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ITR Assignment 1

19110012

Task 2:

1. Robotic Manipulators: Dobot M1: Pro Robotic Arm for Makers & Businesses, 3D Print, Laser Engrave, Solder, Pick&Place... - YouTube
   It can enhance the efficiency in production line with picking and placing feature, visual system and more. Can be used for 3d print, double color 3d print, 3d print on rail, laser engrave on wood, plastic, paper, leather, soldering, drawing, painting, picking and placing and more.
2. Mobile Robots: MAV Product Video Extended Version - Autonomous Mobile Robot AMR showcase - YouTube
   This robot can help in inventory management with it path planning and vision algorithms.
3. Aerial Robots: https://www.youtube.com/watch?v=nCPQ9koh-kE
   AURA UAV is an unmanned drone developed (under developing stage) by DRDO for the IAF and army.
4. Under water robots: Kawasaki: Autonomous Underwater Vehicle "SPICE" - YouTube
   Submarine for maintenance of subsea pipelines in the oil and gas fields, Kawasaki has been developing the autonomous underwater vehicle (AUV) called "SPICE" (Subsea Precise Inspector with Close Eyes), which was based on a fusion of submarine and industrial robot technologies fostered in-house over many years.
5. Soft robots: Why Robots That Bend Are Better - YouTube
   The soft robots are made using flexible materials like plastic. This shown example uses a plastic pump to pressurise the robot to do certain things.
6. Micro robots: Magnetic Micro-Robots - YouTube
   The shown robot in this video is a micro robot of size in mm. it works on the magnetic field as an input. These robots can be used in medical area.
7. Hybrid robots: SIASUN Hybrid Autonomous Collaborative Robot - YouTube
   These types of robots are controlled both electrically and biologically. This robot in the example can do sorting and obstacle avoidance, path planning.

Task 3:

1. Asynchronous AC motors: There is no physical contact between the magnetic field and the rotor because it is an AC motor that operates through induction. It is referred to as asynchronous because the rotor speed and the magnetic field speed of the stator are not the same.
2. Synchronous AC motors: This is comparable to an asynchronous AC motor, with the sole exception that the rotor follows the stator's magnetic field, making the rotor speed and the speed of the magnetic field the same.
3. Brushed DC motors: As implied by the name, the polarity of the current and, consequently, the polarity of the magnetic field produced, are changed by this motor using brushes.
4. Brushless DC motors (BLDC): This operates in a manner similar to brushed DC motors. As opposed to here, where the polarity is altered electrostatically, brushed DC motors use brushes to change the polarity.
5. Stepper motors (Brushless): This operates similarly to a BLDC motor, but whereas in a BLDC motor, the polarity is changed in accordance with the back emf peak, in a stepper motor, the polarity is changed in accordance with the necessary number of steps. A step in the rotor corresponds to each change in polarity.

6. <u>Servo motors (Brushed DC):</u> This is comparable to a DC motor, but the feedback loop, which employs a potentiometer (or encoder) to determine the right angle, is the primary distinction.

Answers to Task6 and Task7 are below

ask 6

To show: Columns of R_0^1 are orthogonal.

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

For columns to be orthogonal :-

$$(\hat{i}_1\cdot\hat{i}_0)(\hat{j}_1\cdot\hat{i}_0) + (\hat{i}_1\cdot\hat{j}_0)(\hat{j}_1\cdot\hat{j}_0) + (\hat{i}_1\cdot\hat{k}_0)(\hat{j}_1\cdot\hat{k}_0) = 0 \to ①$$

~~now, let x, y and z rotate by θ, ϕ, γ respectively. then eqn ① becomes :-~~

now, let rotations about (+)ve x, y and z axis be by θ, ϕ and γ angles respectively.

so, $R_0^1 = R_{x,\theta} R_{y,\phi} R_{z,\gamma}$

$$= \begin{bmatrix} (C_\theta C_\phi C_\gamma - S_\theta S_\gamma) & (-C_\theta C_\phi S_\gamma - S_\theta C_\gamma) & C_\theta S_\phi \\ (S_\theta C_\phi C_\gamma + C_\theta S_\gamma) & (-S_\theta C_\phi S_\gamma + C_\theta C_\gamma) & S_\theta S_\phi \\ -S_\phi C_\gamma & S_\phi S_\gamma & C_\phi \end{bmatrix}$$

where $C_{angle} = \cos(angle)$ and $S_{angle} = \sin(angle)$.

so, eqn ① becomes :-

$$(C_\theta C_\phi C_\gamma - S_\theta S_\gamma)(-C_\theta C_\phi S_\gamma - S_\theta C_\gamma) + (S_\theta C_\phi C_\gamma + C_\theta S_\gamma)(-S_\theta C_\phi S_\gamma + C_\theta C_\gamma) - S_\phi C_\gamma S_\phi S_\gamma = 0$$

$S_\gamma C_\gamma$

$$\Rightarrow S_\gamma^2 \cancel{(S_\theta C_\theta C_\phi)} + S_\theta^2 S_\gamma C_\gamma - C_\gamma S_\gamma (C_\theta^2 C_\phi^2) - C_\gamma^2 \cancel{C_\theta S_\theta C_\phi} + C_\gamma^2 \cancel{S_\theta C_\theta C_\phi} + C_\theta^2 S_\gamma C_\gamma - C_\gamma S_\gamma (S_\theta^2 C_\phi^2) - S_\gamma^2 \cancel{C_\phi C_\theta S_\theta} - S_\phi C_\gamma S_\phi S_\gamma$$

$$\Rightarrow S_\gamma C_\gamma - C_\gamma S_\gamma C_\phi^2 - S_\phi^2 C_\gamma S_\gamma$$

$$\Rightarrow S_\gamma C_\gamma - C_\gamma S_\gamma = 0$$ Hence Proved

Similarly other combinations will also result in a dot product of 0.

Task 7 To show, $\det|(R_0')| = 1$:-

Assuming x, y and z rotate by ψ, θ and ϕ angles

$$R_0' = R_{z,\phi} R_{y,\theta} R_{x,\psi}$$

$$= \begin{bmatrix} C_\phi C_\theta & (-S_\phi C_\psi + C_\phi S_\theta S_\psi) & (S_\phi S_\psi + C_\phi S_\theta C_\psi) \\ S_\phi C_\theta & (C_\phi C_\psi + S_\phi S_\theta S_\psi) & (-C_\phi S_\psi + S_\phi S_\theta C_\psi) \\ -S_\theta & C_\theta S_\psi & C_\theta C_\psi \end{bmatrix}$$

now, $\det|(R_0')| = C_\theta^2 C_\phi [C_\phi C_\psi^2 + S_\phi \cancel{S_\theta} S_\psi C_\psi + C_\phi S_\psi^2 - S_\phi \cancel{S_\theta} C_\psi S_\psi]$

$+ (S_\phi C_\psi - C_\phi S_\theta S_\psi)[C_\theta^2 S_\phi C_\psi - C_\phi S_\theta S_\psi + S_\phi S_\theta^2 C_\psi] +$
$(S_\phi S_\psi + C_\phi S_\theta C_\psi)[C_\theta^2 S_\phi S_\psi + C_\phi S_\theta C_\psi + S_\phi S_\theta^2 S_\psi]$

$= C_\theta^2 C_\phi^2 + (S_\phi C_\psi - C_\phi S_\theta S_\psi)(S_\phi C_\psi - C_\phi S_\theta S_\psi) + (S_\phi S_\psi + C_\phi S_\theta C_\psi)(S_\phi S_\psi + C_\phi S_\theta C_\psi)$

$= C_\theta^2 C_\phi^2 + S_\phi^2 C_\psi^2 - C_\phi S_\phi \cancel{S_\theta} C_\psi S_\psi - C_\phi S_\phi \cancel{S_\theta} S_\psi C_\psi + C_\phi^2 S_\theta^2 S_\psi^2 + S_\phi^2 S_\psi^2 +$
$C_\phi^2 S_\theta^2 C_\psi^2 + S_\phi C_\phi \cancel{S_\theta} C_\psi S_\psi + C_\phi S_\phi \cancel{S_\theta} C_\psi S_\psi$

$= C_\theta^2 C_\phi^2 + S_\phi^2 C_\psi^2 + C_\phi^2 S_\theta^2 + S_\phi^2 S_\psi^2$

$= C_\phi^2 + S_\phi^2 = 1$ Ans