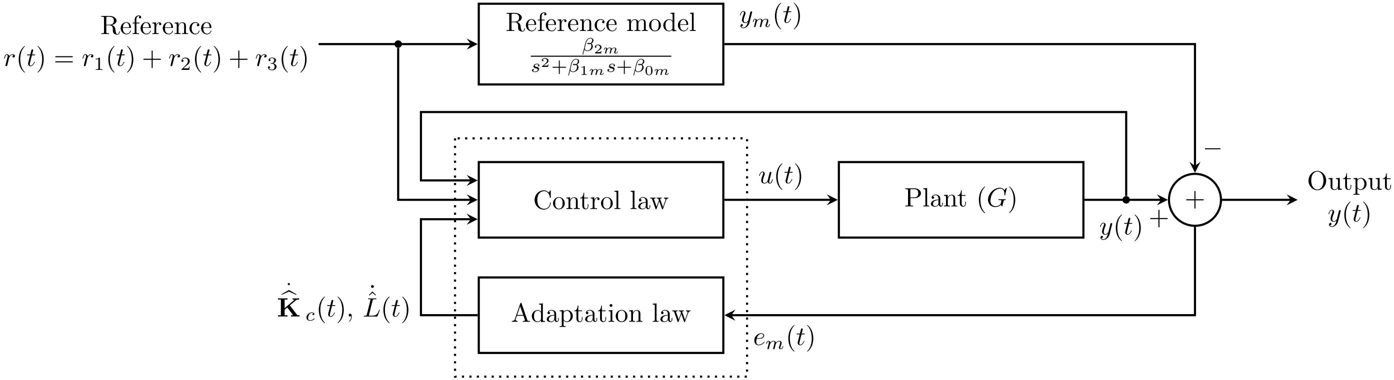

Model rerefence adaptive control (MRAC)

Model:

$$\dot{\mathbf{x}}_m(t) = \mathbf{A}_{mc}\mathbf{x}_m(t) + \mathbf{B}_{mc}r(t)$$

$$\mathbf{A}_{mc} = \begin{bmatrix} 0 & 1 \\ -\beta_{0m} & -\beta_{1m} \end{bmatrix}, \qquad \mathbf{B}_{mc} = \begin{bmatrix} 0 \\ \beta_{2m} \end{bmatrix}, \qquad \mathbf{x}_m(t) = [y_m(t),\ \dot{y}_m(t)]^T$$

Control law:

$$u(t) = \widehat{\mathbf{K}}_c(t)\mathbf{x}(t) + \hat{L}(t)r(t)$$

Adaptation law:

$$\dot{\widehat{\mathbf{K}}}_c(t) = \gamma \mathbf{B}_{mc}^T \mathcal{P}\mathbf{E}(t)\mathbf{x}^T(t)$$
$$\dot{\hat{L}}(t) = \gamma \mathbf{B}_{mc}^T \mathcal{P}\mathbf{E}(t)r(t)$$

where T_S is sampling time, $\gamma > 0$ is the adaptation gain, $\mathbf{x}(t) = [y(t),\ \dot{y}(t)]^T$, $\mathbf{E}_m(t) = [e_m(t),\ \dot{e}_m(t)]^T$, and matrix $\boldsymbol{\mathcal{P}} = \boldsymbol{\mathcal{P}}^T$ satisfies:

$$\mathbf{A}_{mc}^T\mathcal{P} + \mathcal{P}\mathbf{A}_{mc}^T = -\mathbf{I}_{2x2}$$