State-Shared Model for Multi-Input Multi-Output Systems

Zhenhua Tian and Karlene A. Hoo*
Department of Chemical Engineering
Texas Tech University, Lubbock, TX
Submitted : IEEE Transactions Control Systems Technology

December 28, 2002

Abstract

This work proposes a method to construct a state-shared model for multiple-input multiple-output (MIMO) systems. A state-shared model is defined as a linear time invariant state-space structure that is driven by measurement signals - the plant outputs and the manipulated variables, but shared by different multiple input/output models. The genesis of the state-shared model is based on a particular reduced non-minimal realization. Any such realization necessarily fulfills the requirement that the output of the state-shared model be an asymptotically correct estimate of the output of the plant, if the process model was selected appropriately. The approach is demonstrated on two nonlinear MIMO systems – a nonlinear fundamental model of a chemical reactor system and a physiological model of calcium fluxes that controls muscle contraction and relaxation in cardiac myocytes.

Keywords: Adaptive identifier, reduced-order model, multiple models, biological cell, myocyte, nonlinear reactor

1 Introduction

There are at least three important issues to be considered in system identification. The first is the form of the identifier, the second is uniqueness of the identified parameterization, and the third is parameter convergence. The form of the identifier is a modeling structure, including the parameters to be identified, such that each system, in the class of systems to be identified, corresponds to a set of parameters. Uniqueness means that for every system, the identified set of parameters is unique. Parameter convergence if not guaranteed, may not only result in a plant model that is not unique but also in identification failure.

Mathelin and Bodson [12] proposed an identifier form with the number of identifiable parameters, N_θ, for an m-input p-output multiple-input multiple-output (MIMO) system, equal to $(p+m)n$, where n is the order (McMillan degree [8]) of the minimal state space realization of the system.

*author to whom all inquires should be addressed, khoo@coe.ttu.edu