International Journal of Innovative
Computing, Information and Control
Volume **7**, Number **3**, March **2011**

 ISSN 1349-4198
pp. 1133–1144

ENCODING PRIOR KNOWLEDGE INTO DATA DRIVEN DESIGN OF INTERVAL TYPE-2 FUZZY LOGIC SYSTEMS

Chengdong Li[1,2], Jianqiang Yi[2] and Tiechao Wang[2]

[1]School of Information and Electrical Engineering
Shandong Jianzhu University
Fengming Road, Lingang Development Zone, Jinan 250101, P. R. China
chengdong.li@ia.ac.cn

[2]Institute of Automation
Chinese Academy of Sciences
Beijing 100190, P. R. China

Received November 2009; revised March 2010

Abstract. *In system identification or modeling problems, interval type-2 fuzzy logic systems (IT2FLSs), which have obvious advantages for handling different sources of uncertainties, are usually constructed only using the information from sample data. This paper tries to utilize the information from both sample data and prior knowledge to design IT2FLSs to compensate the insufficiency of the information from single knowledge source. First, sufficient conditions on the antecedent and consequent parameters of IT2FLSs are given to ensure that the prior knowledge can be incorporated into IT2FLSs and three kinds of prior knowledge – bounded range, symmetry (odd and even) and monotonicity (increasing and decreasing) – are explored. Then, design of IT2FLSs using the information from both sample data and prior knowledge is transformed to the constrained least squares optimization problem. At last, to show the superiority of the proposed method, simulations and comparisons are made.*

Keywords: Information fusion, Type-2 fuzzy, Least squares algorithm, Prior knowledge

1. **Introduction.** Recently, a number of extensions to classical fuzzy logic systems (type-1 fuzzy logic systems: T1FLSs) have been attracting interest. One of the most widely used extensions is the interval type-2 fuzzy logic system (IT2FLS) [1-10]. IT2FLSs have obvious advantages for handling different sources of uncertainties, reducing the number of fuzzy rules and weakening noisy disturbance, etc., as IT2FLSs utilize interval type-2 fuzzy sets (IT2FSs) which can provide additional degrees of freedom and have more parameters than type-1 fuzzy sets (T1FSs) in T1FLSs [1,2,6]. Due to these merits, IT2FLSs have found lots of applications, for example, time-series forecasting [2], control of autonomous mobile robots [3] and direct model reference control [8].

Until now, IT2FLSs are always constructed only using the information from the single knowledge source – sample data (training data). Sometimes, satisfactory performance of IT2FLSs can be achieved using this data-driven design method, but, in general, only sample data is not enough to provide sufficient information for system identification, especially when the sample data is not informative enough or is noisy.

One way to compensate this weakness is to incorporate prior knowledge into IT2FLSs. Although, in most cases, it is hard to obtain exact physical structure knowledge of some complex systems, part of their physical properties can be observed easily, such as monotonicity, bounded range, symmetry, etc. Such prior knowledge can partly reflect the characteristics of the unknown systems and compensate the insufficiency of the information from sample data. Recently, this topic has gained considerable concern from different