2.

**RRP (Spherical Configuration)**- Standford-type Robot
https://www.youtube.com/watch?v=5JIVfEw61DY

It has six degrees of freedom.

The spherical coordinate defines the position of an end effector with respect to the origin.

**RRR (Articulated Configuration)**– Puma-type Robot
https://www.youtube.com/watch?v=tjOhGqOHfhg

It forms a parallelogram linkage.

The configuration provides for a large degree of freedom in less space.

The dynamics of RRR-type robots are simple as compared to other manipulators.

**RPP (Cylindrical Configuration) -** https://www.youtube.com/watch?v=Hj7PxjeH5y0

The first joint is revolute and followed by two prismatic joints; the joint variables form a cylindrical coordinate system of the end effector with respect to the base.

**PPP (Cartesian Configuration) -** https://www.youtube.com/watch?v=5VCyk38ZVyM

It is a type of Manipulator whose first three joints are prismatic. The end effector and the joint variable form a cartesian configuration with respect to the base. The Kinematic description of this Manipulator is the simplest.

**Parallel Manipulator -** https://www.youtube.com/watch?v=vEkE8RPOrEs

The links form a closed chain. It has two or more kinematics chains connecting the base to the end effector. Since a parallel manipulator has a closed chain, it has greater rigidity and accuracy.

**RRP – SCARA** (Selective Compliant Articulated Robot for Assembly) Type Robot
https://www.youtube.com/watch?v=QSbG2i1Z9B4

It is used for assembly operation.

SCARA type robot system is faster than any Cartesian coordinate system.

3.

Motors can be categorized into two types – AC Motors and DC Motors

**AC Motors** Consists -

**Induction Motor** (also known as Asynchronous Motor):

This motor works on the induced current within the rotor from the rotary magnetic field of the stator. The rotor cannot be synchronized through the moving stator field. The rotating stator field of this motor can induce a current within the windings of the rotor.

**Synchronized Motor**:

In a synchronized motor, the rotor rotates at the same speed as the revolving field in the machine. The stator is like that of an induction machine consisting of a cylindrical iron frame with windings.

**DC Motor** -

**Brushed DC Motor**:

It uses brushes to transfer current to motor windings. The brush is made of carbon material which tears out as time passes because of friction. It is used in automobiles.

**Brush Less DC Motor**:

It does not contain brushes to transfer the current to motor winding. Instead of brushes, it uses a magnetic field generated by a stationary magnet.

**Stepper Motor**:

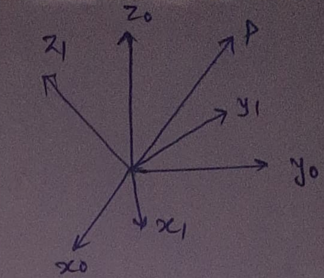
The rotator of the stepper motor can rotate at a specific angle. It can move in a discrete step without any feedback sensor. It is beneficial in a precise position.

**Servo Motor**:

It is a rotary actuator that allows precise control of an angular position. It is coupled with a sensor for positive feedback for precise control.

6.

$$R_0^1 = \begin{bmatrix} \hat{i}_0 \cdot \hat{i}_1 & \hat{j}_0 \cdot \hat{i}_1 & \hat{k}_0 \cdot \hat{i}_1 \\ \hat{i}_0 \cdot \hat{j}_1 & \hat{j}_0 \cdot \hat{j}_1 & \hat{k}_0 \cdot \hat{j}_1 \\ \hat{i}_0 \cdot \hat{k}_1 & \hat{j}_0 \cdot \hat{k}_1 & \hat{k}_0 \cdot \hat{k}_1 \end{bmatrix}$$




let, $X_1 = \begin{bmatrix} \hat{i}_0 \cdot \hat{i}_1 \\ \hat{i}_0 \cdot \hat{j}_1 \\ \hat{i}_0 \cdot \hat{k}_1 \end{bmatrix}$ ; $X_2 = \begin{bmatrix} \hat{j}_0 \cdot \hat{i}_1 \\ \hat{j}_0 \cdot \hat{j}_1 \\ \hat{j}_0 \cdot \hat{k}_1 \end{bmatrix}$ ; $X_3 = \begin{bmatrix} \hat{k}_0 \cdot \hat{i}_1 \\ \hat{k}_0 \cdot \hat{j}_1 \\ \hat{k}_0 \cdot \hat{k}_1 \end{bmatrix}$

$$X_1 \cdot X_1^T = \begin{bmatrix} \hat{i}_0 \cdot \hat{i}_1 \\ \hat{i}_0 \cdot \hat{j}_1 \\ \hat{i}_0 \cdot \hat{k}_1 \end{bmatrix} \begin{bmatrix} \hat{i}_0 \cdot \hat{i}_1 & \hat{i}_0 \cdot \hat{j}_1 & \hat{i}_0 \cdot \hat{k}_1 \end{bmatrix}$$

$$= \begin{bmatrix} |x| \times \cos\theta \\ |x| \times \sin\theta \\ 0 \end{bmatrix} \begin{bmatrix} \cos\theta & \sin\theta & 0 \end{bmatrix}$$

$$= [1]$$

$$X_2 X_2^T = \begin{bmatrix} \hat{j}_0 \cdot \hat{i}_1 \\ \hat{j}_0 \cdot \hat{j}_1 \\ \hat{j}_0 \cdot \hat{k}_1 \end{bmatrix} \begin{bmatrix} \hat{j}_0 \cdot \hat{i}_1 & \hat{j}_0 \cdot \hat{j}_1 & \hat{j}_0 \cdot \hat{k}_1 \end{bmatrix}$$

$$= \begin{bmatrix} -\sin\theta \\ \cos\theta \\ 0 \end{bmatrix} \begin{bmatrix} -\sin\theta & \cos\theta & 0 \end{bmatrix}$$

$$= [1]$$

$$X_3 X_3^T = \begin{bmatrix} \hat{k}_1 \cdot \hat{i}_0 \\ \hat{k}_1 \cdot \hat{j}_0 \\ \hat{k}_1 \cdot \hat{k}_0 \end{bmatrix} \begin{bmatrix} \hat{k}_1 \cdot \hat{i}_0 & \hat{k}_1 \cdot \hat{j}_0 & \hat{k}_1 \cdot \hat{k}_0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 \end{bmatrix}$$

7. $$R_0^1 = \begin{bmatrix} \hat{i}_0 \cdot \hat{i}_1 & \hat{j}_0 \cdot \hat{i}_1 & \hat{k}_0 \cdot \hat{i}_1 \\ \hat{i}_0 \cdot \hat{j}_1 & \hat{j}_0 \cdot \hat{j}_1 & \hat{k}_0 \cdot \hat{j}_1 \\ \hat{i}_0 \cdot \hat{k}_1 & \hat{j}_0 \cdot \hat{k}_1 & \hat{k}_0 \cdot \hat{k}_1 \end{bmatrix}$$

$$\det(R_0^1) = \begin{vmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

$$= \cos\theta(\cos\theta) + \sin\theta(\sin\theta)$$

$$= 1$$