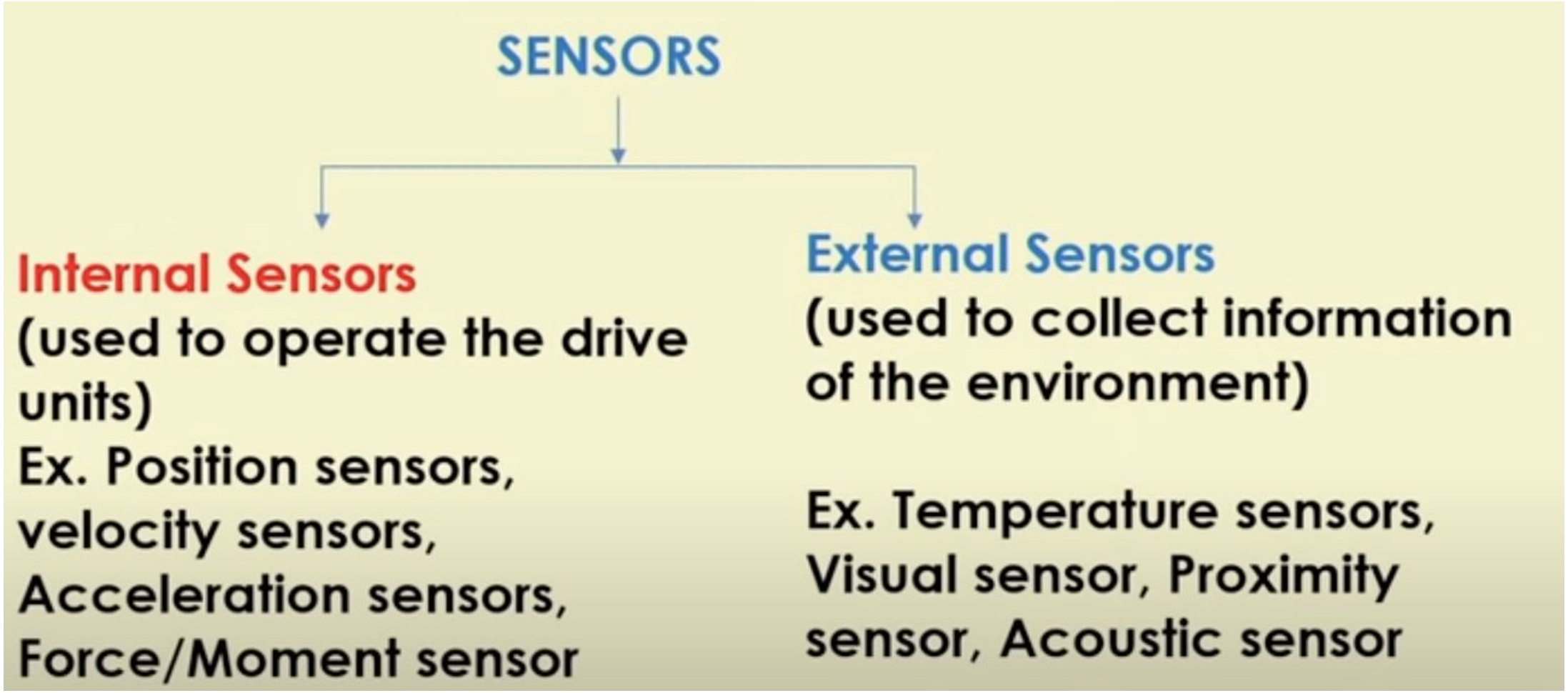
Sensors

SENSORS

- Human-beings collect information of the surroundings using their sensors, namely eyes, ears, nose, skin etc., in order to perform various tasks.
- A sensor is used to take measurement of physical variable.
- A sensor requires calibration
- Sensors are used to build intelligent robots

Classification of Sensors



2.

SENSORS

Contact Sensors

(Physical contact between sensor mounted on robot and object)

Touch sensor/ Tactile sensor/ Binary sensor

(indicates presence or absence of an object)
Ex. Micro-switch, Limit

Force sensor/ Analog sensor

(not only the contact is made but also the force is measured)
Ex. Sensors using strain

Non-Contact Sensors

(No physical contact)
Proximity sensor
Visual sensor
Acoustic sensor
Range sensor

Characteristics of Sensors

- **Range :** Difference between the maximum and minimum values of the input that can be measured.
- **Response :** should be capable of responding to the changes in minimum time.
- **Accuracy :** deviation from exact quantity
- **Sensitivity** = change in output/ change in input
- **Linearity :** constant sensitivity
- **Repeatability :** Deviation from reading to reading, when these are taken for a number of times under identical conditions.
- **Resolution**

Touch Sensor

- Used to indicate whether contact has been made between two objects
- Does not determine the magnitude of contact force
- Ex. : Micro-switch, Limit switch

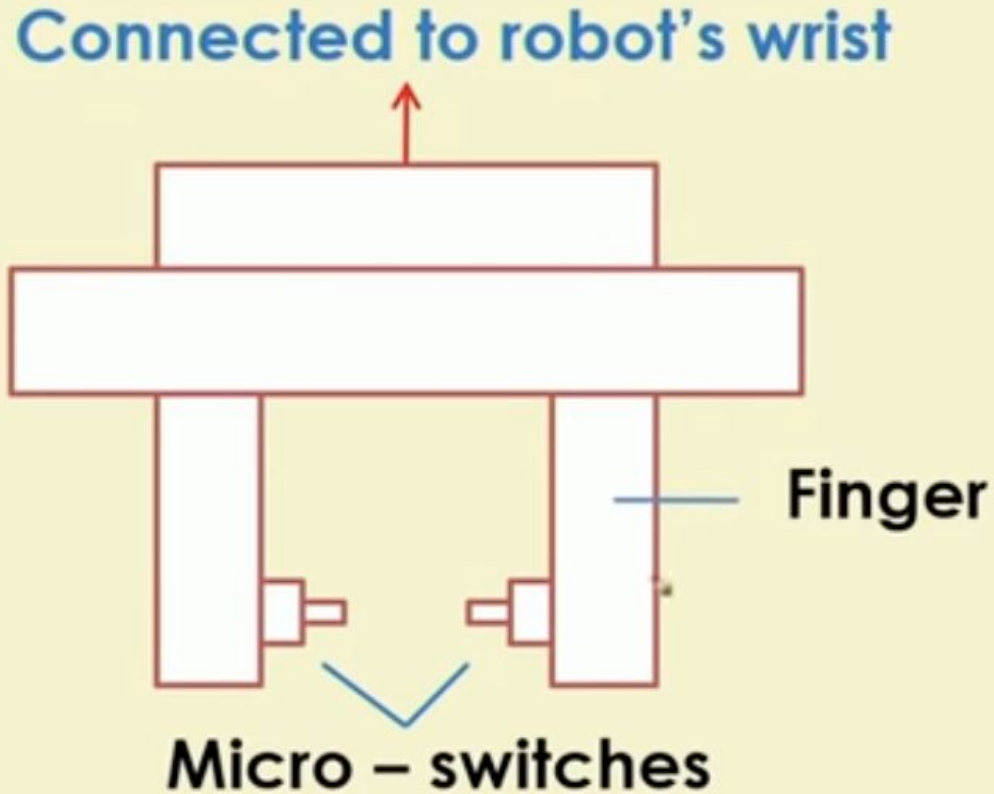


Figure: Micro – switches placed on two fingers of a robotic hand

Position sensor

1. Potentiometer
   - Linear Potentiometer
   - Angular Potentiometer

Angular Potentiometer

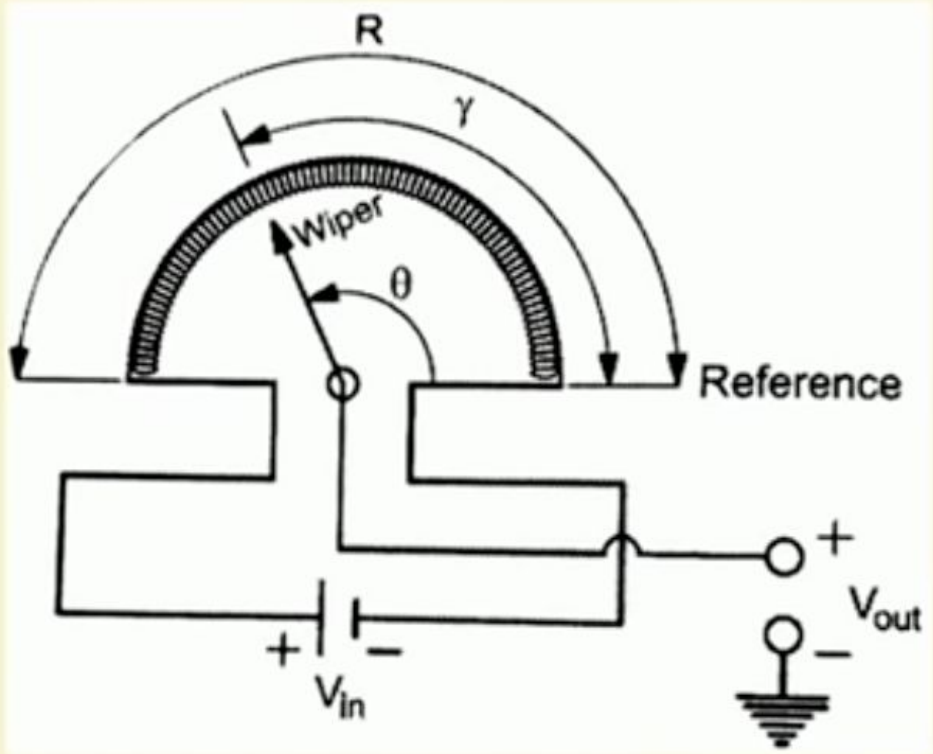
Θ: Angular displacement of the wiper with respect to the reference

R: Total resistance

r : Resistance of the coil between the wiper and the reference

V_{in} : Input voltage

V_{out} : Output voltage

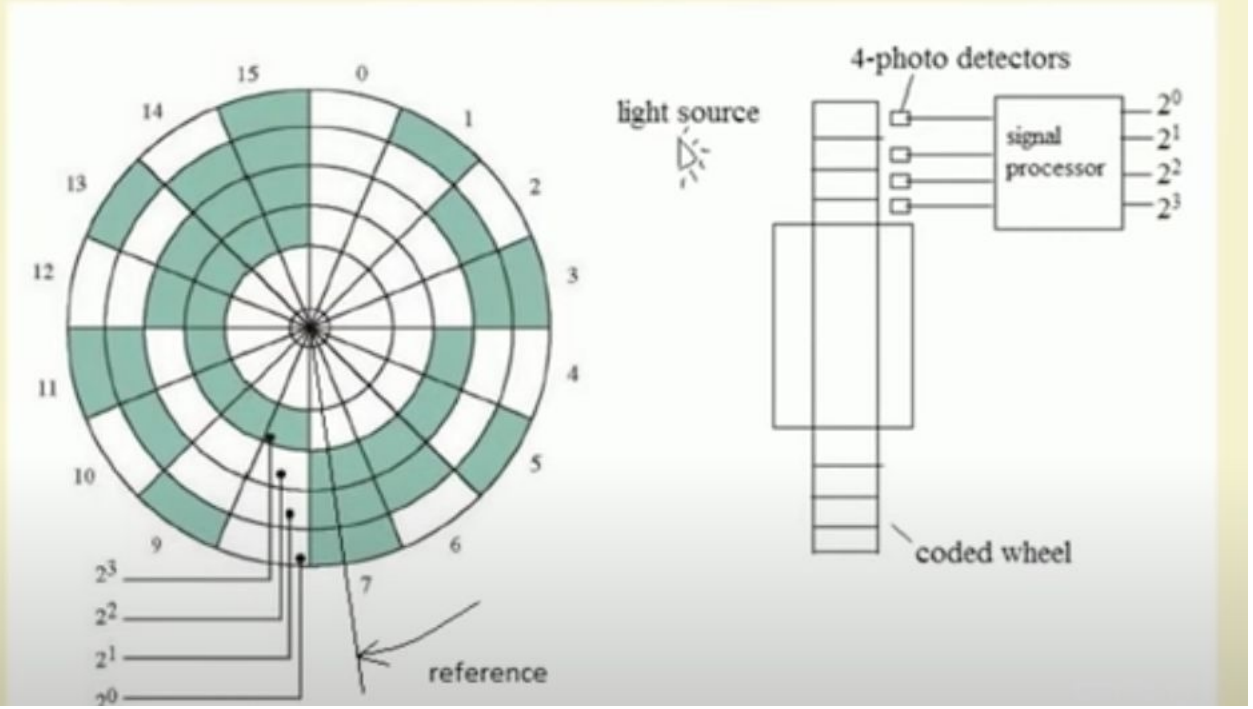


2. Optical Encoder

- Absolute Optical Encoder
- Incremental Optical Encoder

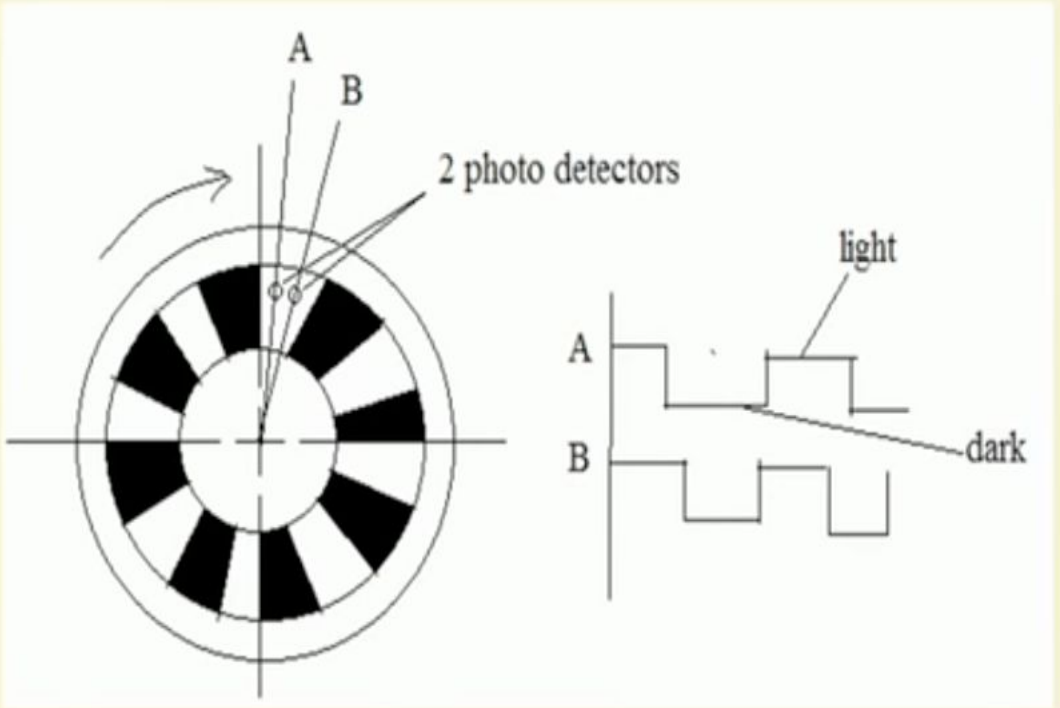
Absolute Optical Encoder

- It is mounted on the shaft a rotary device
- To generate digital word identifying actual position of the shaft measured from zero position



Incremental optical encoder

- Consists of one coded disc and two photo-detectors
- By counting the number of light and dark zones, angular displacement can be measured with respect to known starting position.
- It can determine the direction of rotation also
- It is construction-wise simpler, less accurate and less expensive.



Types of robotic sensor

- Light sensors.
- Sound Sensor.
- Temperature Sensor.
- Contact Sensor.
- Proximity Sensor.
- Distance Sensor.
- Pressure Sensors. .
- Tilt Sensors.
- Voltage sensor
- Current sensor
- IMU Sensor
- Acceleration sensor.

Light sensors

- A Light sensor is used to detect light and create a voltage difference. The two main light sensors generally used in robots are photo resistor and Photovoltaic cells.

TYPES OF LIGHT SENSOR

- VEX light sensor
- LEGO light sensor
- Light Sensor 1000 lux
- SCI-BOX Light Detector
- TAOS TSL235R Light to Frequency Converter
- Parallax QTI Sensor
- DFRobot Ambient Light Sensor
- Arduino LilyPad light sensor
- DFRobot BH1750 light sensor
- CdS photoconductive cell

VEX light sensor:

The light sensor from VEX is one of the simplest light sensors which can be used in robotics to allow a robot to detect the light

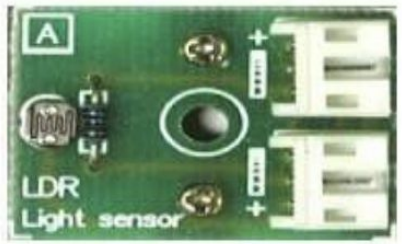
LEGO light sensor:

The LEGO light sensor is designed to fit perfectly into a LEGO robot. It can be used to improve the robot vision and is perfect for light detection, light intensity and to distinguish between a light or dark environment

Light Sensor 1000 lux:

The light sensor from Phidgets can measure the visible light spectrum of the human eye between 1 to 1000 lux. Output signal is analog, has a current consumption of 2 mA and an error of 5%

SCI-BOX Light Detector:
SCI-BOX light detector is used to detect ambient light density. SCI-BOX has two different voltage outputs and works with a photoresistor.

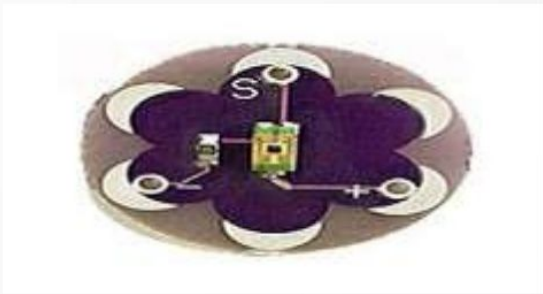


TAOS TSL235R Light to Frequency Converter:
The TSL235R from TAOS is a sensor that measures light intensity and its output is frequency. It can communicate with a microcontroller or other logic circuitry.

Parallax QTI Sensor:
The output signal can be both analog and digital. This sensor can be successfully used in robots to follow a line or for navigation.

DFRobot Ambient Light Sensor:
Ambient light sensor from DFRobot has an analog output value between 0 to 5 Vdc directly proportional to light intensity

Arduino LilyPad light sensor:
Arduino LilyPad is a sensor specifically designed for use with Arduino Lilypad mainboard and can be emulated perfectly on any project in robotics.



DFRobot BH1750 light sensor:
BH1750 is one of the best performing light sensors with a high resolution of 1 to 65535 lux. Works equally well in low light and in sunlight.

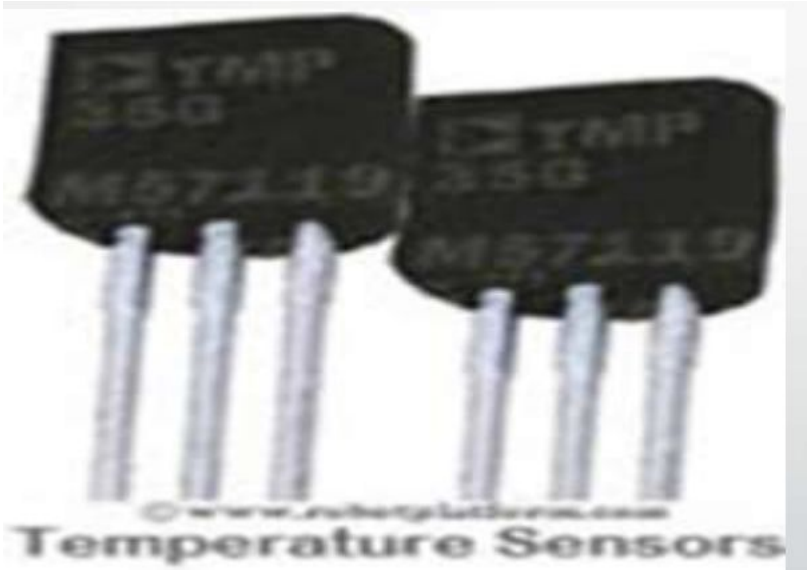
CdS photoconductive cell:
The photoconductive cellis a basic electronic component, both small and simple, that can be integrated into a variety of applications

SOUND SENSOR

- This sensor (generally a microphone) detects sound and returns a voltage proportional to the sound level. A simple robot can be designed to navigate based on the sound it receives. Imagine a robot which turns right for one clap and turns left for two claps. Complex robots can use the same microphone for speech and voice recognition.

Temperature Sensor

- What if your robot has to work in a desert and transmit ambient temperature? Simple solution is to use a temperature sensor. Tiny temperature sensor ICs provide voltage difference for a change in temperature. Few generally used temperature sensor IC's are LM34, LM35, TMP35, TMP36, and TMP37.



Contact sensor

- Contact sensors are those which require physical contact against other objects to trigger. A push button switch, limit switch or tactile bumper switch are all examples of contact sensors

Pressure Sensors

- Pressure sensor measures pressure. Tactile pressure sensors are useful in robotics as they are sensitive to touch, force and pressure. If you design a robot hand and need to measure the amount of grip and pressure required to hold an object, then this is what you would want to use.

Tilt Sensor

- Tilt sensors measure tilt of an object. In a typical analog tilt sensor, a small amount of mercury is suspended in a glass bulb. When mercury flows towards one end, it closes a switch which suggests a tilt

Distance Sensor

- Most proximity sensors can also be used as distance sensors.

Type of distance sensor:

- Ultrasonic Distance Sensors
- Infrared Distance sensor
- Laser range Sensor
- Encoders
- Stereo Camera

Voltage Sensors

- Voltage sensors typically convert lower voltages to higher voltages, or vice versa. One example is a general OperationalAmplifier (Op-Amp) which accepts a low voltage, amplifies it, and generates a higher voltage output. Few voltage sensors are used to find the potential difference between two ends .Even a simple LED can act as a voltage sensor which can detect a voltage difference and light up. (not considering current requirements here)

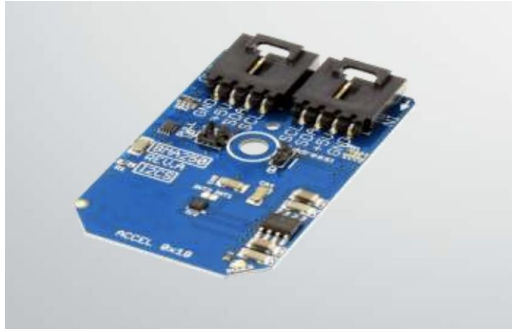
Current Sensors

- Current sensors are electronic circuits which monitor the current flow in a circuit and output either a proportional voltage or a current. Most current sensors output an analog voltage between 0V to 5V which can be processed further using a microcontroller

IMU

- Inertial Measurement Units combine properties of two or more sensors such as Accelerometer, Gyro, Magnetometer, etc, to measure orientation, velocity and gravitational forces.

Acceleration Sensor



- An accelerometer is a device which measures acceleration and tilt. There are two kinds of forces which can affect an accelerometer: Static force and Dynamic Force
- Types of Acceleration Sensor
- Static Force: Static force is the frictional force between any two objects. For example earth's gravitational force is static which pulls an object towards it. Measuring this gravitational force can tell you how much your robot is tilting
- Dynamic force: Dynamic force is the amount of acceleration required to move an object. Measuring this dynamic force using an accelerometer tells you the velocity/speed at which your robot is moving

Difference Between Digital and analogue sensor

Digital sensor

A digital sensor can only have two values: 1 or 0, all or nothing. An example of a digital sensor is a button, which can either have the value of 1 when pressed or 0 when not pressed. On a ZUM board or a similar one, the digital sensors will be connected on the digital pins D0-D13.

Pulsador: Botón que permite el paso de corriente eléctrica al pulsarlo y no la permite al soltarlo (cierra y abre el circuito).

Analogue sensor

An analogue sensor can have multiple states and is able to transform the quantity of light, temperature or other physical elements into a value between 0 and 1023.

Sensor de luz: Detecta la cantidad de luz que hay en el entorno.

7 Types of Industrial Robot Sensors

- 2D Vision
- 3D Vision
- Force Torque Sensor
- Collision Detection Sensor
- Safety Sensors
- Part Detection Sensors