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Computational Control

Project

Introduction

You are a control expert, and you are asked to act as a consultant for an aerospace company.

This company wants to hear your opinion on their rocket landing control scheme. You are provided with a **Jupyter notebook** (at this link). It contains the following pieces of information:

- A simulator of the rocket landing dynamics;
- A linearized model of the rocket derived by their engineers;
- Specifications of the control problem (limits on the actuators, constraints on the landing);
- A basic working controller (PID-type) that is already implemented in the simulator.

The notebook automatically fetches the code from https://gitlab.ethz.ch/bsaverio/coco-project . You don't need to access the git repository directly.

They would like to know if an advanced control method can outperform their PID-type controller.

Your task

You need to produce **two documents**:

- A 5-slide **presentation.**
- A **Jupyter notebook.**

The **presentation** is intended for the Chief Technology Officer of the company. The presentation needs to be compelling, graphically pleasant, void of typos and mistakes, and professional.

Each slide needs to serve a specific purpose:

1. **Current state**: Show how the current controller performs in the standard operating condition that is already implemented in the simulation. Briefly comment on the behavior. *[1 point]*
2. **Failure mode**: Show how under certain conditions their controller can fail the task. In this slide, you want to motivate the need for a better controller. It is your job to find a compelling failure scenario, that is, one that is plausible but that their controller cannot handle well. *[4 points]*
3. **Your recommendation**: Explain what type of controller you would recommend (among those seen in class), providing the three most important reasons that support your choice. *[4 points]*
4. **Demonstration:** Show how the controller that you proposed outperforms their current controller in the failure scenario that you identified in slide 2. Comment on the results: you need to be convincing! *[3 points]*

5. **A plan for deployment:** Briefly describe what would be the necessary steps needed in order to deploy the controller that you proposed, and what are the most important requirements (data, models, computational resources, measurements). *[3 points]*
6. **(Extra slide) A recommendation in case of no model information:** Recommend a solution (among those seen in class) for the hypothetical case in which the model information is missing or highly uncertain. Explain the reason for your recommendation and show its performance in a simulation *[2 bonus points]*

The **Jupyter notebook** is intended as support material for your presentation. Assume that the engineers in the technical team of the company will read it to understand what you are proposing. It needs to work flawlessly: any glitch will make you look unprofessional!

When executed, the notebook must produce all the material that you used in Slide 2 and Slide 4 of your presentation. Therefore, it needs to implement a failure scenario and test both the current controller and the proposed one. *[5 points]*

In case you decide to include also the **Extra slide (model free)**, the notebook needs to produce the simulation included in that slide. *[2 bonus points]*

The code needs to be interleaved with proper documentation. In particular, it needs to be explained:

- How the failure scenario has been modeled in the simulation. *[2 points]*
- What parameters are available to define the failure scenario. *[2 points]*
- How the proposed controller is implemented. *[2 points]*
- What parameters need to be tuned in the controller. *[2 points]*
- How you tuned them and how would you recommend tuning them. *[2 points]*

In case you decide to include also the **Extra slide (model free)**, the model-free solution needs to be briefly explained as well. *[1 bonus point]*

Grading

As detailed above, the **presentation** and the **Jupyter notebook** are worth 15 points each, for a total of 30 points. These 30 points count towards the total of 100 points for the course (70 points are assigned based on the final exam).

By providing a solution to the case in which the model of the rocket is missing (model free), you can get up to 5 additional bonus points towards the final count for the course.

Deadline

The project needs to be handed in before **07 July at 23:59** via Moodle.