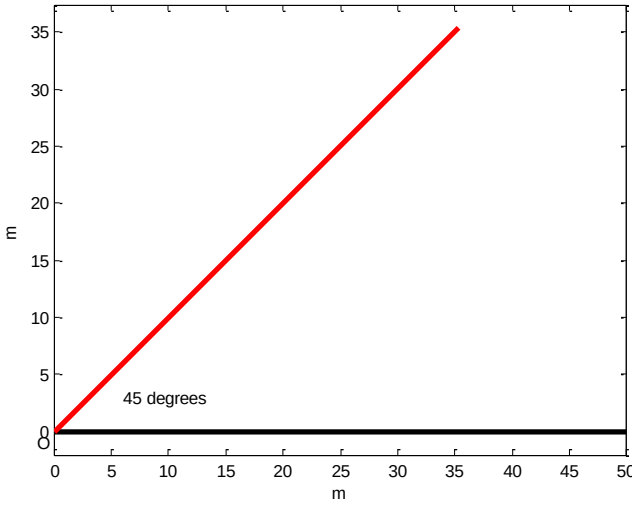
Week 2 – Homogenous Transformations: MATLAB Examples

Example 1

a. Find the transformation matrix of the end tip of a 50 m bar for rotation around y axis by 45 degrees.



$$R(y,45) = \begin{bmatrix} c_{45} & 0 & s_{45} \\ 0 & 1 & 0 \\ -s_{45} & 0 & c_{45} \end{bmatrix}$$

$\ell = 50\ m$

$p_x = \ell\ s_{45}$

$p_z = \ell\ c_{45}$

$$T_y = \begin{bmatrix} c_{45} & 0 & s_{45} & \ell\ s_{45} \\ 0 & 1 & 0 & 0 \\ -s_{45} & 0 & c_{45} & \ell\ c_{45} \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} R & 0_{3x1} \\ 0_{1x3} & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & \ell \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

b. Plot the vector to end of the rotated bar.

Examine example1_UG.m

Example 2

Find the transformation matrix of the end tip of a 30 m bar for rotation around z axis by -40 degrees. Draw the vector as in example 1.

Open **example2_UG.m** and fill in the missing code.

Example 3

Likewise, for a 50 mm bar for rotation around x by 60 degrees.

Open **example3_UG.m** and fill the missing code.

Example 4

Find the transformation matrix R_{UV} (or ${}^{U}_{V}R$) of a frame $\{V\}$ with respect to $\{U\}$.

$\{V\}$ is rotated by 120 degrees around z axis and translated by $p = \begin{bmatrix} -3.72 \\ 2.1 \\ 0 \end{bmatrix}$.

Examine example4_UG.m

Example 5

Find the matrix that describes the rotation of frame $\{1\}$ with respect to the world frame $\{O\}$:

1. Rotation around z
2. Rotation around y
3. Rotation around x
   (roll, pitch, yaw)

a. From the R_{zyx} matrix you created, find the ZYZ Euler angles a, b and c.

b. Find the R_{zyz} rotation matrix

c. Compare the R_{zyx} and R_{zyz} matrices. What do you conclude?

d. Find the transformation matrix if the origin of frame $\{1\}$ is positioned at $O_1(4, -3, 7)$ referenced in $\{O\}$.

e. Express point ${}^{\{1\}}p_1(1,1,1)$ (referenced in $\{1\}$) to the world frame $\{O\}$:

$$ {}^{\{0\}}p_1 = R_{01}\,{}^{\{1\}}p_1 + {}^{\{0\}}p_{\{1\}origin} $$

Examine example5_UG.m