Practice Set 14

Robotics & Automation
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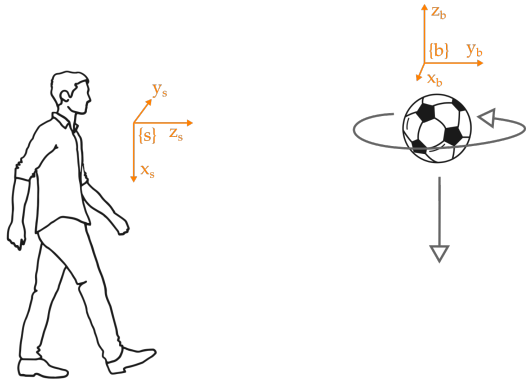
Using your textbook and what we covered in lecture, try solving the following problems. For some problems you may find it convenient to use Matlab (or another programming language of your choice). The solutions are on the next page.

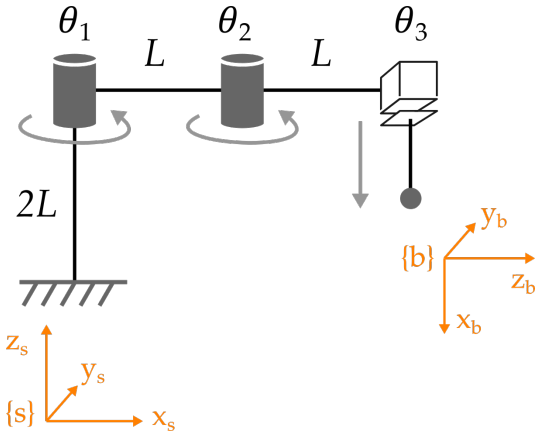
Problem 1



The ball is rotating around the z_b axis at 5 radians per second, and is falling towards the ground at 2 meters per second. If the ball is 3 meters directly in front of the human:

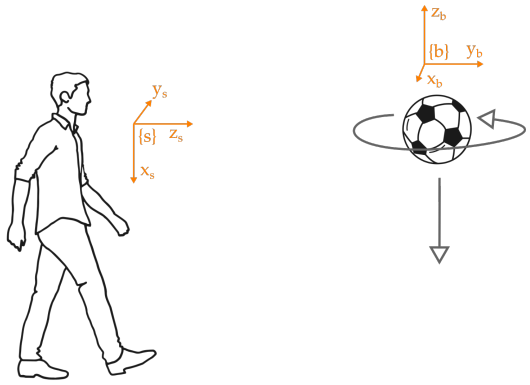
- What is ω_s? What is $\dot{p}_{sb}$?

Problem 2



Imagine that joints one and two are locked in their home position so that $\dot{\theta}_1 = \theta_1 = 0$ and $\dot{\theta}_2 = \theta_2 = 0$. What is $V_b = [\omega_b, v_b]$ and $V = [\omega_s, \dot{p}_{sb}]$ as a function of $\dot{\theta}_3$?

Problem 1



The ball is rotating around the z_b axis at 5 radians per second, and is falling towards the ground at 2 meters per second. If the ball is 3 meters directly in front of the human:

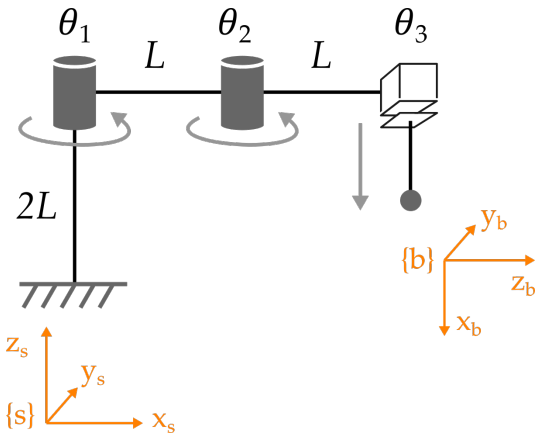
- What is ω_s? What is $\dot{p}_{sb}$?

From the drawing we can see that the ball is rotating around the $-x_s$ axis and is translating along the x_s axis.

$$\omega_s = \begin{bmatrix} -5 \\ 0 \\ 0 \end{bmatrix}, \qquad \dot{p}_{sb} = \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix} \tag{1}$$

This is the linear and angular velocity of a point at $\{b\}$ expressed in frame $\{s\}$. When we use the geometric Jacobian we find these terms.

Problem 2



Imagine that joints one and two are locked in their home position so that $\dot{\theta}_1 = \theta_1 = 0$ and $\dot{\theta}_2 = \theta_2 = 0$. What is $V_b = [\omega_b, v_b]$ and $V = [\omega_s, \dot{p}_{sb}]$ as a function of $\dot{\theta}_3$?

Because we have locked joints one and two this robot can only translate up and down along the x_b axis with velocity $\dot{\theta}_3$. One way to answer this question is by computing the body Jacobian (and geometric Jacobian), and then multiplying by $\dot{\theta} = [0, 0, \dot{\theta}_3]^T$.

But we can also answer this question by just looking at the robot and remembering the definitions of V_b and V. Here:

$$V_b = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \dot{\theta}_3 \\ 0 \\ 0 \end{bmatrix}, \qquad V = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -\dot{\theta}_3 \end{bmatrix} \tag{2}$$

Since the only moving joint is a prismatic joint there is no angular velocity.