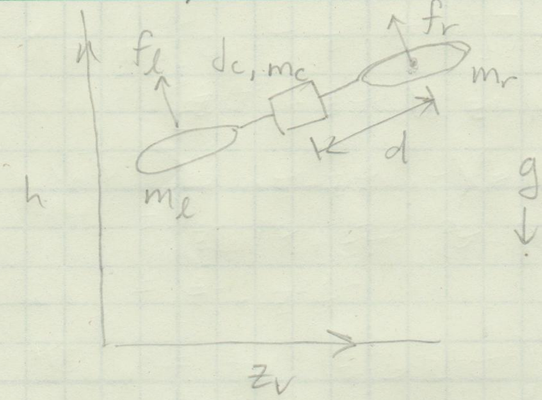
Caleb Groves | Controls | HW 2 | 4

F 2)



$$KE = \frac{1}{2} m_c v_c^T v_c + \frac{1}{2} m_l v_l^T v_l + \frac{1}{2} m_r v_r^T v_r + \frac{1}{2}\omega_c^T J_c \omega_c$$

$$p_r = [z_v + d\cos\theta,\ h + d\sin\theta,\ 0]^T$$

$$p_l = [z_v - d\cos\theta,\ h - d\sin\theta,\ 0]^T$$

! Forgot h! • for $\hat{j}$ components (not z_v)

$$v_r = [\dot{z}_v - d\dot{\theta}\sin\theta,\ \dot{h} + d\dot{\theta}\cos\theta,\ 0]^T$$

$$v_l = [\dot{z}_v + d\dot{\theta}\sin\theta,\ \dot{h} - d\dot{\theta}\cos\theta,\ 0]^T$$

$$\omega_c = [0, 0, \dot{\theta}]^T$$

$$p_c = [z_v, h, 0]^T$$

$$v_c = [\dot{z}_v, \dot{h}, 0]^T$$

$$v_r^T v_r = \dot{z}_v^2 + d^2\dot{\theta}^2\sin^2\theta - 2\dot{z}_v d\dot{\theta}\sin\theta + \dot{h}^2 + d^2\dot{\theta}^2\cos^2\theta + 2\dot{h}d\dot{\theta}\cos\theta$$

$$v_l^T v_l = \dot{z}_v^2 + d^2\dot{\theta}^2\sin^2\theta + 2\dot{z}_v d\dot{\theta}\sin\theta + \dot{h}^2 + d^2\dot{\theta}^2\cos^2\theta - 2\dot{h}d\dot{\theta}\cos\theta$$

$$KE = \frac{1}{2}m_c(\dot{z}_v^2 + \dot{h}^2) + \frac{1}{2}J_c\dot{\theta}^2 + \frac{1}{2}m_l(\dot{z}_v^2 + \dot{h}^2 + d^2\dot{\theta}^2 - 2\dot{z}_v d\dot{\theta}\sin\theta + 2\dot{h}d\dot{\theta}\cos\theta)$$
$$+ \frac{1}{2}m_r(\dot{z}_v^2 + \dot{h}^2 + d^2\dot{\theta}^2 + 2\dot{z}_v d\dot{\theta}\sin\theta - 2\dot{h}d\dot{\theta}\cos\theta)$$

$$\boxed{KE = \frac{1}{2}m_c(\dot{z}_v^2 + \dot{h}^2) + \frac{1}{2}J_c\dot{\theta}^2 + \frac{1}{2}(\dot{z}_v^2 + \dot{h}^2 + d^2\dot{\theta}^2)(m_r + m_l) + \dot{z}_v d\dot{\theta}\sin\theta(m_r - m_l) + \dot{h}d\dot{\theta}\cos\theta(m_l - m_r)}$$