

Accepted Manuscript

Stabilization of Non-minimum Phase Switched Nonlinear Systems with the Concept of Multi-Diffeomorphism

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PII: S1007-5704(14)00558-9

DOI: <http://dx.doi.org/10.1016/j.cnsns.2014.11.018>

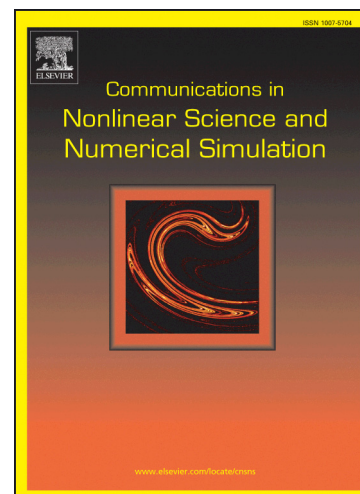
Reference: CNSNS 3424

To appear in: *Communications in Nonlinear Science and Numerical Simulation*

Received Date: 17 May 2014

Revised Date: 19 November 2014

Accepted Date: 24 November 2014



Please cite this article as: Jouili, K., Braïk, N.B.H., Stabilization of Non-minimum Phase Switched Nonlinear Systems with the Concept of Multi-Diffeomorphism, *Communications in Nonlinear Science and Numerical Simulation* (2014), doi: <http://dx.doi.org/10.1016/j.cnsns.2014.11.018>

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Abstract

In this paper we propose a control approach for the stabilization of a class of switched nonlinear systems where each mode may be non-minimum phase. The proposed approach is based on the exact input-output linearization and the Lyapunov stability theory. The main contribution in this work is to elaborate a strategy of switching that recourse to the concept of multi-diffeomorphism makes it possible to guarantee an improvement of the transient state compared to a feedback linearization based on one diffeomorphism. Specifically, we show the sufficient condition for the exponential stability and the exponential upper bound of the trajectory of the switched system. The theoretical results are applied to a non-minimum phase inverted cart-pendulum in order to illustrate the effectiveness of the proposed approach.

Keywords: Non-minimum Phase; Input–Output Feedback Linearization; Multi-diffeomorphism; Stabilization.

1. Introduction

In recent years, control design problem for nonlinear systems with zero dynamics has attracted much attention. If the zero dynamics of a system is asymptotically stable, the system is also called minimum phase. Thus, stabilizing a nonlinear non-minimum phase system is again a challenge. Zero dynamics play an important role in the areas of modeling, analysis, and synthesis of systems [1, 2]. Zero dynamics exist in many practical systems, such as flight control [3, 4], control of rigid robots by the so-called computed torque method [5, 6, 7], continuous stirred tank reactors (CSTR) control, aircraft trajectory tracking control and so on [8, 9 10]. Some contributions have also been devoted to non-minimum phase switched nonlinear systems where each nonlinear mode may be non-minimum phase [11, 12 13, 14, 15]. In [12], H_∞ control goal is achieved for a class of non-minimum phase cascade switched nonlinear systems where the internal dynamics of each mode is assumed to be asymptotically

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