level recognition

- **Pressure Sensor**

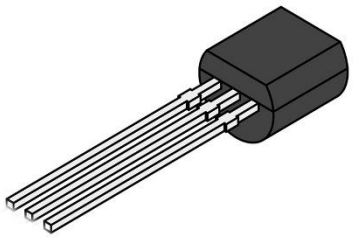
  A pressure sensor is a device that senses pressure and converts it into an electric signal. Here, the amount depends upon the level of pressure applied.

  There are plenty of devices that rely on liquid or other forms of pressure. These sensors make it possible to create IoT systems that monitor systems and devices that are pressure propelled. With any deviation from standard pressure range, the device notifies the system administrator about any problems that should be fixed.



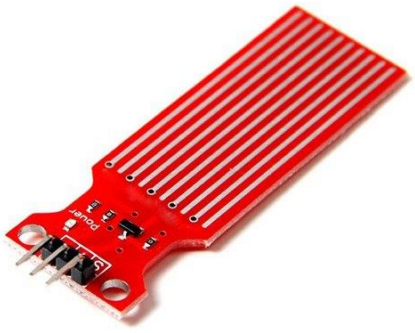
- **Analog Temperature sensor**

  Temperature sensors are widely available as both digital and analog sensors. Typically used analog temperature sensors are thermistors. There are different types of thermistors that are used for different applications. Thermistor is a thermally sensitive resistor that is used for detecting changes in temperature. If the temperature increases, then the electrical resistance of thermistor increases. Similarly, if temperature decreases, then the resistance decreases. It is used in various temperature sensor applications.



- **Water Level Sensor**

  Level sensors are used to detect the level of substances that can flow. Such substances include liquids, slurries, granular material and powders. Level measurements can be done inside containers or it can be the level of a river or lake. Such measurements can be used to determine the amount of materials within a closed container or the flow of water in open channels.



  - Operating voltage: DC3-5V
  - Operating current: less than 20mA
  - Sensor Type: Analog
  - Detection Area: 40mmx16mm
  - Humidity: 10% -90% non-condensing
  - Product Dimensions: 62mmx20mmx8mm

DIGITAL SENSORS:

Electronic sensors or electrochemical sensors in which data conversion and data transmission takes place digitally are called as digital sensors. These digital sensors are replacing analog sensors as they are capable of overcoming the drawbacks of analog sensors. The digital sensor consists of majorly three components: senor, cable, and transmitter.

In digital sensors, the signal measured is directly converted into digital signal output inside the digital sensor itself. And this digital signal is transmitted through cable digitally. There are different types of digital sensors that overcome disadvantages of analog sensors

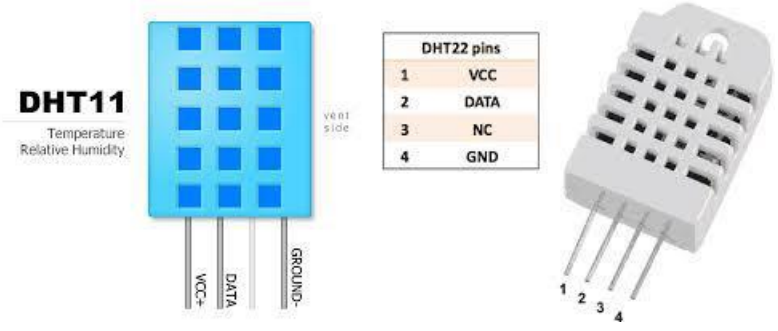
- **Digital Temperature and Humidity Sensor**

DHT11 and DHT22 digital temperature sensor available for measurement of temperature and humidity

The DHT11 sensor includes a resistive-type humidity measurement component, an NTC temperature measurement component and a high-performance 8-bit microcontroller inside, and provides calibrated digital signal output.

- Power Supply: 3.3~5.5V DC
- Output: 4 pin single row
- Measurement Range: Humidity 20-90%RH, Temperature 0~50℃
- Accuracy: Humidity +-5%RH, Temperature +-2℃
- Resolution: Humidity 1%RH, Temperature 1℃
- Interchangeability: Fully Interchangeable
- Long-Term Stability: <±1%RH/year

It has high reliability and excellent long-term stability



DHT22

DHT22 includes a capacitive sensor wet components and a high-precision temperature measurement devices, and connected with a high-performance 8-bit microcontroller. The sensor has excellent quality, fast response, strong anti-jamming capability, and high cost. Standard single-bus interface, system integration quick and easy. Small size, low power consumption, signal transmission distance up to 20 meters, making it the best choice of all kinds of applications and even the most demanding applications.

- **Ultrasonic Sensor**

  An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

- **IR Sensor (Obstacle sensor)**

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. Infrared radiation was accidentally discovered by an astronomer named William Herchel in 1800. While measuring the temperature

of each color of light (separated by a prism), he noticed that the temperature just beyond the red light was highest. IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum). Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation.

- **Gas Sensor**

  It is a hazardous gas detection apparatus for the family, the environment, suitable for ammonia, aromatic compounds, Sulphur, benzene vapors, smoke and other gases harmful gas detection, gas-sensitive element test. Air quality sensor is for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory with simple drive and monitoring circuit.

- **Human/Metal Touch Sensor**

  The module is based on a touch-sensing IC (TTP223B) capacitive touch switch module. In the normal state, the modules output is low, lower power consumption; when a finger touches the corresponding position, the modules output is high, if not touched for 12 seconds, it switches to low-power mode. Jog type : the initial state is lower , higher touch , do not touch is lower (similar touch of a button feature) This Module can be installed in such as surface plastic, glass of non-metallic materials. In addition to the thin paper (non-metallic) covering the surface of the module , as long as the correct location of the touch , you can make hidden in the walls, desktops and other parts of buttons

- **Line Tracker Sensor**

  Line Tracker sensor consists of 3 IR transmitter and IR receiver pairs. This tracker sensor is typically used for robots in line following task. It can be used for either dark or bright line following. The tracker sensors have 3 digital outputs to user indicating the existence of the line. Every sensor is provided with its own LEDs as indication of line detection

Actuators

- **Relay**

  Think of a relay as an electronic light switch. To turn the light on, flick the switch up. To turn the light off, flick the switch down. A light switch simply closes (or completes) an electrical circuit to turn on a light and opens (or breaks) a circuit to turn off the light. A relay does this same exact thing except that the switch is powered not by hand but by a low-power signal. There are different types of relays and they differ by the types of poles and throws.

- **DC Motor**

  A DC motor (Direct Current motor) is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction

- **Servo Motor**

  A Servo Motor is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. If the coded signal changes, the angular position of the shaft changes. In practice, servos are used in radio-controlled airplanes to position control surfaces like the elevators and rudders. They are also used in radio-controlled cars, puppets, and of course, robots.

  Servos are extremely useful in robotics. The motors are small, have built-in control circuitry, and are extremely powerful for their size. A standard servo such as the Futaba S-148 has 42 oz/inches of torque, which is strong for its size. It also draws power proportional to the mechanical load. A lightly loaded servo, therefore, does not consume much energy.

- **Stepper Motor**

  A Stepper Motor or a step motor is a brushless, synchronous motor, which divides a full rotation into a number of steps. Unlike a brushless DC motor, which rotates continuously when a fixed DC voltage is applied to it, a step motor rotates in discrete step angles.

  Imagine a motor on an RC airplane. The motor spins very fast in one direction or another. You can vary the speed with the amount of power given to the motor, but you cannot tell the propeller to stop at a specific position.
  Now imagine a printer. There are lots of moving parts inside a printer, including motors. One such motor acts as the paper feed, spinning rollers that move the piece of paper as ink is being printed on it. This motor needs to be able to move the paper an exact distance to be able to print the next line of text or the next line of an image.

  There is another motor attached to a threaded rod that moves the print head back and forth. Again, that threaded rod needs to be moved an exact amount to print one letter after another. This is where the stepper motors come in handy.

- **LCD Display**

  An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7 pixel matrix.