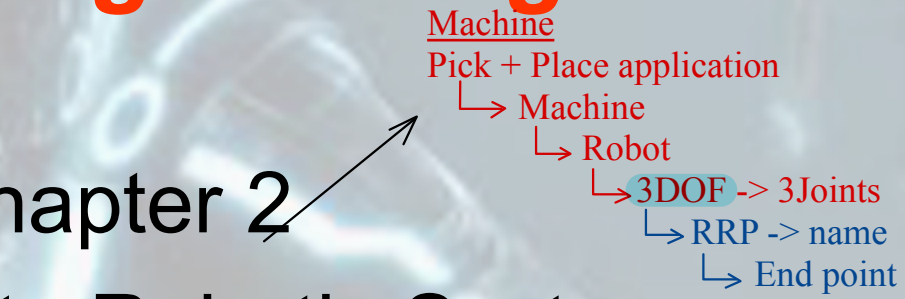
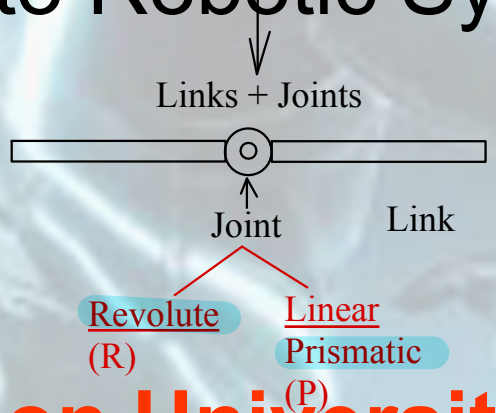
MCE4101
Robotic Engineering



Chapter 2

Introduction to Robotic System

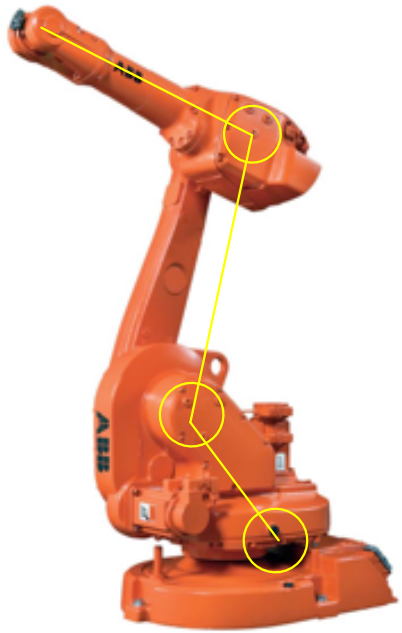


Narong Aphiratsakun, D.Eng

Assumption University
Faculty of Engineering

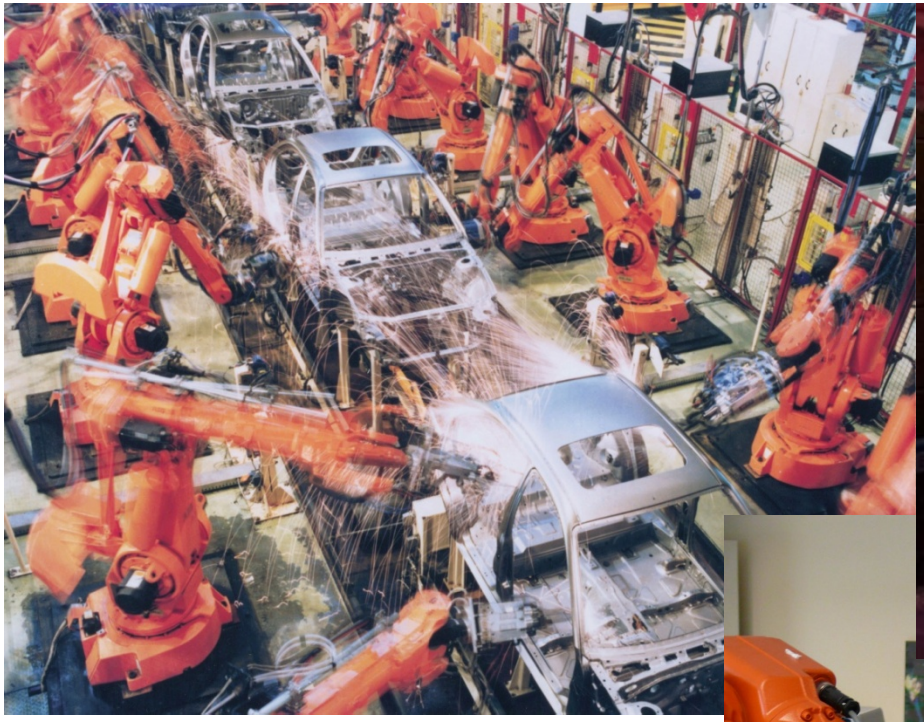
Robot

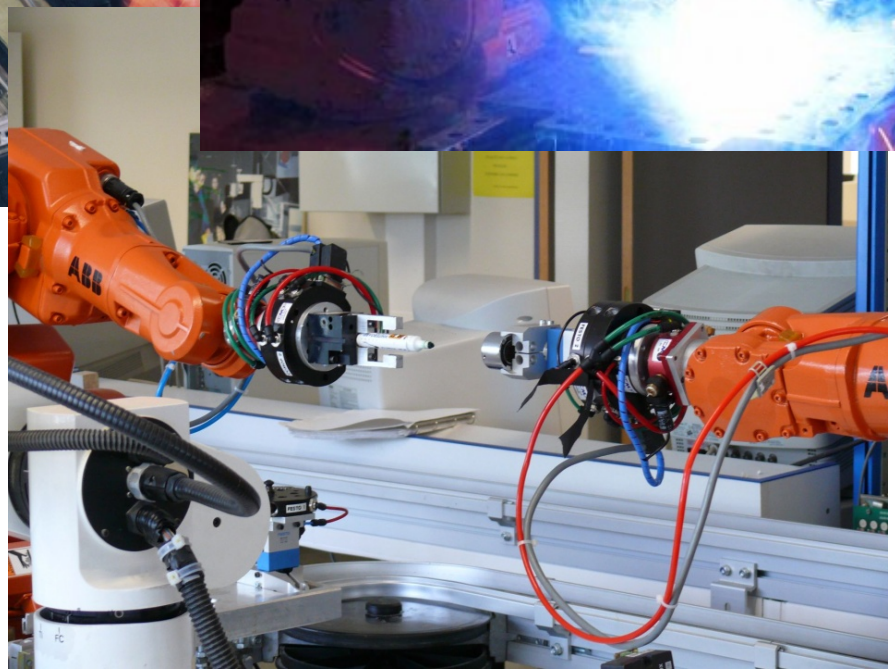
Robot is essentially a mechanism are operating under computer control. A *Robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety tasks.* An official definition of such Robot comes from the Robot Institute of America (RIA).



Robots are widely used in industries. They are becoming more effective-faster, more accurate, and more flexible. They become able to do more and more tasks that might be dangerous or impossible for human workers to perform.

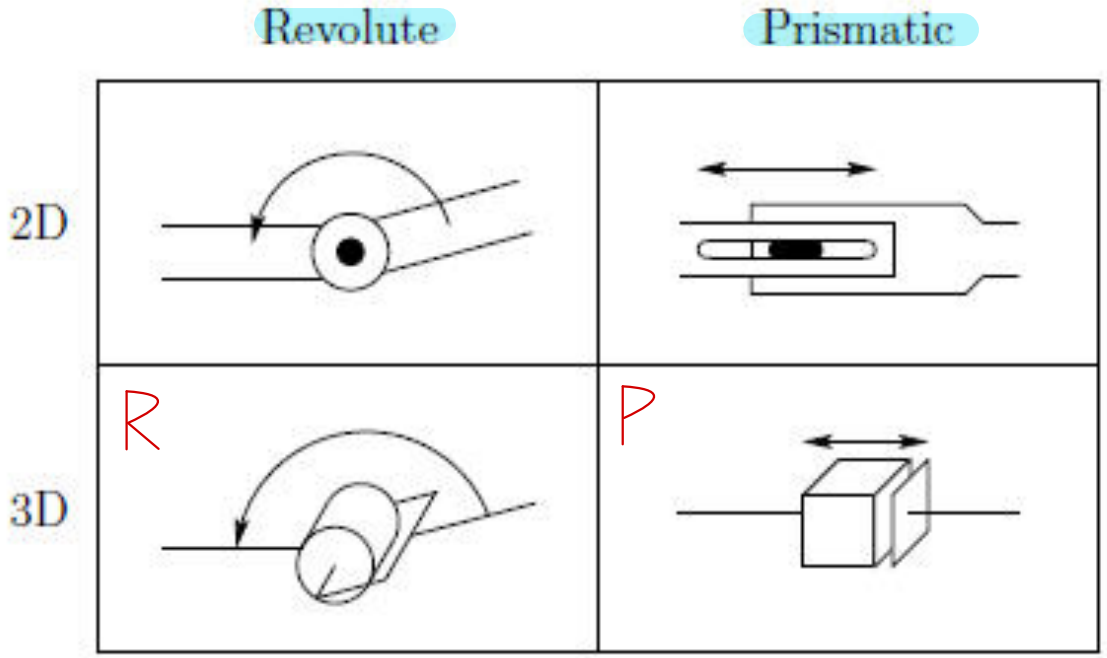
Industries Applications





- Welding (dangerous)
- Assembly (accuracy and high speed)
- Car assembly (large force, high speed and dangerous)

Symbolic Representation



Robot manipulators are composed of **links** connected by **joints** to form a kinematic chain.

Each joint represents the interconnection between two links. Joints are typically rotary (R: revolute) or linear (P:prismatic).

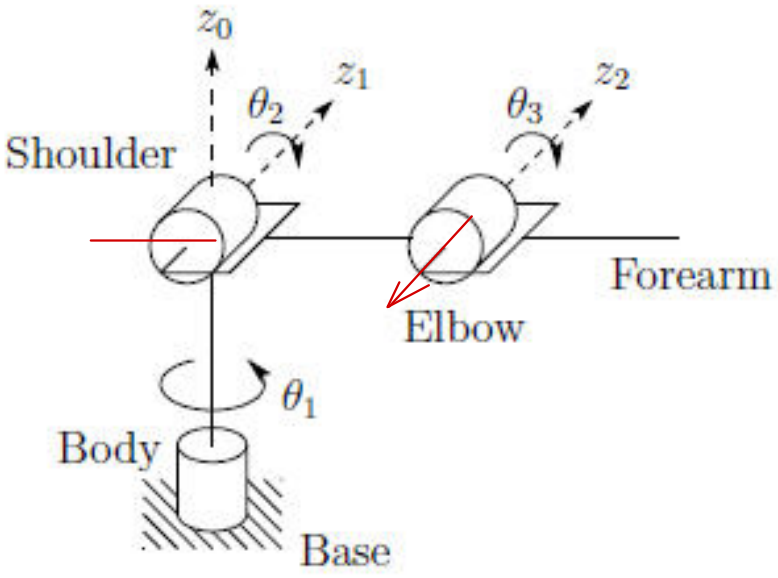
Geometry

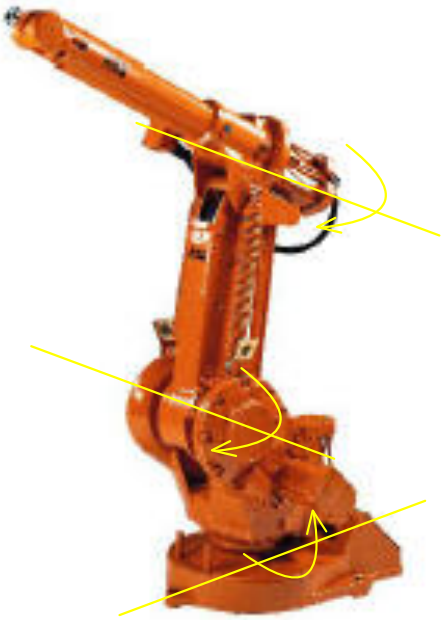
Most industrial manipulators at the present time have 6 or fewer degree of freedom (DOF). The number of DOF is equal to the dimension of the configuration space. The number of joints determines the number of DOF. A manipulator should posses at least six independent DOF (3 for positioning and 3 for orientation). With fewer than 6 DOF, the arm cannot reach every point in its work space. A manipulator having more than 6 DOF is referred to as a kinematic ally redundant (exceeding what is necessary) manipulator.

These manipulators are usually classified on the basis of the first three joints of the arm (the wrist being described separately). There are five geometric types. Each of these five manipulator arms is a serial link robot.

1. RRR : articulated.
2. RRP : spherical.
3. RRP: SCARA.
4. RPP : cylindrical.
5. PPP: cartesian.

RRR : Articulated

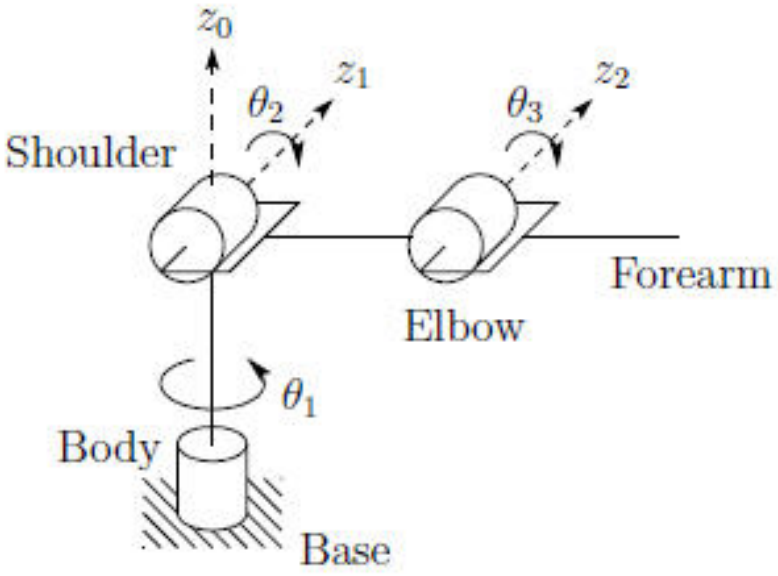


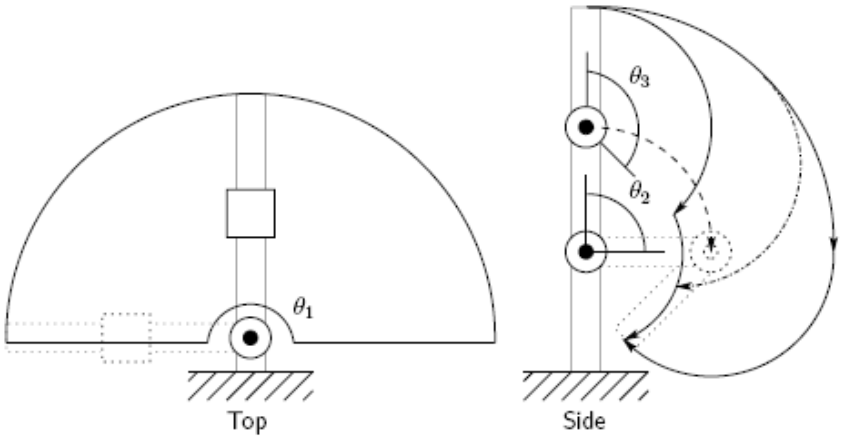


This articulated manipulator is called anthropomorphic manipulator. The three links are designated as the body, upper arm, and forearm, respectively. The joints axes are designated as the waist (z_0), shoulder (z_1) and elbow (z_2). The links and joints are analogous to human joints and limbs.

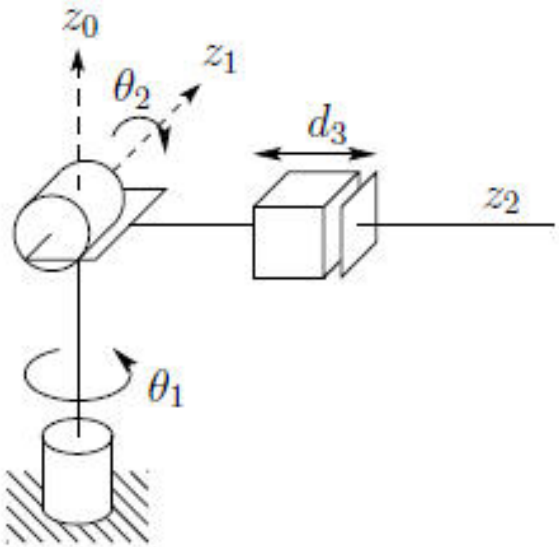
The joint axis z_2 is parallel to z_1 and both z_1 and z_2 are perpendicular to z_0. The ABB IRB1400 articulated arm is shown in Figure.

Workspaces RRR





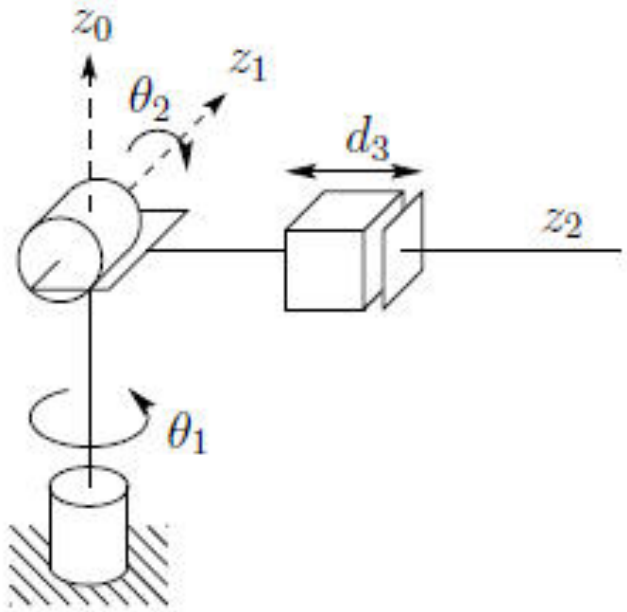
RRP : Spherical

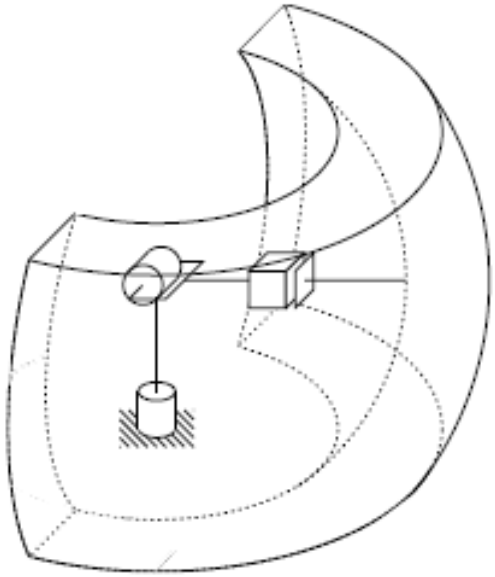


This spherical manipulator is replacing the elbow joint in the revolute by a prismatic joint. The joints axes are designated as z_0 perpendicular to z_1 and z_1 is perpendicular to z_2.

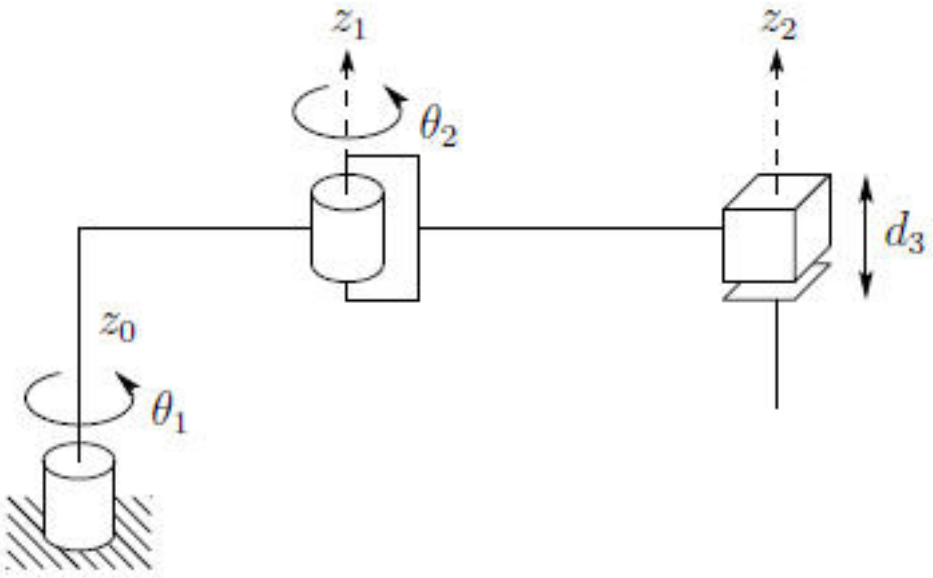
The Stanford Arm is an example of a spherical manipulator.

Workspaces RRP





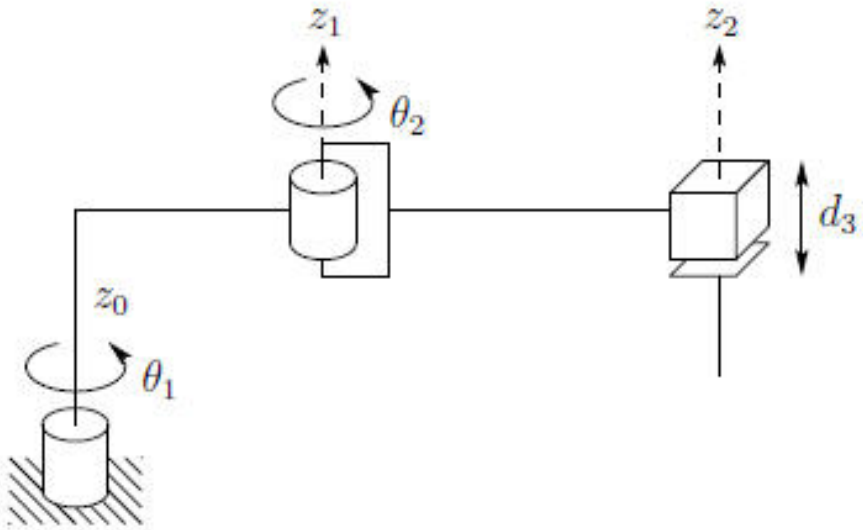
RRP : SCARA

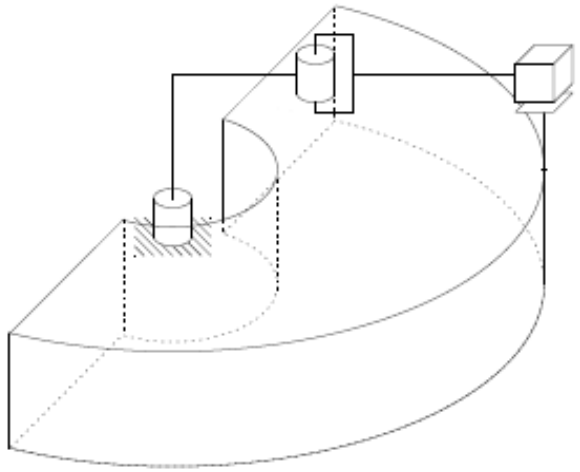


This SCARA (Selective Compliant Articulated Robot for Assembly) manipulator is very popular manipulator for assembly operations or pick and place task. The joints axes are designated as z_0 , z_1 and z_2 mutually parallel.

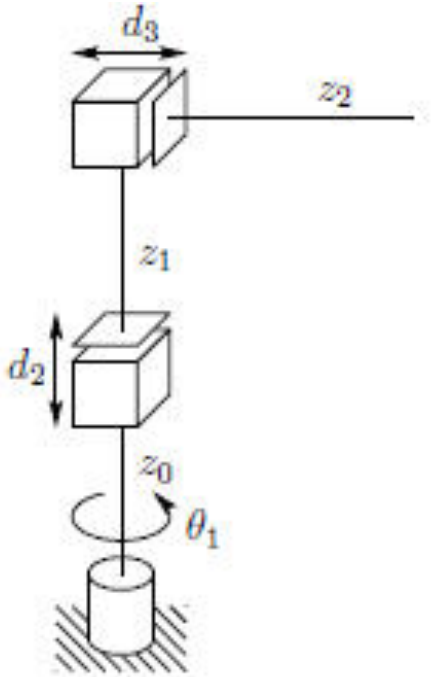
The Epson E2L653S is an example of a SCARA manipulator.

Workspaces RRP SCARA





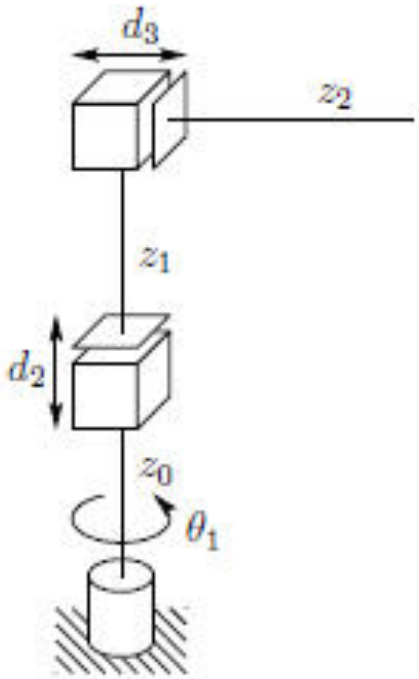
RPP : Cylindrical

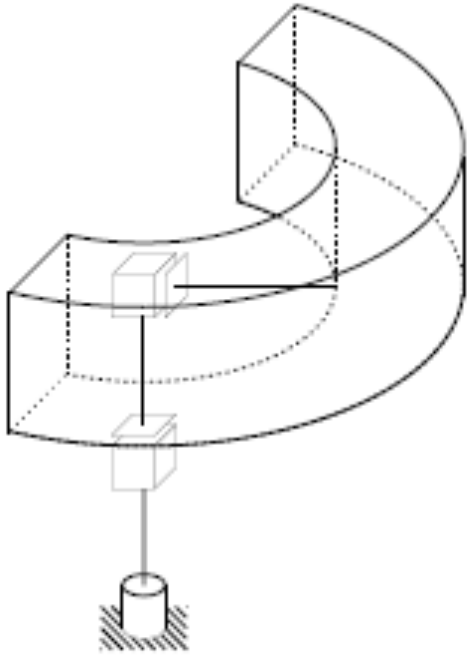


This Cylindrical manipulator is often used in material transfer tasks. The joints axes are designated as z_0 is revolute, while second and third joints are prismatic.

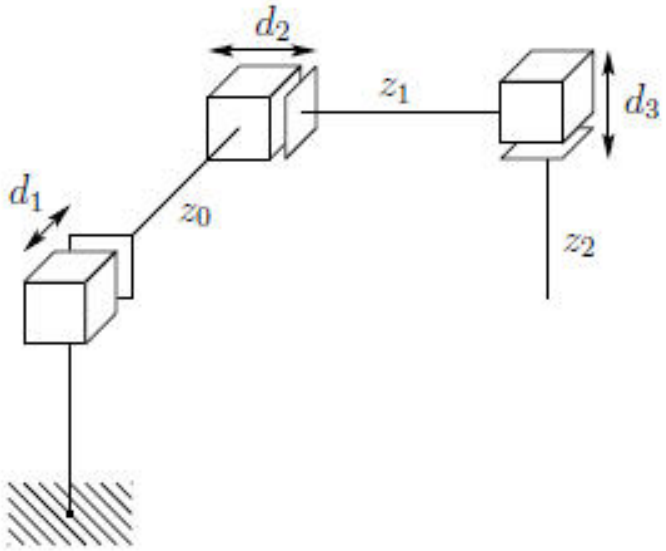
The Seiko RT3300 is an example of a cylindrical manipulator.

Workspaces RPP





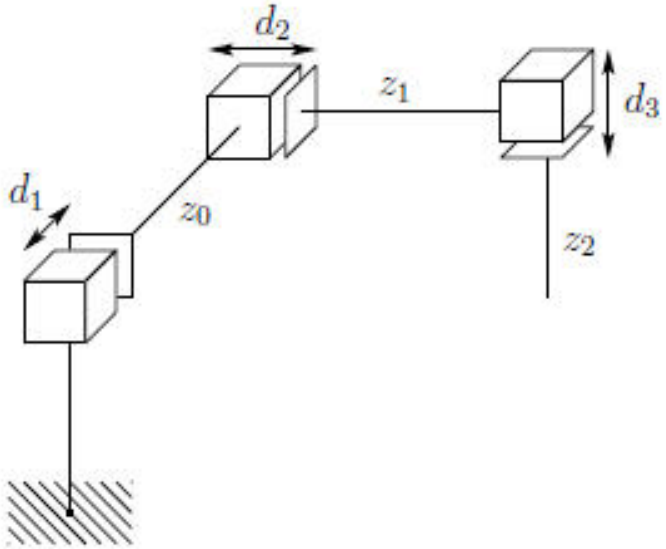
PPP : Cartesian

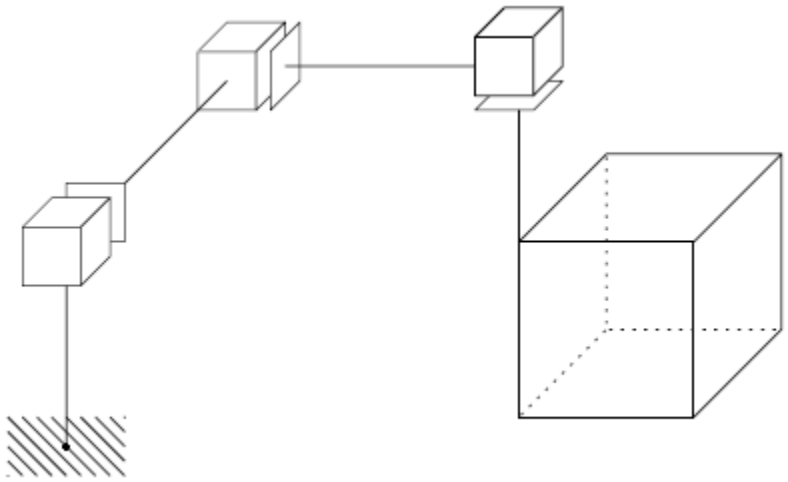


This Cartesian manipulator is useful for table-top assembly applications and transfer of material. The three joints are prismatic.

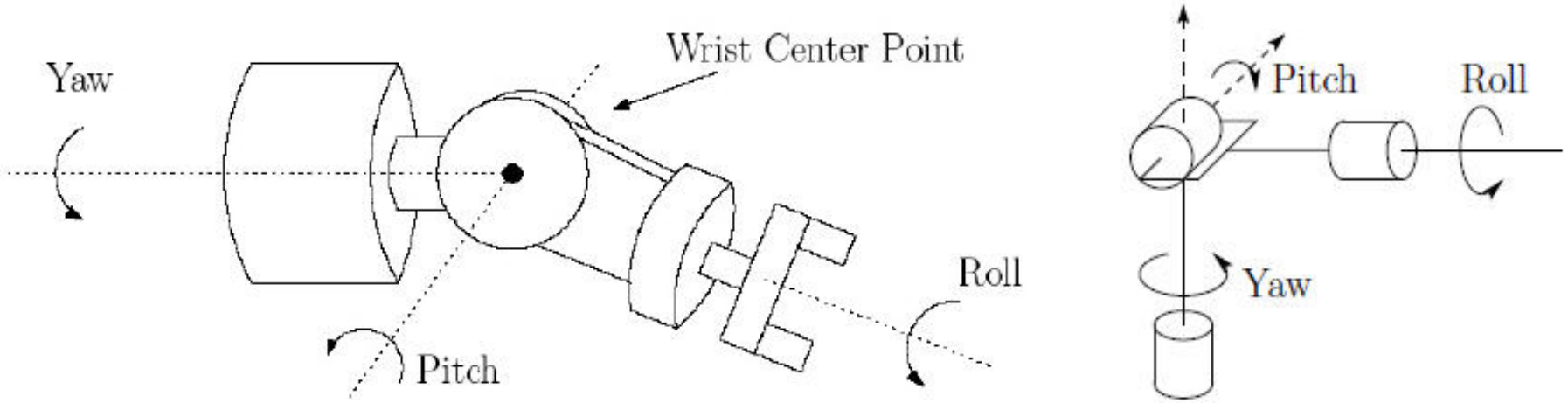
The Epson Cartesian Robot is an example of a Cartesian manipulator.

Workspaces PPP



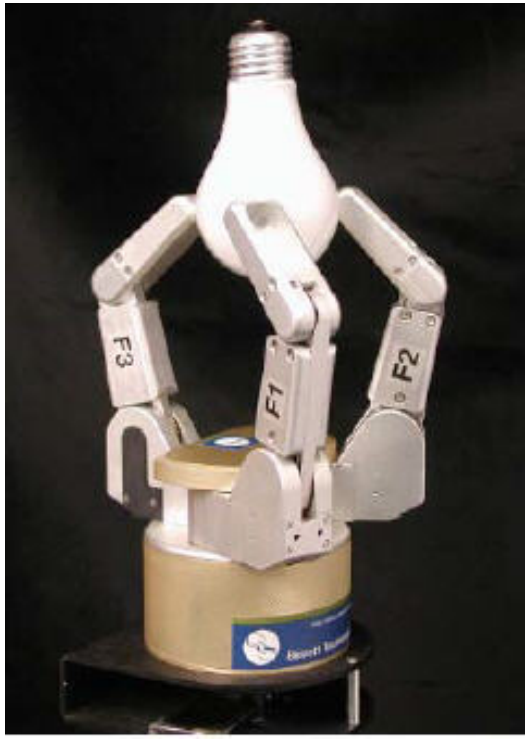


Wrists and End Effectors



The joint in the kinematic chain between the arm and end effector are referred to as the waist. Wrist center point is the common point where three joints axes intersect. Wrist can have 1,2 or 3 DOF depending on application.

Wrists and End Effectors



The arm and waist of a robot are used primarily for positioning the end effector. The end effector (tool) is actually performs the tasks such as handling, gripping, welding, assembly, grinding, etc.