ABSTRACT

This thesis describes the application of some new control strategies, e.g. fuzzy logic control (FLC) with evolutionary programming (EP) and adaptive inverse control (AIC) with recursive least square (RLS) algorithm. Moreover, their results are compared with the traditional approach, proportional-integral-derivative (PID), in controlling dynamic response, and the complexity of design and implementation.

An auto-ignition gas water heating system is selected as the common case-study for control. This system is time-variant since its dynamics response will be changing according to the water flow, and it is non-linear because of the inherent nonlinearity of the gas-valve mechanism. The main objective in this work is to apply the presented control methodologies in controlling the temperature at the output of a gas water heater.

The approaches mentioned above will be simulated in the environment of Simulink® that is a visualization simulation toolbox executed in Matlab®. Some specific-purpose toolboxes, such as signal processing toolbox, nonlinear control toolbox, fuzzy logic toolbox, DSP blockset toolbox, etc, are used for simulating different control approaches. On the other hand, the real performance of fuzzy logic control is investigated on the implemented by construct an 8-bit digital controller.

FLC design is both fast and robust, and provides enough degrees of freedom and can be constructed according to its heuristic approach. However, this sometimes leads to some difficulties in optimizing the performance of the system since there is no direct relationship of the output variable behaviour with the parameters of FLC. Therefore we integrated it with another advance intelligence technology, evolutionary programming, in order to tune the fuzzy logic controller. Very good results were obtained and are presented.

AIC was developed only 20 years ago. It is based on the theory of adaptive control and combined with the technology of adaptive filters. In this thesis, a causal finite-impulse response (FIR) adaptive inverse controller is presented. Its simulation results show the good performance in the plant dynamics control, even for the time-variant system.

As we know, PID control is not suitable in controlling time-variant systems, but the FLC control and AIC are. In design process, AIC is a little simpler than FLC because even the characteristic of the plant is not required to know. However, it will have greater complexity in implementation.