

Switching Control in the Presence of Constraints and Unmodeled Dynamics

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1. Introduction

Recently there has been increased research interest in the study of the hybrid dynamical systems (Sun & Ge, 2005) and (Li et al., 2005). These systems involve the interaction of discrete and continuous dynamics. Continuous variables take the values from the set of real numbers and the discrete variables take the values from finite set of symbols. The hybrid systems have the behaviour of an analog dynamic system before certain abrupt structural or operating conditions are changed. The event driven dynamics in hybrid control systems can be described using different frameworks from discrete event systems (Cassandras & Lafortune, 2008) such as timed automata, max-plus algebra or Petry nets. For dynamic systems whose component are dominantly discrete event, main tools for analysis and design are representation theory, supervisory control, computer simulation and verification. From the classical control theory point of view, hybrid systems may be considered as a switching control between analog feedback loops. Generally, hybrid systems can achieve better performance than non-switching controllers because they can reconfigure and reorganize their structures. For that is necessary correct coordination of discrete and analog control variables.

The mathematical model for real process, generally, has the Hammerstein-Wiener form (Crama & Atkins, 2001) and (Zhao & Chen, 2006). It means that on the input and output of the process are present nonlinear elements (actuator and sensor). Here we will consider Hammerstein model which has the input saturation as nonlinear element. That is the most frequent nonlinearity encountered in practice (Hippe, 2006). Also, unmodeled dynamics with matching condition is present. As a control strategy will be used switching control. The switched systems can be viewed as higher abstraction of hybrid systems.

The design of switching controllers having guaranteed stability, known as the piecewise linear LQ control (PLC), is first considered in (Wredenhagen & Belanger, 1994). The piecewise linear systems are systems that have different linear dynamics in different regions of the continuous state space (Johansson, 2003). The PLC control has the associated switching surfaces in form of positively invariant sets and yields a relatively low-gain controller. In the LHG (low-and-high gain) design a low gain feedback law is first designed in such a way

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