Dynamics of Continuous, Discrete and Impulsive Systems
Series **A:** *Mathematical Analysis* **11 (2004)** 771-786

INPUT-OUTPUT BLOCK DECOUPLING OF AFFINE NONLINEAR SINGULAR SYSTEMS

Xiaoping LIU[1], Daniel W. C. Ho[2], and Xiaohua Wang[2]

[1]Department of Electrical Engineering
Lakehead University, Thunder Bay, ON P7B 5E1, Canada
xliu@mail1.lakeheadu.ca
[2] Department of Mathematics
City University of Hong Kong, 83 Tat Chee Ave. Hong Kong
madaniel@cityu.edu.hk

Abstract. The input-output block decoupling problem by state feedback is studied for affine nonlinear singular systems. First, an algorithm, named regularization algorithm, is recalled such that the system can have a unique impulse-free solution via a state feedback. Second, another algorithm, called block decoupling algorithm, is proposed, which provides necessary and sufficient conditions for the solvability of the input-output block decoupling problem. Then a decoupling feedback law is constructed such that the corresponding closed-loop system is regular, impulse-free, and noninteractive. Finally, an example is given to illustrate the applicability of the algorithms.
Keywords. Nonlinear singular system, input-output block decoupling, state feedback control.

1 Introduction

In this paper, the following affine nonlinear singular system is considered:

$$\begin{aligned} \dot{x} &= f_1(x) + p_1(x)z + g_1(x)u \\ 0 &= f_2(x) + p_2(x)z + g_2(x)u \\ y^i &= h^i(x) + d^i(x)z + l^i(x)u, \quad i = 1, ..., r \end{aligned} \tag{1}$$

defined in U, the neighborhood of x_0, where $x \in R^n$ is the vector of states, $z \in R^s$ is the vector of constraints, $u \in R^m$ is the vector of inputs, $y^i \in R^{r_i}$ is the vector of block outputs, $f_1(x)$, $p_1(x)$, $f_2(x)$, $p_2(x)$, $g_1(x)$, $g_2(x)$, $h^i(x)$, $d^i(x)$, and $l^i(x)$ are analytic matrices of dimensions $n \times 1$, $n \times s$, $s \times 1$, $s \times s$, $n \times m$, $s \times m$, $r_i \times 1$, $r_i \times s$, $r_i \times m$, respectively.

The system in the form of (1) represents a class of nonlinear singular system which also includes the special cases of linear singular systems [3],[4]. The class in (1) describes a large number of physical systems of interest in many engineering applications. We encounter many examples of physical control systems that can be modeled by equations of the form (1). For