

# Impact Model

$[F] = \text{function - reaction force } (q_1, q_2, \dot{q}_1, \dot{q}_2, \ddot{q}_1, \ddot{q}_2)$

$\vec{G}_1, \vec{G}_2$

$$COM_x = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{m(x_1 + x_2)}{2m}$$

$$COM_y = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2} = \frac{m(y_1 + y_2)}{2m}$$

$$X_G = \frac{1}{2} \left[ \underbrace{(l-s)}_n s(-q_1) - l s q_1 - S \sin(q_1 + q_2) \right]$$

$$= -\frac{1}{2} \left[ (l-s) \sin(q_1) + l s \sin q_1 + S \sin(q_1 + q_2) \right]$$

$= + \frac{1}{2} l s q_1 + \frac{1}{2} S q_1 + \frac{1}{2} S \sin(q_1 + q_2)$

$$Y_G = \frac{1}{2} \left[ (l-s) \cos q_1 + l \cos q_1 + S \cos(q_1 + q_2) \right]$$

$= l \cos q_1 + \frac{1}{2} S \cos q_1 + \frac{1}{2} S \cos(q_1 + q_2)$

$\dot{X}_G$  and  $\dot{Y}_G$

$$\dot{X}_G = -\frac{1}{2} \left[ (l-s) \cos(q_1) \dot{q}_1 + l \cos q_1 \dot{q}_1 + S \sin(q_1 + q_2) (\dot{q}_1 + \dot{q}_2) \right]$$

$$\dot{Y}_G = \frac{1}{2} \left[ -(l-s) \sin q_1 \dot{q}_1 - l \sin q_1 \dot{q}_1 - S \sin(q_1 + q_2) (\dot{q}_1 + \dot{q}_2) \right]$$

let's group some terms

~~$$\dot{X}_G = l \cos \theta_1 \dot{\theta}_1 + S \cos \theta_1 \dot{\theta}_1 + S \cos(\theta_1 + \theta_2) (\dot{\theta}_1 + \dot{\theta}_2)$$~~

no no

$$\dot{X}_G = \begin{bmatrix} -l \sin \theta_1 + \frac{1}{2} S \sin \theta_1 - \frac{1}{2} S \sin(\theta_1 + \theta_2) \\ l \cos \theta_1 - \frac{1}{2} S \cos \theta_1 + \frac{1}{2} S \cos(\theta_1 + \theta_2) \end{bmatrix}$$

$$\ddot{X}_G = \begin{bmatrix} -l \cos \theta_1 \dot{\theta}_1 + \frac{1}{2} S \cos \theta_1 \dot{\theta}_1 - \frac{1}{2} S \cos(\theta_1 + \theta_2) (\dot{\theta}_1 + \dot{\theta}_2) \\ -l \sin \theta_1 \dot{\theta}_1 + \frac{1}{2} S \sin \theta_1 \dot{\theta}_1 - \frac{1}{2} S \sin(\theta_1 + \theta_2) (\dot{\theta}_1 + \dot{\theta}_2) \end{bmatrix}$$

$$\ddot{X}_G = \begin{bmatrix} +l \sin \theta_1 \dot{\theta}_1^2 - l \cos \theta_1 \ddot{\theta}_1 + \frac{1}{2} S \cos \theta_1 \ddot{\theta}_1 - \frac{1}{2} S \sin \theta_1 \dot{\theta}_1^2 + \frac{1}{2} S \cos(\theta_1 + \theta_2) (\dot{\theta}_1 + \dot{\theta}_2)^2 - \frac{1}{2} S \cos(\theta_1 + \theta_2) (\ddot{\theta}_1 + \ddot{\theta}_2) \\ -l \cos \theta_1 \dot{\theta}_1^2 - l \sin \theta_1 \ddot{\theta}_1 + \frac{1}{2} S \sin \theta_1 \ddot{\theta}_1 + \frac{1}{2} S \cos \theta_1 \dot{\theta}_1^2 - \frac{1}{2} S \sin(\theta_1 + \theta_2) (\dot{\theta}_1 + \dot{\theta}_2)^2 - \frac{1}{2} S \sin(\theta_1 + \theta_2) (\ddot{\theta}_1 + \ddot{\theta}_2) \end{bmatrix}$$

↓ find velocity & acceleration.

The reaction force is  $F = M \ddot{X}_G - M \bar{g}$       $M = 2m$   
 $F = 2m \ddot{X}_G - 2mg$

$$\bar{g} = \begin{bmatrix} g \sin \theta \\ -g \cos \theta \end{bmatrix}$$

FUNCTION IMPACT

$A_1 J_R = \text{function IMPACT.}$

$$\begin{bmatrix} A_1 & -J_R^T \\ J_R & 0_{n \times n} \end{bmatrix} \begin{bmatrix} \dot{x}_1^+ \\ \dot{y}_1^+ \\ \dot{\theta}_1^+ \\ \dot{x}_2^+ \\ \dot{y}_2^+ \\ \dot{\theta}_2^+ \\ J_{n \times x} \end{bmatrix} = \begin{bmatrix} A_1 \\ 0_{2 \times n} \end{bmatrix} \begin{bmatrix} \dot{x}_1^- \\ \dot{y}_1^- \\ \dot{\theta}_1^- \\ \dot{x}_2^- \\ \dot{y}_2^- \\ \dot{\theta}_2^- \end{bmatrix}$$