ASSIGNMENT - 2

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★ Task-2

- ❖ Mobile Robots : (Ground Robots)
  - ➔ A mobile robot is an automatic machine that is capable of locomotion.
  - ➔ Mobile robots have the capability to move around in their environment and are not fixed to one physical location.
  - ➔ Mobile robots can rely on guidance devices that allow them to travel a predefined navigation route in relatively controlled space.
  - ➔ https://www.youtube.com/watch?v=NnXYX3Y2KIk
  - ➔ https://www.youtube.com/watch?v=YZQDPML2W5Y

- ❖ Aerial Robots : (UAV - Unmanned Aerial Vehicle)
  - ➔ Aerial robots contain UAV commonly known as drone, is an aircraft without any human pilot, crew, or passengers on board.
  - ➔ The flight of aerial robots may operate under remote control by a human operator or with various degrees of autonomy, such as autopilot assistance.
  - ➔ https://www.youtube.com/watch?v=loHzoeFP9Io
  - ➔ https://www.youtube.com/watch?v=xLuQifpJv_8

- ❖ Underwater Robots (AUV):
  - ➔ These robots can be programmed to go to remote, dangerous, and often previously unexplored parts of the ocean to measure its key characteristics.
  - ➔ An autonomous underwater vehicle (AUV) is a robot that travels underwater without requiring input from an operator.
  - ➔ https://www.youtube.com/watch?v=4WOOwesIkss
  - ➔ https://www.youtube.com/watch?v=tGJvrKFQcpM

- ❖ Soft Robots :
  - ➔ Soft robotics is a subfield of robotics that concerns the design, control, and fabrication of robots composed of compliant materials, instead of rigid links.
  - ➔ The compliance of soft robots can improve their safety when working in close contact with humans.
  - ➔ https://www.youtube.com/watch?v=A7AFsk40NGE
  - ➔ https://www.youtube.com/watch?v=ifLvpxMuos8

- ❖ Micro Robots :
  - ➔ Microbotics (or microrobotics) is the field of miniature robotics, in particular mobile robots with characteristic dimensions less than 1 mm.

- ➔ Microrobots have shown significant potential to conduct microscale tasks such as drug delivery, cell manipulation, microassembly, and biosensing using manual control.
- ➔ https://www.youtube.com/watch?v=k8IsYb31He8
- ➔ https://www.youtube.com/watch?v=N7lXymxsdhw

- ❖ Stanford type Robot (RRP):
  - ➔ The Stanford arm is an industrial robot with six degrees of freedom.
  - ➔ Stanford arm is a serial manipulator whose kinematic chain consists of two revolute joints at the base, a prismatic joint, and a spherical joint.
  - ➔ In this type of robot, the axis of rotation of the first two Rs is perpendicular.
  - ➔ https://www.youtube.com/watch?v=-gGgTKxPgVE

- ❖ PUMA(Programmable Universal Machine for Assembly) type Robot (RRR):
  - ➔ PUMA is the most commonly used industrial robot in assembly, welding operations and university laboratories.
  - ➔ In all PUMA has six degrees of freedom. Each rotary joint is actuated by DC servomotors and accompanying gear trains.
  - ➔ https://www.youtube.com/watch?v=c3PzyzGng1M

- ❖ SCARA (Selective Compliant Articulated Robot Arm) type Robot (RRP):
  - ➔ SCARA is most adept in pick and place operations in any assembly line in industries with speed as well as precision.
  - ➔ In this type of robot, the axis of rotation of the first two Rs is perpendicular.
  - ➔ The parallel axis structure of SCARA makes it flexible or compliant in the XY direction and rigid in the vertical or Z direction.
  - ➔ https://www.youtube.com/watch?v=l4VUSbE5Ngs

★ Task-3

- ❖ AC Motor :
  - ➔ An induction AC motor is an asynchronous type unit that consists of a wire-wound stator and a rotor.
  - ➔ Power is connected to the wire and AC current flowing through it induces an electromagnetic (EM) field in the coiled wire, with a strong-enough field providing the force for rotor motion.
  - ➔ Synchronous motors are constant-speed motors that operate in synchronism with AC line frequency and are commonly used where precise constant speed is required.

- ❖ BLDC Motor : (Brushless)
  - ➔ Brushless motors can operate more efficiently and at higher speeds than conventional DC motors.
  - ➔ Most brushless DC motors run on a trapezoidal AC waveform, but some of the motors operate with sine waves.
  - ➔ Sine wave-driven brushless motors can achieve smooth operation at lower speeds with low torque ripple, making them ideal for grinding, coating, and other applications such as surface finishing.

- ❖ Brushed DC Motor :
  - ➔ In the case of Brushed DC motors, if you want your motor to rotate slower without losing power, you can use pulse width modulation (PWM).
  - ➔ This basically means to switch the motor on and off very fast. This way, the motor rotates with a lower speed as if lower voltage would be applied without taking care of the power.
  - ➔ The torque generated by a brushed DC motor is too small and the speed is too great to be useful.

- ❖ Stepper Motor :
  - ➔ Stepper motors can operate with or without feedback, with the rotation of the motor broken up into small angular steps.
  - ➔ It is controlled by pulsed command signals, and can stop precisely at a commanded point without need for brakes or clutch assemblies.
  - ➔ When power is removed, a permanent-magnet stepper motor generally remains in its last position.

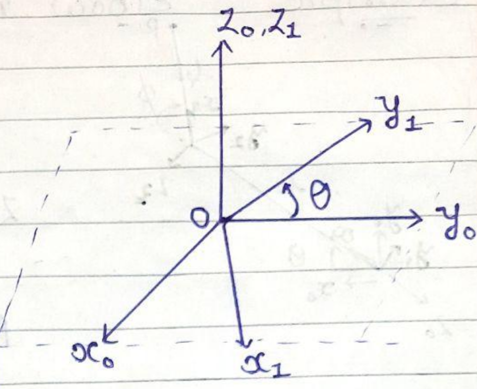
- ❖ Servo Motor :
  - ➔ Servo motors are used in closed-loop systems with a digital controller. The controller sends velocity commands to a driver amplifier, which in turn feeds the servo motor.
  - ➔ Some form of feedback device, such as a resolver or encoder, provides information on the servo motor’s position and speed.
  - ➔ Because of the closed-loop system, a servo motor can operate with a specific motion profile that is programmed into the controller.

★ Task-6 + Task-7 :

For a given coordinates frames

$O - x_0 - y_0 - z_0$

$O - x_1 - y_1 - z_1$



Rotation Matrix $R_0^1 = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

Let

$$\left.\begin{aligned} \hat{e}_1 &= \cos\theta\ \hat{e}_i + \sin\theta\ \hat{e}_j + 0\cdot\hat{e}_k \\ \hat{e}_2 &= -\sin\theta\ \hat{e}_i + \cos\theta\ \hat{e}_j + 0\cdot\hat{e}_k \\ \hat{e}_3 &= 0\ \hat{e}_i + 0\ \hat{e}_j + 1\cdot\hat{e}_k \end{aligned}\right\} \text{Assume Column vector}$$

→ $\hat{e}_1 \cdot \hat{e}_2 = -\cos\theta\cdot\sin\theta + \sin\theta\cos\theta + 0 = 0$

$\hat{e}_2 \cdot \hat{e}_3 = 0 + 0 + 0 = 0$

$\hat{e}_3 \cdot \hat{e}_1 = 0 + 0 + 0 = 0$

$|\hat{e}_1| = \sqrt{\cos^2\theta + \sin^2\theta} = 1$

$|\hat{e}_2| = \sqrt{\sin^2\theta + \cos^2\theta} = 1$

$|\hat{e}_3| = \sqrt{1 + 0 + 0} = 1$

→ $\det(R_0^1) = \cos\theta(\cos\theta) + \sin\theta(\sin\theta) + 0$

$\det(R_0^1) = 1$

$$R^T \cdot R = \begin{bmatrix} c & s & 0 \\ -s & c & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} c & -s & 0 \\ s & c & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} c^2+s^2 & 0 & 0 \\ 0 & c^2+s^2 & 0 \\ 0 & 0 & c^2+s^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

→ Hence, we can say that columns of the rotation matrix R_0^1 are orthogonal and $\det(R_0^1) = 1$.