Design and application of a Linear Algebra Based Controller from a reduced order model for regulation and tracking of chemical processes under uncertainties

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Supporting Information

The uncertainty that represents model mismatches can be formulated as follows:

From equation (1):

$$\tau \dot{y}\left(t+t_0\right)+y\left(t+t_0\right)=K\,u\left(t\right) \qquad \text{(A-1)}$$

$$y\left(t+t_0\right)=y\left(t\right)+\dot{y}\left(t\right)t_0+\underbrace{\ddot{y}\left(t+\lambda t_0\right)\frac{t_0^{\,2}}{2}}_{\textbf{ComplementaryTerm = H (t)}}\quad ,0<\lambda<1 \qquad \text{(A-2)}$$

$$\dot{y}\left(t+t_0\right)=\dot{y}\left(t\right)+\ddot{y}\left(t\right)t_0+\underbrace{\dddot{y}\left(t+\lambda t_0\right)\frac{t_0^{\,2}}{2}}_{\textbf{ComplementaryTerm}=\frac{dH(t)}{dt}}\quad ,0<\lambda<1 \qquad \text{(A-3)}$$

replacing equations A-1 and A-2 in A-3, the following expression is obtained:

$$\ddot{y}+K_A\,\dot{y}+K_B y+K_B\left(\mathrm{H}(t)+\tau\frac{\mathrm{H}(t)}{dt}\right)=K\,K_B\,u$$

From equations (6) and (7), and applying Euler approximation, equation (25) is obtained and the uncertainty term takes the form:

$$E_n=-K_B T\left(\mathrm{H}(nT)+\tau\left.\frac{\mathrm{dH(t)}}{dt}\right|_{t=nT}\right)$$