COMS W4733 Computational Aspects of Robotics -- HW2

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Problem 1

Problem 2

(a)

$$J_p(q) = egin{bmatrix} rac{\partial p_x}{\partial q_1} & rac{\partial p_x}{\partial q_2} & rac{\partial p_x}{\partial q_3} \ rac{\partial p_y}{\partial q_1} & rac{\partial p_y}{\partial q_2} & rac{\partial p_y}{\partial q_3} \ rac{\partial p_z}{\partial q_1} & rac{\partial p_z}{\partial q_2} & rac{\partial p_z}{\partial q_3} \end{bmatrix} \ = egin{bmatrix} -(L_1 + L_2 c_2 + L_3 c_{23}) s_1 & -L_2 c_1 s_2 - L_3 c_1 s_{23} & -L_3 c_1 s_{23} \ (L_1 + L_2 c_2 + L_3 c_{23}) c_1 & -L_2 s_1 s_2 - L_3 s_1 s_{23} & -L_3 s_1 s_{23} \ 0 & L_2 c_2 + L_3 c_{23} & L_3 c_{23} \end{bmatrix}$$

Link	a_i	$lpha_i$	d_i	$ heta_i$
1	L_1	90	0	$ heta_1$
2	L_2	0	0	$ heta_2$
3	L_3	0	0	$ heta_3$

Problem 3

(a)

\$\$

\begin{equation}

\begin{split}

 $J_p(q) &=$

\begin{bmatrix}

 $\label{partialpx}{\operatorname{partialp}_x}{\operatorname{partialp}_x}_{\operatorname{q}_3} \$

 $\label{eq:partialp_y}{\quad q_1} & \frac{p_y}{\quad q_2} & \frac{p_y}{\quad q_3} \\$

 $\label{partialp_z}{\operatorname{partialp_z}_{$

\end{bmatrix}\\

&= \begin{bmatrix}

\end{bmatrix}

\end{split}

\end{equation}

\$\$

$$J_p(q) = egin{bmatrix} rac{\partial p_x}{\partial q_1} & rac{\partial p_x}{\partial q_2} & rac{\partial p_x}{\partial q_3} \ rac{\partial p_y}{\partial q_1} & rac{\partial p_y}{\partial q_2} & rac{\partial p_y}{\partial q_3} \ rac{\partial p_z}{\partial q_1} & rac{\partial p_z}{\partial q_2} & rac{\partial p_z}{\partial q_3} \ \end{bmatrix} \ = egin{bmatrix} -(L_1 + L_2 c_2 + L_3 c_{23}) s_1 & -L_2 c_1 s_2 - L_3 c_1 s_{23} & -L_3 c_1 s_{23} \ (L_1 + L_2 c_2 + L_3 c_{23}) c_1 & -L_2 s_1 s_2 - L_3 s_1 s_{23} & -L_3 s_1 s_{23} \ 0 & L_2 c_2 + L_3 c_{23} & L_3 c_{23} \ \end{bmatrix}$$

Link	a_i	$lpha_i$	d_i	$ heta_i$
1	1	90	0	θ_1 +90
2	0	-90	d_2 +2	0
3	2	0	0	θ_3 -90