- UUV Dynamics

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

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

$$M\dot{\nu} = \tau + \tau_{env} - C(v)v - D(v)v - g(\eta)$$

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

τ_{sys} is this gravity?

$$M\dot{\nu} = \tau_{sys} + \boxed{\tau_{env}} - g(\eta)$$

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

$\tau_{sys} \in \mathbb{R}^3$

$\tau_{sys} - g(\eta) \in \mathbb{R}^3$

$$\hat{a}_B = a_B + b_a + g_B + \eta$$

$$\Rightarrow a_B = \hat{a}_B - b_a - g_B - \eta_a$$

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

$$\dot{p}_t = v_t$$

$$\dot{v}_t = R_t(\tilde{a} - b_{a_t} - \eta_a) + g$$

$$\dot{R}_t = R_t(\tilde{\omega} - b_{g_t} - \eta_g)^\wedge$$

$$\dot{b}_{g_t} = \eta_{bg}$$

$$\dot{b}_{a_t} = \eta_{ba}$$

$$\dot{g} = 0$$

$p_t = p + \delta p$

$v_t = v + \delta v$

$R_t = R\,\delta R$

$b_{gt} = b_g + \delta b_g$

$b_{at} = b_a + \delta b_a$

$g_t = g + \delta g$

nominal state

$$\delta\dot{p} = \delta v$$

$$\delta\dot{b}_g = \eta_g$$

$$\delta\dot{b}_a = \eta$$

$$\delta\dot{g} = 0$$