IFAC World Congress 2017 Toulouse
Open Invited Track
Tensor Methods for Modelling and Control

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Abstract: Tensors are a basic modelling structure for multidimensional problems in physics for more than a century. In the last decade, new results on tensor based algorithms have been achieved in applied mathematics. Additionally, numerical tools e.g. for CP, tucker, and tensor train decompositions are available. This open invited track welcomes all application and theory related submissions showing the use of tensor methods for modelling, data analysis, representation, reduction, (supervisory) controller design, fault diagnosis and reconfiguration in control engineering.

Keywords: Nonlinear systems, Models, Fault diagnosis, Fault Tolerance, Controller design, Model reduction, Data reduction, Multilinear systems

1. MOTIVATION

Many of todays control engineering challenges are nonlinear and/or large scale, e.g. control of distributed networks, smart grids, medical homecare, building automation systems, etc. Modelling and control problems for these applications are sometimes hard to solve efficiently, because of the curse of dimensionality and their hybrid nature, e.g. discrete-event and continuous-valued signals coexist and interact. Normally, complexity of modelling and controller design tasks grow with the dimension of the problem as well as with the ability to model nonlinear behaviour.

Tensor decompositions are known since 90 years, see Hitchcock (1927). But they have been applied only recently to structured analysis of big data in various application domains like medical signal processing, chemometrics, image processing and many more, see Cichocki et al. (2015). Their ability to reduce large scale problems by orders of magnitude without loosing too much information has shown to be superior to standard matrix techniques, see Kolda and Bader (2009) and Oseledets (2011). Although the underlying optimization problems are in general nonconvex and sometimes even ill-posed, current tools compute approximate solutions in reasonable time which then can be used for efficient algorithms in engineering applications, see Bader et al. (2015) and Vervliet et al. (2016).

The applicability of tensor methods for control engineering has been shown within the class of multilinear time-invariant (MTI) systems. These are a subclass of polynomial systems and a superclass of bilinear as well as binary systems. Moreover, they are able to model hybrid systems behaviour, see Pangalos et al. (2014). Tensor methods also have shown to be useful for Boolean networks, see Cheng et al. (2011) and pneumatic models, see Grof et al. (2011).

2. RESTRICTIONS

All papers in this session should be concerned with multi-index structures, i.e. problems of at least dimension 3. Due to the novelity of the approaches, there will be no restrictions to certain application domains or methods.

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⋆ For Evaluation: TC 1.3 Discrete Event and Hybrid Systems.

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