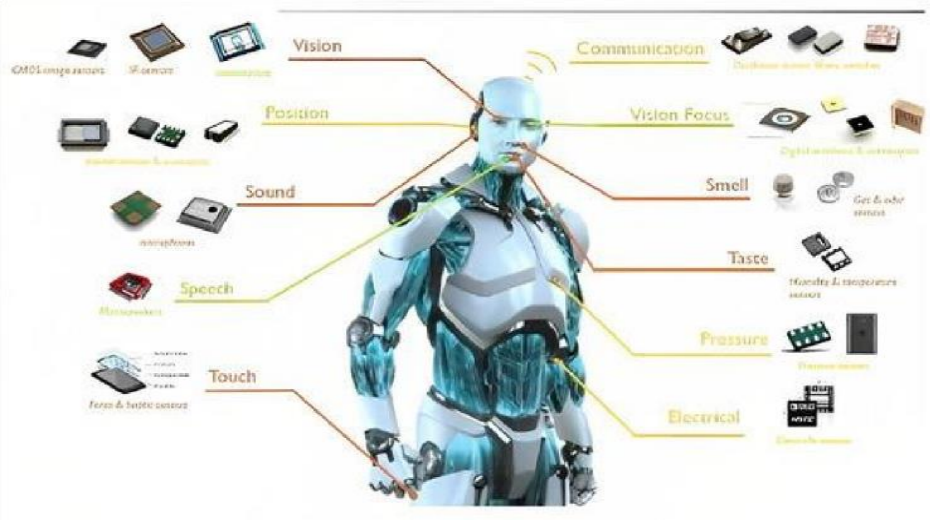
Subject: Skill Enhancement Elective – III - Introduction to Robotics
Semester: IVth Sem ETC
Name of the Faculty: Mr. Ashish Katore

Robotic Sensors and Drivers

Sensors are the "eyes, ears, and skin" of a robot. They collect data from the environment so the robot can make decisions or take action.

- Accuracy
- Dead Band & Hysteresis
- Calibration
- Repeatability
- Resolution
- Linearity
- Drift
- Temperature
- Power
- Usable Temperature
- Output Form
- Storage Temperature
- Spot Size
- Reliability



Types of Robotic Sensors:

1) Proximity Sensor: Proximity sensors detect objects within a certain distance without physical contact. Some common types of sensors are Infrared sensors, ultrasonic sensors, and capacitive sensors. These sensors are mostly used for the obstacle detection in the autonomous robots and robotic arms in assembly lines.

1. Detect how close an object is.
2. Types: Infrared (IR), ultrasonic, capacitive , inductive

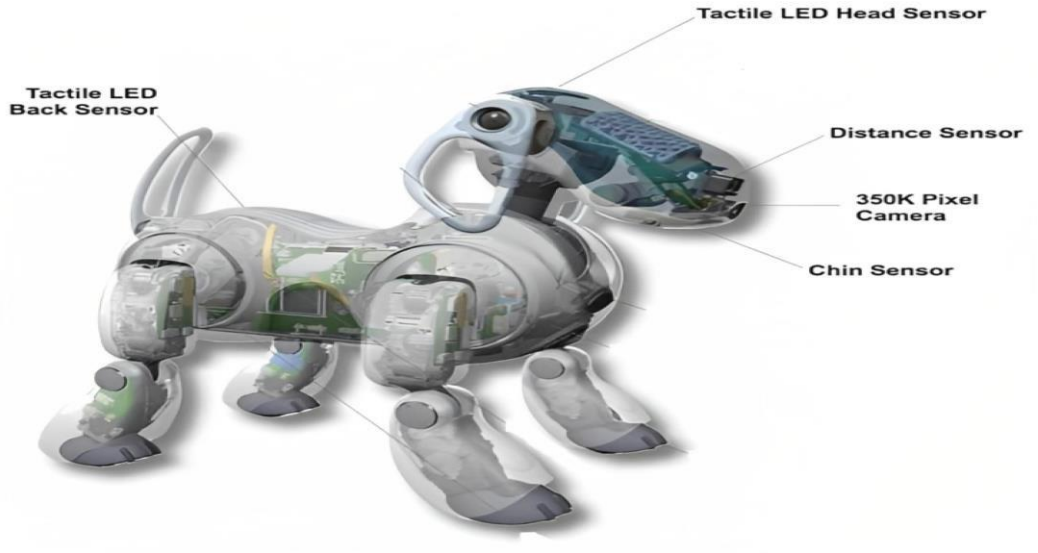


2) Vision Sensors (Cameras): Vision sensors are helps to capture images and videos for processing and interpretation. It has 2D & 3D cameras, infrared cameras, and LiDAR. These help into quality inspection, navigation in autonomous robots, and facial recognition.

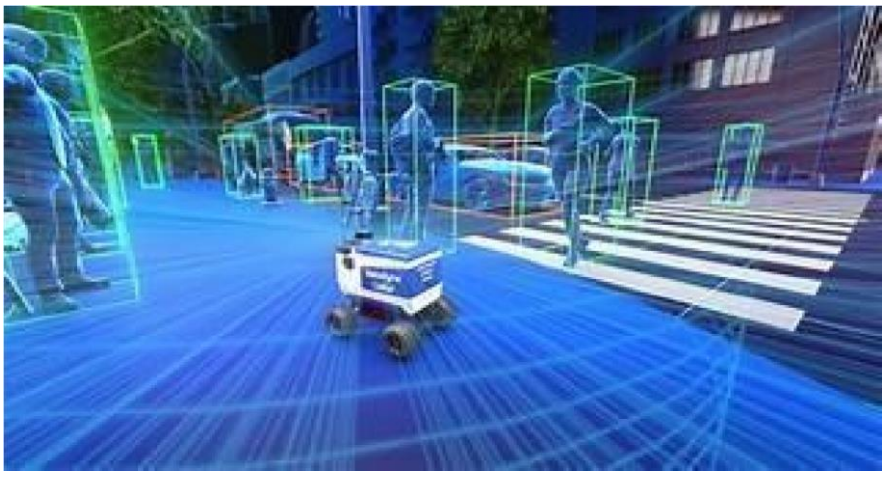
3. Capture images/video for object detection, recognition, and navigation

4. May include stereo cameras or depth sensors (e.g., LiDAR, 3D cameras)





LiDAR



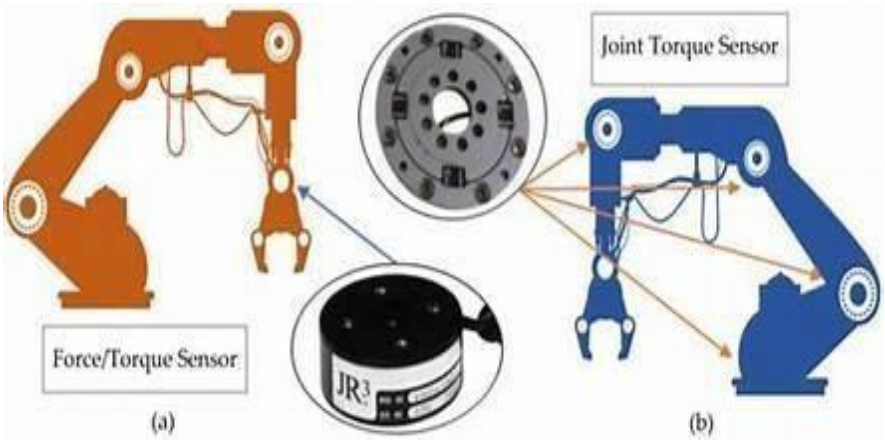
4) Tactile/Touch Sensors:): Touch Sensors (Tactile sensors) are used to detect physical contact and pressure. For the touch sensors, it having two types capacitive and resistive touch sensors. These sensors are used in humanoid robots to simulate the human touch and in industrial robots for secure gripping.

- Detect physical contact or pressure
- Useful in robotic arms and grippers



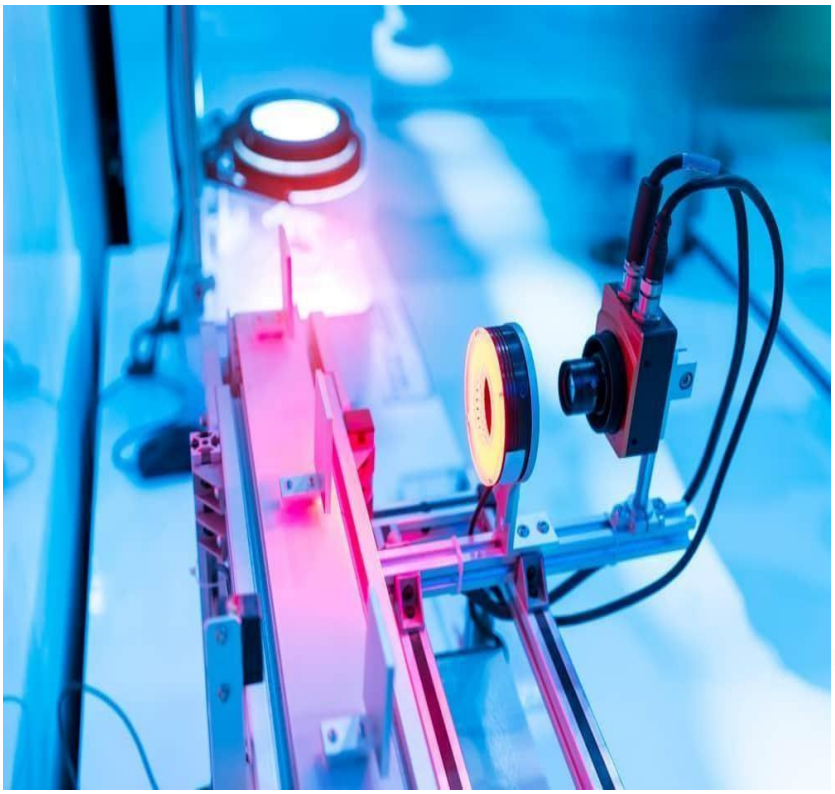
5)Force & Torque Sensors: Force and Torque sensors are helps to measure force and torque applied to a surface or joint. These are essentials for collaborative robots to ensure safe interaction with humans.

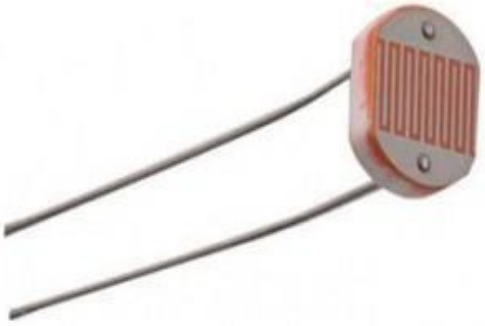
- Measure the force/torque applied to a robot's joint or tool
- Often used in collaborative robots (cobots)



6)Light sensor:

The light sensor is used to discover the light & generates a voltage difference. The light sensors used in robots are two types' photovoltaic cells & photo resistors. Photovoltaic cells are used to change the solar radiation energy to electrical and these sensors are used in solar robot manufacturing. Photo resistors are used to alter their resistance by modifying light intensities. When light is more on it then resistance will be less. These light sensors are not expensive, so used easily in robots.





7) Pressure Sensors

The pressure sensor is used to detect pressure, so these sensors are used in robotics because they are responsive to touch, pressure & force. This sensor is used to design a robot hand to calculate the amount of grip & force necessary to clutch an object.





Robotic Drivers (Actuators)

Drivers are the "muscles" of a robot. They convert electrical signals into physical motion.

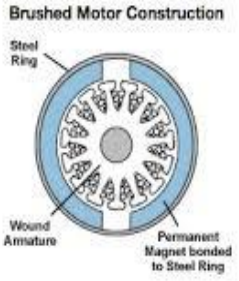
Types of Robotic Actuators:

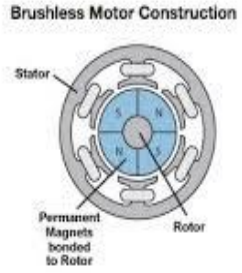
1. **Electric Motors**: These are the most common type in robotics due to their precision, controllability, and ease of integration.
    - **Electric Motors:** Convert electrical energy into rotational motion. Various types exist, each with unique characteristics:

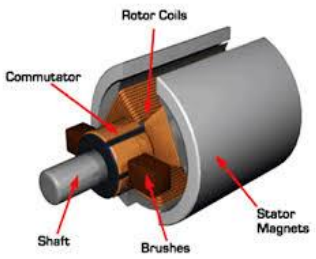




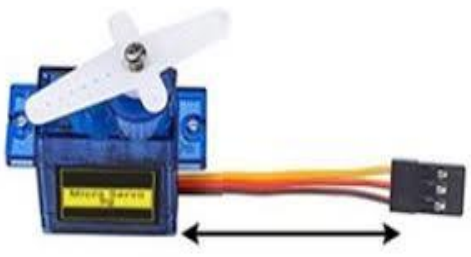
    -
        - **DC Motors (Brushed and Brushless):** Simple to control (brushed), or offer higher efficiency and longer lifespan (brushless). Often used with gearboxes to increase torque and reduce speed.

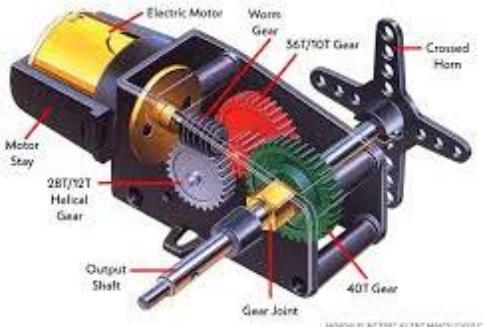




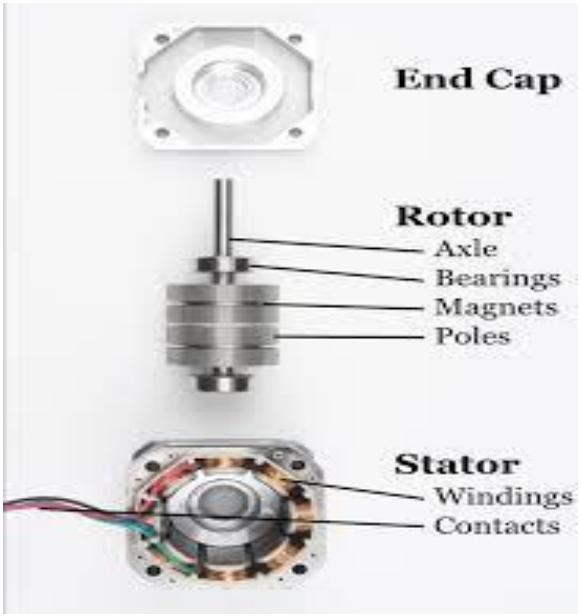


        - **Servo Motors:** Provide precise control over angular position, velocity, and acceleration, often with feedback mechanisms. Ideal for robotic arms and legs.



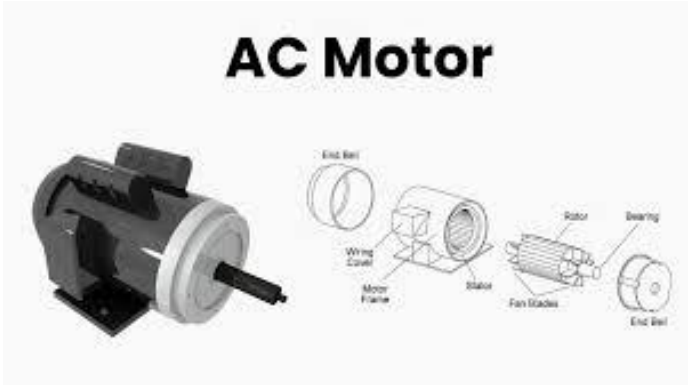


- **Stepper Motors:** Move in discrete steps, allowing for accurate positioning without feedback. Commonly used in 3D printers and CNC machines.





- **AC Motors:** Typically used for high-power applications requiring constant speed.
- **Linear Motors:** Generate direct linear motion, eliminating the need for rotary-tolinear conversion mechanisms.



- **Solenoids:** Electromagnetic devices that produce linear motion when an electric current passes through a coil. Used for on/off actions like valve control or latching.

- Most common type

- DC motors, stepper motors, servo motors Used in wheels, arms, and joints

2. Hydraulic Actuators: Utilize pressurized hydraulic fluid to generate linear or rotary motion and exert large forces.
   - **Hydraulic Cylinders (Linear):** Consist of a piston within a cylinder, where pressurized fluid pushes the piston to create linear movement.
   - **Hydraulic Motors (Rotary):** Convert hydraulic pressure and flow into rotational motion.
   - **Advantages:** High power-to-weight ratio, capable of generating significant forces and torques, robust for heavy-duty applications.

Disadvantages: Can be messy, require complex and bulky power units, and are less energyefficient than electric systems

- Use pressurized fluid to generate force
- High power, used in heavy-duty robots (like industrial arms)

3. Pneumatic Actuators: **:** Employ compressed air to produce motion, typically linear or rotary.
   - **Pneumatic Cylinders (Linear):** Similar in principle to hydraulic cylinders but use compressed air.
   - **Pneumatic Motors (Rotary):** Use compressed air to drive a rotating mechanism.
   - **Advantages:** Simple and relatively inexpensive, lightweight components, fast operation.
   - **Disadvantages:** Lower force capabilities compared to hydraulics, can be noisy, and control can be less precise due to air compressibility.

- Use compressed air
- Fast and lightweight but less precise

Piezoelectric Actuators: Convert electrical energy directly into small, precise mechanical movements. Used in micro-robotics and high-precision applications.

Use materials that change shape when voltage is applied

Very precise, used in micro-robotics

- Shape Memory Alloys (SMA): **Actuators:** Materials that change shape in response to temperature changes caused by electrical current. Offer compact size and smooth motion for smaller robots.

- Metals that contract when heated Used in small or bioinspired robots

Soft Actuators

- Made from flexible materials
- Used in soft robotics for safe interaction with humans

Also known as artificial muscles, these polymers change shape or size when an electric field is applied. Still a developing technology with potential for bio-inspired robotics.