ASSIGNMENT 1

Task-2.

Categories of robot :

1. Mobile robots: This type of robots are not constrained by its positional rigidity but can be able to move to required position . Modern robot like automated guided vehicle is one of the most perfect example .
2. Manipulator:
    a. Articulate robot(RRR): In this type of robot , joint axis z2 is parallel to z1 and both z1 and z2 are perpendicular to z0 .https://youtu.be/wNY01XEi_nI . This parallelogram linkage configuration is that the actuator for joint 3 is located at joint 1. Since the weight of motor is born by link 1 , link 2 and link 3 then the structure becomes lightweight and motor effort is reduced.
    Motoman SK16 MRC With Camco and Slide Welding Demonstration - YouTube
    b. PUMA robot (RRR): Also known as programmable universal machine for assembly . Design of such robot is based on two main components : mechanical arm and control system . These are interconnected with two large multi-conductor cable - one carries power and brake , while other carries position feedback from each joint to control system. https://www.youtube.com/watch?v=tjOhGqOHfhg
    c. Spherical robot (RRP): standford robot is well known kind of spherical robot
    d. SCARA robot(RRP): https://www.youtube.com/watch?v=pTr45EagXwk
    e. Cylinderical robot(RPP): https://www.youtube.com/watch?v=lTA4zxka-1E
    f. Cartesian robot (PPP): Nowadays these category of robot are being evolving and becoming more in use from rapid prototyping to final production with less material waste. http://www.youtube.com/watch?v=O-Auj6z08vY
3. Aerial robot: used mostly in military application and surveillance https://youtu.be/4WOOwesIkss
4. Underwater robot: waterproof type of robot is used to detect unknown research https://youtu.be/4WOOwesIkss
5. Soft robot: Most flexible type of robot aresoft robots , its length can be adjusted according to its usage https://youtu.be/CDohWwEXQ68

Task-3.

In the application of robots , the most commonly types of motors used are radial flux motor.

Radial flux motor can be broadly classified into power consumed either in the form of AC or DC:

1. Most commonly used DC motor are
    a. Brushed Dc motor: These motors work using carbon brusher as commutator , the commutator switch the polarity after 180 degree of rotation , Hence keeping the motor constantly running.
    b. Brushless Dc motor: Unlike brushed DC motor these motors do not use commutator. Brushless DC motor have rotor and stator windings and are usually controller by complex controller which use position sensors such as hall effect sensor and rotor encoder.

c. Stepper motor : These motors are very high resolution motors which can control the position very accurately and used in applications where precisions is very important.
d. Servomotor : servomotor is a rotor actuator that allows the precision control of angular position.

2. Most commonly used AC motor are
    a. Induction motor : An induction motors that operates on the mutual electromagnetic induction . The rotor of an induction motor can either have coil or squirrel cage . This motor operates on asynchronous speed.
    b. PMSM (PERMANENT MAGNET SYNCHRONOUS MACHINES) : These are advanced form of AC induction machine which have permanent magnet as rotors due to which they have higher power density than in induction motors similar to bdlc motors PMSM motors required complex commutations .
    c. Synchronous reluctance motor : synchronous E motors uses ferromagnetic materials as a rotor when influence in rotating electromagnetic field . They rotate at synchronous speed due to magnetic locking between rotor and stator.

References:

1. Robot dynamics and control second edition – Mark W.spong , Seth Hutchinson and M.vidyasagar.

6. Columns of the rotation matrix R_0^1 are orthogonal.

Sol.

$$R_0^1 = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{matrix} \rightarrow R_1 \\ \rightarrow R_2 \\ \rightarrow R_3 \end{matrix}$$

$$\downarrow C_1 \quad \downarrow C_2 \quad \downarrow C_3$$

Let C_1, C_2, C_3 be the column vectors.

For orthogonality,

$$C_1^T \cdot C_2 = \begin{bmatrix} \cos\theta & \sin\theta & 0 \end{bmatrix} \begin{bmatrix} -\sin\theta \\ \cos\theta \\ 0 \end{bmatrix}$$

$$= -\sin\theta\cos\theta + \sin\theta\cos\theta = 0$$

$$C_2^T \cdot C_3 = \begin{bmatrix} -\sin\theta & \cos\theta & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = 0$$

We can also check with row vectors

$$R_1 \cdot R_2^T = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \end{bmatrix} \begin{bmatrix} \sin\theta \\ \cos\theta \\ 0 \end{bmatrix}$$

$$= \cos\theta \cdot \sin\theta - \sin\theta\cos\theta = 0$$

Hence, it is proved Columns of R_0^1 are orthogonal.

7. $|R_0^1| = \begin{vmatrix} C_\theta & -S_\theta & 0 \\ S_\theta & C_\theta & 0 \\ 0 & 0 & 1 \end{vmatrix}$

$= 1(C_\theta^2 + S_\theta^2) = 1$