

Design of Temperature Control Simulation System with FPGA

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Abstract — This paper describes FPGA implementation of a Fuzzy Logic Controller (FLC) using VHDL for temperature control (FTC). This paper describes the implementation for a basic fuzzy logic controller in Very High speed integrated-circuit Hardware-Description Language (VHDL). It is not intended as an introduction to fuzzy logic control methodology; instead, we try to demonstrate the implementation of a fuzzy logic Programmable Gate Array (FPGA). The main advantages of using the HDL approach are rapid prototyping, and allowing usage of powerful synthesis controller through the use of the VHDL code. Use of the hardware description language (HDL) in the application is suitable for being implemented into an Application Specific Integrated Circuit (ASIC) and Field tools such as Xilinx ISE. The system is built up with major modules namely fuzzification, inference, implication and defuzzification. The VHDL code is downloaded into FPGA board of SPARTAN

Index Terms FLC, FTC, Fuzzification implication, defuzzification controller, Fuzzy, Synthesis, FPGA

1. INTRODUCTION

An effective and efficient controller for the surrounding environment is crucial in many technical processes. Ranging from IC fabrication to the production of chemical solutions, any changes in the ambient parameters can have a drastic effect in the outcome of a process, at the very least lowering the yield or quality of the product. Among the crucial parameters that merits close supervision is the temperature of the environment. As such, temperature controller is critical to the quality, appearance and consumer acceptance of a manufacturer's products.

The processes that requires temperature controller has various unfavorable characteristics including non-linearity, dead zone time, external disturbances and so on. Conventional approximations do not produce satisfactory temperature controls for controlling complex processes, which is usually the case in the industry because they suffer from various drawbacks such as slow stabilization, overshooting and overall slow response and reduces the steady-state error

The Fuzzy Logic Controller (FLC) is also able to bring the A fuzzy system improves the relative performance of a temperature control process with respect to the conventional scheme. It compensates non-linear errors, accelerates temperature constant at the desired value regardless of changes in the load or environment. This project attempts to enable a fuzzy-based control of the temperature employing VHDL as a mean of improving upon conventional methods.

Several works had been done in this area. Zhiqiang et al. [9] had developed a closed loop control system incorporating fuzzy logic for a class of industrial temperature control problems employing a unique FLC structure with an efficient realization and a small rule. Their works demonstrated in both software simulation and hardware test in an industrial setting that the fuzzy logic control is much more capable than the current temperature controllers. This includes compensating for thermo mass changes in the system, dealing with unknown and variable delays and operating at very different temperature set points without retuning. Thyagarajan *et al.* in [3] presented four control schemes designed using advanced techniques for regulating the temperature of the Air Heat Plant. The four control schemes are namely, PID, fuzzy logic control, FLC using genetic algorithms (FLC-GA) and Neuro-Fuzzy control (NFC). All these schemes are evaluated with respect to set-point tracking using performance indices. Their works to design a fuzzy logic temperature controller with FPGA. The FLTC is able to bring the temperature constant at the desired value regardless of changes in the load or environment.