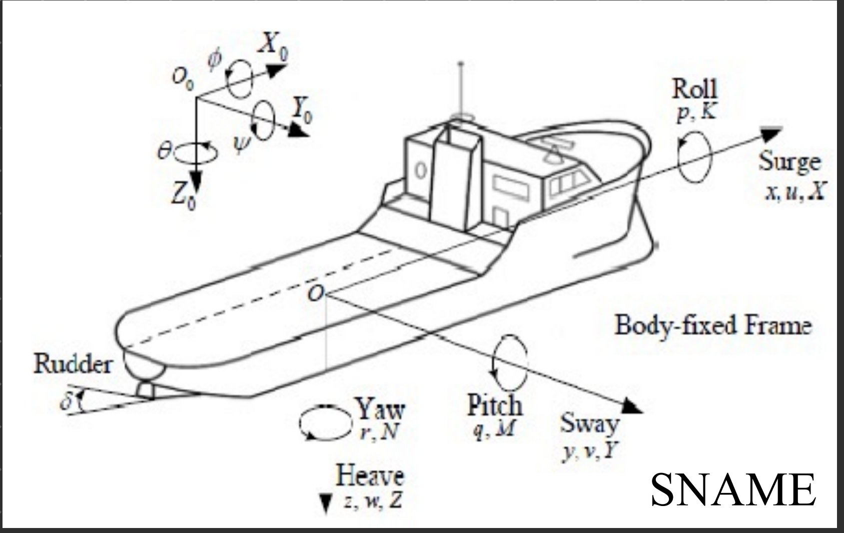
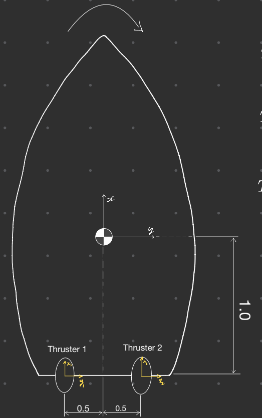




$$T_1 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0.5 & 0 \end{bmatrix} \quad T_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -0.5 & 0 \end{bmatrix} \quad T_e = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 0.5 & 0 & -0.5 & 0 \end{bmatrix}$$

Tilnærmet krefter i systemet

$$\sum F = ma \Rightarrow \underbrace{F_{drag}}_{\frac{1}{2}\rho v^2 C_D A} + \underbrace{F_{thrust}}_{u} + \underbrace{F_{disturbance}}_{=0} = ma$$

Kan ikke modelleres; takles av PID

Tilnærmet dynamikk til systemet

$$\ddot{x} + 2\zeta\omega\dot{x} + \omega^2 x = 0$$

Def av ctrl input

$$u = \dot{e} + e = (\dot{x}_s - \dot{x}_o)\cdot k_d + (x_s - x_o)\cdot k_p$$

Linearisering

$$\frac{1}{2}\rho C_D A \cdot |v| \cdot v \Rightarrow d^* = \frac{1}{2}\rho C_D A \cdot |v|, \quad F_D = d^* \cdot |v|$$

Beholder fortegn

$$-d^*\dot{x} + (0 - \dot{x}_s)k_d + (0 - x_s)k_p = ma$$

$$a = \frac{1}{m}\left(-\dot{x}_s k_d - x_s k_p - d^*\dot{x}\right)$$

$$\ddot{x} = -\frac{(k_d + d^*)}{m}\dot{x} - \frac{k_p}{m}x \Rightarrow \ddot{x} + \frac{(k_d + d^*)}{m}\dot{x} + \frac{k_p}{m}x = 0$$

$$\frac{k_d + d^*}{m} = 2\zeta\omega \Rightarrow k_d = 2m\zeta\omega - d^*$$

$$\frac{k_p}{m} = \omega^2 \Rightarrow k_p = m\omega^2$$

$$\dot{x} = Ax + Bu, \quad y = Cx + w$$

- $\bar{x}$ (Systemet) n-elementer
- $\bar{u}$ (Input) m-elementer
- $\bar{y}$ (Output) p-elementer

- $A \rightarrow n \times n$
- $B \rightarrow n \times m$
- $C \rightarrow p \times n = I$
- $\omega \rightarrow$ White noise, støy i måling

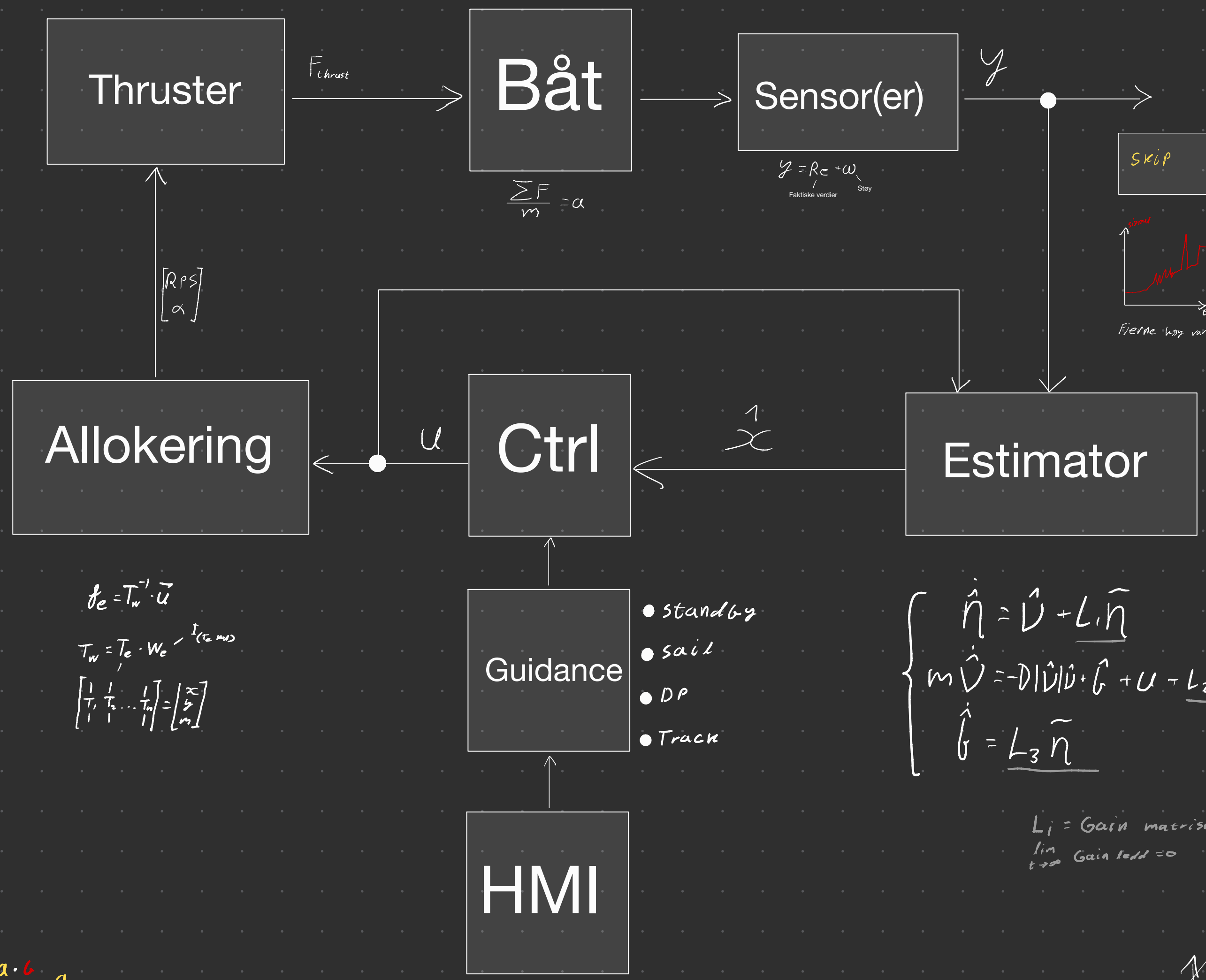
$$\dot{x} = \frac{d}{dt}\begin{bmatrix} p \\ v \end{bmatrix} \Rightarrow \begin{bmatrix} v \\ a \end{bmatrix} = A\begin{bmatrix} p \\ v \end{bmatrix} + Bu$$

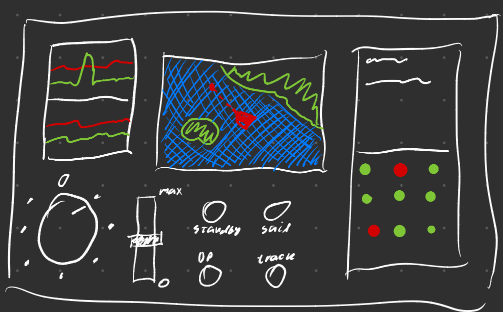
$$\ddot{x} + \frac{(k_d + d^*)}{m}\dot{x} + \frac{k_p}{m}x = 0 \Rightarrow a + \frac{k_d + d^*}{m}v + \frac{k_p}{m}p = 0$$

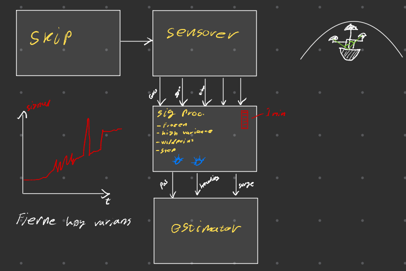
$$a = -\frac{k_d + d^*}{m}v - \frac{k_p}{m}p \qquad \begin{cases} \dot{p} = v \\ \dot{v} = -\frac{k_d + d^*}{m}v - \frac{k_p}{m}p \end{cases}$$

$$\dot{v} = -\frac{k_d + d^*}{m}\dot{p} - \frac{k_p}{m}p$$

$$\begin{bmatrix} \dot{p} \\ \dot{v} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -\frac{k_d + d^*}{m} & -\frac{k_p}{m} \end{bmatrix}\begin{bmatrix} p \\ v \end{bmatrix}$$







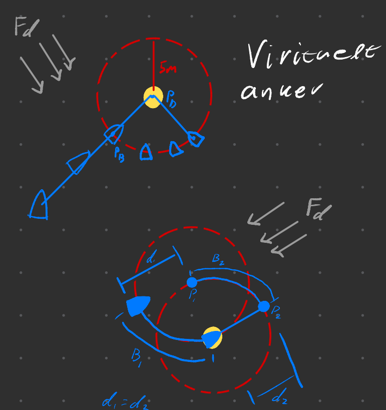
$$f_e = T_w^{-1}\bar{u}$$

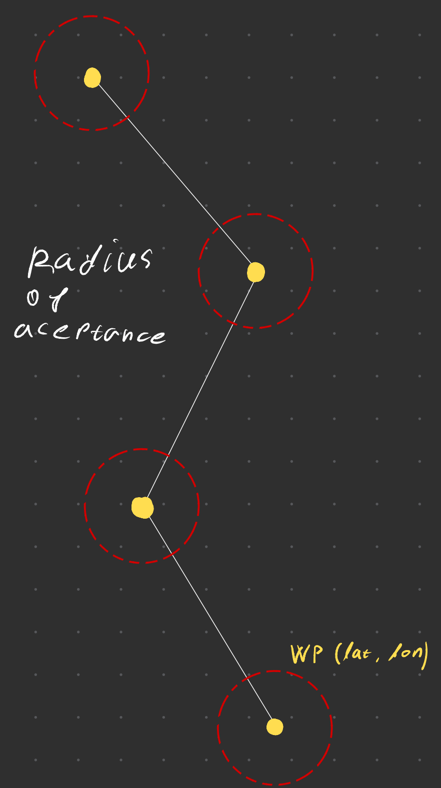
$$T_w = T_e \cdot W_e^{-1}$$

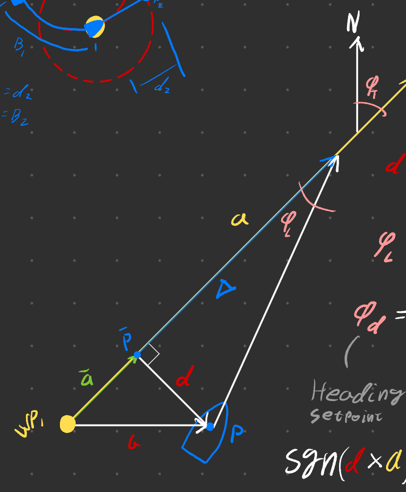
$$\begin{cases} \dot{\hat{\eta}} = \hat{\nu} + L_1\tilde{\eta} \\ m\dot{\hat{\nu}} = -D|\hat{\nu}|\hat{\nu} + \hat{b} + u - L_2\tilde{\eta} \\ \dot{\hat{b}} = L_3\tilde{\eta} \end{cases} \Rightarrow \begin{cases} \hat{\eta} = \int(\hat{\nu} + L_1\tilde{\eta})\,dt \\ \hat{\nu} = \int\left(\frac{-D|\hat{\nu}|\hat{\nu} + \hat{b} + u + L_2\tilde{\eta}}{m}\right)dt \\ \hat{b} = \int L_3\tilde{\eta}\,dt \end{cases}$$

L_i = Gain matrise

$\lim_{t\to\infty}$ Gain ledd = 0







$$\bar{a} = \frac{a \cdot b}{a \cdot a} \cdot a$$

$$d = p - \bar{p}$$

$$\varphi_L = \arctan\left(\frac{\Delta}{\Delta}\right) \text{ WPs}$$

$$\varphi_d = \varphi_T - \varphi_L$$

Heading setpoint

LOS

$sgn(d \times a)$ gir fortegn til d-vektor