Tutorial 2, Sep 15, 2025

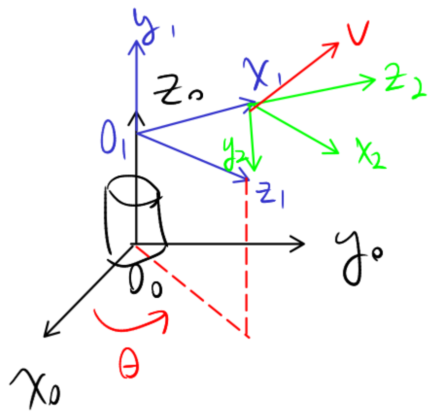

Figure 1: Diagram for example.

- Example 1: $v^2 = \begin{bmatrix} 1/2 \\ -1/2 \\ 1/2 \end{bmatrix}$
  - What is v^1?
    * $v^1 = R_2^1 v^2$
    * $x_2^1 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$
    * $y_2^1 = \begin{bmatrix} 0 \\ -1 \\ 0 \end{bmatrix}$
    * $z_2^1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$
    * $R_2^1 = \begin{bmatrix} 0 & 0 & 1 \\ 0 & -1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$
    * $v^1 = R_2^1 v^2 = \begin{bmatrix} 1/2 \\ 1/2 \\ 1/2 \end{bmatrix}$
  - What is v^0?
    * To see what R_1^0 we drop frame 0 down so its origin coincides with frame 0
    * $z_1 \cdot x_0 = \cos\theta$
    * $z_1 \cdot y_0 = \cos(\pi/2 - \theta) = \sin\theta$
    * y_1 is parallel to z_0 so $y_1 \cdot z_0 = 1$
    * $x_1 \cdot y_0 = \cos\theta$
    * $x_1 \cdot x_0 = -\sin\theta$
    * $R_1^0 = \begin{bmatrix} x_1 \cdot x_0 & y_1 \cdot x_0 & z_1 \cdot x_0 \\ x_1 \cdot y_0 & y_1 \cdot y_0 & z_1 \cdot y_0 \\ x_1 \cdot z_0 & y_1 \cdot z_0 & z_1 \cdot z_0 \end{bmatrix} = \begin{bmatrix} -\sin\theta & 0 & \cos\theta \\ \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \end{bmatrix}$
    * $v^0 = R_1^0 v^1 = \begin{bmatrix} (\cos\theta - \sin\theta)/2 \\ (\cos\theta + \sin\theta)/2 \\ 1/2 \end{bmatrix}$