

Module 1 : Introduction to robotics

Lecture 3 : Industrial Manipulators & AGVs

Objectives

In this course you will learn the following

- History of development of robots.
- Main body types of manipulators with examples.
- Typical end effectors.
- Power transmission systems in robots.
- Tasks executed by robots/ manipulators.
- Part presentation.

History of robots :

- 1954- Devol & Engleburger – establish Unimation Incorporation.
- 1961- Robots are used in die casting application.
- 1968- AGVs (automated guided vehicles) implemented.
- 1970- Stanford arm developed.
- 1979- SCARA robot for assembly developed in Japan .

Main bodies and wrists

Fig. 3.1.1 shows a typical industrial robot with a main body and a wrist.

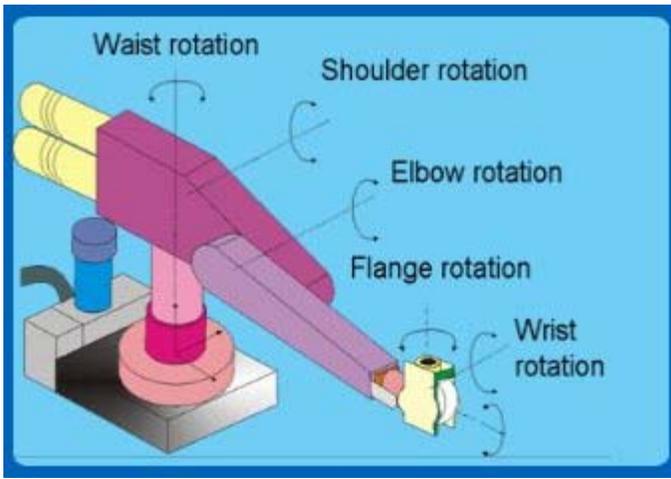


Figure 3.1.1 .

Figure 3.1.1 shows PUMA robot (the manipulator). A total of 6 variables are required, for specifying the position and orientation of a rigid body in space. Therefore PUMA has 6 axis of rotation with 1 DOF (degree of freedom) per axis.

The functioning of this robot is like a human arm. Each DOF has an actuator for motion.

Types of Main bodies type

One generalization is that the main body of the robot is used to position an object (or tool) while the wrist is used to orient it. Grippers are used to grasp objects.

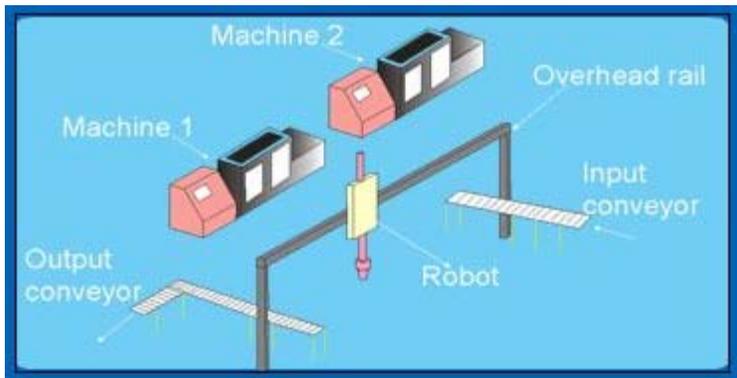
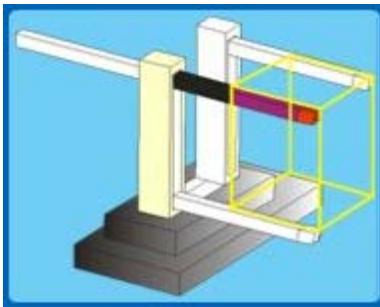


Figure 3.2.1

Cartesian Robot (see figure 3.2.1). On several shop floors "Gantry" type of Cartesian robots (consisting of overhead rails) are used for operations over large spaces.

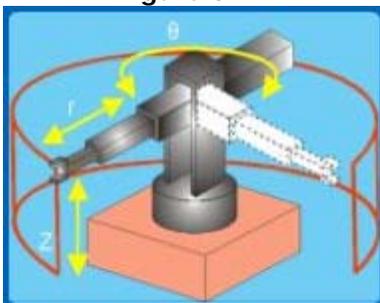


Figure 3.2.2

Cylindrical main body. PPR (See figure 3.2.2). Such motions are found typically in drilling machines. A similar main body is used in robots to access points in a cylindrical volume. (Essentially R- q motion in a plane – which in turn translates along the Z axis.)

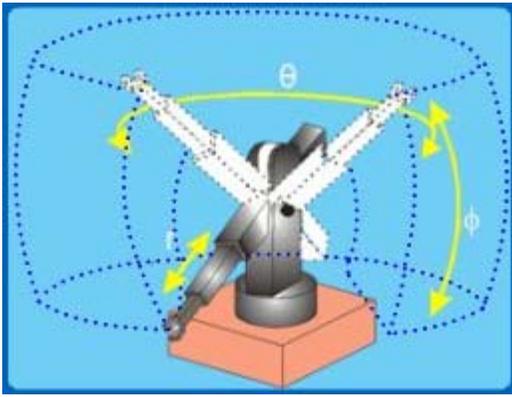


Figure 3.2.3 -Spherical Main Body

- Spherical main body (RRP - Figure 3.2.3)
There is a base rotation and a portion of the arm moves in and out (a telescopic motion). The work volume is a portion of a hollow sphere. (Essentially R- q - f motions)

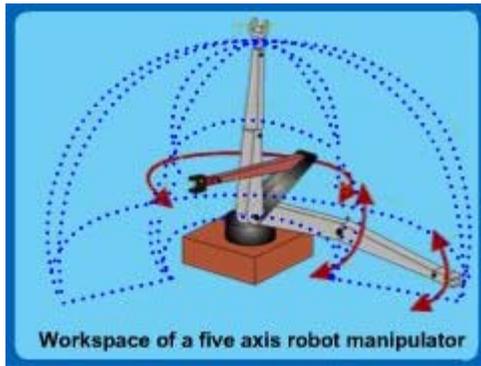


Figure 3.2.4 Articulated Arm

- Articulated type main body robot (typical human arm) (RRR Type) (See Figure 3.2.4)

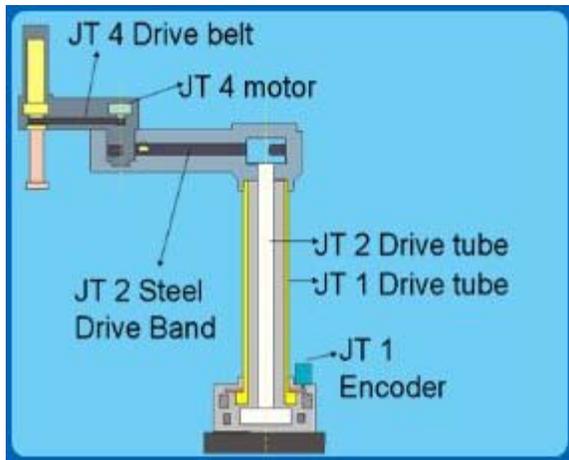


Figure 3.2.5 -SCARA Robot.

- SCARA robot – This also has a cylindrical work space. RRP main body. Such robots were used to assemble the SONY walkman. The “P” is for raising and lowering the end effector. Otherwise all the motion is in a horizontal plane. (See Figures 3.2.5)

Wrists

WRISTS : Wrist roll, yaw, and pitch (Figure 3.3.1). There are 3 motions and 3 actuators are required for motion.

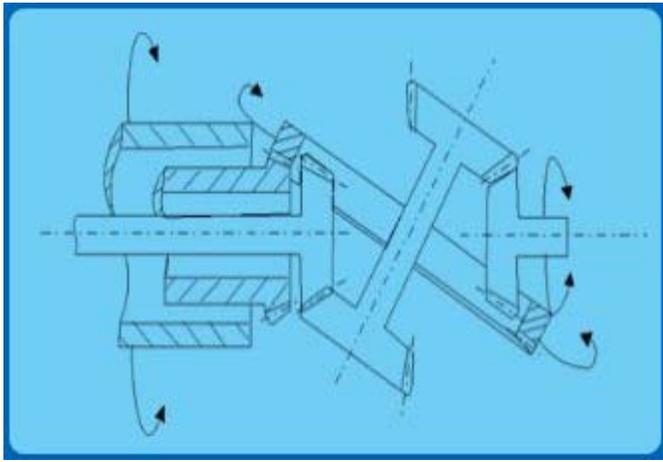


Figure 3.3.1

End Effectors (Figure 3.3.2): Welding head, riveter, spot welder.

Grippers in manipulators

Grippers are used to grip, pick, place, and release the object.

There may be single gripper and / or multiple grippers. Many a time grippers are actuated by pneumatic systems.

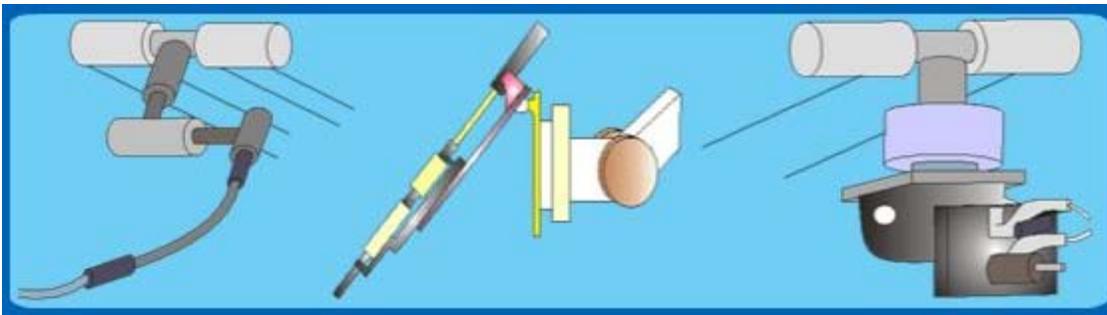


Figure 3.3.2

EE types (Figure 3.3.2): spot welding gun for different position weld on automotive assembly line. Following figure shows typical End Effectors used on assembly, machining line.

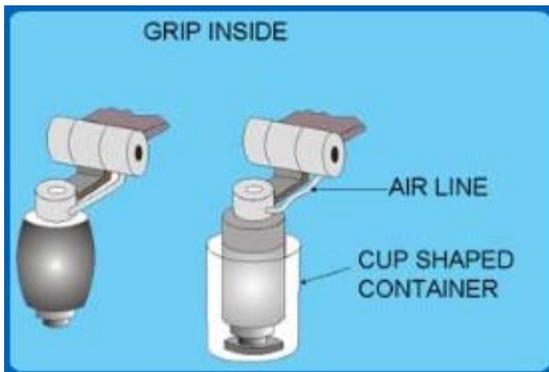


Figure 3.3.3

Gripper (figure 3.3.3) This pneumatic gripper (balloon shaped) is being used to pickup hollow cylindrical objects by gripping them on the inside surface.

In this gripper the gripper faces move parallel to each other using a parallel bar mechanism.

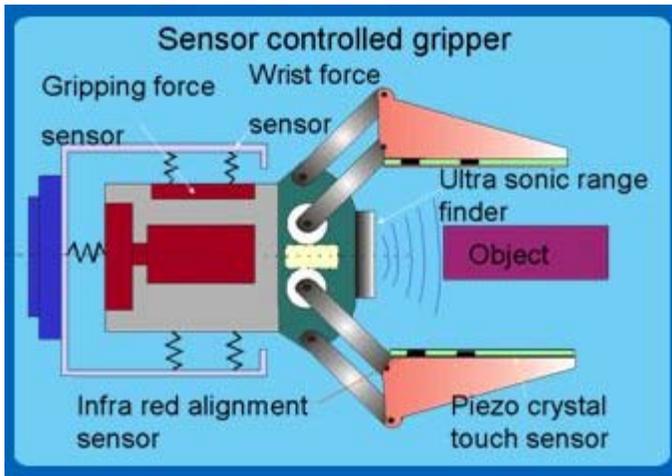


Figure 3.3.4

Ultrasonic waves detect whether the object is present and then the fingers close to pick the object. (Figure 3.3.4)

Transmission

Ball screw drive (motor at base) Ball Screws reduce friction and preloading them reduces backlash (Figure 3.4.1.1)

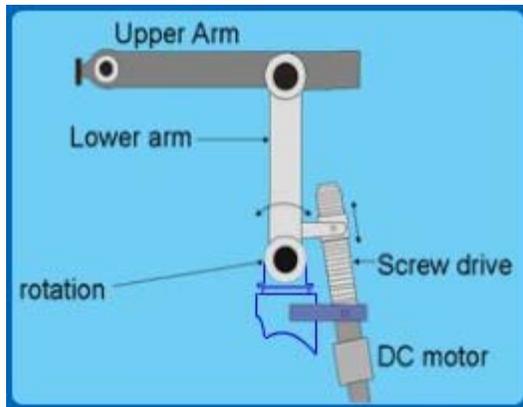


Figure 3.4.1.1

Motor rotation is converted into linear motion of a nut engaging a screw and this in turn is converted into oscillation of output.

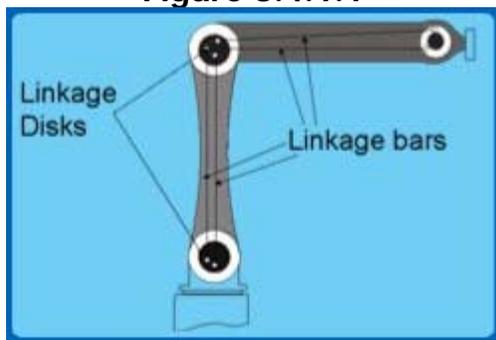


Figure 3.4.2.1

Linkages for transmission. The actuator (mounted at the base, drives the output through linkage mechanisms.

Tasks Planning for robots

Point to point tasks (PTP): This requires the robot to carry an object from one position to another. The end locations (position and orientation) are known. A simple manipulator for such tasks is the pneumatic manipulator.

Continuous Path Motion - Painting application are an example where the end effector has to move over a desired curve in space. Painting, being hazardous for manual operation servo controlled electric robots (with fire proof motors) are employed.

3. Palletizing (soft drink bottles to be placed in a crate). This is a special type of Point to Point task – this occurs when bottles are placed in a crate. See Figure 3.5.1

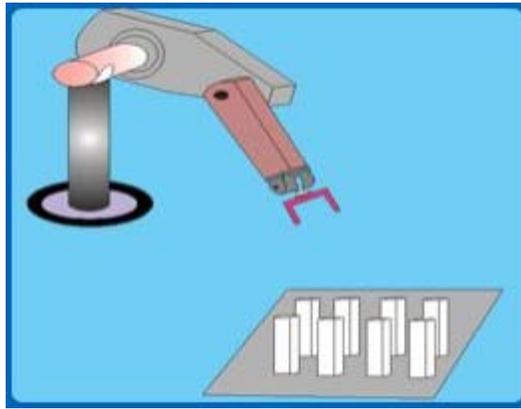


Figure 3.5.1

4. Assembly tasks are typically those which involve insertion of a peg into a hole. See Figure 3.5.2

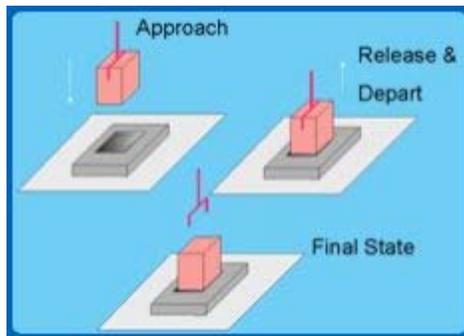


Figure 3.5.2: Assembly of parts

Stiffness and work space are among the parameters for selecting a robot manipulator. The question as to whether one can position and orient a rigid body in any way in the work space is of importance. In some portion of the workspace called the dexterous work space wherein a high degree of orientation is possible, elsewhere the range of orientation is far less.

Part Presentation

Most industrial manipulators do not possess adequate number of sensors to determine whether the part it has to handle is in the right position and orientation. So part presentation systems are used to present parts in correct orientation.

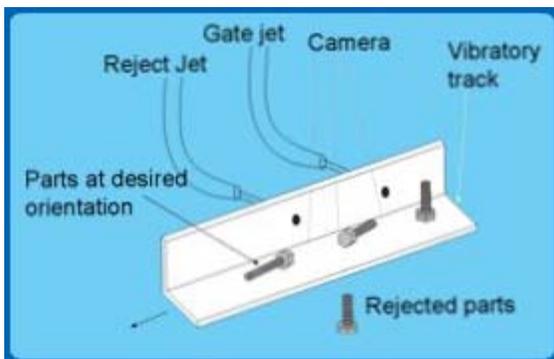


Figure 3.6.1

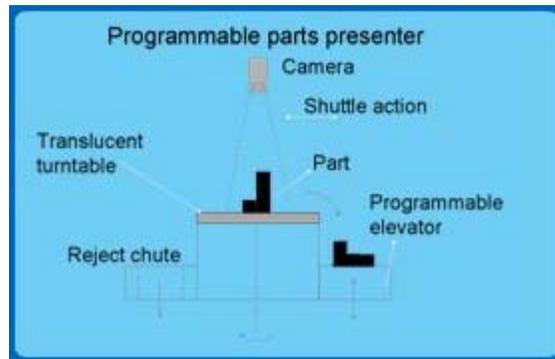


Figure 3.6.2

In Fig 3.6.1 and 3.6.2 parts are inspected by a camera and if they are wrongly oriented, rejected for example by blowing a jet of air at them as in Fig. 3.6.1.

Recap

In this lecture we have discussed

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- Part presentation

Congratulations, you have finished Lecture 3. To view the next lecture select it from the left hand side menu of the page