UNIT V
AUTOMATION

ROBOTS:

The anatomy of industrial robots deals with the assembling of outer components of a robot such as wrist, arm and body.

Before jumping into robot configurations, here are some of the key facts about robot anatomy.

(a) Joints and Links

(b) Common Robot Configurations

Joints and links:

The manipulator of an industrial robot consists of a series of joints and links.

• Robot anatomy deals with the study of different joints and links and other aspects of the manipulator's physical construction.

• A robotic joint provides relative motion between two links of the robot.

• Each joint, or axis, provides a certain degree-of-freedom (dof) of motion.

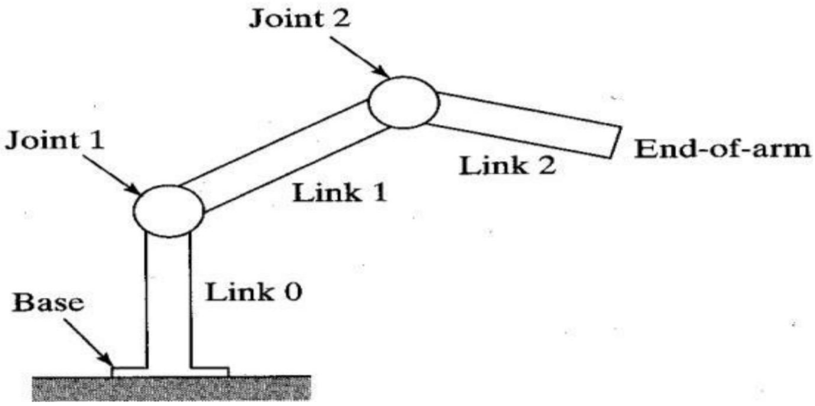
• In most of the cases, only one degree-of-freedom is associated with each joint.

• Robot's complexity can be classified according to the total number of degrees -of-freedom they possess.

• Each joint is connected to two links, an input link and an output link.

A Joint provides controlled relative movement between the input link and output link. A robotic link is the rigid component of the robot manipulator.

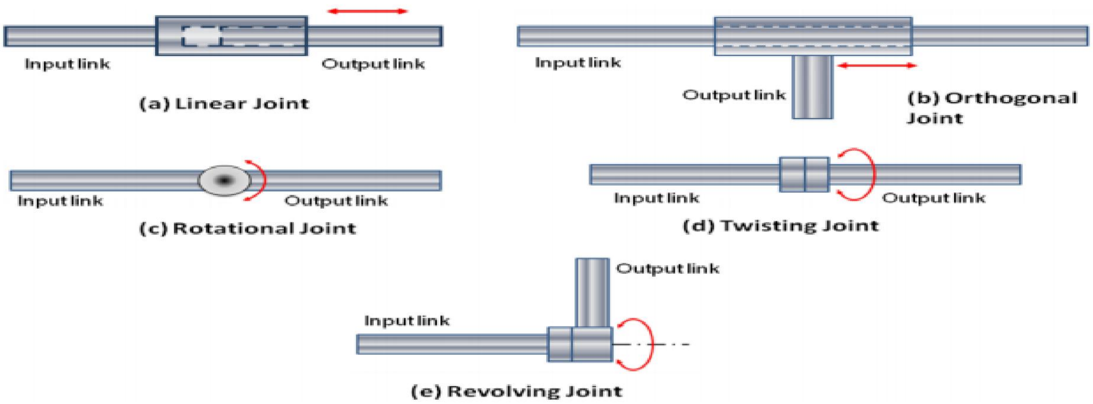
Robot:



The robotic base and its connection to the first joint are termed as link-0.

The first joint in the sequence is joint-1. Link-0 is the input link for joint-1, while the output link from joint-1 is link-1 which leads to joint-2. Link 1 is the output link for joint-1 and the input link for joint-2. • This joint-link-numbering scheme is further followed for all joints and links in the robotic systems.

Nearly all industrial robots have mechanical joints that can be classified into following five types as shown in Figure below.

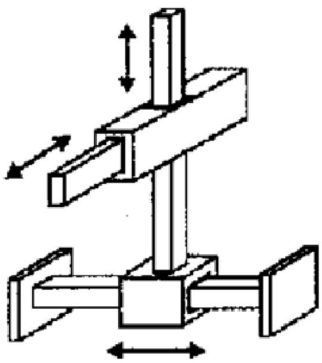


Linear joint (type L joint):
The relative movement between the input link and the output link is a translational sliding motion, with the axes of the two links being parallel.
Orthogonal joint (type U joint):
This also has a translational sliding motion, but the input and output links are perpendicular to each other during the move.
Rotational joint (type R joint):
This type provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.
Twisting joint (type T joint):
This joint also involves rotary motion, but the axis or rotation is parallel to the axes of the two links.
Revolving joint (type V-joint, V from the "v" in revolving):
In this type, axis of input link is parallel to the axis of rotation of the joint. Axis of the output link is perpendicular to the axis of rotation.

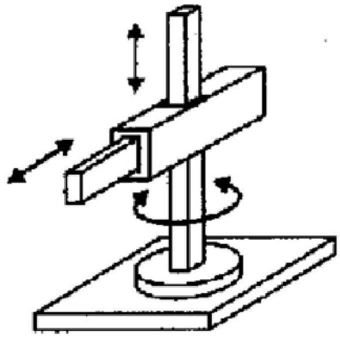
COMMON ROBOT CONFIGURATIONS:

Basically the robot manipulator has two parts viz.

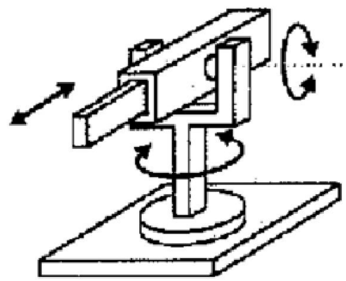
• A body-and-arm assembly with three degrees-of-freedom and A wrist assembly with two or three degrees-of-freedom.
• For body-and-arm configurations, different combinations of joint types are possible for a three-degree-of-freedom robot manipulator.



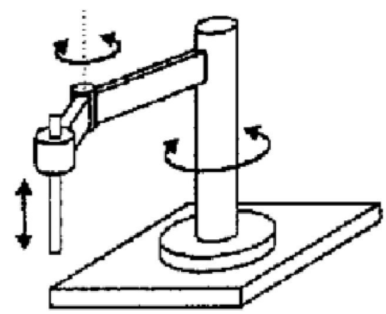
Cartesian Robot



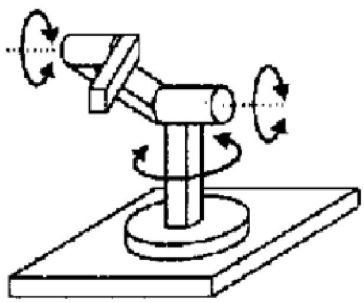
Cylindric Robot



Polar or spheric Robot



SCARA Robot



Angular or anthropomophic Robot

i) Polar configuration:

It consists of a sliding arm L-joint, actuated relative to the body, which rotates around both a vertical axis (T-joint)and horizontal axis (R-joint).

ii) Cylindrical configuration:

It consists of a vertical column. An arm assembly is moved up or down relative to the vertical column. Arm can be moved in and out relative to the axis of the column. Common configuration is to use a T-joint to rotate the column about its axis. An L-joint is used to move the arm assembly vertically along the column, while an Ojoint is used to achieve radial movement of the arm.

iii) Cartesian co-ordinate robot:

It is also known as rectilinear robot and x-y-z robot. It consists of three sliding joints, two of which are orthogonal O-joints.

iv) Jointed-arm robot:

It is similar to the configuration of a human arm. It consists of a vertical column that swivels about the base using a T-joint. Shoulder joint (R-joint) is located at the top of the column. The output link is an elbow joint (another R joint).

v) SCARA: Its full form is ‘Selective Compliance Assembly Robot Arm'.

It is similar in construction to the jointer-arm robot, except the shoulder and elbow rotational axes are vertical. The arm is very rigid in the vertical direction, but compliant in the horizontal direction. Robot wrist assemblies consist of either two or three degrees-offreedom.

END EFFECTORS – GRIPPERS:

It is commonly known as robot hand.

• It is mounted on the wrist, enables the robot to perform specified tasks.
• Various types of end-effectors are designed for the same robot to make it more flexible and versatile.
• End-effectors are categorised into two major types:

1. Grippers
2. Tools

Grippers:

Grippers grasp and manipulate objects during the work cycle.

• Typically the objects grasped are work parts that need to be loaded or unloaded from one station to another.
• It may be custom-designed to suit the physical specifications of the work parts they have to grasp.

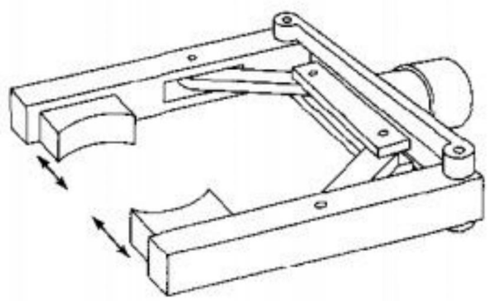


Figure 7.10 Robot mechanical gripper.

Tools :

The robot end effecter may also use tools.

• Tools are used to perform processing operations on the work part.
• Typically the robot uses the tool relative to a stationary or slowly moving object.
• In this way the process is carried out.

Examples of the tools used as end effectors by roots to perform processing applications include:

• Spot welding gun
• Arc welding tool
• Spray painting gun
• Rotating spindle for drilling, routing, grinding, etc.
• Assembly tool (e.g. automatic screwdriver)
• Heating torch
• Water-jet cutting tool

Application of robot:
Industrial Robot Applications can be divided into:
(i) Material-handling applications
(ii) Processing Operations
(iii) Assembly Applications

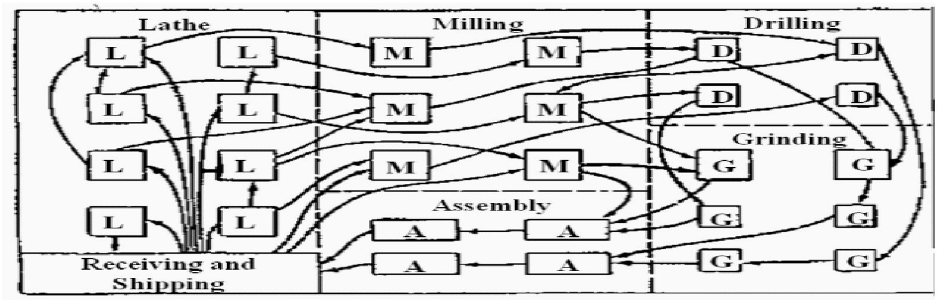
MATERIAL-HANDLING APPLICATIONS
The manipulator must be able to lift the parts safely.
2. The robot must have the reach needed.
3. The robot must have cylindrical coordinate type.
4. The robot's controller must have a large enough memory to store all the programmed points so that the robot can move from one location to another.
5. The robot must have the speed necessary for meeting the transfer cycle of the operation.

GROUP TECHNOLOGY:
Group technology emphasis on part families based on similarities in design attributes and manufacturing, therefore GT contributes to the integration of CAD and CAM.

- GT is a theory of management based on the principle that similar things should be done similarly
- GT is the realization that many problems are similar, and that by grouping similar problems, a single solution can be found to a set of problems thus saving time and effort
- GT is a manufacturing philosophy in which similar parts are identified and grouped together to take advantage of their similarities in design and production

TYPES OF LAYOUTS
In most of today's factories it is possible to divide all the made components into families and all the machines into groups, in such a way that all the parts in each family can be completely processed in one group only.
The two main types of layout are:
- Functional Layout
- Group Layout

Functional Layout
- In Functional Layout, all machines of the same type are laid out together in the same section under the same foreman. Each foreman and his team of workers specialize in one process and work independently. This type of layout is based on process specialization.

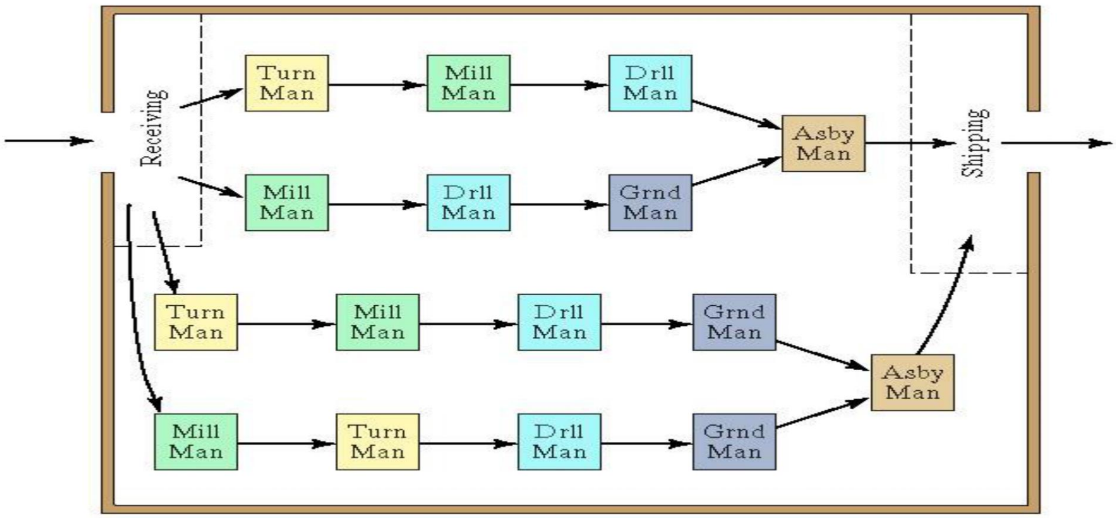


PROCESS-TYPE LAYOUT

In process lay out all the machine tools of same process are grouped in a single department and placed together.
1. This results in a significant amount of material handling.
2. A large in process inventory.
3. Usually more setups than necessary.
4. Long lead times.

GROUP LAYOUT

- In Group Layout, each foreman and his team specialize in the production of one list of parts and co-operate in the completion of common task. This type of layouts based on component specialization.



Advantages are gained in the form of reduced
1. Work piece handling
2. Lower setup times
3. Less in process inventory
4. Less floor space and shorter lead times