CIE 318 Control Systems
Project (Part 2)
deadline 20th April 12 PM

Summary:

Use the transfer function derived in Part 1 to design a digital PID controller using Simulink, then implement the designed controller on a microcontroller with the actual hardware. The closed loop response with the controller in the Simulink should match (as close as possible) the actual hardware response with the controller. If the responses don't match then you may need to re-identify your open loop transfer function, e.g., by considering a higher order transfer function than the one you started from, or by including some neglected effects, e.g., delays, etc. In general, you should be operating in the linear range of your system to avoid nonlinear effects

Project phase 2 requirements:

1- Define the specifications of the closed loop system with the controller. These specifications should depend on your control problem and should differ from one problem to another. The specifications should include:
  a. Transient time domain characteristics: rise time – [illegible]ling time – maximum percentage overshoot
  b. Steady state error
  c. Stability margins: Gain and phase margins
  d. Response to disturbance: overshoot - settling time – steady state error due to disturbance.
  e. Controller output signal, i.e., control effort.

2- Start by designing your digital PID controller in the simulator using the open loop transfer function derived in phase 1. You should design 2 versions of the digital PID controller:

a. Using root locus

b. Using a grid search approach in which you test different values of the P, I, and D gains until you satisfy the design criteria. You can use Ziegler's method (if applicable) to choose the starting gains of your search. It is preferable to derive the Ziegler's gains using the system model and not the actual hardware to avoid any hardware damage. In case the Ziegler's method is not applicable (as a result of the response not matching either methods of Ziegler), then you can make an educated guess for the initial gains based on your knowledge about proportional, integral, and derivative effects.

3- Iterate your designs in the simulator until the specifications in step (1) are achieved. If the specifications cannot be achieved, try to relax the specifications a bit.

4- After designing the digital controller, you should derive the time-domain difference equation of your controller and implement it first on the simulator and check that it works properly.

5- Implement your digital PID controller on a microcontroller (both designs), then test them on the actual hardware and collect the closed loop response of your system.

6- Compare the response of the actual hardware with the response in the simulator. In case of a mismatch, you need to understand where the mismatch comes from (modelling, delays, sampling time, etc.). Iterate your design until the performance of the hardware matches the simulator performance, and both should meet the specifications in step (1).

7- Document every step clearly from (1) – (6). You should have a **video** for each milestone of the project that will be presented in the discussion. Note that a missing documentation is not acceptable. **Projects without documentation will not be graded**.

Documents :

- .pdf full report.
- all .m & .slx files
- Video/ milestone
- Power Point (to be submitted during the presentation)

Grading:

Whole project: 15% from final grade

Part 1: 4%
Part 2: 6%
Presentation and discussion: 5%

Part 2 (6% of the final grade, distributed over 100 marks):
The marks distribution per requirement (check the requirements above) is as follows:

1- 10 marks
2- 20 marks
3- 10 marks
4- 10 marks
5- 30 marks
6- 10 marks
7- 10 marks