IVR Coursework

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Neil and Matt worked on this coursework collaboratively - answering all questions and coding together. Thus there was an equal contribution from both members of the team.

Access the GitHub link to our code here: `https://github.com/the-raspberry-pi-guy/IVR-Assignment`

2 Robot Vision

2.1 Joint State Estimation

DESCRIBE ALGORITHM
PROVIDE 3 PLOTS EACH OF ONE JOINT WITH THE SINUSOIDAL SIGNAL, EACH FOR AT LEAST 5 SECONDS

2.2 Target Detection

DESCRIBE ALGORITHM & COMMENT ON SOURCES OF ERROR IN MEASUREMENTS
PROVIDE PLOT SHOWING THE ESTIMATED X, Y, Z POSITION OF SPHERE FOR AT LEAST 10 SECONDS

3 Robot Control

3.1 Forward Kinematics

$$\begin{bmatrix} 3s(\theta_1)s(\theta_2)c(\theta_3)c(\theta_4) + 3.5s(\theta_1)s(\theta_2)c(\theta_3) + 3s(\theta_1)s(\theta_4)c(\theta_2) + 3s(\theta_3)c(\theta_1)c(\theta_4) + 3.5s(\theta_3)c(\theta_1) \\ 3s(\theta_1)s(\theta_3)c(\theta_4) + 3.5s(\theta_1)s(\theta_3) - 3s(\theta_2)c(\theta_1)c(\theta_3)c(\theta_4) - 3.5s(\theta_2)c(\theta_1)c(\theta_3) - 3s(\theta_4)c(\theta_1)c(\theta_2) \\ -3s(\theta_2)s(\theta_4) + 3c(\theta_2)c(\theta_3)c(\theta_4) + 3.5c(\theta_2)c(\theta_3) + 2.5 \end{bmatrix}$$

MOVE ROBOT TO 10 DIFFERENT PLACES IN WORKSPACE, DON'T KEEP ANY JOINTS ZERO - PROBABLY DISPLAY IN TABLE.
COMPARE ESTIMATED END-EFFECTOR POSITION VIA IMAGES TO ESTIMATED END-EFFECTOR POSITION VIA FK. COMMENT ON ACCURACY

3.2 Closed-Loop Control

$$A =$$

$$\begin{bmatrix} -3s(\theta_1)s(\theta_3)c(\theta_4) - 3.5s(\theta_1)s(\theta_3) + 3s(\theta_2)c(\theta_1)c(\theta_3)c(\theta_4) + 3.5s(\theta_2)c(\theta_1)c(\theta_3) + 3s(\theta_4)c(\theta_1)c(\theta_2) \\ 3s(\theta_1)s(\theta_2)c(\theta_3)c(\theta_4) + 3.5s(\theta_1)s(\theta_2)c(\theta_3) + 3s(\theta_1)s(\theta_4)c(\theta_2) + 3s(\theta_3)c(\theta_1)c(\theta_4) + 3.5s(\theta_3)c(\theta_1) \\ 0 \end{bmatrix}$$

$$B =$$

$$\begin{bmatrix} -3s(\theta_1)s(\theta_2)s(\theta_4) + 3s(\theta_1)c(\theta_2)c(\theta_3)c(\theta_4) + 3.5s(\theta_1)c(\theta_2)c(\theta_3) \\ 3s(\theta_2)s(\theta_4)c(\theta_1) - 3c(\theta_1)c(\theta_2)c(\theta_3)c(\theta_4) - 3.5c(\theta_1)c(\theta_2)c(\theta_3) \\ -3s(\theta_2)c(\theta_3)c(\theta_4) - 3.5s(\theta_2)c(\theta_3) - 3s(\theta_4)c(\theta_2) \end{bmatrix}$$

$$C =$$

$$\begin{bmatrix} -3s(\theta_1)s(\theta_2)s(\theta_3)c(\theta_4) - 3.5s(\theta_1)s(\theta_2)s(\theta_3) + 3c(\theta_1)c(\theta_3)c(\theta_4) + 3.5c(\theta_1)c(\theta_3) \\ 3s(\theta_1)c(\theta_3)c(\theta_4) + 3.5s(\theta_1)c(\theta_3) + 3s(\theta_2)s(\theta_3)c(\theta_1)c(\theta_4) + 3.5s(\theta_2)s(\theta_3)c(\theta_1) \\ -3s(\theta_3)c(\theta_2)c(\theta_4) - 3.5s(\theta_3)c(\theta_2) \end{bmatrix}$$

$$D =$$

$$\begin{bmatrix} -3s(\theta_1)s(\theta_2)s(\theta_4)c(\theta_3) + 3s(\theta_1)c(\theta_2)c(\theta_4) - 3s(\theta_3)s(\theta_4)c(\theta_1) \\ -3s(\theta_1)s(\theta_3)s(\theta_4) + 3s(\theta_2)s(\theta_4)c(\theta_1)c(\theta_3) - 3c(\theta_1)c(\theta_2)c(\theta_4) \\ -3s(\theta_2)c(\theta_4) - 3s(\theta_4)c(\theta_2)c(\theta_3) \end{bmatrix}$$

Where A, B, C and D are column vectors that form the Jacobian when arranged like (formatted to save space):

$$\begin{bmatrix} A & B & C & D \end{bmatrix}$$