Course:
Networked Control

Projects

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Things to do

- The **scope of the project work** is to design centralized, decentralized, and distributed controllers for a selected case study.

- **Steps**:

1. Download the case study (in the form of a system to be controlled, including MATLAB model and a short description), i.e.,
   i. Go to the WeBeep page of the course 052369 - NETWORKED CONTROL (FARINA MARCELLO) [2023-2024].
   ii. Open the folder MATERIALI -> Projects
   iii. Download the file «groups_Webeep.pdf»
   iv. If you have sent me an email in the previous days, you have a project number # assigned to your group.
   v. Download the files «#_*.pdf» with a general description of the system and of the requirements and «MAT#*.m» with the matrices of the system.
2. You will perform the necessary analysis (see later for more details) and design using MATLAB.
3. You will have to make a short powerpoint presentation discussing the results.
4. The group will show the presentation and the MATLAB code to the teacher in an **oral exam**, where the **awareness and knowledge** of each group member **of the achieved results, of the design choices, and of the related theory** will be evaluated. The date of the oral exam is at discretion of the students (before/after the written test, request by email).

Tasks (in general)

As available data, in the .m file you will get the matrices of the model

$$\dot{x} = Ax + Bu$$

1. Modelling

- Decompose the state and input vectors into subvectors, consistently with the physical description of the system. Obtain the corresponding decomposed model.
- Generate the system matrices (both continuous-time and discrete-time, the latter with a sampling time selected compatibly with the continuous-time dynamics)

2. Analysis

- Compute the eigenvalues and the spectral abscissa of the (continuous-time) system. Is it open-loop asymptotically stable?
- Compute the eigenvalues and the spectral radius of the (discrete-time) system. Is it open-loop asymptotically stable?
- For different state-feedback control structures (i.e., centralized, decentralized, and different distributed schemes) compute the (continuous-time and discrete-time) fixed modes.

Tasks (in general)

3. Design

For different state-feedback control structures (centralized, decentralized, and distributed) compute, if possible, the (CONTINUOUS-TIME and DISCRETE-TIME) control gains using the LMIs to achieve the desired performances. Apply, for better comparison, different criteria for computing the control laws.
This is done possibly using the MATLAB functions used and provided during the laboratory lectures **as a starting point**.

4. Simulation

Compute and plot the closed-loop system trajectories (generated both in continuous-time and in discrete-time) starting from a common random initial condition for all considered control structures.

Powerpoint presentation

The powerpoint presentations must include:

- A short and schematic description of the system and of the model.
- Description of the "modelling" choices (e.g., decomposition, sampling time, etc).
- Results of the analysis regarding the stability properties of the open-loop system and of the fixed modes for various control structures (centralized, decentralized, distributed – with possibly different information exchange graphs).
- Results of the control design (feasibility/spectral radius of the closed loop system, with necessary short comments) for various control structures.
- Plots of the closed loop system trajectories.
- Remarks and comments on the achieved results.

And now good luck for your work!