Homework assignment 1 (hand in your solution next week):

A typical hard disk drive actuator can be modeled quite accurately as a double integrator:

$$G(s) = \frac{Y(s)}{U(s)} = \frac{6 \times 10^7}{s^2}$$

where y is the displacement of the read/ write head in micrometer and u is actuator input voltage in volts. The sampling rate used in a typical hard disk drive servo system is about 10 kHz, which is equivalent to a sampling period T = 1/10000 = 0.0001 seconds. It is required to design an appropriate control law such that the resulting closed-loop system has an overshoot less than 25% and a settling time less than 8 milliseconds due to a step reference of 1 micrometer.

- Design a digital PD or PI or PID controller that meets the above design specifications using the emulation method.
- Design a digital PD or PI or PID controller that meets the design specifications using the pole placement technique.

Show all the detailed design procedures and simulation results. Use MATLAB and SIMULINK whenever is possible.

Homework assignment 2 *(hand in your solution next week)*:

Reconsider the hard disk drive servo system in the Homework Assignment 1, i.e.,

$$G(s) = \frac{Y(s)}{U(s)} = \frac{6 \times 10^7}{s^2}$$

where y is the displacement of the read/ write head in micrometer and u is actuator input voltage in volts. The sampling rate is again chosen to be 10 kHz, which gives a sampling period T = 1/10000 = 0.0001 seconds. It is required to design an appropriate compensator such that the resulting closed-loop system has an overshoot less than 25% and a settling time less than 8 milliseconds as well as a steady state error to be less 1% due to a step reference of 1 micrometer.

- Can you design a digital lead compensator that would achieve the above design specifications?

If your answer is yes, please give your solutions together with all detailed derivations and simulation results. If your answer is no, please give your reasons together with detailed justifications. Again, make use of MATLAB and SIMULINK whenever is possible.

Homework assignment 3 *(hand in your solution to my office next week)*:

Reconsider the hard disk drive servo system in the Homework Assignments 1 and 2, i.e.,

$$G(s) = \frac{Y(s)}{U(s)} = \frac{6 \times 10^7}{s^2}$$

where y is the displacement of the read/ write head in micrometer and u is actuator input voltage in volts. The sampling period is chosen to be T = 1/10000 = 0.0001 seconds. It is required to design an appropriate compensator such that the resulting closed-loop system has an overshoot less than 5% and a settling time less than 2 milliseconds due to a step reference of 1 micrometer.

Design a digital control system using the state space approach with a deadbeat estimator. Show all your design procedures together with simulation results. Again, make use of MATLAB and SIMULINK whenever is possible.

By now, you have designed the same system using four different approaches. Please comment the advantages and disadvantages of these methods. Which one would you recommend?

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