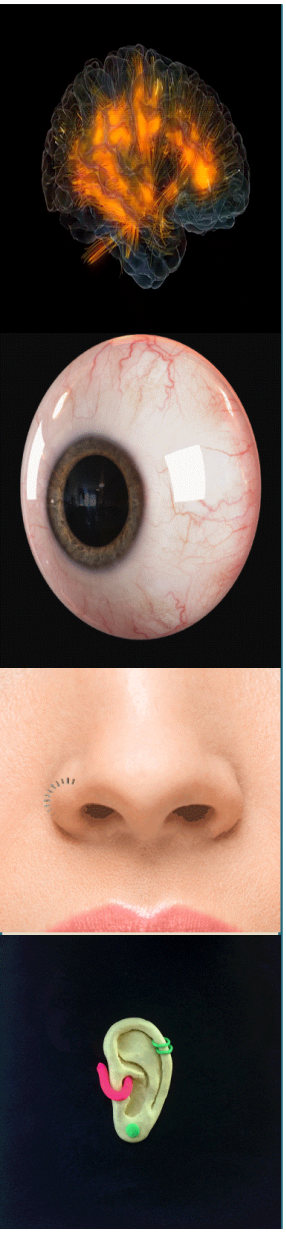
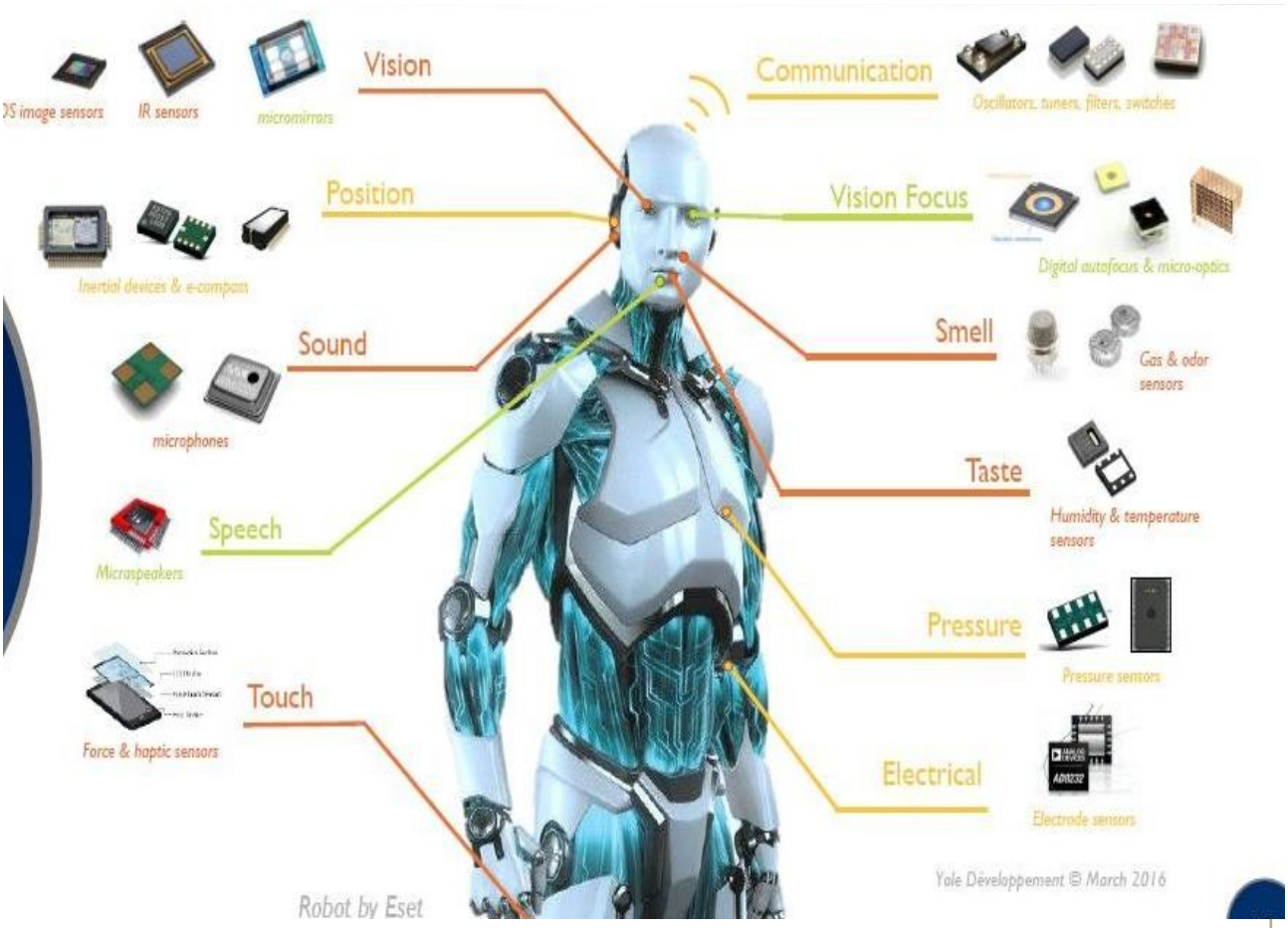


Robotic Sensors

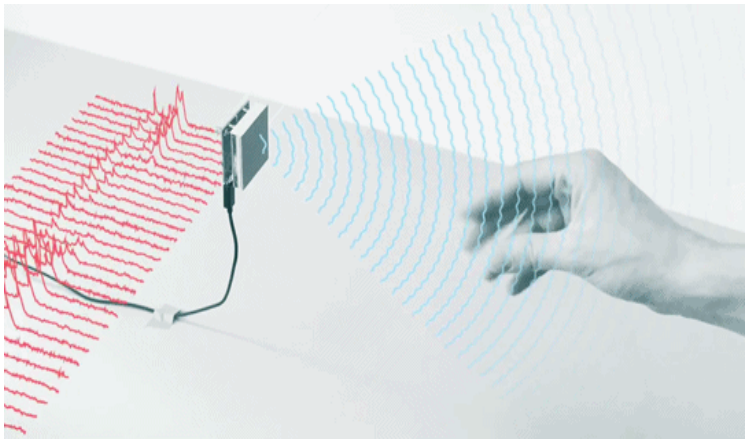


Agenda

- Introduction
- Types of Sensors
- Classification
- Internal sensors
- Position sensors
- Velocity sensors
- External Sensors
- Proximity sensors
- Force or Torque sensors.
- Exercise

“More and better” robots means “more and better” sensors

Introduction

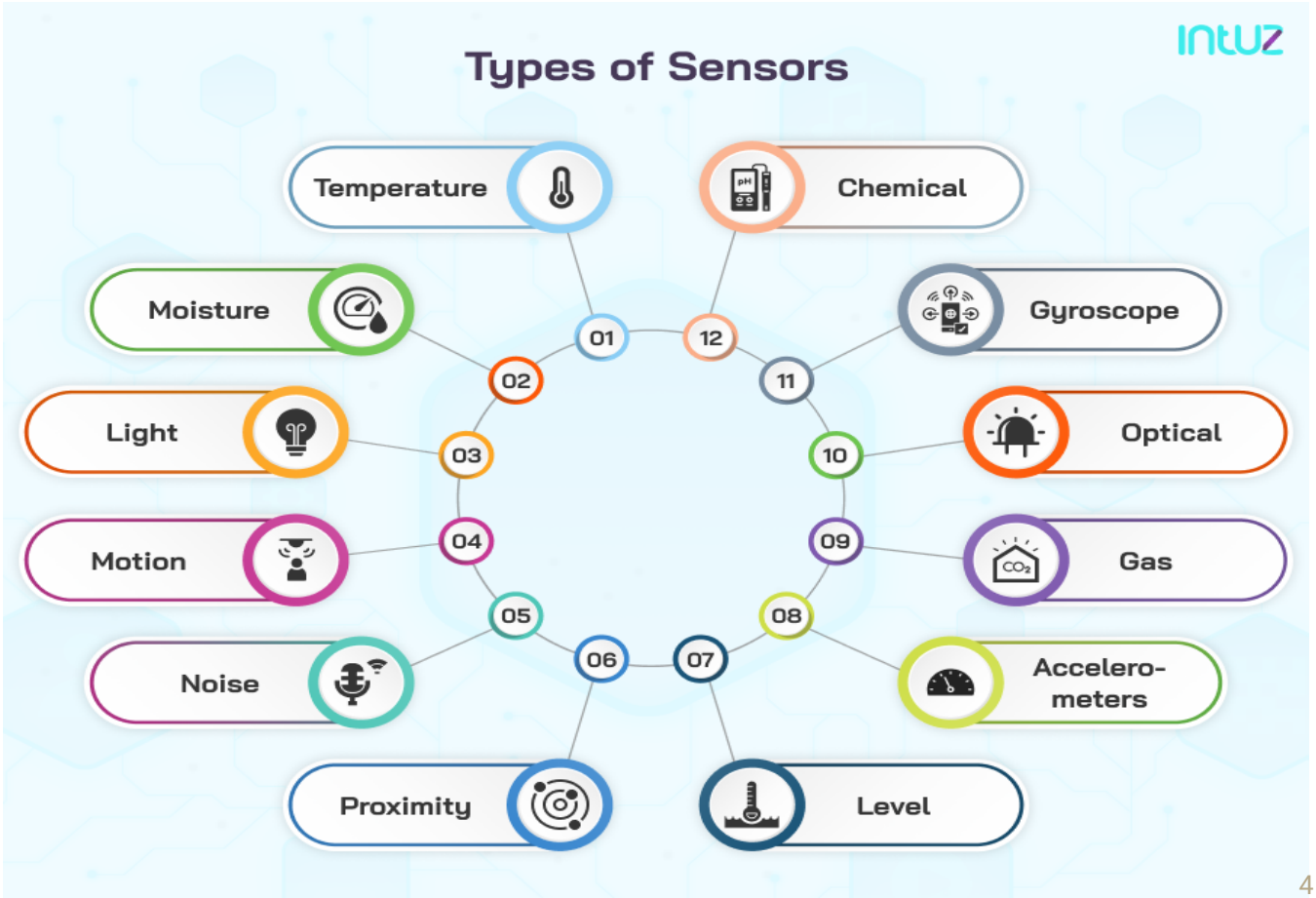


• A Sensor is an electronic device that is used to measure some sort of physical parameters (e.g. temperature, pressure, light intensity, etc). The output of an electronic sensor is an electrical signal that is either analog or digital. Processing the sensor's output can be done in hardware (using discrete electronic elements) or in software (using some sort of microcontrollers or MPUs).

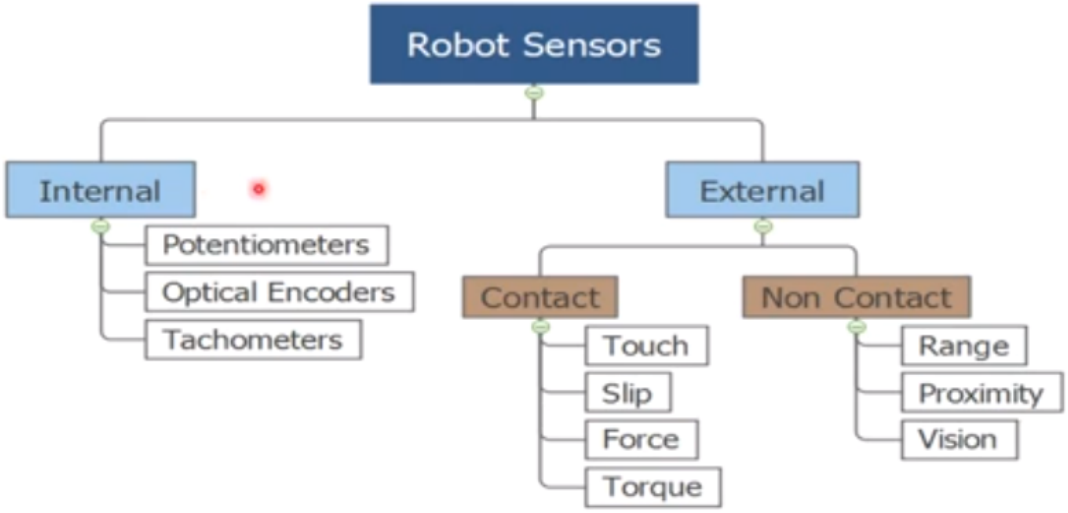
• Robotic sensors are used to estimate a robots condition and environment. These signals are passed to a controller to enable appropriate behavior.

• Robot sensors performs several functions like identification of objects, guiding the robot without obstruction, identification of path, object avoidance and so on.

Choose a suitable sensor



Classification of sensors



- Internal/ status sensors: Internal sensors are used to measure aspects about the robot itself, such as how fast it is going and at what angle it is facing.

- External/Environment Sensors: The external sensors, such as cameras, are used to capture user's trace, pose, salient body parts, related objects, scene context, etc.

Internal & External sensors

- Internal sensors such as its

  position sensor, velocity sensor, acceleration sensors, motor torque sensor, etc obtain the information about the robot itself.

- External sensors such as cameras, range sensors (IR sensor, laser range finder, and ultrasonic sensor) contact and Proximity sensors(photodiode, IR detector, RFID, touch, etc.) and force sensors gather the information in the surrounding environment.

- Sensors are used in robots for a variety of tasks. A greater use of sensors, therefore, is highly essential to avoid uncertainty and achieve higher productivity.

Position Sensors

- Position sensors are devices that can detect the movement of an object or determine its relative position measured from an established reference point. These types of sensors can also be used to detect the presence of an object or its absence.
- Positioning sensors are used to approximate the position of a robot. The usual positioning sensor is a GPS (Global Positioning System).

- Applications

  Printing process control

  Labelling control

  Ramp and bridge positioning

  MRI machines

  CCTV camera positioning

Vikram Lander is a good example of how sensors are making space exploration smarter, safer, and more efficient.

Types of Position Sensors

- Potentiometric Position Sensors (resistance-based)
- Inductive Position Sensors
- Eddy Current-Based Position Sensors
- Capacitive Position Sensors
- Magnetostrictive Position Sensors
- Hall Effect-Based Magnetic Position Sensors
- Fiber-Optic Position Sensors
- Optical Position Sensors
- Ultrasonic Position Sensors

Velocity Sensors

- A velocity or speed sensor measures speed of an object could be known with the help of this sensor. Due to the effects caused by the mechanical force, gravity, etc, the desired speed and required force to reach the speed can be computed.

- Types:

  Tachometers

  LSV

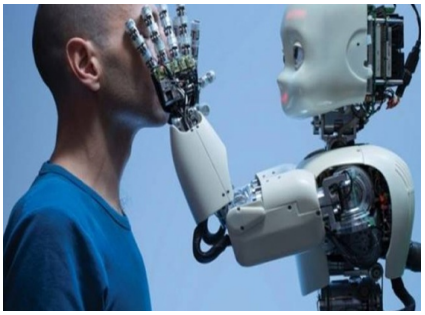
  Piezoelectric sensors

  Accelerometer sensor

These devices can help ensure your machinery(Robot) is working correctly. Instead of measuring an absolute position, a velocity sensor uses a seismic device to measure changing positions over time. Then it calculates this change to determine the velocity.

External sensors- contact sensors

- Contact sensors can be sorted into two principal types: Touch Sensor and Force Sensor.
- **Touch Sensor** is capable of sensing and detecting sensor and object touch. Some of the commonly used simple devices are micro-switches, limit switches, etc. These sensors are mostly used for robots to avoid obstacles. When these sensors hit an obstacle, it triggers a task for the robot, which can be reversed, turned, switched on, stopped, etc.



- **Force sensor** is included in calculating the forces of several functions, such as machine loading & unloading, material handling, and so on, performed by a robot. This sensor will also be a better assembly process to check problems.

Non-contact sensors

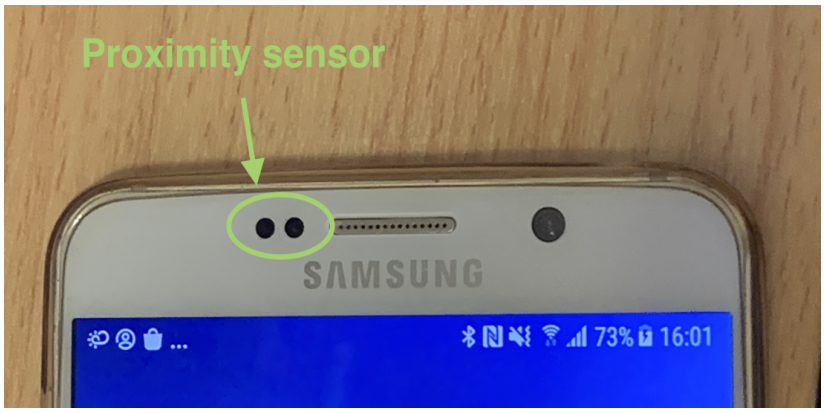
- Non-contact sensors, on the other hand, function without the need to physically touch the object or system being monitored.
- Infrared thermometers — such as those used by physicians to take a patient's temperature — are an example of this.

- Non-contacting sensors are also of various types mainly six such as,

1. visual and optical sensor,
2. magnetic and inductive sensor,
3. capacitive sensor,
4. resistive sensor,
5. ultrasonic and sonar sensor,
6. air pressure sensor.

Proximity Sensor

- This is a type of sensor which can detect the presence of a nearby object within a given distance, without any physical contact. The working principle of a Proximity sensor is simple. A transmitter transmits an electromagnetic radiation or creates an electrostatic field and a receiver receives and analyzes the return signal for interruptions. There are different types of Proximity sensors and we will discuss only a few of them which are generally used in robots.



Types of Proximity Sensors

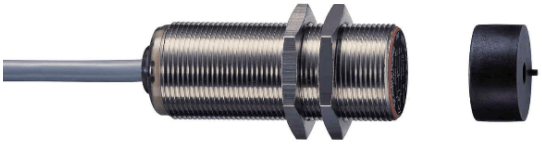
1. Ultrasonic proximity Sensor.
2. Inductive proximity Sensor
3. Magnetic proximity Sensor.
4. Capacitive proximity Sensor
5. Optical proximity Sensor

- Ultrasonic sensors emit an ultrasonic pulse which is reflected by objects in its path and the reflected wave enters the sonic cone.

- Inductive proximity Sensor to detect the metallic object which is present next to their active side.

Types

- Base on the mechanical principle, this sensor only detects the magnetic field.



- Capacitive proximity Sensor can detect both metallic and non-metallic targets in powder, granulate, liquid, and solid form.

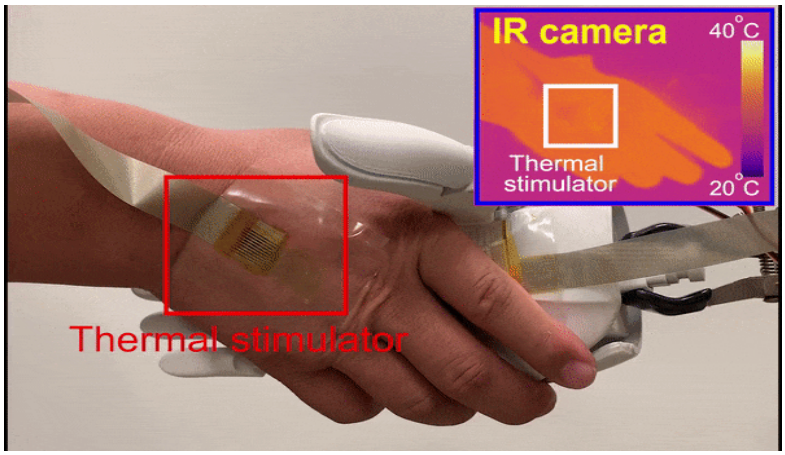
- A complete optical proximity sensors includes a light source,
- and a sensor that detects the light.

In Robot

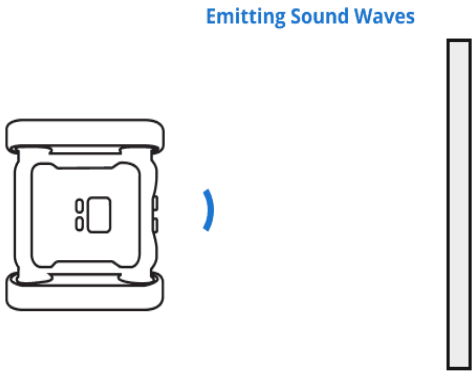
- **Infrared (IR) transceiver:** An IR LED transmits an IR light beam that reflects the light captured by an IR recipient when an obstacle is found.
- **Ultrasound Sensor:** These sensors generate sound waves at high frequencies; the received echo indicates an object is interrupted. Ultrasound sensors can also be used for distance measurement.
- **Photoresistor:** Photoresistor is a light sensor, but it can still be utilized as a sensor of proximity. If an object approaches the sensor, the number of light changes, which changes the resistance of the Photoresistor. This is detectable and processable.

IR Proximity Sensor

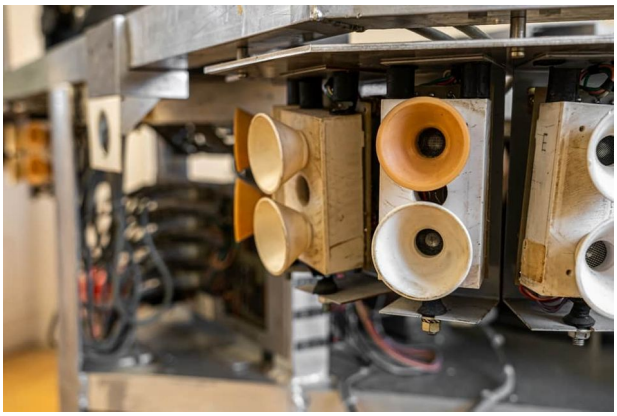
IR, in short for infrared, detects the presence of an object by emitting a beam of infrared light. It works similarly to ultrasonic sensors, though instead of using sonic waves, IR is transmitted.
Infrared proximity sensors consist of an IR LED that emits, and a light detector for detection of reflection. It has an in-built signal processing circuit that determines an optical spot on the PSD.



Ultrasonic Sensors Exist in Nature!



Ultrasonic Sensor: These sensors generate high frequency sound waves; the received echo suggests an object interruption. Ultrasonic Sensors can also be used for distance measurement.



Applications

- Object detection
- Counting of pieces
- Velocity measurements
- Rotation
- Positioning objects / containers
- Detection of materials
- Determine the direction of movement
- Monitoring of tools
- Detection of liquid levels
- Distance measuring
- Machine Protection
- Edge detection of an object
- Gear Checking
- Detection of metal objects
- Positioning fork lift truck
- Positioning of equipment in stock
- Detection and filling quantities
- Obstacle detection

Photoresistor:

- Photoresistor is a light sensor; but, it can still be used as a proximity sensor. When an object comes in close proximity to the sensor, the amount of light changes which in turn changes the resistance of the Photoresistor. This change can be detected and processed.