PDF - DESIGN AND CONSTRUCTION OF A SPEED CONTROL OF A DC FAN USING A FUZZY CONTROLLER - researchcub.infoCHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

Temperature Control cuts through a variety of Industrial and domestic processes such as temperature controlled heat exchangers, baths, green houses, incubators. A DC motor may be used as Fan in accomplishing temperature control. An Electric Fan is basically a device which comprises of three blades at 120 degrees mounted on the DC motor spindle.An electric fan circulates the air around its environment while an air-conditioning system changes the temperature of the air in it environment. Many system used in our daily life which require controlling are non-linear in nature; hence, a detailed system dynamics is difficult to represent mathematically. Temperature control is stochastic and a slowly changing process which requires heuristic based control. Many authors have proposed Fuzzy Logic Inference System in dealing with temperature control. In households during summer which is analogous to dry season in West Africa, Air conditioners are responsible for 60-70% of summer electricity bill. A window air-conditioning unit uses 500 to 1440 watts,while a 2.5-ton central system uses 3500 watts .However, an electric fan uses only 90 watts, depending upon the speed and size (Ali Newaz Bahar et al, 2012). An electric fan is a device that on the long run will on the one hand help in keeping us cool in summer and on the other hand help in saving money as well as protecting the environment by limiting the release of Carbon-monoxide (Lakshya Kumar et al, 2015).

In this project, a Fuzzy logic controller design is proposed for deployment of the process variable due to the fact that temperature is a slowly changing variable. Hence, for precision control of a stochastic process variable Fuzzy logic based control suffices. While all the regularly used systems are defined by mathematical equations. The temperature of the metal plate decides the amount of current that can pass through it. Temperature of the metal plate is measured with the help of temperature sensors (Lakshya Kumar et al, 2015). The amount of energy supplied to the fan is to be controlled by SVM or PWM technique.

The human brain has an unpredictable way of reasoning and thus has a high adaptive approach with recourse to control. It does not reason as computers do. Computers reason in a clear statement that uses true or false (0 or 1) - an element is either a number of a given set or it is not. There are many complex systems which do not fit into the precise categories of conventional set theory. This is because of the fact that there is no way to define a precise threshold to represent their complex boundary, and as such their control system is complex. Fuzzy logic was developed owing to this imprecise nature of solving control problems by computer. In a fuzzy logic-based system, a variable can take any truth value from a close set [0, 1] of real numbers thus generalizing Boolean truth values [1]. But the fuzzy facts are true only to some degrees between 0 and 1, and they are false to some degrees (Isizoh A. N., et al, 2012). The Fuzzy inference is based on Human heuristic reasoning pattern. But computers cannot do so because its logic is based on approximate reasoning in a more familiar Boolean forms of logic used in conventional set theory. Fuzzy logic allows the use of labels like “slightly”, “moderately”, medium, and “very” so that statements may be made with varying degree of precision. This flexibility is useful in coping with the imprecision of real-world situations such as designing precision environmental control systems. In a broad sense, fuzzy logic refers to fuzzy sets - a set with non-sharp boundaries. Fuzzy logic is widely used in machine controls, as it allows for a generalization of conventional logic and provides for

terms between “true” and “false”, like “almost true” or partially false”. This makes the logic not to be directly processed on computers but must be emulated by special codes. A fuzzy logic based design control system offers flexibility in system design and implementation, since its implementation uses “if then” logic instead of sophisticated differential equations. It’s technology that provides room for graphical user interface, which makes it understandable by people who do not have process control backgrounds. Another key significance of a fuzzy logic-based control design is the ability to automatically and smoothly adjust the priorities of a number of controlled variables. Finally, it helps to achieve a process that is stable for a long period of time without a need for intervention. However, because of the rule-based operation of fuzzy systems, any reasonable number of inputs can be processed and numerous outputs generated; although defining the rule-base quickly becomes complex if too many inputs and outputs are chosen for a single implementation, since rules defining their inter-relations must also be defined. There are countless applications of fuzzy logic. In fact many researchers still claim that fuzzy logic is an encompassing theory over all types of logic .Fuzzy logic can control non-linear systems that would be difficult or impossible to model mathematically. This opens door for control system that would normally be deemed unfeasible for automation. There are many approaches to implement fuzzy logic systems; they can be software only, hardware only or the combination of software and hardware. In recent years, fuzzy logic has been implemented using several technologies to solve real world problems such as image processing, robotics/motion control, pattern recognition, fuzzy database and industrial engineering applications. Fuzzy logic is also spreading applications in the field of telecommunications, particularly in broad band integrated networks, based on ATM Technology.

1.2 STATEMENT OF PROBLEM

The control modes used varies like ON/OFF control, the linear predictive control (LPC) and PID control system.

The ON/OFF system regulator is not accurate enough. This control mode is the simplest form of control Low accuracy and quality leads the system to become unstable due to mismatch error generated by inaccurate time delay parameter used in the model. Transient and overshoot are present when the controller is used to control the cooling system because it exceeded the required control for certain period.

Figure 1: Block diagram of a ON/OFF system for temperature control system

The linear predictive control, is capable of controlling the indoor temperature within the required limits most of the time but not all the time, the linear predictive control in the relative short prediction periods are used which do not cause any problem, but it is obvious that with larger prediction periods more computing time is necessary and the linear programming problems require more memory.

Figure 2: optimal predictive control system for temperature control

The proportional integral derivative (PID) controller structure is mostly widely used thanks to its structural simplicity and applicability in solving practical control problems but is not however almighty in many cases, it provide disturbance ,this disturbance is unknown ,making it difficult to attenuate.

Figure 3: Block diagram of a PID controller

Traditional proportional integral derivative (PID) controller sometimes doesn’t satisfy the control purpose for the object which has larger inertia delays and non- linear characteristics and uncertain disturbances factor like the tall and big space, because of the dissatisfaction of the tuning parameter, the effect of dissatisfying performance and the adaptability to different medium.

But the used PD controller is better than PID control because the strictly limit and the overshoot and easy deals gives us good result than PID control.

So in this project we choose to use fuzzy logic control (FLC) because the fuzzy logic control provides a good performance without transient and overshoot and the use of appropriate automatic control strategies such as fuzzy control system is based on the operational experience of human expert, the system is robust to changes in environment.

Figure 4: Block diagram of fuzzy logic controller

The main advantage of fuzzy logic controller as compared to conventional control approaches resides in the fact that no mathematical modeling is required for the design of the controller. Fuzzy controllers are designed on the basis of the human knowledge of the system behavior.in addition the controllers that directly regulate humans thermal comfort have advantages over the thermostatic controller. The main advantages are increased comfort and energy saving.

1.3 AIM AND OBJECTIVES OF WORK

The aim of the project is to control the speed of a DC fan using a fuzzy controller based on variation in temperature, to achieve good response during changes in load demand, self- tuning fuzzy controller is designed to reduce overshoot, undershoot during command speed variations and transient.

The objectives of this project are:

- To develop a cooling ventilation system integrated with speed controller based on temperature sensor.
- To improve the cooling system in room using fan rather than using air conditioner associated with sustainability and environmental friendly using fuzzy control logic
- To design a controller using MAT-LAB Fuzzy Logic tool box
- To evaluate the performance of the controller for both the experimental and Simulated model

1.4 SIGNIFICANT OF WORK

The needs for the design of an automatic room temperature control fan are as follows:

- It helps in controlling fluctuating room temperature by adjusting Fan to achieve the desired set point.
- It eliminates the need for human intervention as opposed to constant watching on the device by set controlling the temperature of the system
- It overcomes the disadvantages of thermostatic analogue system in terms of accuracy.
- It is used where it is important to maintain precise temperature.
- It overcome the limitation of conventional control that how to be operated by physically going near them and switch on the button.
- The designed controller may be deployed for other slowly changing controlled process variable.

1.5 SCOPE OF WORK

The project scopes relates to

- Development of model house included the dimension and high ceiling using solid work
- Design and Construction of the Prototype
- Simulation of the process using MAT LAB AND PROTEUS
- Microcontroller programing of Fuzzy logic Inference
- Construction and Soldering of the Temperature Control Circuitry (e.g Power Supply based SVM or PWM).

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