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IMRT Measurement and Control Laboratory

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151-0590-00 **Regelungstechnik II** (FS 2008) **Übung 9**

Thema: **State Observer, LQG, Matlab/Simulink**

Ausgabe: 15. 05. 08 Vorbesprechung: 16. 05. 08 Abgabe: 23. 06. 08 Nachbesprechung: 30. 05. 08

Name: .... Vorname: .... Visum: ....

C.B., 15. Mai 2008

Aufgabe 1 (State Observer)

A plant is described by the following set of differential equations:

$$\dot{x}_1(t) = 3x_2(t) + u(t)$$
$$\dot{x}_2(t) = x_1(t) + x_2(t) + 2u(t)$$
$$y(t) = 2x_2(t)\,.$$

A state observer

$$\dot{\hat{x}}(t) = (A - LC)\hat{x}(t) + Bu(t) + Ly(t)\,,$$

must be designed for the above plant.

a) Taking the design parameter $q = \frac{1}{2}$ calculate by hand the observer gain L. What are the observer poles?

b) You discover that the observer includes two noise signals n_u and n_y. Assuming the noise to be uncorrelated white noise signals with intensities $R_u = 4$ and $R_y = 1$ design a new observer gain L which minimises the estimation error $\bar{x}(t)$.

Aufgabe 2 (Cart and Inverted Pendulum with Observer, Matlab/Simulink)

This exercise is an extension of the cart pendulum exercise in Uebung 8. You no longer have full state feedback from the system and only the cart position can be measured, $C = \begin{bmatrix} 0 & 0 & 1 & 0 \end{bmatrix}$. As before, the observer and controller should be applied to the nonlinear model which was distributed with Uebung 8. The parameters are the same as those given with Uebung 8.

a) Design an observer for the system with suitable weighting matrices to maintain the pendulum in the upright position. Run a simulation from the initial conditions $x(0) = \begin{bmatrix} 0.1 & 0 & 0 & 0 \end{bmatrix}^T$ and $\hat{x}(0) = \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}^T$. Plot the estimation error $\bar{x}(t)$ and response.

b) Just as in Uebung 8, the cart must move from position $d = 0m$ to $d = 1m$ over 5 seconds (a ramp function). Include any appropriate feedforward action and integral action to the controller structure. A good initial guess for the weighting matrices would be $Q = I$,$r = 0.01$, $q = 1$ and $\gamma = 10$. Plot the estimation error $\bar{x}(t)$ and response.