Assignment 3

Exercise 1. Show that the distance between points is not changed by rotation, that is,

$$\| p_1 - p_2 \| = \| Rp_1 - Rp_2 \| \tag{1}$$

Exercise 2. Find rotation matrix corresponding to Euler Angles $\phi = 90°, \theta = 0°, \psi = 45°$.

Exercise 3. R is a rotation of $90°$ about y_0 followed by a rotation of $45°$ about z_1. Find the equivalent Axis-Angle (k, θ) to represent R.

Exercise 4. Compute the homogeneous transformation representing a translation of 3 units along the x-axis followed by a rotation of $\frac{\pi}{2}$ about the current z-axis followed by a translation of 1 unit along the fixed y-axis. Sketch the frame. What are the coordinates of the origin o_1 with respect to the original frame in each case?

Exercise 5. A robot is set up 1 meter from a table (See Figure 1). 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 2 meters 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. In the previous Exercise, suppose that, after the camera is calibrated, it is rotated $90°$ about z_3. Recompute the above coordinate transformations.

Exercise 7. In the previous Exercise, ff the block on the table is rotated $90°$ about z_2 and moved so that its center has coordinates $[0, .8, .1]^T$ relative to the frame $o_1x_1y_1z_1$, compute the homogeneous transformation relating the block frame to the camera frame; and the block frame to the base frame.
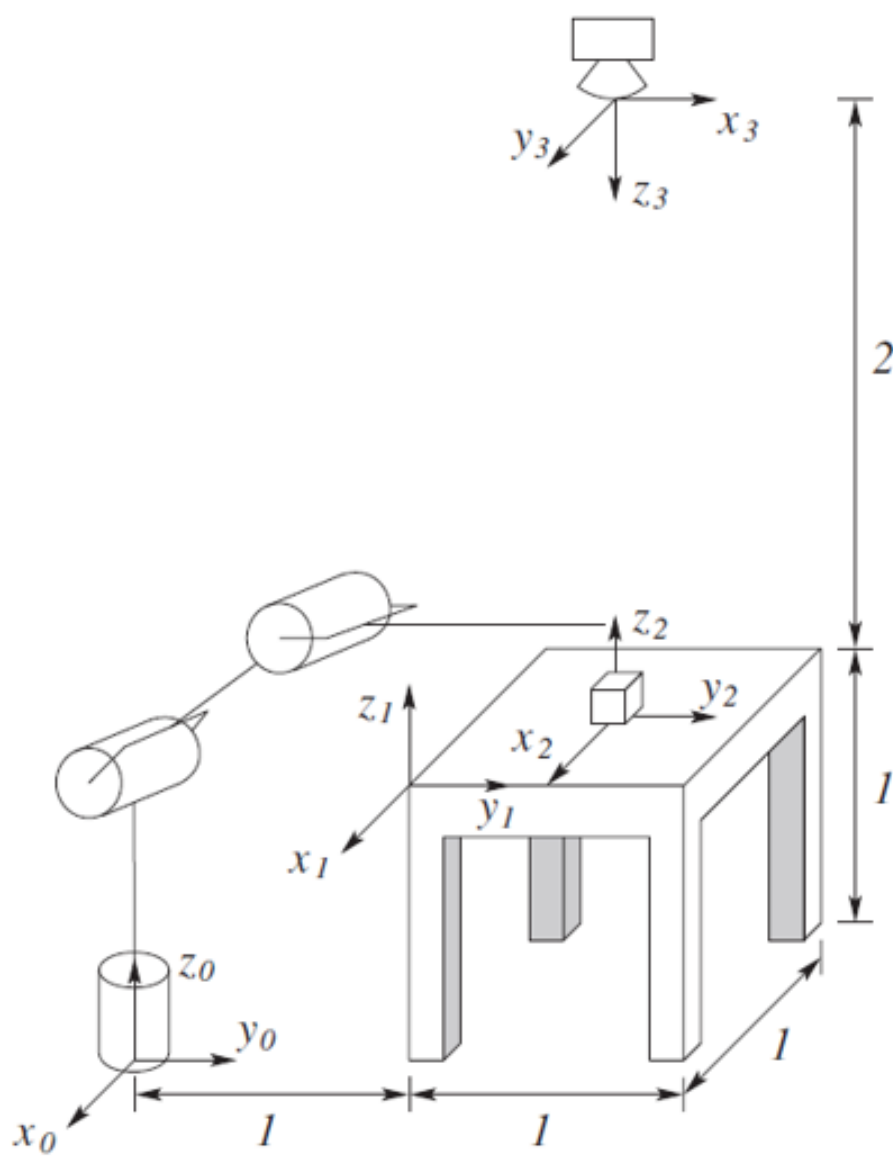
Figure 1: Exercise 5 diagram