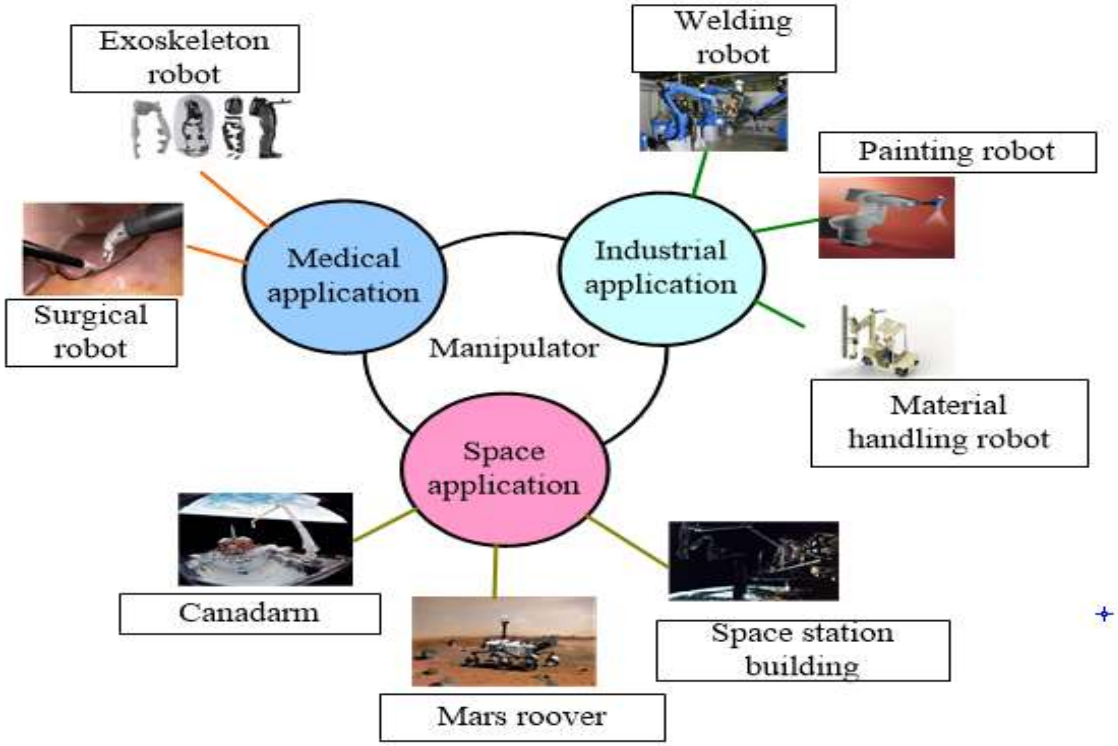
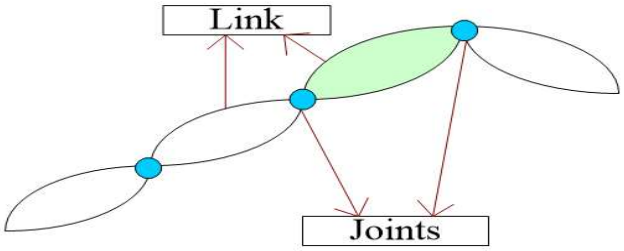
Introduction to Robotics

Soumya S

Canadarm Canadarm_ Canadian Robotics for the Shuttle.mp4

Samsung knife wielding robotic chef
These robotic arms put a five-star chef in your kitchen.mp4

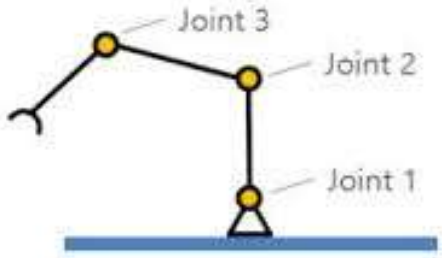




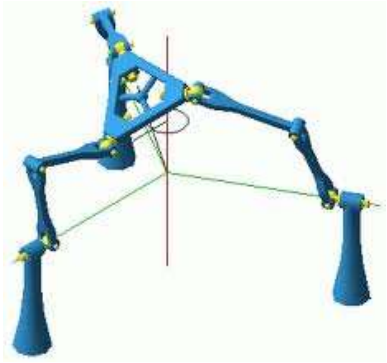
Manipulator arm in General

- A robot is mechanically constructed by connecting a set of bodies, called links, to each other using various types of joints.
- Actuators, such as electric motors, deliver forces or torques that cause the robot's links to move.

Serial link Manipulator

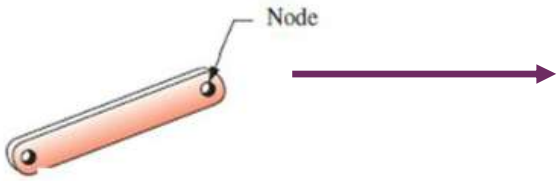


Parallel link Manipulator

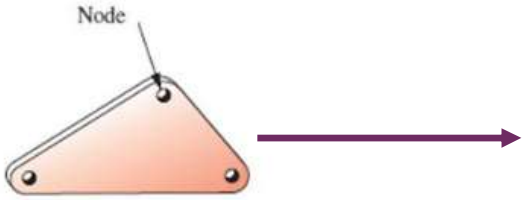


Hybrid link Manipulator

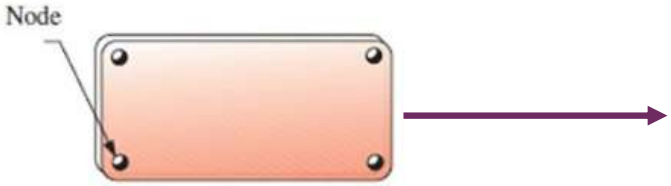
Mechanical Links



Binary Link: Single link with two nodes



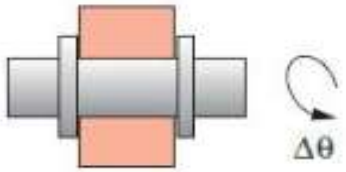
Ternary Link: Single link with three nodes



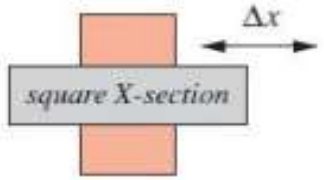
Quaternary Link: Single link with four nodes

Mechanical Joints

1R



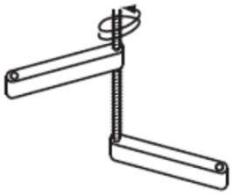
Revolute (R) joint

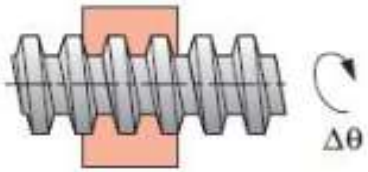


Prismatic (P) joint

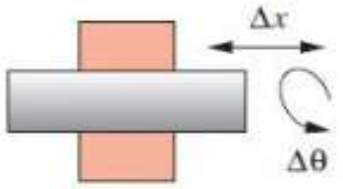
1P

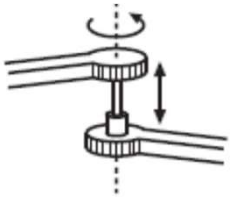
1R





Helical (H) joint

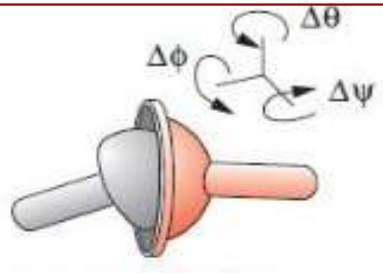




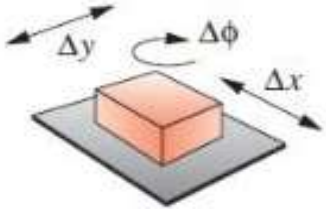
Cylindrical (C) joint

1R & 1P

3R



Spherical (S) Joint

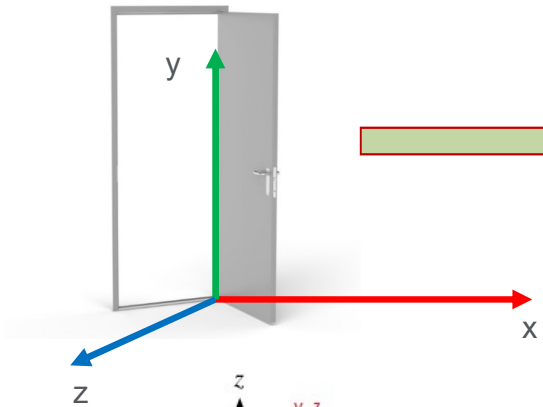


Flat (F) Joint

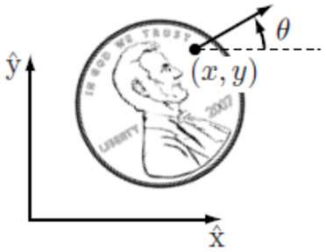
1R & 2P

Where is the Robot ???

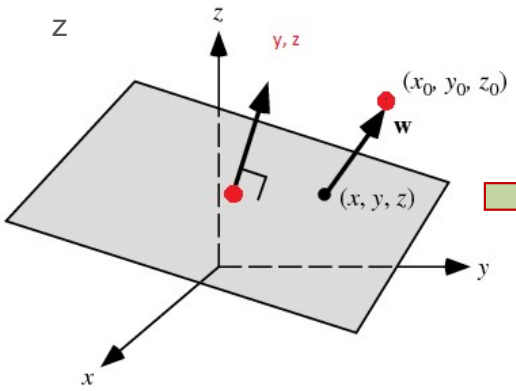
- Configuration: Specification of the positions of all points of the robot.



Configuration of a door : ??? 1



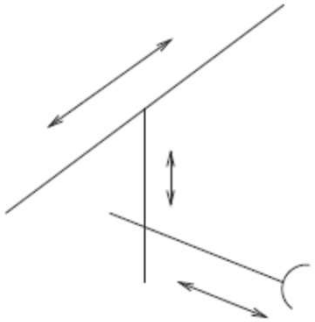
Configuration of a coin on a table ???

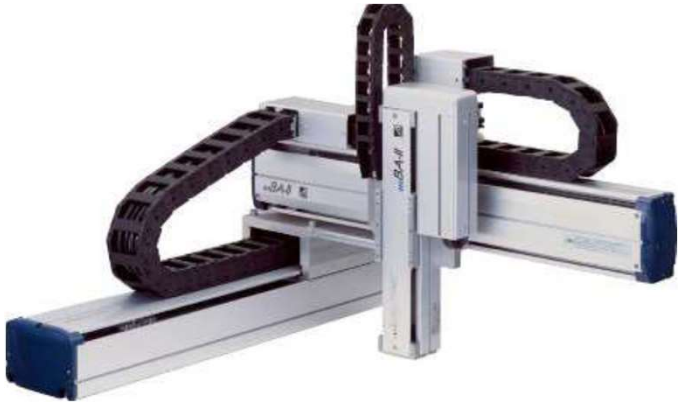


Configuration of a point in a plane & and space

Joint type	dof f	Constraints c between two planar rigid bodies	Constraints c between two spatial rigid bodies
Revolute (R)	1	2	5
Prismatic (P)	1	2	5
Helical (H)	1	N/A	5
Cylindrical (C)	2	N/A	4
Universal (U)	2	N/A	4
Spherical (S)	3	N/A	3

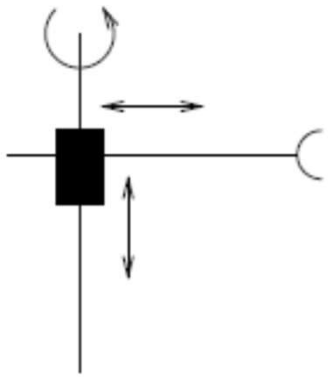
Classification of manipulator based on its configuration





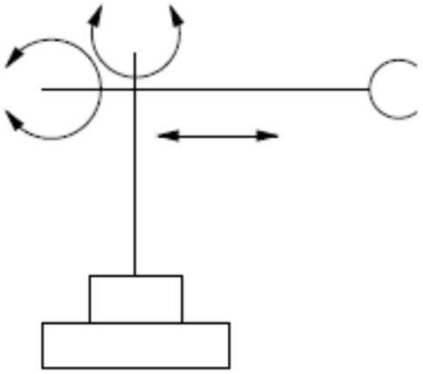
A Toshiba BA-II series cartesian robot.

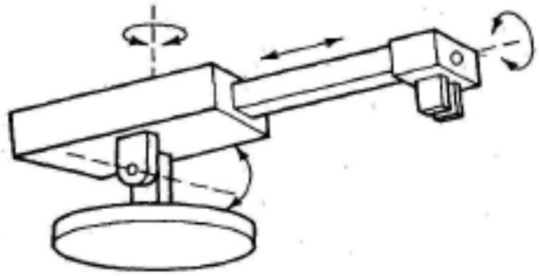
Cartesian configuration: In this configuration, the manipulator has a natural motion in the Cartesian space. Each joint allows a linear (sliding or prismatic) motion in x, y, and z directions, respectively



Cylindrical configuration: A robot in cylindrical configuration has a natural motion in polar co-ordinate system. The manipulator has one revolute and two prismatic joints (PRP)

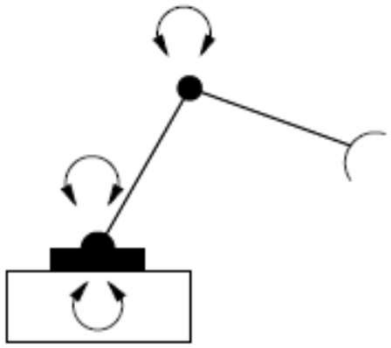
Plate Cran EX, a cylindrical robot from Hudson Robotics.

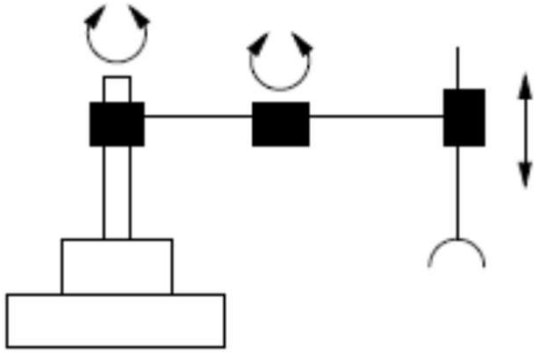




A robot with spherical configuration.

Spherical configuration: In this configuration, the robot has a natural motion capability in a spherical coordinate system the robot has two rotational degrees of freedom (revolute joints) at the base and one linear motion (prismatic joint) in radial direction (RRP)





Toshiba TH series SCARA robot

Anthromorphic robot: Anthromorphic or articulated robots mimic human arm motion. It has three revolute joints (RRR or 3-R). Note that if all the axes are parallel to each other, then the end-effector motion is restricted to a plane.

SCARA: SCARA stands for Selective Compliance Assembly Robot Arm. This configuration has two revolute and one prismatic joints (RRP)

Degree of Freedom: Grubler's Formula

$$\text{dof} = \underbrace{m(N-1)}_{\text{rigid body freedoms}} - \underbrace{\sum_{i=1}^{J} c_i}_{\text{joint constraints}}$$

$$= m(N-1) - \sum_{i=1}^{J}(m - f_i)$$

$$= m(N-1-J) + \sum_{i=1}^{J} f_i.$$

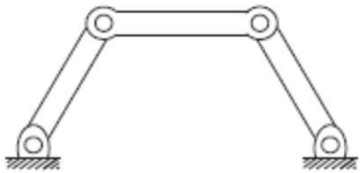
J = number of joints

m = number of degrees of freedom of a rigid body (m = 3 for planar mechanisms and m = 6 for spatial mechanisms)

f_i = number of freedoms provided by joint 'i'

c_i = number of constraints provided by joint 'i'

N = No.of links,



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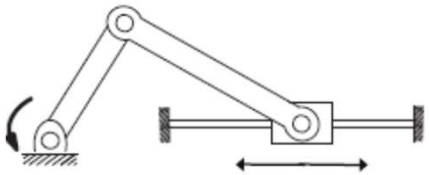

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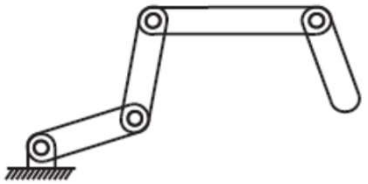

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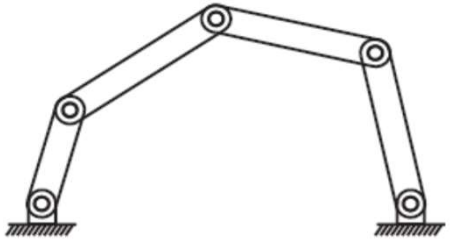

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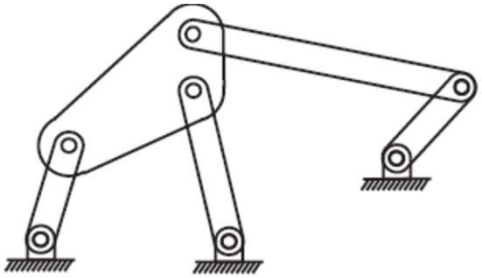

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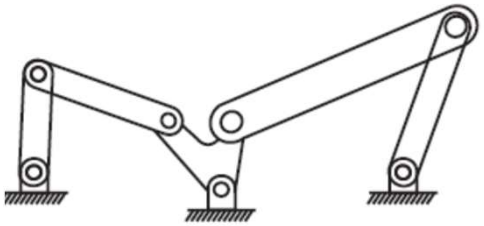

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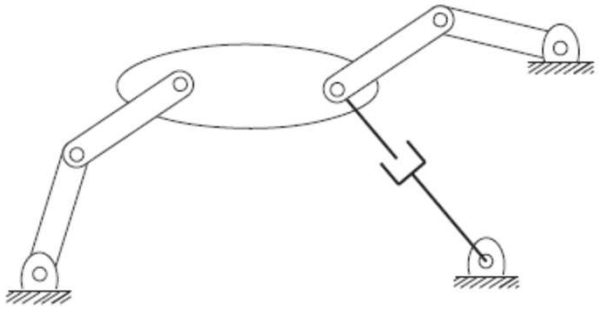

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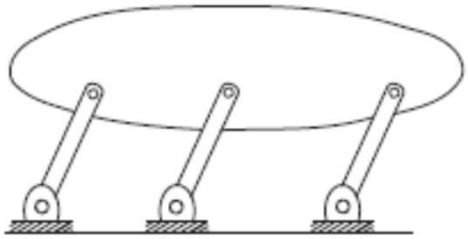

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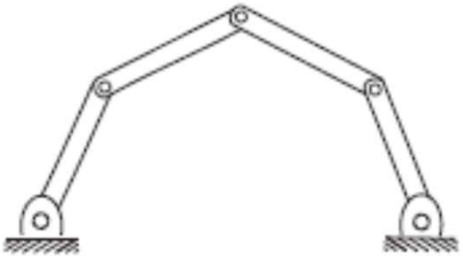

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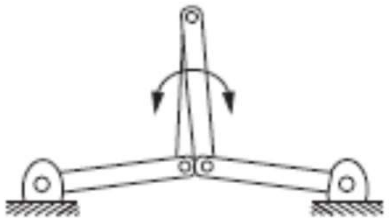

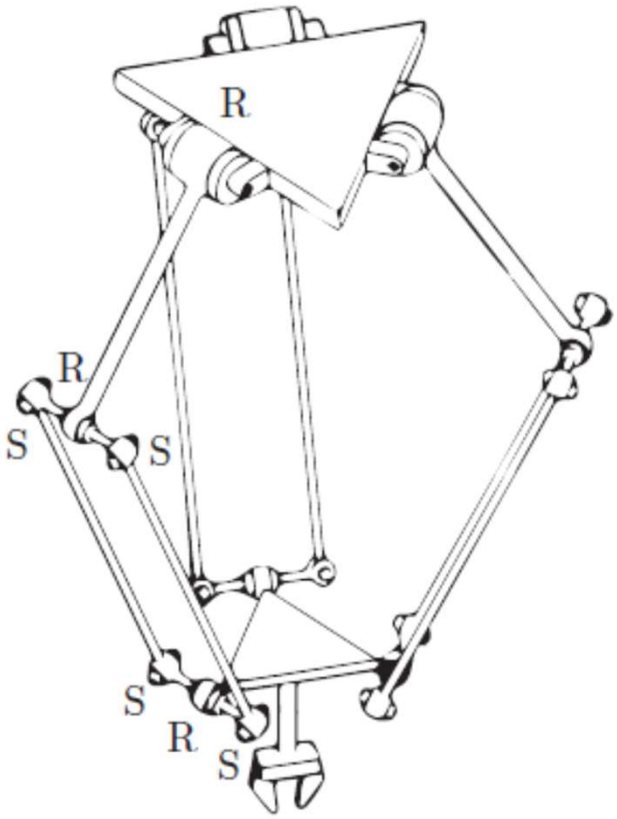

The Delta robot.