2019 IFAC workshop on Time-delay Systems

Invited Session on "New Trends in Computational Methods for Time-delay Systems"

Session Organizers:

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Synopsis:

Research on time delay systems goes back to the second half of the 20th century, and since then significant advances have been reported on the topic. In the last 20 years specifically, there has been strong and ever-growing interest on time delay systems mainly with the increasing complexity in applications from network control systems and mechatronics to biology and economics, all which have their own peculiarities in bringing time delays in their dynamics. It is therefore necessary to include the consideration of delay effects within control methods. While the theoretical landscape is rich, it is of no surprise that new problems and more advanced techniques are developed as research advances, and new application domains are incorporated into consideration. This session is dedicated for capturing some new trends in time delay systems research, in particular considering application problems along with the development of numerical tools used to study stability, preform parametric design, or synthesize controllers.

A proportional-plus-delay based controller for active vibration damping through a partial pole assignment

Sami Tliba (L2S), Islam Boussaada (L2S), Fazia Bedouhene (UMMTO), Silviu-Iulian Niculescu (L2S)

Abstract: This paper is about the active vibration damping for a thin mechanical structure, equipped with piezoelectric transducers, both used as sensor and actuator. Such system are known to lead to linear time invariant models but of infinite dimension, ie with an infinite number of vibration modes. For such systems, finite dimensionel models can be obtained thanks to the use of a finite element modeling, followed by a modal analysis. A previous work has permitted to perform the active vibration damping by assigning the considered poles of a low order synthesis model onto a rightmost-characteristic root, through a specific output-feedback controller built on delayed proportionnal effects applied to the output and input signals. The drawback of this strategy is that the closed-loop control

signal can be of high amplitude, which can be of matter in an experimental device, facing to input saturation.

Recently, it has been theoretically shown that the location of each pole could be independently chosen in the complex plane with the same kind of controller, by an appropriate choice of parameters. In this paper, we shall present an application of this new result to show its effectiveness when damping slightly the considered vibration modes.

A generalization of Fiagbedzi-Pearson's transformation for linear differential time-delay systems

Alban Quadrat (Inria Paris)

Abstract: In this paper, we show how an algebraic analysis approach to linear differential time-delay systems based on a ring of integro-differential time-delay operators can be used to generalized the so-called \emph{Fiagbedzi-Pearson's transformation} which maps the trajectories of a linear differential systems with delayed state and delayed input to trajectories of a linear differential system without delays. As a particular case, we find again Artstein's transformation for linear differential systems with a delayed input.

Curve analysis for the stability of differential systems with commensurate time-delays

Yacine Bouzidi (Inria Paris), Adrien Poteaux

Abstract: In this work, we investigate the {\em asymptotic stability} of LTI differential commensurate time-delay systems whose dynamics are defined in the frequency domain by quasi-polynomials of the form $f(s,\tau)= \sum_{j=0}^{m} p_j(s)\, e^{-j\,\tau\,s}$. For studying the stability with respect to the delay, we propose a new approach based on real space curve analysis to determine the asymptotic behavior of the roots near to the critical pairs of $f(s,\tau)$. Compared to the existing methods, our method does not require any Puiseux series computation. Instead, the stability is derived by analyzing the intersection of a space curve with 3D real boxes.

Optimization of the smoothed spectral abscissa for retarded type systems

Marco A. Gomez and Wim Michiels (KU Leuven)

Abstract: We introduce a new robust stability measure for retarded type systems, which is called smoothed spectral abscissa. The main characteristics of the smoothed spectral abscissa are that it is smooth with respect to the system parameters, and it provides a trade-off between the spectral abscissa and the H2 norm of a transfer matrix related with the system. It is given by an implicit relation with the H2 norm of an auxiliary system, and its computation is based on the delay Lyapunov matrix.

We show that these features make the smoothed spectral abscissa suitable for the design of robust controllers by using standard gradient-based optimization techniques.