Assignment 1
ME 639 - Introduction to Robotics
IIT Gandhinagar

Rohan Naika
20110169

Tasks completion:

Task 2:
Categories:
i. Industrial Robots: These robots are used in manufacturing and industrial processes. They can perform tasks like welding, assembly, painting, and material handling in factories and production lines.https://youtube.com/shorts/iDiARlpw3S8?feature=share

ii. Service Robots: Service robots are designed to interact with and assist humans. They include robots used in healthcare, hospitality, cleaning, security, and other service-oriented industries.https://youtu.be/RaTKObI1xyc

iii. Mobile Robots: Mobile robots are capable of autonomous or semi-autonomous movement. They can navigate and operate in various environments, including indoor and outdoor spaces, and are used in applications like exploration, delivery, and surveillance.https://youtu.be/xL8deJDusns

iv. Collaborative Robots (Cobots): Collaborative robots are designed to work safely alongside humans. They can assist workers in tasks that require precision, strength, or repetitive actions, enhancing productivity and safety in industries such as manufacturing and healthcare.https://youtu.be/PtncirKiBXQ

v. Aerial Robots (Drones): Aerial robots, commonly known as drones, are capable of flying and are used in various applications, including aerial photography, surveillance, agricultural monitoring, and disaster response.https://youtu.be/IgMKiIEbfN8

vi. Underwater Robots: They are also known as autonomous underwater vehicles (AUVs) They are used for exploring and conducting research in underwater environments, such as ocean research, marine exploration, and oil rig maintenance.https://youtu.be/4WOOwesIkss

vii. Humanoid Robots: Designed to resemble and mimic human movements and interactions.https://youtu.be/-e1_QhJ1EhQ

Task 3:
They most common types of motors are-
AC motors, DC motors and servo motors. They are further classified into further categories.
Synchronous and asynchronous AC motor. Synchronous AC motors rotate at a fixed speed synchronized with the frequency of the power supply, offering high efficiency and precision but requiring external control to maintain synchronization. Asynchronous AC motors, including induction motors, run at variable speeds without synchronization, making them versatile and suitable for various applications, but at the cost of slightly lower efficiency and speed precision compared to synchronous motors.
DC motors come in various types, including brushed motors, which use physical brushes for commutation, offering simplicity and affordability but with maintenance requirements. On the other hand, brushless DC motors (BLDC) operate without brushes, enhancing efficiency and reducing wear, making them suitable for applications requiring longer lifespan and higher performance. Additionally, stepper motors move in discrete steps and are universally used for precise position control of the shaft in applications such as 3D printers and CNC machines.
A **servo motor** is a specialized type of motor designed only for precise control of position of the shaft. It employs a feedback mechanism, often using encoders, to maintain accuracy in its movement and can respond quickly to changes in commands. Servo motors find applications in robotics, automation, CNC machines, and other systems where precise and dynamic control is essential.

Task 6:
Bellow:

→ The columns of the rotation matrix R are orthogonal as its colowmns and rows are orthogonal unit vectors

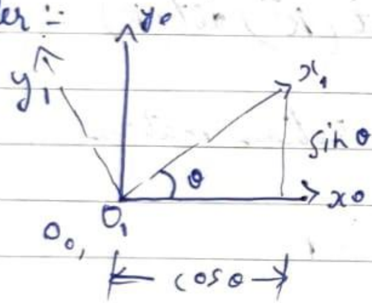
i.e. $A^{-1} = A^{T}$ or $AA' = A'A = I$

i.e. $(R_0^1)^{-1} = (R_0^1)^{T}$

let $x_1^0 = \begin{bmatrix} x_1 . x_0 \\ x_1 . y_0 \end{bmatrix}$, $y_1^0 = \begin{bmatrix} y_1 . x_0 \\ y_1 . y_0 \end{bmatrix}$

$\therefore$ $\cancel{R_0^1 = \begin{bmatrix} x . x_0 & y_1 . x_0 \\ x_1 . y_0 & y_1 . y_0 \end{bmatrix}}$ $R_0^1 = \begin{bmatrix} x_0 . x_1 & y_0 . x_1 \\ x_0 . y_1 & y_0 . y_1 \end{bmatrix}$

Consider :-



Coordinate frame $O_1 x_1 y_1$ is oriented at an angle θ with respect to $O_0 x_0 y_0$.

$\therefore$ Here, $(x_i y_j = y_j x_i)$; $R_0^1 = (R_1^0)^T$

$\therefore (R_1^0)^T = (R_1^0)^{-1}$

mutually orthogonal coordinate axes.

$\therefore$ Matrix is orthogonal.

and for columns, $\left[(x_0 . x_1) . (x_0 . y_1) \bullet (y_0 . y_1) . (y_0 . x_1) \right]$

$= \left[(x_0 . y_1) . (y_0 . y_1) \bullet (x_0 . x_1) . (y_0 . x_1) \right] = 0$

$\therefore$ Columns are orthogonal.

Task 7:

→ Here, to show $\det(R_0') = 1$

Here, its columns are orthogonal unit vectors
∴ determinant is $+1$ or -1

so, for $\det = +1$

We can also see that the transformation preserves distances :-

∴ $\det(R^T R)$:-

$$\det(R^T R) = \det(R^T)\det(R) = \det(R)^2$$

and since $R'R$ is a rotation matrix, $\det(R^T R) = +1$

$$\therefore \det(R^T R) = 1^2 = 1$$

$$\therefore \text{As } \det(R^T R) = \det(R^T)\det(R) = \det(R)$$

$$\therefore \underline{\underline{\det(R_0') = 1}}$$

Hence, proved.

References:

You tube videos and shorts