Name: Pathan Mohammad Rashid

Roll Number : 22110187

ME 639: ITR

Assignment 1

Task 2:

Here are some examples of robots for each of the given categories:

Mobile:

Autonomous Mobile Robots (AMRs) are robots that can navigate and perform tasks in an uncontrolled environment without the need for human intervention. They are equipped with sensors, cameras, and other technologies that allow them to perceive their surroundings and make decisions based on that information. Some examples of AMRs in action include warehouse robots that can autonomously transport goods, delivery robots that can navigate sidewalks and streets to deliver packages, and agricultural robots that can perform tasks such as planting and harvesting crops.

Roomba: A mobile robot vacuum cleaner that uses sensors to navigate and clean floors. https://youtu.be/XIPzSmwClJ8

Aerial (UAV):

DJI Phantom: A popular quadcopter drone used for aerial photography and videography. https://youtu.be/dY8KIMQRTf0?feature=sharedi

Zipline: A drone delivery system that delivers medical supplies to remote areas. https://youtu.be/__lhaW_yizk

Legged:

Boston Dynamics' Spot: A four-legged robot designed for a variety of applications, including inspection, mapping, and security. https://youtu.be/wE3fmFTtP9g

Soft:

Soft Robotics' grippers: Soft robotic grippers designed to handle delicate objects such as fruits and vegetables. https://youtu.be/gI0tzsO8xwc

Harvard's Octobot: A soft-bodied robot inspired by the octopus, designed for underwater exploration. https://youtu.be/1vkQ3SBwuU4

Nanobots:

Xenobots: Nanorobots less than 1 mm in length constructed of living cells, designed for a variety of applications including drug delivery and environmental remediation. https://youtu.be/wL64jqYn4CE

DNA nanobots: Nanorobots constructed from DNA molecules, designed for targeted drug delivery and other medical applications. https://youtu.be/Q8tAj8A4pc0

Exoskeletal and humanoid:

ReWalk: A wearable exoskeleton designed to help individuals with spinal cord injuries walk again. https://youtu.be/1_V2s4vw39o

Honda's ASIMO: A humanoid robot designed for a variety of tasks, including assisting the elderly and disabled. https://youtu.be/NZngYDDDfW4

Manipulator:

KUKA's KR QUANTEC: An industrial robot manipulator designed for a variety of tasks, including welding, assembly, and material handling. https://youtu.be/kROzVbWpANw

Fanuc's M-2000iA: An industrial robot manipulator designed for heavy lifting, with a payload capacity of up to 2300 kg. https://youtu.be/69RtLBImXiU

AUV (autonomous underwater vehicle):

Bluefin Robotics' Bluefin-21: An autonomous underwater vehicle designed for a variety of applications, including oceanographic research and underwater surveying. https://youtu.be/wE3fmFTtP9g

OceanServer Technology's Iver3: An autonomous underwater vehicle designed for a variety of applications, including environmental monitoring and search and rescue operations. https://youtu.be/5wAPjKyG4kA

Task 3:

The most common types of motors and their summary :

DC Motors: DC motors are powered by direct current and are commonly used in applications such as toys, power tools, and appliances. They are known for their simplicity, reliability, and low cost.

AC Motors: AC motors are powered by alternating current and are commonly used in applications such as pumps, fans, and air conditioners. They are known for their efficiency and durability.

Stepper Motors: Stepper motors are a type of brushless DC motor that can be precisely controlled in terms of position and speed. They are commonly used in applications such as printers, scanners, and CNC machines.

Servo Motors: Servo motors are a type of motor that can be precisely controlled in terms of position, speed, and acceleration. They are commonly used in applications such as robotics, radio-controlled vehicles, and animatronics.

Brushless DC Motors: Brushless DC motors are a type of motor that uses electronic commutation instead of brushes to control the flow of current. They are commonly used in applications such as drones, electric vehicles, and computer cooling fans.

Synchronous Motors: Synchronous motors are a type of AC motor that rotates at a constant speed in synchronization with the frequency of the AC power supply. They are commonly used in applications such as clocks, timers, and synchronous generators.

Asynchronous Motors: Asynchronous motors, also known as induction motors, are a type of AC motor that rotates at a speed slightly less than the synchronous speed of the AC power supply. They are commonly used in applications such as pumps, fans, and compressors.

Assignment - 1

Task 6

Q- Show that columns of the rotation matrix R_0^1 are orthogonal.

We know,

$$R_0^1 = \begin{array}{ccc} C_1 & C_2 & C_3 \\ \left[\begin{matrix} \hat{i}_1\hat{i}_0 & \hat{j}_1\hat{j}_0 & \hat{k}_1\hat{i}_0 \\ \hat{i}_1\hat{j}_0 & \hat{j}_1\hat{j}_0 & \hat{k}_1\hat{j}_0 \\ \hat{i}_1\hat{k}_0 & \hat{j}_1\hat{k}_0 & \hat{k}_1\hat{k}_0 \end{matrix}\right. & & \left.\right] \end{array}$$

↳ This matrix describe a rotation transformation in Euclidean Space.

We know that R_0^1 is an orthogonal matrix, which means its columns (or rows) are orthogonal to each other.

For orthogonality, dot product of any two columns (or rows) is zero if the columns are distinct.

$\therefore$ $C_1 . C_2 = 0$, $C_1 C_3 = 0$, $C_2 . C_3 = 0$

$\therefore$ $((\hat{i}_1\hat{i}_0).(\hat{j}_1\hat{j}_0)) + ((\hat{i}_1\hat{j}_0).(\hat{j}_1\hat{j}_0)) + ((\hat{i}_1\hat{k}_0).(\hat{j}_1\hat{k}_0))$

$\therefore$ 0

Similarly

$C_2 . C_3 = 0$ & $C_3 . C_4 = 0$

$\therefore$ Columns of the rotation matrix R_0^1 are orthogonal.

* Task-7

Q Show that $\det(R^1_0) = I$

We know, $R^1_0 = \begin{bmatrix} \hat{i}_1\hat{i}_0 & \hat{j}_1\hat{j}_0 & \hat{k}_1\hat{i}_0 \\ \hat{i}_1\hat{j}_0 & \hat{j}_1\hat{j}_0 & \hat{k}_1\hat{j}_0 \\ \hat{i}_1\hat{k}_0 & \hat{j}_1\hat{k}_0 & \hat{k}_1\hat{k}_0 \end{bmatrix}$

$\therefore \det(R^1_0) = \hat{i}_1\hat{i}_0(\hat{j}_1\hat{j}_0 \times \hat{k}_1\hat{k}_0 - \hat{j}_1\hat{k}_0 \times \hat{k}_1\hat{j}_0) - \hat{j}_1\hat{j}_0(\hat{i}_1\hat{j}_0 \times \hat{k}_1\hat{k}_0 - \hat{i}_1\hat{k}_0 \times \hat{k}_1\hat{j}_0)$
$+ \hat{k}_1\hat{k}_0(\hat{i}_1\hat{j}_0 \times \hat{j}_1\hat{k}_0 - \hat{i}_1\hat{k}_0 \times \hat{j}_1\hat{j}_0)$

$\therefore \det(R^1_0) = \hat{i}_1\hat{i}_0(\hat{j}_1\hat{j}_0 \times \hat{k}_1\hat{k}_0 - 0) - \hat{j}_1\hat{i}_0(0-0) + \hat{k}_1\hat{k}_0(\cancelto{0}{\hat{i}_1\hat{j}_0 \times \hat{j}_1\hat{k}_0} - \cancelto{0}{\hat{i}_1\hat{k}_0 \times \hat{j}_1\hat{j}_0})$

$\therefore \det(R^1_0) = 1 + 0$ ($\because \hat{i}, \hat{j}$ & $\hat{k}$ are orthogonal, dot product $= 0$)
($\because$ dot product with itself $= I$)

$\therefore \boxed{\det(R^1_0) = I}$

Hence Showed.