SAMA Proposal

Plug-and-play Control of Interconnected Systems

Description:

Control of interconnected systems has attracted the attention of the control systems community due to its broad range of applications (e.g. DC microgrids and electric vehicle charging). These systems can be controlled centrally where a central entity is used to collect measurements from the whole system and compute all control inputs accordingly. A major disadvantage of centralized control is that it is not well-suited for varying-topology networks. This is because the overall controller of the whole network needs to be modified once the network topology changes, even if the changes are minor. Considering the problem of electric vehicle charging for example, network topology changes take place when a new vehicle joins the network for charging and/or another leaves for mobility duties.

To circumvent this challenge, plug-and-play (PnP) control schemes are developed where the interconnected system is decomposed into smaller subsystems and a local controller is developed for each. When the network topology changes, only the local controllers of a few subsystems are modified depending on how close the subsystems are to these changes. Particularly, PnP model predictive control (MPC) has gained attention due to its ability to take state and input constraints into account. PnP MPC schemes are usually divided into two phases; an offline redesign phase which ensures stability and an online phase which ensures feasibility.

In our group, we have developed novel decentralized and distributed MPC schemes for interconnected systems. We would like to explore the possibility of augmenting and applying these schemes to plug-and-play applications as shown in Figure 1.

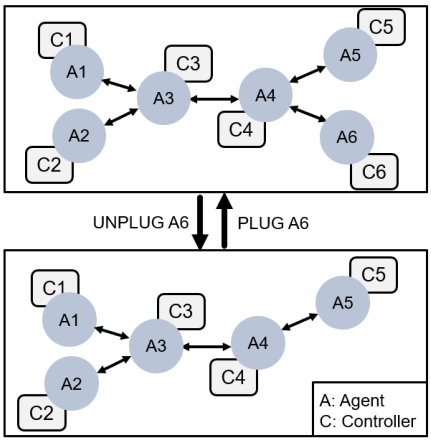

Figure 1: Plug-and-play Applications

Goal:

The student is expected to perform the following tasks:

- Exploring different PnP control schemes in the literature, which can be used for controlling varying-topology networks

- Exploring the possibility of augmenting and applying the developed schemes in our group to plug-and-play applications
- Comparing the developed PnP MPC scheme to existing ones in the literature using a case study in DC Microgrids

Qualifications:

We are looking for highly motivated and talented students who are interested in working on PnP MPC for varying-topology networks. The student is expected to have a background in systems & control and optimization. Sufficient mathematical maturity is required, and MATLAB knowledge is necessary to perform the simulations.

Keywords: Model Predictive Control, Plug-and-play Control, Convex Optimization, Passivity Theory

Labels: Semester Project, Master Thesis

Earliest Start: 01.08.2021

Contact Details: Please apply by writing to Ahmed Aboudonia at ahmedab@control.ee.ethz.ch or Andrea Martinelli at andremar@control.ee.ethz.ch and including your CV and transcript of grades at Bachelor and Master's level.

Covid-19 Disclaimer: This project can be done in person at the Automatic Control Laboratory, hybrid, or completely remotely, depending on the current ETH regulations. Most importantly, we can change between these forms whenever needed.

Project Publication: If the results are promising they can be turned into a publication.