International Journal of Innovative
Computing, Information and Control
Volume **6**, Number **12**, December **2010**

 ISSN 1349-4198
pp. 5709–5723

A TIME-VARYING FUZZY SETS AS FUNCTIONS OF THE ERROR

Ziani Salim[1], Filali Salim[1] and Yunfu Huo[2]

[1]Laboratory of Automatic and Robotic L.A.R.C.
University of Mentouri
Constantine 25000, Algeria
zianide_s@yahoo.fr; safilali@hotmail.com

[2]Institute of E-Commerce and Logistics
Dalian University
Dalian 116622, P. R. China
huoyunfu@dlu.edu.cn

Received July 2009; revised December 2009

Abstract. *This paper presents a robust fuzzy controller for nonlinear and uncertain system in continuous time described by the T-S fuzzy model. In this approach we used a PDC fuzzy controller built on the time-Varying Fuzzy Sets (VFS) based on a function depending on the error which characterizes the movement of the midpoint of the universe to the left or to the right. To achieve this objective, we use a decay rate controller and relaxed stability conditions for a nonlinear system.*
Keywords: Fuzzy sets, Membership function, Fuzzy system, PDC fuzzy controller, LMI

1. **Introduction.** Recently, fuzzy control has emerged as one of the most important control technique for nonlinear and uncertain systems. The interest of the Takagi-Sugeno (T-S) [1] model lies in that the stability and performance characteristics of the system represented by a T-S model can be analyzed using a Lyapunov function approach. It achieved great success in its application to many systems in the real world [2-4]. The so-called Parallel Distributed Compensation, PDC [1,5] is a control design framework that has been proposed and developed over the last few years. The PDC control structure [1,5] utilizes a nonlinear state feedback controller which mirrors the structure of the associated T-S model. The stability analysis is based on the quadratic Lyapunov function [6,7]. The main interest of this function is that finding a common matrix and the gains for state feedback which are easy to implement that can be expressed as a convex optimization problem in LMI formalism [7-9].

Fuzzy controller's design depends mainly on the rule base and membership functions; these rules are based on fuzzy sets which contain the linguistic elements which characterize the functioning of the industrial process. In reality, we cannot exactly evaluate the length of an element of fuzzy sets. If we talk about these linguistics variables like the temperature is {'HOT', 'COLD'}, the speed is {'SMALL', 'BIG'}, the device is {'FAR', 'NEAR'}, or the level water {'EMPTY', 'FULL'} ..., all these linguistics values of fuzzy sets do not have a numeric range well-defined, during all the time and they depend on operations of industrial process. In general, we approximate the linguistics values of fuzzy sets by a proper numeric range, or the membership functions are fixed during the computation time called the fixed fuzzy sets (FFS). Conventionally, this type of fuzzy sets is called as type-1 fuzzy sets and type-2 fuzzy sets is a set in which we also have uncertainty about the membership function [10,11].