- U U V Dynamics

$$x = \begin{bmatrix} \eta_I \\ v_I \end{bmatrix} \longrightarrow \text{position} \\ \longrightarrow \text{velocity}$$

$$\dot{x} = \begin{bmatrix} \dot{\eta}_x \\ \dot{v}_x \end{bmatrix} = \begin{bmatrix} v_I \\ R_B^I f_B + g_I + \delta_I \end{bmatrix}$$

$$M \dot{v} = \boxed{T} + \tau_{env} \underbrace{- C(v)v - D(v)v}_{} - g(\eta)$$

$$= \boxed{T - C(v)v - D(v)v \underbrace{- g(\eta)}_{} + \tau_{env}}$$

$$\underbrace{M \dot{v}}_{} = \underbrace{\boxed{T_{sys}}}_{T_{sys}} + \boxed{\tau_{env}} + \underbrace{g(\eta)}_{} \qquad \text{is this relaxing?}$$

$$m a_B = \tau_{sys} + \tau_{env}$$

$$\hat{a}_B = a_B + b_a + g_B + \eta \qquad \boxed{T_{sys}} \in \mathbb{R}^3$$

$$\Rightarrow a_B = \hat{a}_B + b_a - g_B - \eta_a \qquad \boxed{T_{sys} - g(\eta)} \in \mathbb{R}^2$$

$$x_T = [p, v, R, b_a, b_g, g]$$

$$\dot{p}_t = v_t$$
$$\dot{v}_t = R_T(\tilde{a} - b_{a_t} - \eta_a) + g$$
$$\dot{R}_t = R_t(\tilde{\omega} - b_{g_t} - \eta_g)^\wedge$$
$$\dot{b}_{g_t} = \eta_{b_g}$$
$$\dot{b}_{a_t} = \eta_{b_a}$$
$$\dot{g} = 0$$

$$p_t = p + \delta p$$
$$v_t = v + \delta v$$
$$R_T = R \, \delta R$$
$$b_{g_t} = b_g + \delta b_g$$
$$b_{a_t} = b_a + \delta b_a$$
$$g_T = g + \delta g$$

nominal state

$$\dot{\delta p} = \delta v$$
$$\dot{\delta b_g} = \eta_g$$
$$\dot{\delta b_a} = \eta$$
$$\dot{\delta g} = 0$$