ENME489C/ENME808M Problem Set3

Prof. Axel Krieger
Fall 2017
Due Date: Monday, September 25th, at 5 PM

September 20, 2017

Exercise 1: 20 points

Show that the length of a free vector is not changed by rotation, i.e., that $||v|| = ||Rv||$. [R is 3×3 rotation matrix]

Exercise 2: 20 points

Consider the following sequence of rotations:

a. Rotate by ϕ about the world *x-axis*.

b. Rotate by θ about the current *z-axis*.

c. Rotate by ψ about the current *x-axis*.

d. Rotate by α about the world *z-axis*.

Write the matrix product that will give the resulting rotation matrix (do not perform the matrix multiplication).

Exercise 3: 20 points

If the coordinate frame $o_1x_1y_1z_1$ is obtained from the coordinate frame $o_0x_0y_0z_0$ by a rotation of $\frac{\pi}{2}$ about the *x-axis* followed by a rotation of $\frac{\pi}{2}$ about the fixed *y-axis*, find the rotation matrix R representing the composite transformation. Sketch the initial and final frames

Exercise 4: 20 points

From the figure 1, find the homogeneous transformation H_1^0, H_2^0 and H_2^1 representing the transformations among the three frames shown. Show that $H_2^0 = H_1^0 H_2^1$.

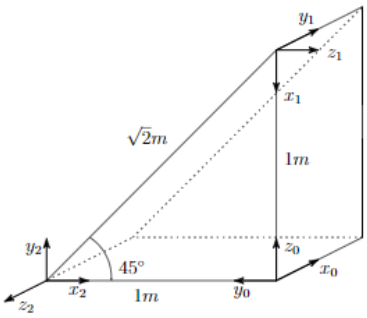

Figure 1: Exercise 4

Exercise 5: 20 points

Consider the diagram of Figure 2. A robot is set up 1 meter from a table. The table top is 1 meter high and 1 meter square. A frame $o_1x_1y_1z_1$ is fixed to the edge of the table as shown. A cube measuring 20 cm on a side is placed in the center of the table with frame $o_2x_2y_2z_2$ established at the center of the cube as shown. A camera is situated directly above the center of the block $2m$ above the table top with frame $o_3x_3y_3z_3$ attached as shown. Find the homogeneous transformations relating each of these frames to the base frame $o_0x_0y_0z_0$. Find the homogeneous transformation relating the frame $o_2x_2y_2z_2$ to the camera frame $o_3x_3y_3z_3$.

Exercise 6: 20 points

[**MUST for GRAD students and optional for undergrad students**].

In Exercise 5, suppose that, after the camera is calibrated, it is rotated by 90 degrees about z_3. Recompute the above coordinate transformations.

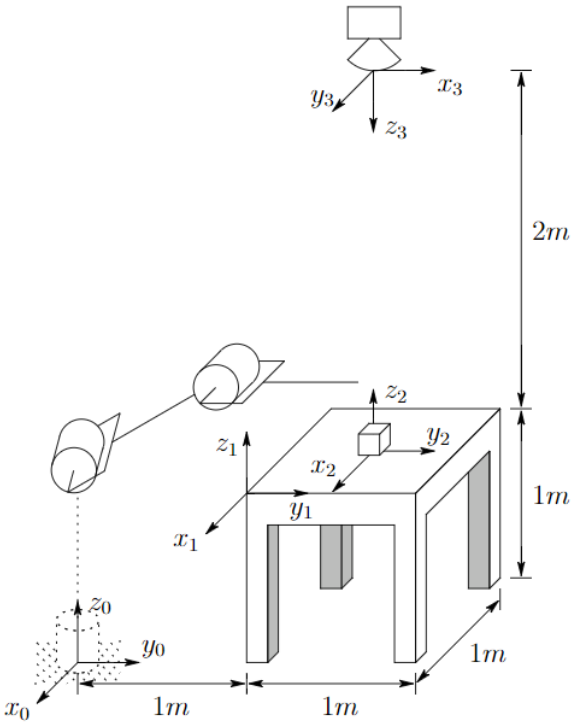

Figure 2: Exercise 5