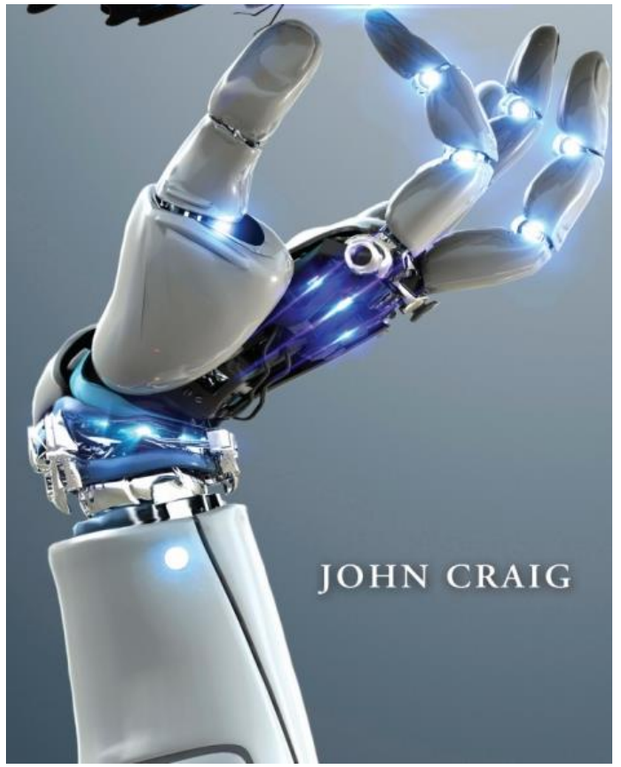
Chapter 2

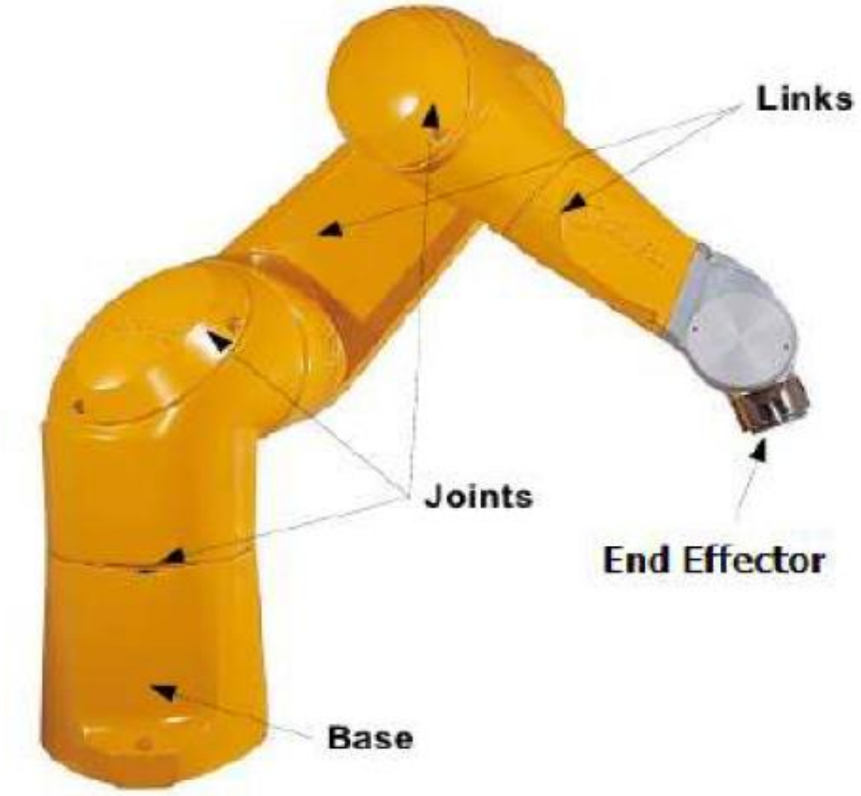
Robotics Anatomy: Joints



Structure of Robot Manipulators:

The robotic manipulators are composed of:

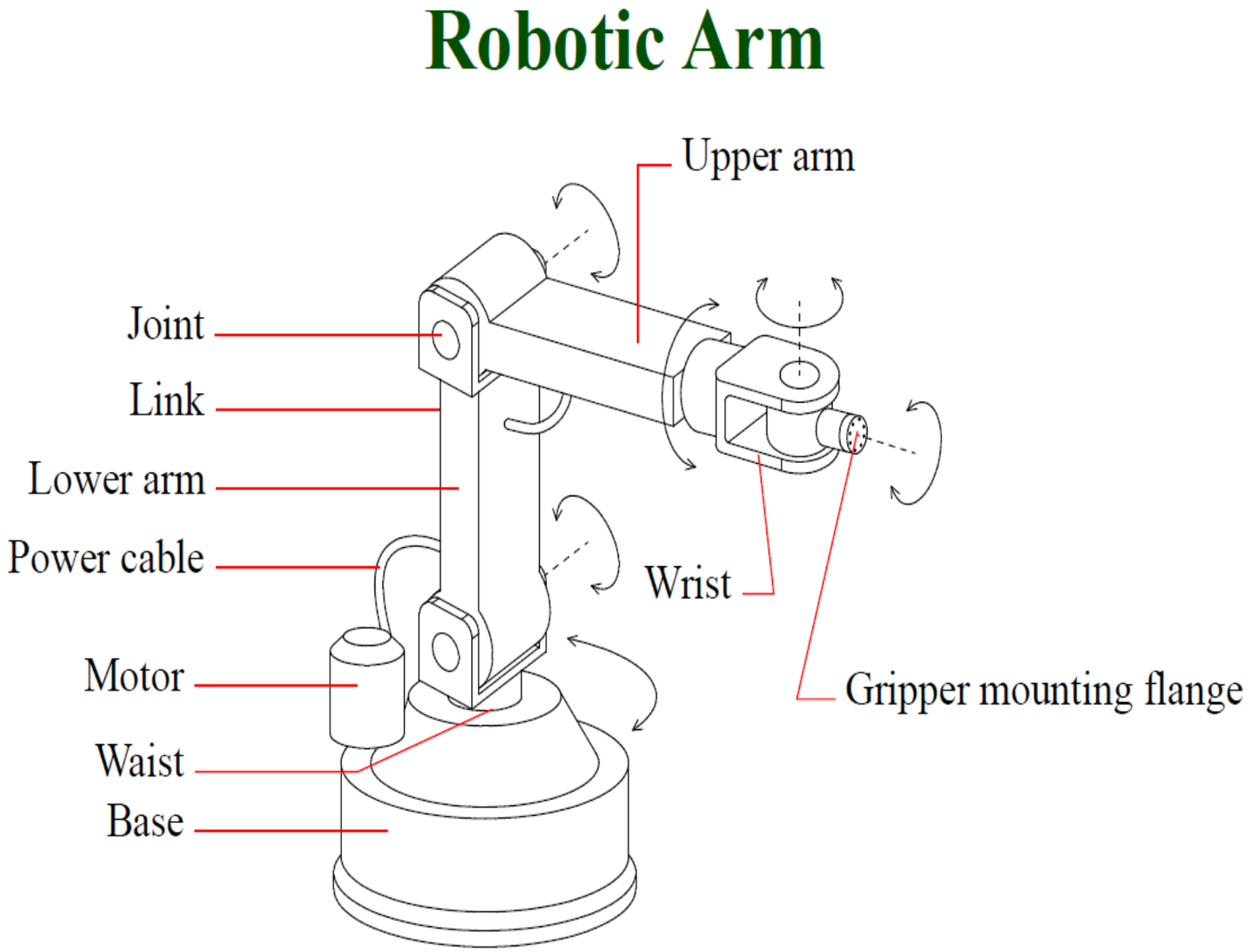
- **Kinematic open chain** composed of **Rigid Links** and **Joints**.
- The **BASE**: can be either **fixed** in the work environment or placed on a **mobile** platform.
- **End-Effector:** Tool is located at the end, used to execute the desired operations [gripper or specific tool].



Each joint connects two links together.

Robot Manipulator

1. Manipulator is also known as robotic arm.
2. The arm is made up of a finite number of individual rigid segments.
3. Each rigid segment is called as a Link.
4. Links are connected to each other by joints.
5. Links move with respect to its joint.

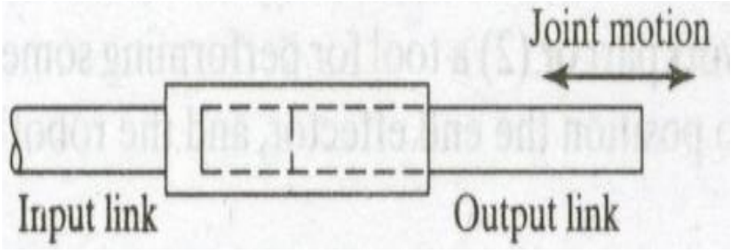


Robot Motion

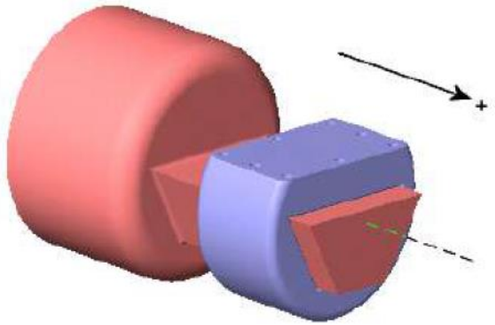
- Industrial robots perform productive work
- To move body, arm and wrist through a series of motions and positions
- End effector is used to perform a specific task
- Individual joint motions referred as Degrees of Freedom: ‘ DOF ’
- Motions are accomplished by powered joints

a) **Linear/Prismatic joint (Type L/P joint)**

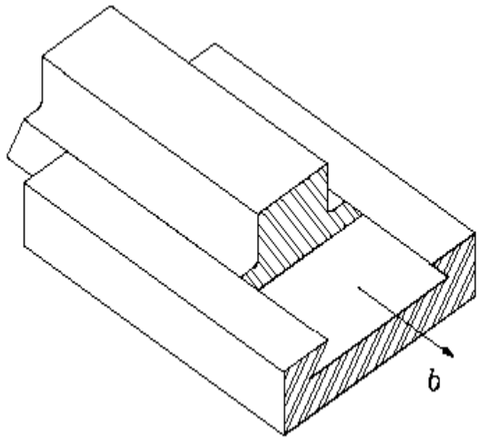
The relative movement between the input link and the output link is a translational sliding motion, the axis of the two links being parallel

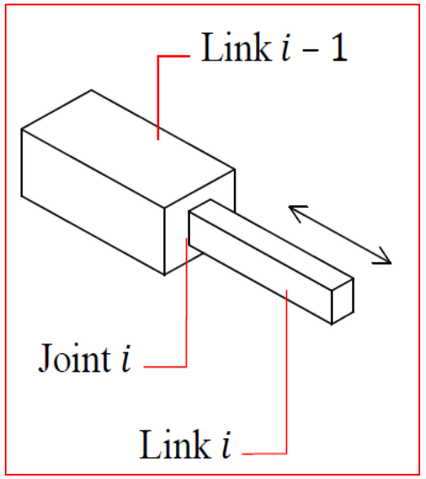


Linear (Prismatic) Joint



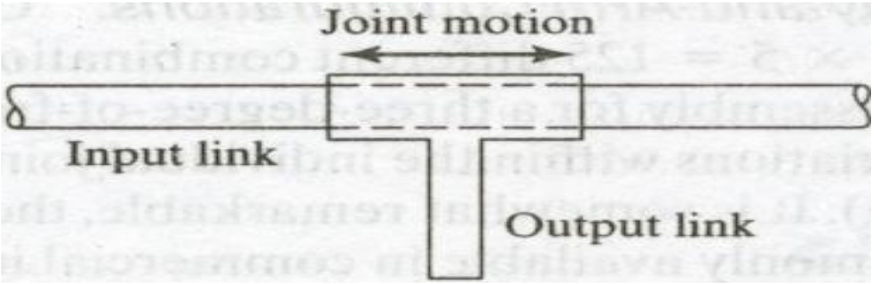
- Allows **translation** between two links.
- It is represented by symbol P.
- The joint variable is displacement d.





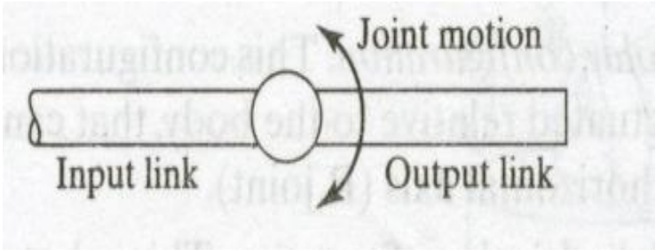
b) **Orthogonal joint (Type O joint)**

a translational sliding motion, the input and output links are perpendicular to each other.

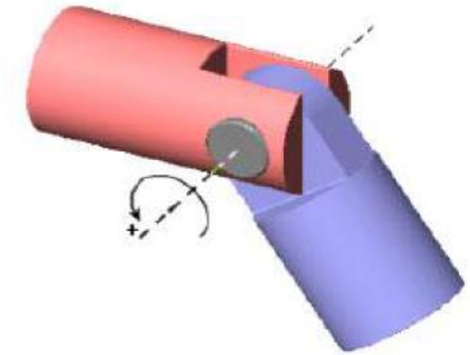


c) Rotational joint (Type R joint)

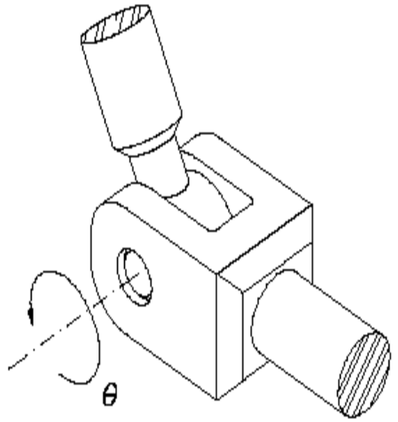
provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.

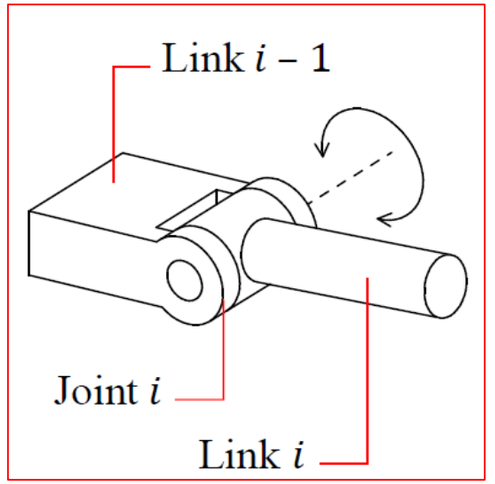


Rotary (Revolute) Joint



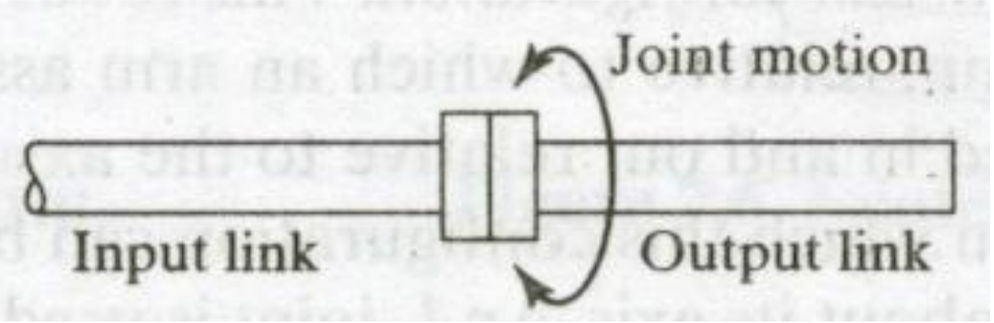
- Allows **rotation** between two links.
- It is represented by symbol R.
- The joint variable is angle θ.





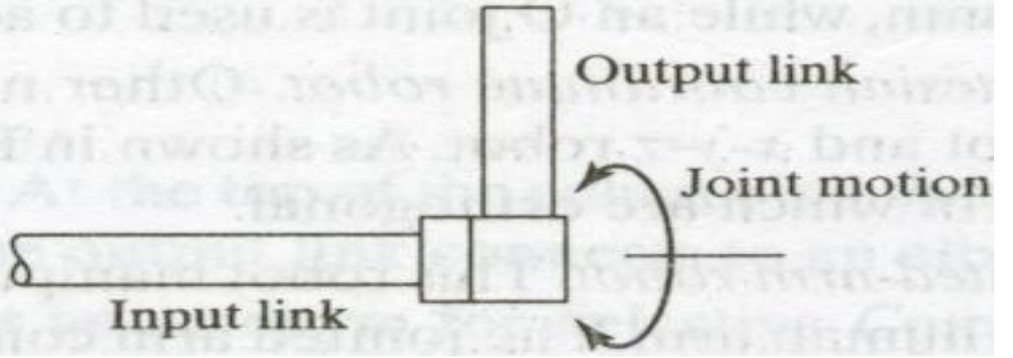
d) **Twisting joint (Type T joint)**

Involves rotary motion, but the axis of rotation is parallel to the axes of two links.

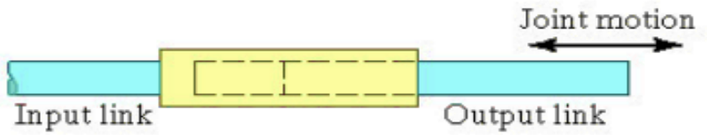
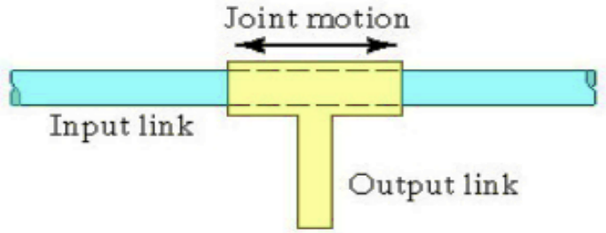
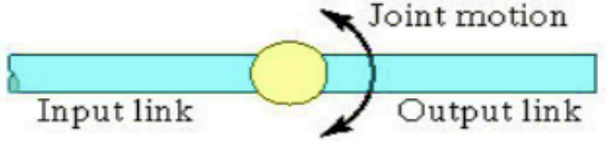
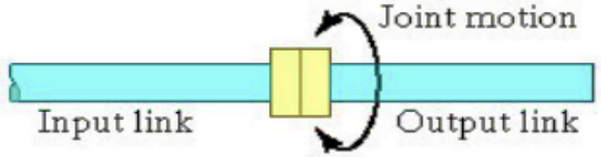
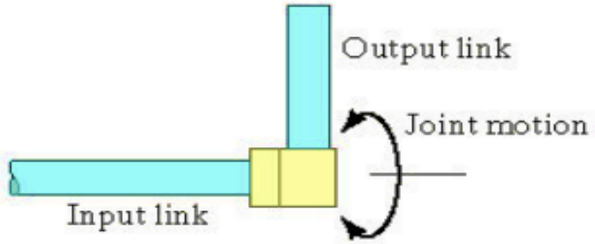


e) Revolving joint (Type V joint)

The axis of the input link is parallel to the axis of rotation of the joint, and the axis of the output link is perpendicular to the axis of rotation



Mechanical Joints for Robots

Joint	Description	Schematic
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 parallel.	
Orthogonal joint	Type O joint; the relative movement between the input link and the output link is a translational sliding motion, but the output link is perpendicular to the input link.	
Rotational joint	Type R joint; this 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 provides rotary motion, but the axis of rotation is parallel to the axes of the two links.	
Revolving joint	Type V joint; the axis of the input link is parallel to the axis of rotation of the joint, and the axis of the output link is perpendicular to the axis of rotation.	

Mechanical Joints for Robots

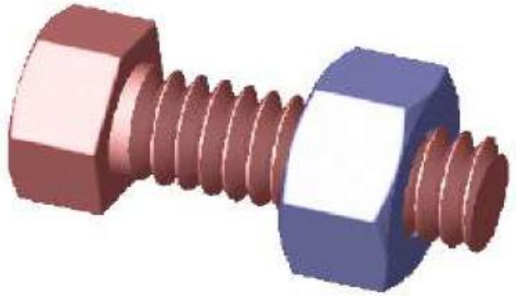
https://www.youtube.com/watch?v=SMcqUjQ2Swo

Difference between Joints

- When an object turns around an internal axis (like the Earth turns around its axis) it **is** called a **rotation**.
- When an object circles an external axis (like the Earth circles the sun) it **is** called a revolution.
- Rotational joint can be represented as R – Joint. This type will allow the joints to move in a *rotary motion* along the axis, which is vertical to the arm axes.
- Linear joint can be indicated by the letter L – Joint. This type of joints can perform both translational and sliding movements. These motions will be attained by several ways such as telescoping mechanism and piston. The two links should be in *parallel axes* for achieving the linear movement.
- Twisting joint will be referred as V – Joint. This joint makes *twisting motion* among the output and input link. During this process, the output link axis will be vertical to the rotational axis. The output link rotates in relation to the input link.
- The *O – joint* is a symbol that is denoted for the orthogonal joint. This joint is somewhat similar to the linear joint. The only difference is that the output and input links will be moving at the right angles.
- Revolving joint is generally known as V – Joint. Here, the output link axis is *perpendicular* to the rotational axis, and the input link is *parallel* to the rotational axes. As like twisting joint, the output link spins about the input link

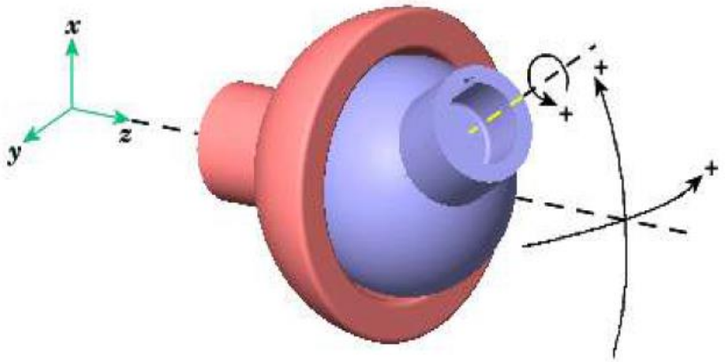
More Types of Joints

Screw Joint



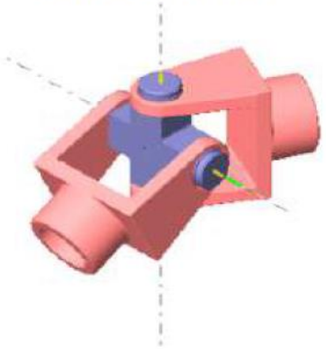
- Allows rotation and a constrained translation.
- It is represented by symbol SC.

Spherical Joint



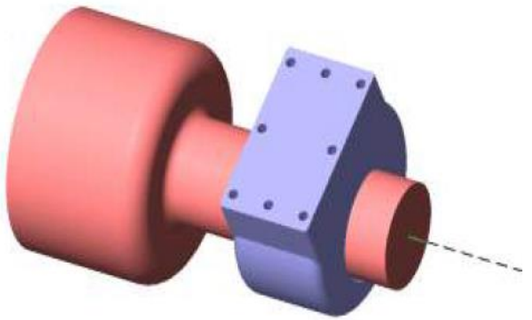
- Allows rotation around three axes.
- It is represented by symbol S.
- The joint variables are θ, γ and ψ.

Universal Joint



- Allows rotation around two axes.
- It is represented by symbol U.
- The joint variables are θ_1 and θ_2.

Cylindrical Joint



- Allows rotation and translation.
- It is represented by symbol C.