

HYBRID CONTROL OF SYSTEMS WITH INPUT DELAY

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Abstract: In this paper the concept of multiple models and concept of switching controllers is used. The analog part of the system is described by finite set of continuous-time models with input delays. The continuous-time models include unmodeled dynamics in the form of affine matrix family. Using suitable transformation the models with input delay is converted in the delay free models. Then for multiple models, for fixed subsystem, using LMI tool, the robust LQ controller with prescribed degree of stability is derived.. The switching rule, between robust LQ controllers, is based on the selection of the best performance of the closed loop subsystems. Finally is proved that original hybrid system is stable. *Copyright © 2005 IFAC*

Key words: Multiple models, Input delay, LMI tool, switching rule, stability

1. INTRODUCTION

Hybrid systems are digital real-time systems which are embeded in analog environments. Analog part of the hybrid system is described with differential equations (Goodwin et al., 2001) and discrete part of the hybrid systems is a event driven dynamics which can be described using concept from discrete event systems. (Cassandras and Lafortune, 1999).

From the clasical control theory point of view hybrid systems can be considered as a switching control between analog feedback loops ([Liberzon, 2003](#); Savkin and Evans, 2002).

Recently, the new approach for adaptive control is introduced ([Narendra and Xiang , 2000](#)). In the case of large parameters errors the classic adaptive control results in a slow convergence with large transient errors. To overcome such problems the concept of multiple models is proposed. Similar approach is taken, also, in ([Wang et al., 1999](#)) where mapping of hybrid state to hybrid control is based on system performance.

In this paper we will adapt the multi model approach for control of systems with input delay. Time delay is a difficult element in process control systems (Shinskey, 1988). Mathematical formalism for description of time-delay systems belongs to the class of functional differential equations which are infinite dimensional. The excellent overview of some recent results for control of time-delay system is given in (Richard, 2003). Some new results for stability of time delay systems are presentid in (Gu et al., 2003). Design of feedback control law for time-delay systems, based on dynamic programming, is presented in (Yanushevsky, 1978).

In this paper we will use predictor-like techniques for systems with input delay. Such techniques is considered in ([Kwon and Pearson, 1980](#); Arstein 1982). Using suitable transformation the original problem can be described in the form of delay free system.

For description of input delay system we will use multiple model concept. Parts of the input signal have different delays. In the model, also, unmodeled dynamics, in the form of affine matrix family, is

