Master of science degree in Computer Engineering
Academic Year 2021-2022, Second Semester

01UDSOV - Modeling and control of cyberphysical systems

Diego Regruto, Sophie Fosson

Part II, Homework n. 3

Main learning objectives

Upon successful completion of this homework, students will

1. Be able to design a state-variables feedback (SVFB) distributed control protocol for solving cooperative tracking problem for multi-agents systems.
2. Be able to analyze the effect of the different parameters involved in the design of the distributed control protocol on the system performance.

Assigned problem

In this problem we consider the multi-agents systems presented in the last classroom lesson, where each one of the N agents is a two-mass-spring system. Physical parameters of the agents and the structure of the graph describing the communication network have been assigned in the classroom lesson.

Using such information and the theory developed in the last classroom lesson, the students are invited to **design a SVFB distributed control protocol** in order to drive the global disagreement error to zero asymptotically (hint: solution of the Algebraic Riccati Equation can be performed in Matlab by using the command ARE). More specifically:

- Solve the SVFB distributed control problem by using Theorem 1.
- Build the obtained controlled multi-agent systems as a Simulink scheme.
- Simulate the system by assuming $x_i(0) = [0\ 0]'$ for $i = 1, 2, \ldots, N$ and $x_0(0) = [10\ 0]'$.
- In order to better investigate the behavior of the distributed controlled system, students are invited to change the initial condition $x_i(0), i = 0, \ldots, N$ and to also investigate the effect of the coupling gain c (how the value of c affect the performance?)
- How can you modify the reference behavior dictated by the leader agent? (Could you modify the reference behavior by acting on a local control loop closed around the leader node?)
- In particular, try to design the whole control system such that all the agents' outputs are converging (for $t \to \infty$) to the same constant value
- Try to modify the structure of the communication network (i.e. the graphs G and $\overline{G}$) in order to analyze the effect of the network structure on the behavior of the controlled multi-agents system.