# RBE501 Week 1 Assignment
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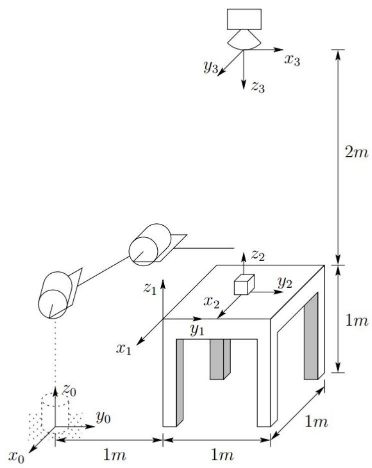


Fig. 1. Diagram for Problem 2-37 [1]

## I. Introduction

The objective of this problem set was to gain a familiarity with the MATLAB live scripting environment and review the implementation of transformation matrix.
The problem presents a picture of a robot near a table with various frames defined. The objective of the problem is to determine the transformation matrices between each frame.

## II. Materials and Methods

The approach to the problem is simple if you take it step by step due to the properties of the transformation matrices. The transformations from frame zero to frame one and frame one to frame two are simple translations. The transformation from frame two to frame three has both a translation and rotation involved. This transformation matrix can be created by a translation, a 180 degree rotation around the y axis, and a 90 degree rotation around the z axis. These matrices are seen in H_y_rotation, and H_z_rotation. Finally, the translation and rotation matrices can be multiplied together as seen in equation 1. The transformation frame from frame zero to frame two can be found using the equation 2

$$H_1^0, H_1^2$$

$$\text{H\_translation} = \begin{pmatrix} 1 & 0 & 0 & x \\ 0 & 1 & 0 & y \\ 0 & 0 & 1 & z \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$\text{H\_y\_rotation} = \begin{pmatrix} \cos\left(\frac{\pi\,\theta}{180}\right) & 0 & \sin\left(\frac{\pi\,\theta}{180}\right) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\left(\frac{\pi\,\theta}{180}\right) & 0 & \cos\left(\frac{\pi\,\theta}{180}\right) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$\text{H\_z\_rotation} = \begin{pmatrix} \cos\left(\frac{\pi\,\theta}{180}\right) & -\sin\left(\frac{\pi\,\theta}{180}\right) & 0 & 0 \\ \sin\left(\frac{\pi\,\theta}{180}\right) & \cos\left(\frac{\pi\,\theta}{180}\right) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$H_3^2 = H\_translation * H\_y\_rotation * H\_z\_rotation \quad (1)$$

$$H_2^0 = H_1^0 * H_2^1 \quad (2)$$

## III. Results

Below are the labeled transformation matrices to each frame in reference to frame 0.

$$H_1^0 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_2^0 = \begin{bmatrix} 1 & 0 & 0 & -1/2 \\ 0 & 1 & 0 & 3/2 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_3^0 = \begin{bmatrix} 0 & 1 & 0 & -1/2 \\ 1 & 0 & 0 & 3/2 \\ 0 & 0 & -1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Lastly following equation 1. The resulting matrix is show below.

$$H_3^2 = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

## IV. Discussion

This problem set served as a good review for the fundamentals of transformation matrices. This is important when the DH parameters method can not be applied to a problem, and it further strengthens the intuitive understanding of what the math operations actually mean. In addition learning to use the Matlab live scripting and automatic LaTeX conversion will be a useful for future papers.

## References


[1] Mark W. Spong, Seth Hutchinson, and M. Vidyasagar. *Robot modeling and control*. Vol. 26. 2006. DOI: 10.1109/MCS.2006.252815.