DEVELOPMENT OF FUZZY LOGIC TEMPERATURE MICROCONTROLLER

MUHAMMAD FARHAN BIN ABDUL LATIP

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ABSTRACT

In this study, temperature of a closed environment is kept constant by a PIC16F877A. An acrylic container, dimension of 20*20*30 cm is aimed to be cooled by fuzzy logic methods. The microcontroller holds the fuzzy control process. The temperature data is acquired from LM35DZ temperature sensor and the control output determines speed of a 12V fan by means of Pulse Width Modulator (PWM). The heat control system will be used to cool a highly sensitive measurement device. The container is heated by a resistance and heat of the inner environment is increased depending on the outer environment. The microcontroller acquires the temperature data and its control output adjusts the cooling rate of the fan decreasing heat of the inner environment down to the outer conditions. The control system will be used to eliminate the self heating effect of resistors of a measurement device which increases uncertainties in the measurement.

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ABSTRAK

Dalam kajian ini, suhu persekitaran tertutup dikawal oleh PIC16F877A. Sebuah bekas akrilik berdimensi 20*20*30 cm bertujuan untuk disejukkan menggunakan kaedah logik fuzzy. Mikropengawal ini mempunyai proses kawalan fuzzy. Data suhu diperolehi daripada pengesan suhu LM35DZ dan keluaran kawalan menentukan kelajuan kipas 12V dengan menggunakan pemodulat lebar denyut (PWM). Sistem kawalan kepanasan akan digunakan untuk menyejukkan peranti pengukur yang sangat sensitif. Bekas dipanaskan oleh kerintangan dan suhu pada persekiran di dalam bekas meningkat bergantung pada persekitaran di luar bekas. Mikropengawal memerlukan data suhu, dan keluaran kawalannya akan mengubah kadar penyejukan daripada kipas untuk menurunkan suhu persekitaran di dalam bekas sama seperti suhu persekitaran di luar bekas. Sistem kawalan ini akan digunakan untuk menghilangkan kesan pemanasan diri daripada perintang pada peranti pengukur dimana ianya akan meningkatkan ketidak pastian dalam pengukuran.

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LIST OF ABBREVIATIONS

OTP ROM	-	One-time Programmable Read Only Memory
ALGOL	-	Algorithmic Language
PC	-	Personal Computer
IC	-	Integrated Circuit
PIC	-	Programmable Integrated Circuit
PWM	-	Pulse Width Modulator
PID	-	Proportional Integral Derivative
FLC	-	Fuzzy Logic Control
DOF	-	Degree of Fulfillment
A/D	-	Analog to Digital
LCD	-	Liquid Crystal Display
IDE	-	Integrated Development Environment
DC	-	Direct Current

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RISC	-	Reduce Instruction Set Computer
RAM	-	Random Access Memory
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
BOR	-	Brown-Out Reset
CMOS	-	Complementary Metal Oxide Semiconductor
OCG	-	Omniscient Code Generation
PPM	-	Parts Per Million

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CHAPTER 1

INTRODUCTION

Nowadays, a technology becomes an essential in our life. Without technology, human's tasks are functionless especially in communication and learning process. Human activities are mostly including PC, hand phone, internet, television and others. Some of it will produce heat when used it. The heat capable to damage the inner components of the product that is sensitive to heat such as IC, transistor and capacitor. Sometimes when the heat is too high, it will reduce the work effectiveness of the device used. As a result, this project is proposed. This temperature microcontroller can be implemented to the room or gadget in reducing surrounding's temperature thus prevent the heat sensitive components from damage indirectly.

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In this project, temperature of a closed environment is kept constant by a PIC16F877A. The microcontroller holds the fuzzy control process. The temperature data is acquired from LM35 temperature sensor and the control output determines speed of 220V AC fan by means of PWM and a triac triggering circuits. The heat control system will be used to cool a highly sensitive measurement devise. This project consists of four parts which is the heat control system, output layer, control method, and control program [1].

An acrylic container is aimed to be cooled by a Fuzzy control method. The container is heated by a resistance and heat of the inner environment is increased depending on the outer environment. The microcontroller acquires the temperature data and its control output adjusts the cooling rate of the fan in order to decrease heat of the inner environment down to the outer condition. The control system will be used to eliminate the self-heating effect of the resistors of the measurement device which increases uncertainties in the measurement.

1.1 Objectives of Project

1. To develop programming code of fuzzy logic temperature control system.
2. To design the hardware that have been required for fuzzy logic temperature microcontroller using PIC 16F877A.
3. To implement the programming to the output device.
4. To integrate software and hardware and make it well function.

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1.2 Project's Scope of Work

This project will focus primarily on the several concepts of programming and electronic engineering such as calibration and function of the sensor, programming and microcontroller for the operation of the system besides in setting the quantity of measurement which will be corresponding to the temperature. For programming, it is totally focuings in coding a PIC 16F877A. In addition, hardware and software will be integrated and will be tested the functionality.

1.3 Organization

The organization of this report is as follow:

- **Chapter 1**

  Introduction – It is about an introduction of the project, objectives, and scope of works.

- **Chapter 2**

  Literature review – It is mainly explain the concept of the project in details. It is also include the review of several projects that have been made by researchers from other university. With this, we are able to compare and differentiate our project with others especially related to the control approach in developing the temperature microcontroller.

- **Chapter 3**

  Methodology – It is included with block diagram and the system overview.

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- **Chapter 4**

  Results – It will cover all the result of testing, hardware construction and software development for this project.

- **Chapter 5**

  Conclusions and recommendations – It concludes the overall project that has been done for this semester and recommend for future upgrade.

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CHAPTER 2

LITERATURE REVIEW

Lots of research by reading the journal, article from the internet and also books in order to give some illustration on how the fuzzy logic application works with the microprocessor. Fuzzy logic is a form of multi-valued logic derived from fuzzy set theory to deal with reasoning that is approximate rather than precise [2]. In contrast with binary sets having binary logic, also known as crisp logic, the fuzzy logic variables may have a membership value of not only 0 or 1. Just as in fuzzy set theory with fuzzy logic the set membership values can range between 0 and 1, in fuzzy logic the degree of truth of a statement can range between 0 and 1 and is not constrained to the two truth values, true (1) and false (0), as in classic propositional logic.

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2.1 Fuzzy Logic Essentials

2.1.1 Benefits of Fuzzy Logic

Fuzzy logic is a technique that attempts to systematically and mathematically emulate human reasoning and decision-making. Fuzzy logic allows engineers to exploit their empirical knowledge and heuristics represented in the “if/then” rules and transfer it to a function block. Fuzzy logic thus provides engineers with a clear and intuitive way to implement control systems, decision-making and diagnostic systems in various branches of industry [3]. Fuzzy logic algorithms can be used for advanced applications in industrial automation such as:

- Intelligent control system

  Fuzzy control solutions are especially useful for complex systems where standard means such as PID control fails. Fuzzy logic can be an advantage in cases where an explicit analytical-process model is not available or is too complex. Another advantage of fuzzy logic is that it can be easily combined with conventional controllers and substantially enhance their functionality. For example, fuzzy rules interpolate between a series of locally linear controllers and schedule gains of a PID controller based on changing operating conditions. So fuzzy rules do not have to necessarily replace conventional control methods, but rather extend their capabilities.

- Process diagnostics, fault detection

  If an analytical process model is not available or is too complex to be run in real-time, empirical knowledge can be used to classify process conditions and early detect faults.

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- Decision-making and expert systems

  Fuzzy rules can emulate an experienced human operator in real time, for example select appropriate ingredients, components or machines according to specific situations in the manufacturing process.

2.1.2 Degree of Truth

Both degrees of truth and probabilities range between 0 and 1 and hence may seem similar at first. However, they are distinct conceptually; truth represents membership in vaguely defined sets, not likelihood of some event or condition as in probability theory. For example, let a 100 ml glass contain 30 ml of water. Then we may consider two concepts: Empty and Full. The meaning of each of them can be represented by a certain fuzzy set. Then one might define the glass as being 0.7 empty and 0.3 full. Note that the concept of emptiness would be subjective and thus would depend on the observer or designer. Another designer might equally well design a set membership function where the glass would be considered full for all values down to 50 ml. It is essential to realize that fuzzy logic uses truth degrees as a mathematical model of the vagueness phenomenon while probability is a mathematical model of randomness.

A probabilistic setting would first define a scalar variable for the fullness of the glass, and second, conditional distributions describing the probability that someone would call the glass full given a specific fullness level. This model, however, has no sense without accepting occurrence of some event, for example that after a few minutes, the glass will be half empty. Note that the conditioning can be achieved by having a specific observer that randomly selects the label for the glass, a distribution over deterministic observers, or both. Consequently, probability has nothing in common with fuzziness, these are simply different concepts which superficially seem similar because of using the same interval of real numbers [0, 1].

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