International Journal of Innovative
Computing, Information and Control
Volume 4, Number 4, April 2008
 ISSN 1349-4198
pp. 771–783

INTELLIGENT SYSTEMS WITH INTERVAL TYPE-2 FUZZY LOGIC

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Received February 2007; revised August 2007

Abstract. *Uncertainty is an inherent part of intelligent systems used in real-world applications. The use of new methods for handling incomplete information is of fundamental importance. Type-1 fuzzy sets used in conventional fuzzy systems cannot fully handle the uncertainties that are present in intelligent systems. Type-2 fuzzy sets that are used in type-2 fuzzy systems can handle such uncertainties in a better way because they provide us with more parameters. This paper deals with the design of intelligent systems using interval type-2 fuzzy logic for minimizing the effects of uncertainty produced by the instrumentation elements, environmental noise and other external disturbances.*
Keywords: Intelligent control, Type-2 fuzzy logic, Interval fuzzy logic, Hybrid intelligent systems

1. **Introduction.** Uncertainty affects decision-making and appears in a number of different forms. The concept of information is fully connected with the concept of uncertainty. The most fundamental aspect of this connection is that the uncertainty involved in any problem-solving situation is a result of some information deficiency, which may be incomplete, imprecise, fragmentary, not fully reliable, vague, contradictory, or deficient in some other way. Uncertainty is an attribute of information [1]. The general framework of fuzzy reasoning allows handling much of this uncertainty, fuzzy systems employ type-1 fuzzy sets, which represent uncertainty by numbers in the range $[0, 1]$. When something is uncertain, like a measurement, it is difficult to determine its exact value, and of course type-1 fuzzy sets make more sense than using sets [2]. However, it is not reasonable to use an accurate membership function for something uncertain, so in this case what we need is another type of fuzzy sets, those which are able to handle these uncertainties, the so called type-2 fuzzy sets [3,4]. So, the amount of uncertainty in a system can be reduced by using type-2 fuzzy logic because it offers better capabilities to handle linguistic uncertainties by modeling vagueness and unreliability of information [5,6].

Recently, we have seen the use of type-2 fuzzy sets in Fuzzy Logic Systems (FLS) in different areas of application. A novel approach for realizing the vision of ambient intelligence in ubiquitous computing environments (UCEs), is based on intelligent agents that use type-2 fuzzy systems which are able to handle the different sources of uncertainty in UCEs to give a good response [7]. There are also papers with emphasis on the implementation of type-2 FLS [8] and in others, it is explained how type-2 fuzzy sets let us model the effects of uncertainties in rule-base FLS [9]. In industry, type-2 fuzzy logic and neural networks was used in the control of non-linear dynamic plants [10,11]; also we can find studies in the field of mobile robots [12,13]. In this paper we deal with the application of interval type-2 fuzzy control to non-linear dynamic systems. It is a well known fact, that in the control of real systems, the instrumentation elements (instrumentation amplifier,