SENSOR CLASSIFICATION

The major capabilities required by a robot are as follows:

- Simple Touch The presence or absence of an object.
- Taction or Complex Touch The presence of an object plus some information on its size and shape.
- Simple Force Measured force along a single axis.
- Complex Force Measured force along two or more axes.
- Proximity Noncontact detection of an object.
- Simple Vision Detection of edges, holes, corners, and so on
- Complex Vision Recognition of shapes.

TYPES OF SENSORS USED IN ROBOTICS

1) TACTILE SENSORS: Tactile Sensor is a device specifying an object's contact. Often used in everyday objects such as elevator buttons and lamps, which dim or brighten by touching the base, a tactile sensor allows the robot to touch and feel. These sensors are used to measure applications and gently interact with the environment.

   It can be sorted two principal types: Touch Sensor And Force Sensor.

- Touch Sensor Or Contact 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: 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.
- Light sensors: There are different types of light sensors used in robot parts, such as photoresistors, photovoltaic cells, CCDs, and

phototubes. These sensors detect changes in light intensity and can be used for object detection, line following, and color recognition

- Sound sensors: These sensors detect sound waves and can be used for speech recognition, noise detection, and vibration analysis
- Temperature sensors: These sensors measure temperature changes and can be used for temperature control, object detection, and fire detection.
- Contact sensors: These sensors detect physical contact between the robot and objects in its environment. They can be used for collision detection, object recognition, and force sensing.
- Proximity sensors: These sensors detect the presence of objects in the robot's vicinity and can be used for obstacle avoidance, object detection, and position sensing.
- Vision sensors: These sensors capture visual data and can be used for object recognition, tracking, and inspection. Two-dimensional and three-dimensional visual sensors are commonly used in industrial robots.

APPLICATIONS

- Patient monitoring in medical applications: Temperature sensors are used to monitor the patient temperature in medical facilities.

- Aerospace Applications: Position sensors are used for wing flap position measurement as well as other applications integral to the safety of passengers.

- Motorsport Applications: Monitoring fuel, gas, tyre and oil pressure within motorsport vehicles. We have a range of combined pressure and temperature transducers which are perfect for motorsport applications as they are very compact for these tight environments.

- Manufacturing and industrial equipment : Temperature sensors are used within machines to ensure they do not overheat and become unsafe.

- Agriculture Applications – Steering systems in agricultural machinery use both rotary and linear position sensors.

END EFFECTOR:

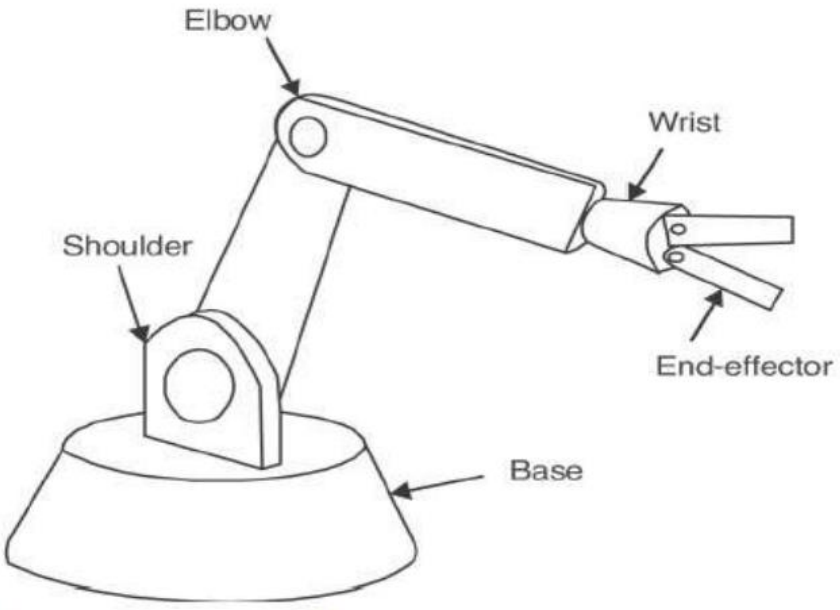
An end effector is an important part of a robotic arm that is attached to the robotic arm's end and serves like a human hand. End effectors are devices attached to the end of a robot's arm to help it interact with the surrounding environment. They are essential to robotic systems as they handle, manipulate, and sense objects.

Types of End Effector:

- Grippers
- Tools

1. Grippers: Grippers are devices, which can be used for holding or gripping an object. These include mechanical hands and anything like hooks, magnets, and suction devices, which can be used for holding or gripping.

2. Tools: Tools are devices, which robots use to perform operations on an object, e.g., drills, paint sprays, grinders, welding torches, and any other tool which get a specific job done.



End Effector Attached to Robot Wrist.

GRIPPERS

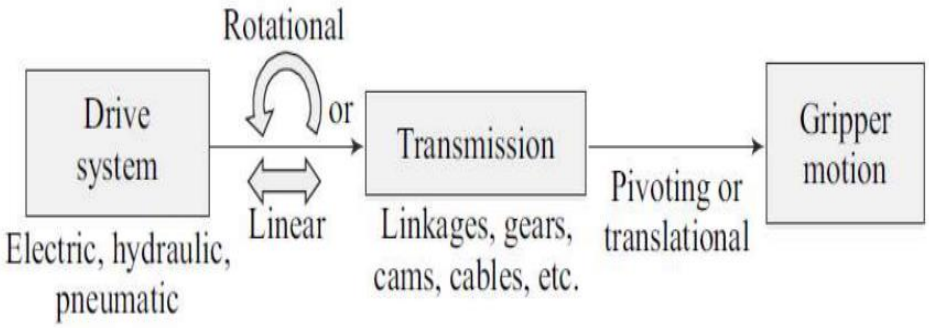
Grippers are end-effectors, which are used to grasp an object or a tool, e.g., a grinder, and hold it. Tasks required by the grippers are to hold work pieces and load/unload from/to a machine or conveyer. Grippers can be mechanical in nature using a combination of mechanisms driven by electric, hydraulic, or pneumatic powers. Grippers can be classified based on the principle of grasping mechanism. For example, grippers can hold with the help of suction cups, magnets, or by other means. A gripper is then accordingly referred to as pneumatic gripper, magnetic gripper, etc. Another way to classify a gripper is based on how it holds an object, i.e., based on grasping the object on its exterior (external gripper) or interior (internal gripper) surface.

Types of Grippers

- Mechanical Grippers:

  Mechanical grippers have their jaw movements through pivoting or translational motion using a transmission element, e.g., linkages or gears, etc. The gripper can be of single or double type. While the former has only one gripping device at the robot's wrist, the latter type has two. The double grippers

can be actuated independently and are especially useful in machine loading and unloading. The function of a gripper mechanism is to translate some form of power input, be it electric, hydraulic or pneumatic, into the grasping action of the fingers against the part.



2) Magnetic Grippers

Unlike mechanical grippers, the principle of a magnetic gripper is based on the magnetic property of a gripper. Hence, they can be used only for ferrous objects. They have the following advantages:

- Variations in object sizes can be tolerated.
- Operations are very fast.
- Require only one surface to hold an object. The disadvantages with magnetic grippers are, however, the
- Difficulty to pick thin sheets one at a time because the magnetic force penetrates through more than one sheet. As a result, more than one sheet is picked up. To overcome such disadvantages, one needs to take care during the design stage itself either by limiting the magnetic force by the gripper or by introducing some means (mechanical or otherwise) not to allow more than one sheet to be picked up. Magnetic grippers can have either (i) permanent magnets, or (ii) electromagnets

3)Vacuum Grippers

Such grippers are suitable to handle large flat objects. The material of an object is of no concern with vacuum gripers, except that the object's surface should not have any holes. An example of vacuum gripper which uses suction cups made of

elastic materials is shown in Fig. For a vacuum gripper, lifting capacity can be determined from the negative pressure and the effective area of the cups as

$f = pA$

where f is the force or lift capacity, p is the negative pressure, and A is the total effective area of the suction cups

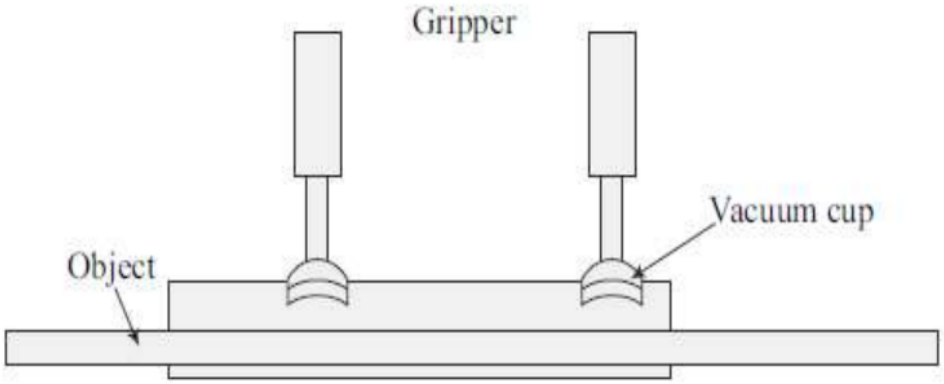


Fig. Vacuum gripper

4) Adhesive Grippers

An adhesive substance used for a grasping action can be used to handle fabrics and other lightweight materials. One of the limitations is that the adhesive substance loses its effectiveness with repeated use. Hence, it has to be continuously fed like a mechanical typewriter's ribbon which needs to be attached to the robot's wrist. Hooks, Scoops, and Others There exist other types of gripping devices, e.g., hooks, scoops or ladles, inflatable devices, etc., based on the need of item to be handled.

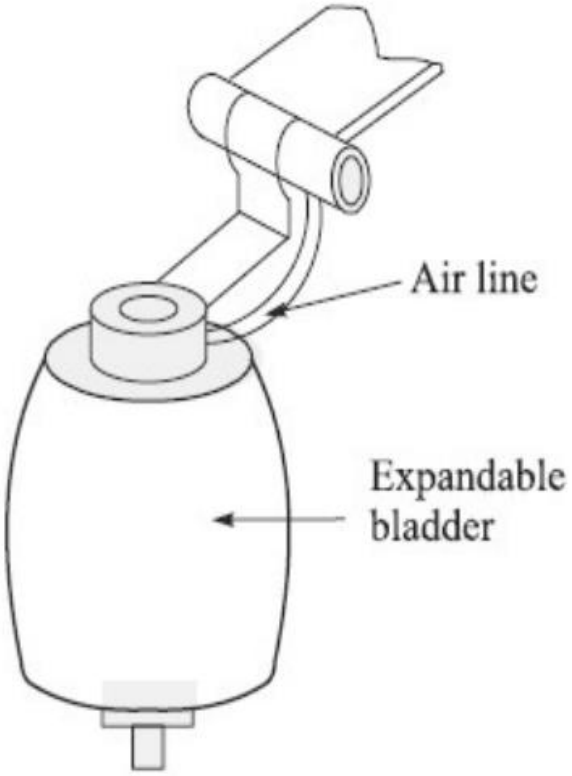


Fig. Expandable bladder to grip objects with holes from inside

Selection of Grippers

Some of the criteria to be used in selecting an appropriate gripper are highlighted below:

- Source of power
- Gripping force
- Gripping style
- Weight
- Environmental capabilities
- Sensor capabilities
- Number of jaws
- Other factors