International Journal of Innovative Computing, Information and Control
Volume **4**, Number **6**, June **2008**

ICIC International ©2008 ISSN 1349-4198
pp. **1283–1297**

CONTRACTIVE PREDICTIVE CONTROL OF MIXED LOGICAL DYNAMICAL HYBRID SYSTEMS

Jalal Habibi and Behzad Moshiri

Control and Intelligent Processing, Center of Excellence
School of Electrical and Computer Engineering
University of Tehran
North Kargar Ave., Tehran, I. R. Iran
habibi@control.ee.ethz.ch; moshiri@ut.ac.ir

Ali Khaki Sedigh

Department of Electrical Engineering
K. N. Toosi University of Technology
Seyed Khandan, Tehran, I. R. Iran
sedigh@kntu.ac.ir

Received April 2007; revised September 2007

Abstract. *Current state-of-the-art approaches for control of hybrid systems face two main important challenging problems which are stabilization and computational complexity. This paper aims at improving a special strategy i.e. predictive control for a special class of hybrid systems i.e. mixed logical dynamical systems. For mixed logical dynamical systems as a main class of hybrid systems, the only existing way to ensure the closed loop stability of predictive controllers is to use a terminal state equality constraint in the successive optimization problems. Limitations caused by this type of constraint have been discussed. Contractive predictive control is proposed as a good alternative which assures the closed loop stability in a more feasible manner. As a Lyapunov function, the L_1 norm of the state vector is enforced to shrink in successive optimization steps. A suboptimal version of contractive MPC scheme has been proposed which reduces the computational complexity of the control problem while preserving the stability.*
Keywords: Hybrid systems, Mixed logical dynamical systems, Computational complexity, Predictive control, Contractive control

1. **Introduction.** Hybrid systems theory involves the analysis of different event-driven/ time-driven dynamics within general frameworks. Several areas in mathematics, control theory and computer science motivate the researchers to study this class of systems [1]. The growing filed of hybrid systems has shown great capabilities in dealing with different real world engineering problems, among them are power electronics [2], communications [3], industrial control [4] and air traffic management [5].

A wide range of systems and phenomena could be covered in hybrid systems theory by different hybrid modeling frameworks like piece-wise affine systems [6], mixed-logical dynamical systems [7] and discrete hybrid automata [8]. In this paper we are involved in the mixed logical dynamical (MLD) systems as a main class of hybrid systems. The main contribution of this article is the introduction of a contractive predictive control approach for MLD systems which results in more general optimization problems with respect to the existing approaches. Also a suboptimal version of contractive control has been proposed to reduce the computational complexity of the optimization problems for MLD systems while still having guaranteed closed loop stability.