

## HYBRID LQ CONTROLLER WITH PRESCRIBED DEGREE OF STABILITY

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**Abstract:** In this paper design of switching controllers for linear systems is considered. The controllers are LQ controllers with prescribed degree of stability and switching sequence is determined by minimization of suitable defined priority function. Hybrid controller is developed based on system performance. In the form of theorem is proved: equilibrium point of the hybrid system is exponentially stable and performance of system is no worse than the best non-switching strategy.

**Key words:** LQ controller, degree of stability, hybrid control, priority function, exponential stability

### 1. INTRODUCTION

Hybrid dynamical systems (HDS) have attracted considerable attention in the last a few years. 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 a finite set of symbols. The HDS systems have the behaviour of an analog dynamic system before certain abrupt structural or operating condition changes. Well known example of hybrid system is the dynamic system described by a set of ordinary differential equations with discontinuous right-hand sides (systems with relays, switches, and hysteresis). Such kind of system is described in the frame of theory in (Filippov, 1988). Another example is the sliding mode control (Utkin, 1992). The next typical example of a hybrid system is control of continuous-time process by digital controller. These systems known under the name sampled-data systems (Chen and Francis, 1995; Goodwin et al., 2001)

The important part of hybrid systems is event driven dynamics which can be described using different framework used for discrete event systems (DES) such as timed automata, max-plus algebra or Petri

nets (Cassandras and Lafontaine, 1999). For HDS whose components are dominantly discrete events main tool for analysis and design are: representation theory, supervisory control, computer simulation and verification. From the classical control theory point of view HDS may be considered as a switching control between analog feedback loops ([Hespanaha and Morse, 1999](#)). That is discontinuous feedback control. For the nonholonomic systems, that can be possible approach for control because in that case no smooth feedback control law exists for stabilization or tracking. The second approach for such system is approximate inversion (Brockett, 1996). It is, also, possible to interpret HDS as a special form of adaptation. Such control system are capable of adapting to large modeling errors and structural changes ([Wang et al., 1999](#)). Generally, HDS can achieve better performance than non-switching robust controllers because they can reconfigure and reorganize their structures. For that necessary correct coordination of discrete and analog control variables.

It is possible to mention a few approaches for design of hybrid controllers. The first one is dwelling-time switching strategies ([Hespanaha and Morse, 1999](#)). For stabilization it is necessary to have enough long







