Summary

INTRODUCTION

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Contrary to the linear automatic, nonlinear automatic has no universal solutions neither for analyzing systems nor designing their controllers. Analysis and control of these systems are not always easy tasks .Most non-linear control approaches require the availability of a mathematical model of the system. The performance will be insured directly related to the accuracy of the model. To solve these problems, the use of controllers based on human expertise can be an alternative. They have the advantage of tolerating model uncertainty and compensate its effect. Among these approaches, we find the fuzzy logic control which allows the control of systems available linguistic information which can carry both on the model the [1], [2]. Uncertainties and nonlinearities overlooked in the mathematical modeling of the process can also be compensated by the fuzzy controller [3], [4]. These controllers have been very successful and have become a dominant issue in the research of intelligent systems [5], [6], [7], [8], [9].

The advantage of fuzzy logic is its ability to process and manipulate imprecise, uncertain and vague information. Its capacity is derived from the ability of human beings to decide a relevant way despite the fuzzy nature of the available knowledge. Indeed, the human operator can set of linguistically control strategies with a minimum of knowledge about the process. Fuzzy logic translates this strategy into a set of rules of the form "If 'Observation' Then 'Decision' " where "If 'Premise' Then 'Conclusion' ', which can be used for system identification and for orders.

The first use of the fuzzy logic in control appeared in the 70s by Mamdani [10]. He developed a type of fuzzy controllers where the conclusion part is symbolic. This type of controllers has two major drawbacks. The first is the time constraint, because the calculation of the aggregation rules and defuzzification can be discriminatory in the case of the control of power systems. The use of such a controller is advised only for slow systems or for which the calculation time is not a predominant parameter. The second disadvantage, at least from a purely theoretical point of view, is the heuristic implementation, not taking into account any criteria of stability or robustness of the control theory.

A second type of fuzzy controllers has been developed in the 80s by Takagi and Sugeno [11], [12]. These controllers, whose rules findings are functional, are in exact analytical form and compatible with automatic tools. Therefore, they can be considered as a special class of nonlinear controllers. Due to their structure they lend themselves well to the study of the stability and robustness.

Type-1 fuzzy logic control (T1FLC), using linguistic information, possesses several advantages such as robustness, model-free, universal approximation theorem and rule-based algorithm [13, 14]. The T1FLC -which include fuzzifier, rules, inference engine, and defuzzifier- have been successfully used in various applications, for which the processes of analyses are too complex by conventional mathematical techniques.

The T1FLCs proposed in [13, 14] -whose membership functions are type-1 fuzzy sets- are unable to directly handle the rule uncertainties. To solve this problem, the concept of type-2 fuzzy set was initially proposed as an extension oftype-1 fuzzy set by Prof. Zadeh [15]. Similar to type-1 fuzzy systems, the type-2 fuzzy systems include fuzzifier, rule base, fuzzy inference engine, and output processor.

The output processor includes type-reducer and defuzzifier; it generates a type-1 fuzzy set output (from the type-reducer) or a crisp number (from the defuzzifier). Type-reduction methods are extended versions of type-1 defuzzification methods. Type reduction captures more information about rule uncertainties than the defuzzified value (a crisp number) does [16]. Thetype-2 fuzzy system is characterized by a fuzzy membership function, i.e., the membership value (or membership grade) for each element of this set is a fuzzy set in [0,1], unlike a type-1 fuzzy set where the membership grade is a crisp number in [0,1]. Such sets are very useful in circumstances where they are difficult to determine an exact membership function for a fuzzy set; hence, they are useful for incorporating uncertainties [17].

Recently, some researches are interested in type-2 fuzzy logic controller (T2FLC) to solve the control problem [18, 19]. It shows that the T2FLC can handle rule uncertainties when the operation is extremely uncertain and/or the engineers cannot exactly determine the membership grades.

Several architectures of fuzzy controllers have been developed in the literature involving one or more fuzzy systems according to the desired performance [20], [21], [22], [23]. The majority of applications during the past two decades belong to the class of fuzzy PID controllers [21], [23][24].

The use of fuzzy controllers for controlling static converters allows to have better performance in the case of DC-DC converters. The fuzzy control of DC-DC converters has been implemented successfully at a low cost [25].

In this thesis our objective is to design a type-2 fuzzy logic PID controller for a DC-DC Boost converter and to compare its results to those obtained by a type-1 a fuzzy logic PID controller using the same structure and under the same functioning conditions. This choice is motivated by the fact to take into account the different uncertainties of the controlled system.