Assignment 1

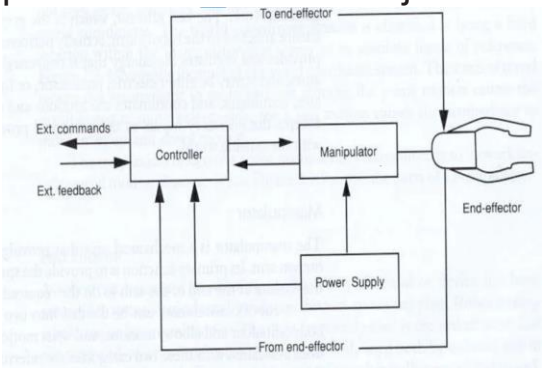
Introduction to Robotics

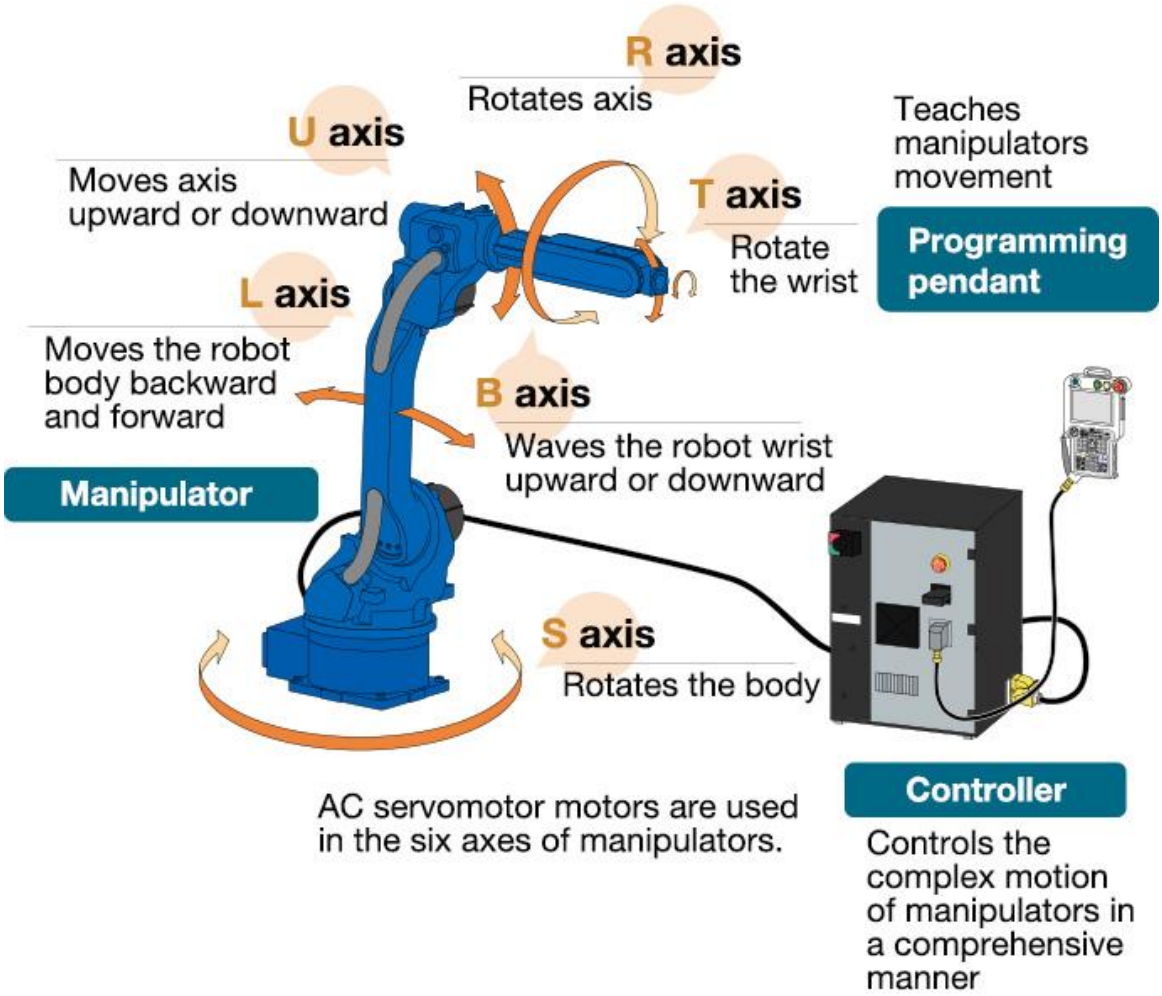
Shreyas Dayal

1. Define the components of an industrial robot? What is the role of sensors?

Industrial Robots can be defined as an automatically controlled and reprogrammable manipulator which can be used for various purposes and can be programmed in three or more axes. They are used processes in which repetitive action and have high speed and precision.
Some of the important components of robots are:
a) Sensors (Role of Sensors)
Sensors provide industrial robots with feedback about their workspace. The most common types of sensors include vision systems and microphones as these acts as the eyes and ears of a robot. Sensors allow robots to dynamically adapt to their work environment by sending signals to the robot's CPU.
b) Control Unit
The robot controller is a computer that is connected to the robot and serves as its "brain." All industrial robots need a controller in order to be able to operate. The controller is used to instruct the robot on how to operate through code, which is more commonly referred to as a program.
c) Actuators
Just like the human arm, the robot consists of what is called an Actuators having several joints and links. These parts are what allow robots to position end effectors correctly in order to perform an application.
d) Drive
The drive of an industrial robot is the engine or motor which moves the different robot parts around. Robot drives are typically powered hydraulically, electrically, or pneumatically.
e) End Effector

The base of the manipulator is fixed to base support and at its other free end, the End effector is attached. End effector is used to manipulate parts to assemble an object. They act as robot's hand.





2. Give a brief description on anatomy of a robot.

Similar to Anatomy of a body, anatomy of a robot tells about the physical arrangement of a robot, i.e., robot anatomy deals with the study of different joints and links and other aspects of the manipulator's physical construction.

The "***brain***" of a robot consists of one or more computers running software that process inputs from its sensors and computes outputs that drive the robot's actuators. Communication between the processor, sensors, and actuators is accomplished via wires or sometimes wireless communication.
A ***robotic joint*** provides relative motion between two links of the robot. Each joint, or axis, provides a certain degree-of freedom of motion. In most of the cases, only one degree-of-freedom is associated with each joint.
Each of these components is analogous to some component of a biological system. Links are analogous to bones; joints are analogous to, well, joints; sensors are analogous to sensory organs; actuators are analogous to muscles, and wires are analogous to nerves.

3. What is an actuator and what are the common types of actuators?

An actuator is a part of a device or machine that helps it to achieve physical movements by converting energy, often electrical, air, or hydraulic, into mechanical force. Simply put, it is the component in any machine that enables movement. Like muscles in a body that enable energy to be converted to some form of motion like the movement of arms or legs, actuators work in a machine to perform a mechanical action. Types of actuators are

Electric Linear Actuator

Electric linear actuators use electrical energy to enable movements in a straight line. They work by moving a piston back and forth based on electrical signals and are mostly used for movements such as pulling, pushing, blocking, lifting, ejecting, clamping, or descending.

Electric Rotary Actuator

Electric rotary actuators use electrical energy to achieve rotational movement. This movement can either be continuous or be towards a fixed angle.

Hydraulic actuators

Hydraulic actuators are similar to electric actuators but achieve this with an unbalanced pressure that is applied with hydraulic fluid on a piston in a hollow cylinder that can lead to torque strong enough to move an external object. The main advantage of a hydraulic linear actuator is the massive amount of torque it can generate.

Pneumatic Linear Actuator

Pneumatic actuators are often considered to be the most cost-effective and simplest of all actuators. Pneumatic linear actuator's function using compressed air to create movement, either by extending and retracting a piston, this retraction of the piston is either done with a spring or by supplying fluid from the other end. Pneumatic linear actuators are best suited to achieve high speed and torque on a relatively small footprint.

Piezoelectric Actuators

Piezo materials are a group of solids like ceramic that reacts to electrical charge by expanding or contracting and generate energy when mechanical force is applied.

4. What are the various configurations of robot architecture?

There area mainly 4 configuration of robot architecture:

- **Cartesian Robot**
  These consist of 3 sliding joints, 2of which are orthogonal. The work envelope of a rectangular robot is a cube or rectangle, so that any work performed by robot must only involve motions inside the space. Their linear movement allows for simpler controls.
  They have high degree of mechanical rigidity, accuracy, and repeatability due to their structure. They can carry heavy loads because the weight-lifting capacity does not vary at different locations within the work envelope.
- **Spherical Robot**
  Consists of a sliding arm (L joint) actuated relative to the body, which can rotate about both a vertical axis (T joint) and horizontal axis (R joint). Has one linear motion and two rotary motions. The work volume is like a section of sphere. The first motion corresponds to a base rotation about a vertical axis. The second motion corresponds to an elbow rotation. The third motion corresponds to in-out, translation. Larger work envelope than the

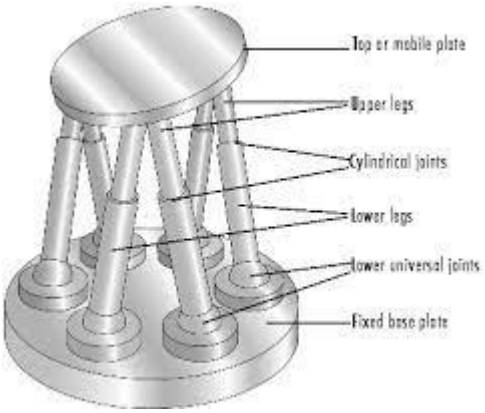
rectilinear or cylindrical robot. Design gives weight lifting capabilities.

- **Cylindrical Robot**
  Consists of a vertical column, relative to which an arm assembly is moved up or down. The arm can be moved in or out relative to the column. Rotational ability gives the advantage of moving rapidly to the point in z plane of rotation. Results in a larger work envelope than a rectangular robot manipulator. Suited for pick-and-place operations.
- **Selective Compliance Articulated Robot Arm (SCARA)**
  SCARA (Selective Compliance Assembly Robot Arm) is a subclass used for rapid and smooth motions. It is similar in construction to the jointer arm robot, except the shoulder and elbow rotational axes are vertical. It means that the arm is very rigid in the vertical direction, but compliant in the horizontal direction.

5. Explain about parallel manipulators with a diagram.

A parallel manipulator is a mechanical system that uses several computer-controlled serial chains to support a single platform, or end-effector.

- **Stewart Platform**
  A Stewart platform is a type of parallel manipulator that has six prismatic actuators, commonly hydraulic jacks or electric linear actuators, attached in pairs to three positions on the platform's baseplate, crossing over to three mounting points on a top plate. All 12 connections are made via universal joints. Devices placed on the top plate can be moved in the six degrees of freedom in which it is possible for a freely-suspended body to move: three linear movements x, y, z (lateral, longitudinal, and vertical), and the three rotations (pitch, roll, and yaw).



- **Delta Robot**
  A Delta robot is a type of parallel robot[2] that consists of three arms connected to universal joints at the base. The key design feature is the use of parallelograms in the arms, which maintains the orientation of the end effector, by contrast to Stewart platform that can change the orientation of its end effector.