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Methods and tools for simplified dynamic simulations in real time based on expression approximation

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Abstract

The core of this paper is the methodology of the dynamical models' simplification for the real time simulation. The simplified simulation models are based on neuro-fuzzy modelling approach, which was originally designed for predictive control-oriented modelling of nonlinear dynamical systems. The two ways of the neuro-fuzzy modelling utilization are presented. First, the training of the predictive dynamical neuro-fuzzy model and, second, the training of the statical approximation of the right-hand side of the system's state space description. We demonstrate the results on the examples of nonlinear spring damper system and double pendulum.

Keywords: real time simulation, LOLIMOT, neuro-fuzzy model, identification of dynamic systems, state space

1. Introduction

For the real time simulation of complex dynamical systems one often needs to find simplifications of the original model. In practice, such simplifications are developed usually ad hoc and some robust unified strategy is missing. On the other hand, in the model predictive control branch the neuro-fuzzy models for short time simulation (i.e., prediction) are utilized. We investigate the possibilities of the adaptation of the neuro-fuzzy approach in the real time simulation.

To identify a dynamic system from measured data, we use the algorithm called LOLIMOT that builds the so called neuro-fuzzy model of the dynamic system under the consideration. So far, this methodology was used in such a way that the values of quantities have been considered in several consequent times to model the derivatives. We propose here a different utilization of the neuro-fuzzy identification methodology that allows also for the measured derivatives of the quantities and, mainly, builds statical neuro-fuzzy models of the right-hand side of the state space description of the system's dynamics.

2. Neuro-fuzzy models and LOLIMOT

We shall briefly present here the basic concepts and terminology used in the neuro-fuzzy identification as introduced by [1].

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