SYST003 - LINEAR CONTROL SYSTEMS
Final report

Instructions

- ✓ 3 students per group
- ✓ Maximum **40 pages**
- ✓ Deadline: 10th December 2019 at 23:59
- ✓ Submission online: https://submit.montefiore.ulg.ac.be
- ✓ **Property and clarity** of your figures: 1/20

Section 1: Control Problem + Introduction

1. Choice of the topic
2. Context: describe the framework of your project (tell the "story" about your control problem).
   For example, for the camera stabilizer; one group did a stabilizer on a bike (fast constraints) or a camera following a football player. As you can guess the constraints, sensors and implementations are different – not too long !
3. Open loop system diagram (with clear labels)

Section 2: State-space representation

1. Open loop model description
   - Signals (inputs, outputs, states) description (domain and image) (do not need to be long)
   - Output laws and update laws
   - Linearization (if necessary)
2. State-space model (ABCD Matrices) with the labels associated to our diagram
3. Constraints, limitations of your system and numerical choice of parameter values /!
   - Do not forget your sources or assumptions.
   - This section will be the one that you will refer to for all your design because you will describe the constraints on all your signals
     - On your reference (how this reference can vary, how far my output signal can be from its reference value, …),
     - On your input signal (controllable input: give a physical range),
     - On your uncontrollable input: be realistic for your scenario, …),
     - On your output signal, …
4. Stability + discussion of eigenvalues
5. Open Loop system simulations
   - Show your scenario and explain what you see and why a controller is necessary
   - Relationship between your scenario and your eigenvalues.
6. Observability + sensor discussion/choice
7. Controllability + actuator discussion/choice

Section 3: Controller in Time domain

1. State feedback controller: Computation of K and kr
   - justify accurately your choice.
   - be explicit and clear in your computations.
2. Observer: Computation of L
   Be sure you have understood the role of the observer and what you are tuning.
3. Simulations and discussion

In order to choose the right parameters of your controller, discuss how did you choose the state-feedback and observer gains (why these values for K and L).

- Response to a reference variation
- Response to a perturbation(disturbance). Do not hesitate to do several physical/biological scenarii.
- Check what happens when you have noise in your system. Explain where noise is affecting your system.
- *Supplement:* You can also check the impact of delays in your system

Interpret your results. Do not forget that you are modeling "something" that could be implemented and tested in a lab. Each simulation tells a story of your system.

Section 4: Controller in frequency domain

1. Transfer function of your open-loop system
   - Computation
     Be sure your understand the expression if you are using a Matlab function.
   - Bode diagram in amplitude and phase
     Explain it ! you should be able to draw it by hand. So describe it according to your parameter and so on.

2. Loop Shaping
   For each component of C(s), describe
   - Utility/role and explain why it is useful to shape L ("predict the behavior")
   - Parameter description
   - Explain your trade-off / discuss parameter choice in
     - bode diagram (or Nyquist or both)
     - output signal
     - control input signal
3. Gang of four:
   - Role and description of their shape (especially S and T)
   - Connect the bode diagram to theoretical notions seen in Lectures
4. Delays
   Discuss the presence of delays in your system through the controller design
   You should be able to see/explain the impact of the delay in your bode diagram or Nyquist plot
5. Noise
6. Supplement: Feedforward discussion/implementation (if necessary ,for your project)

Rem: be careful with your units, when you use a bode diagram check if you are working in frequency [Hz] or in pulsation [rad/s]

Section 5 Conclusion

1. Comparison between time domain and frequency domain
2. General conclusion

Appendix:

1. Bibliography (follow convention of scientific paper)
2. Any additional information that is not necessary in the main report but if you think it might be useful to refer to for any complementary information (or for yourself if you want to use complementary figures during the oral discussion.