NEURO-FUZZY IDENTIFICATION OF NONLINEAR DYNAMIC MIMO SYSTEMS

Marek Štefan, Zbyněk Šika, Michael Valášek, Václav Bauma*

This paper deals with the identification of nonlinear dynamic systems by LOLIMOT algorithm, which allows to gradually build the neuro-fuzzy model of the identified system. The mathematical model as well as the identification algorithm for MISO and MIMO systems are described. The methodology is demonstrated on several examples.

Key words: *identification, MISO, MIMO, LOLIMOT*

1. Introduction

This paper presents the traditional MISO (multiple input single output) and also the modified MIMO (multiple input multiple output) LOLIMOT algorithm that allows the identification of dynamic nonlinear systems by gradually building of neuro-fuzzy model of the system. The MIMO variant of the algorithm iteratively builds one partitioning of the measured data region common to the LOLI-models of all system outputs. The outputs of the neuro-fuzzy models then differ in the parameters of the local linear models only.

Both identification algorithms have been implemented in Matlab and tested on several problems: a) double-pendulum system, b) combustion engine control, and c) vehicle suspension force.

2. Neuro-fuzzy model for identification

We are certainly interested in the nonlinear dynamic systems, but for the sake of simplicity, we concentrate on the static systems first. Nonlinear static system is represented by the vector function $\mathbf{y} = (y_1, y_2, \dots) = \mathbf{y}(\mathbf{u})$ of the vector variable $\mathbf{u} = \mathbf{u}(u_1, u_2, \dots)$. Let's, for the moment, consider only one scalar component y_r of such vector function $\mathbf{y}$ and denote it simply as y omitting the relevant index.

2.1. Mathematical model of the system

The basic idea of the neuro-fuzzy model** of a scalar function is the approximation of generally nonlinear function output $\mathbf{y}(\mathbf{u})$ by the scalar product of the vector of linear functions $\widehat{y}_i(\mathbf{u})$ and the vector of validity functions $\Phi_i(\mathbf{u})$, i.e.

$$\widehat{y} = \sum_{i=1}^{M} \widehat{y}_i \, \Phi_i(\mathbf{u}) = \sum_{i=1}^{M} (w_{i0} + w_{i1}\, u_1 + w_{i2}\, u_2 + \dots + w_{ip}\, u_p)\, \Phi_i(\mathbf{u}) \tag{1}$$

* M. Štefan, Z. Šika, M. Valášek, V. Bauma, Department of Mechanics, Faculty of Mechanical Engineering, Czech Technical University in Prague, Czech Republic

** By authors, often refered to as 'LOLI-model'.