Chair of Automatic Control

FAU

Announcement for Master/Bachelor Thesis

Control of Timed Discrete-Event Systems Based on Max-Plus Algebra

Motivation

A wide variety of human-made systems, such as manufacturing lines and transportation networks, can be characterized as discrete-event systems (DES), meaning their dynamic evolution consists in the sequential occurrence of events that cause (quasi-)instantaneous transitions among a discrete set of states. Even though the dynamics of DES is event-driven, in some applications time still plays a crucial role, for example for performance evaluation, deadline enforcement, or scheduling of time-sensitive tasks. A particular subclass of timed DES has become known as *max-plus linear systems*, due to the fact that, within a suitable mathematical setting (like the max-plus algebra), their behavior can be represented by a set of linear state-space equations. Based thereon, a rich control theory has been established, carrying over some key concepts and techniques from classical control theory such as transfer functions, output- and model-reference control, state estimation, observer-based control, and model predictive control. Recent efforts in this context often aim at broadening the applicability of this control framework by adapting and enhancing existing methods, enabling to treat commonly-encountered phenomena such as resource sharing as well as specific kinds of restriction/interdependence for the occurrence of events in the system.

Possible topics for theses projects

A variety of potential topics can be offered in this field of research, which can be fine-tuned according to the sought degree (Bachelor or Master) as well as to individual preference/aptitude. Examples are:

- optimal control design for resource-sharing manufacturing lines with varied structures;
- development and analysis of comprehensive case-study (using existing C++ toolbox) for systems with different kinds of event synchronization;
- study and control design for systems with shared resources under partial observation;
- development and implementation of a user interface for existing C++ library.

Prerequisites

Motivation to delve into a new research area, a solid mathematical background, and English proficiency are important. Some familiarity with discrete-event systems is advantageous, although not strictly necessary.

References

L. Hardouin, B. Cottenceau, Y. Shang, and J. Raisch (2018). *Control and state estimation for max-plus linear systems.* Foundations and Trends in Systems and Control (6.1), pp. 1–116.

B. Heidergott, G. J. Olsder, and J. W. van der Woude (2006). *Max Plus at Work: Modeling and Analysis of Synchronized Systems.* Princeton University Press.

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