

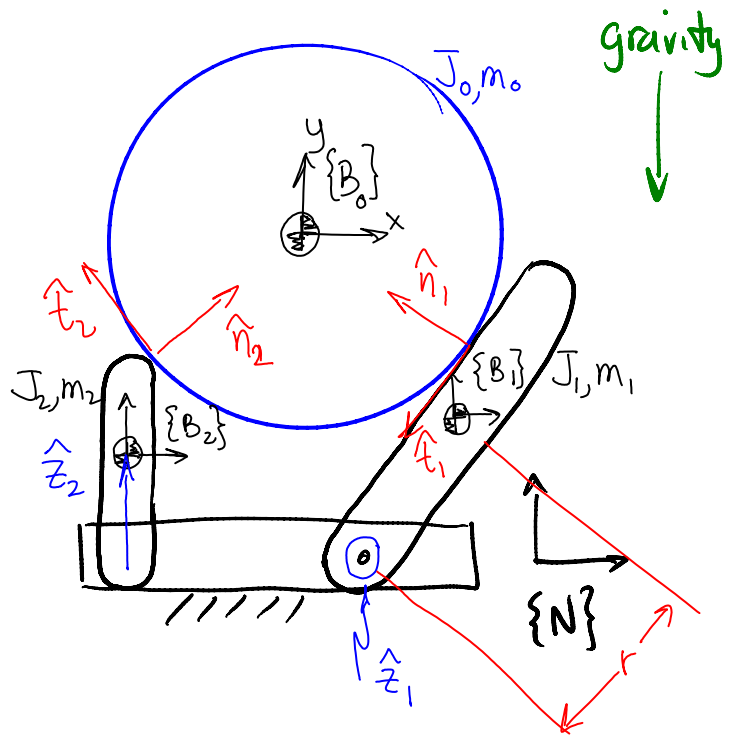
# In-class: Dynamics

Monday, February 09, 2009  
12:28 PM

Define the quantities need to take a step in the simulation of this system.

$$u = \begin{bmatrix} x_1 \\ y_1 \\ \theta_1 \\ x_2 \\ y_2 \\ \theta_2 \\ x_3 \\ y_3 \\ \theta_3 \end{bmatrix} \quad v = V\dot{u}$$

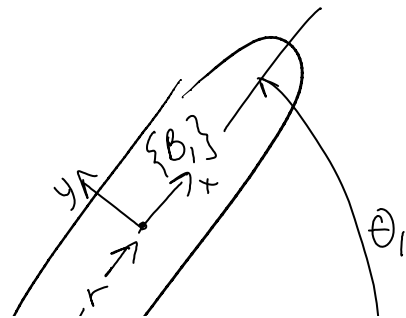
$$V = I_{(9 \times 9)}$$

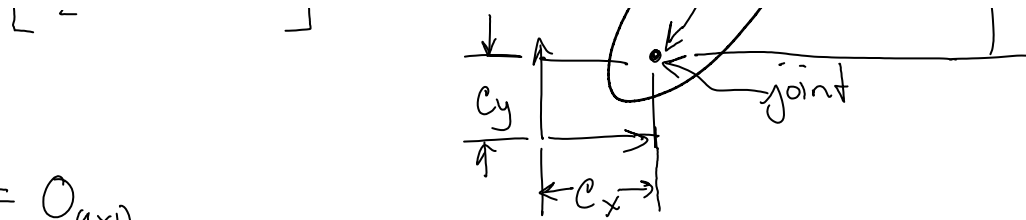


$$M = \text{diag}(m_0, m_0, J_0, m_1, m_1, J_1, m_2, m_2, J_2)$$

$$\psi_B = \begin{bmatrix} x_1 - r c_1 - c_x \\ y_1 - r s_1 - c_y \\ x_2 - \text{constant} \\ \theta_1 - \text{constant} \end{bmatrix}$$

← constants





$$\frac{\partial \Psi_B}{\partial t} = \mathbf{0}_{(4 \times 1)}$$

$$\frac{\partial \Psi_B}{\partial u} = \left[ \begin{array}{c|ccc|ccc} & 1 & 0 & r_{s1} & & & & & \\ & 0 & 1 & -r_{c1} & & & & & \mathbf{O}_{2 \times 3} \\ \hline & & & & \mathbf{O}_{2 \times 3} & & & & \\ & & & & & 1 & 0 & 0 & \\ & & & & & 0 & 0 & 1 & \end{array} \right]$$

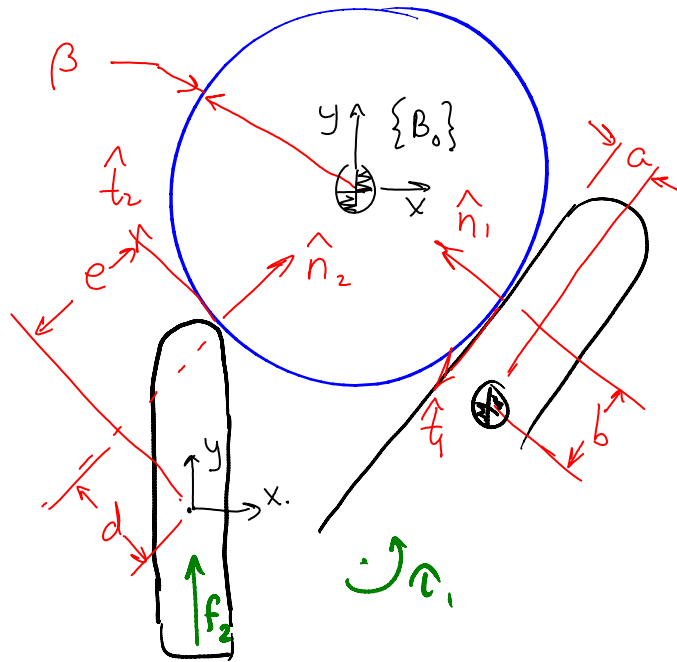
$$\mathbf{G}_B^T = \frac{\partial \Psi_B}{\partial u} \mathbf{v} = \frac{\partial \Psi_B}{\partial u}$$

Hard to write  $\Psi_n$  in closed form. Assume collision detection gives distances. At the moment,  $\Psi_n^l = \mathbf{0}_{(2 \times 1)}$

$$\frac{\partial \Psi_n}{\partial t} = \mathbf{0}, \text{ since } \Psi_n \text{ not explicit fcn of time.}$$

$$\frac{\partial \Psi_f}{\partial t} = \mathbf{0}, \text{ since no treadmill-effect on surfaces.}$$

$$G_n = \begin{bmatrix} 0.6 & \sqrt{2}/2 \\ 0.8 & -\sqrt{2}/2 \\ 0 & 0 \\ 0.6 & 0 \\ 0.8 & 0 \\ -b & 0 \\ 0 & -\sqrt{2}/2 \\ 0 & -\sqrt{2}/2 \\ 0 & d \end{bmatrix} \quad (9 \times 2)$$



$$G_f = \begin{bmatrix} -0.8 & 0.8 & \sqrt{2}/2 & -\sqrt{2}/2 \\ -0.6 & 0.6 & \sqrt{2}/2 & -\sqrt{2}/2 \\ -\beta & \beta & 1-\beta & \beta \\ -0.8 & 0.8 & | & \\ -0.6 & 0.6 & | & \text{circle} \\ a & -a & | & \text{circle} \\ \text{circle} & & \sqrt{2}/2 & \sqrt{2}/2 \\ & & -\sqrt{2}/2 & \sqrt{2}/2 \\ & & e & -e \end{bmatrix} \quad (9 \times 4)$$

$$u = \begin{bmatrix} \mu_1 & 0 \\ 0 & \mu_2 \end{bmatrix}$$

$$E = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix}$$

$$p_{\text{ext}} = \begin{bmatrix} 0 & -m_0 g & 0 & \vdots & 0 & -m_1 g & 0 & \vdots & 0 & -m_2 g & 0 \end{bmatrix}^T h$$

$$\Gamma = \begin{bmatrix} 0 & 0 & 0 & \vdots & 0 & 0 & \tau_1 & \vdots & 0 & f_2 & 0 \end{bmatrix}^T h$$