SIMULATION ON AIR CONDITIONING USING FUZZY LOGIC

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SUPERVISOR'S DECLARATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Computer Science (Computer Graphic and Multimedia Technology)."

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DECLARATION

I declare that this thesis entitled “Simulation on Air Conditioner Using Fuzzy Logic” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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DEDICATION

First of all,
I would like to dedicate this dissertation to my family, especially my parents,
Mustafa Kamal B. Abd. Wahab and
the only mom that I have,
Sapiah Bt. Muda.
There is no doubt in my mind that without their continued support,
pray and counsel, I could not have completed this process and task.
I would like to express sincere appreciation to my supervisor,
Mr. Wan Muhammad Syahrir B. Wan Hussin
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Besides that, I would also thank my lecturers from my faculty that have contributed ideas, feedback and advices.
Not forgotten Hafiz Firdaus B. Mohd Taat for his support and understanding.
Last but not least,
I would like to thank all my friends for their support, assistance and encouragement throughout of the project completion.

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ABSTRACT

Air conditioning systems are integral part of almost every institution. It contributes significant part of total energy consumption. Studies suggest that in locations like class rooms, hall and offices in UMP, air conditioning can contribute as much as 75% of total energy intake. Even in homes and offices, power consumed by air conditioners is significant. Fuzzy logic is actually one of the artificial intelligence techniques that being used widely in development system nowadays. Simulation on Air Conditioner Using Fuzzy Logic is a stand-alone system that enable user to display the simulation of air conditioner spinning fan. This system is made for UMP's staff or lecturer to simulate how the fan is spin according to the temperature. The system has been successfully developed within time and user can display the output of the percentage of the fan speed based on two inputs that are set_temp and current_temp. The simulation is shown based on the inputs and output calculated using Fuzzy Logic technique.

ABSTRAK

Sistem penghawa dingin memaikan peranan sebahagian besar kepada setiap institusi. Ia menyumbang sebahagian besar daripada jumlah penggunaan tenaga. Kajian menunjukkan bahawa di lokasi seperti bilik kelas, dewan dan pejabat-pejabat di UMP, penghawa dingin boleh menyumbang sebanyak 75% daripada jumlah pengambilan tenaga. Walaubagaimanapun di rumah dan pejabat, kuasa yang digunakan oleh penghawa dingin adalah penting. *Fuzzy Logic* sebenarnya adalah salah satu teknik yang digunakan secara meluas dalam sistem pembangunan pada masa kini. Simulasi Sistem Penghawa Dingin yang menggunakan *Fuzzy Logic* adalah satu sistem yang berdiri sendiri yang membolehkan pengguna untuk memaparkan simulasi kipas penyaman udara berputar. Sistem ini dibuat untuk kakitangan atau pensyarah UMP untuk mensimulasikan bagaimana kipas berputar mengikut perubahan suhu. Sistem ini telah berjaya dibangunkan dalam masa yang ditetapkan dan pengguna boleh memaparkan yang keputusan peratusan kelajuan kipas berdasarkan dua input iaitu set_temp dan current_temp. Simulasi akan ditunjukkan berdasarkan input dan keputusan yang dikira menggunakan teknik *Fuzzy Logic*.

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CHAPTER I

INTRODUCTION

This chapter briefly discussed on the overview of this research. It contains five sections. The first sections are introduction then follow by the problem statements. Next are the objectives where the project's goal is determined. After that are the scopes of the system and lastly is the thesis organization which briefly describes the structure of this thesis.

1.1. Background

An air conditioner is a home appliance, system or machine that builds to extract heat air to turn it into a cool air. Nowadays, lots of air conditioner use fuzzy logic, for example Mitsubishi Air conditioner.

Conventional air conditioning systems use on-off controllers. When the temperature drops below a preset level the unit is automatically turned off. When the temperature rises above a preset level the unit is turned on. The former preset value is lower than the later preset value, providing a dead zone, so that high-frequency on-off cycling is avoided. The thermostat in the system controls the on-off action. For example, when the temperature rises to 25°C, turn on the unit, and when the temperature falls to 20°C, turn off the unit.

The Mitsubishi air conditioner controls by using fuzzy rules such as, IF the air is getting warmer THEN turn the cooling power up a little AND IF the air is getting cold, THEN turn the power down moderately. The machine becomes smoother as a result. This means less wear and tear of the air conditioner, more consistent comfortable room temperatures, increased efficiency and energy savings.

The same technique is going to be show using simulation that will be develop to be apply to University Malaysia Pahang's class rooms or Lecture Hall (*Dewan Kuliah*). The simulation will show how the speed of the fan rotates accordingly to the temperature that is set by user, and the current room temperature of the rooms or halls.

1.2. Problem Statement

There are few problems that need to be concern. One of the problems is when students having an examination for example in Lecture Hall, they will complain to the staff or the lecturer that the hall is too cold and they cannot concentrate to answer the paper well. The staff or the lecturer will find it difficult to increase the temperature because the air conditioner is already set to 20˚c.

The other problem is the government has issue an order to maintain the temperature of the air conditioning to 24˚c. If there are only few students in the hall, the temperature should be increase to avoid students from froze and if there are too many students in the hall, the temperature should be decrease suitably according to total of students. It is hard only to maintain the temperature. It has to adapt based on the current hall temperature and the set temperature in the hall or class rooms.

1.3. Objective

The objectives of the project are:

i. To develop a prototype to simulate an air conditioner.

ii. Apply fuzzy logic technique to the simulation.

1.4. Scope

The scope for the project is:

i. Classes, halls and offices in University Malaysia Pahang that uses air conditioner system.
ii. The inputs for the simulation are current temperature, and set temperature.
iii. The output for the simulation is increasing or decreasing of the air conditioner fan speed.

1.5. Thesis Organization

This thesis consists of four (4) chapters. Chapter one (1) is Introduction. Explanation of introduction to the system. In this chapter, system overview, problem statements, objectives and scope of the project is disscussed.

Chapter two (2) is Literature Review that will discuss more on the research about the project that has been chosen. The research is divided into two, that is current system or case study and research for technique that will be used to develop the current system.

In Chapter three (3) is Methodology of overall work load to develop this system will be disscuss. The content consists of the approach and framework for the project that used in the system also the implementation of the process that is involved during development of this system.

Lastly in chapter four (4) is the Conclusion. In this chapter, briefly summarize all the chapters involve and the results or outputs that obtained from the implementation of the system is discussed thoroughly. The constraints of this project are also stated clearly.

CHAPTER II

LITERATURE REVIEW

This chapter is to explain about reviews for this project. It is divided to two major parts: system/present review and technique, method, equipment, as well technology review.

2.1 Current Practice in University Malaysia Pahang (UMP)

This section is reviewed the current practice system on fuzzy logic control of air conditioner were adapt in UMP.

2.1.1 Fuzzy Logic Control of Air conditioners in WDK, UMP

An interview has been conducted with Mr. Azizan b. Jernia, Assistant Mechanical Department. There are several class rooms that have different types and total of air conditioner. A system have been develop for air conditioning control in WDK block where it is been monitored through a computer in a control room. This system is still under supervision and tested within 70% – 80% in a month. On-Off control is in the control room that means, even there is an air conditional remote control in the class, students or lecturer cannot change the temperature because it has been set default to 24˚C in the system. The air conditioner used is Acson that have fuzzy logic technology built in.

2.2. Article about Setting the Temperature of Air Conditioner to 24˚C

Minister of Energy, Green Technology and Water, Datuk Seri Peter Chin Fah Kui, an act will be drafted to enact the existing Acts and it is expected to be enforced by 2013. The Prime Minister has ordered a good move to reduce or to provide energy efficiency and all government buildings will be required to raise the temperature setting for government buildings through a circulars letter that will be issued by the Secretary of State.

In the article, the Prime Minister has said that 24˚ Celsius is the appropriate temperature level in this country compared to China, who placed 26˚ Celsius for their government buildings. However, exemption is granted to the government buildings that have a specific reason such as a in hospital that are operating room and intensive care unit (ICU) that need temperature lower than 24˚ Celsius. [21]

2.3. Existing Systems Review

This section is reviewed the current system and the existing system that related to simulation of fuzzy rules for air conditioning.

2.3.1. Fuzzy Logic Control of Air Conditioners

Most of the air conditioning nowadays has adapted the fuzzy logic technology. By adapting the fuzzy logic control (FLC), temperature can be control well. Cost and time consuming can be save also goes to electrical energy intake of the AC compressor/Fan while utilizing all available resources in the most efficient manner using fuzzy logic control (FLC). Three variables were used that are user temperature preference, actual room temperature and room dew point temperature. User temperature is subtracted from actual room temperature before being sent for fuzzyfication. Fuzzy arithmetic and criterion is applied on these variables and final result is defuzzyfied. The Fuzzy logic system is used to design the algorithm. [1]

Software to make use of these FCL files is written in C++ using Free Fuzzy Logic Library (FFLL), an open source fuzzy logic class library and API. Simulation is also done in MATLAB. [2]

Use of FLC system in combination with LON (Local Operation Network), technology for control and power management of air conditioning systems increases the exchange of control information of the system. Using variable speed operated pumps for the heat exchangers reduces enormously the electrical power consumption of the pump during the control mode of the system. The control information exchange system provided by LON works ensures that only one of the actuators executes the control task within the scan time cycle, which is important for robust control. [3]

2.3.2. Fuzzy Logic Control for Vehicle Air Conditioning System

Vehicle also adapts the fuzzy logic control technology. Few studies have been made about the fuzzy logic control for vehicle. Measurements to study the vehicle air conditioning are time interval of one minute for a set point temperature of 22, 23 and 24˚C with internal heat loads of 0, 1 and 2kW. The main objective of the study was to evaluate the energy saving obtained when the fuzzy logic control (FLC) algorithm continuously regulates the compressor speed. It was proved that the experiment is successful, energy can be saved and indoor comforts were improved compared to the conventional (On/Off) control technique. [4]

A practical application of a fuzzy control system for a non-linear air conditioning system in the automobile was simulate and the results are gathered. Temperature control in an automobile passenger environment is more complex than that of a static room in a building. With regards to both driver and passenger comfort and safety, a lot of factors must be taken. The objective of the paper is to study the implementation of fuzzy logic control in automobile climate control system compared to the existing state flow controller. [5]

2.3.3. Traffic Light Controller

Traffic congestion is the main thing that worries people around the world. By developing a sophisticated traffic and more effective monitoring and control system that is effective, it can help solve this problem. In the conventional traffic light controller, traffic lights change at constant cycle time. It does not provide an optimal solution. Traffic light controller based on fuzzy logic can be used for optimal control of variable volume overload, such as the saturated conditions or unusual. Objective is to increase the vehicle throughput and minimize delays to the public. [6]

When the numbers of road user constantly increase, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future. However, some limitations to the usage of intelligent traffic control exist to avoiding traffic jams. Three series of experiments was performing with using the green light district traffic simulator. The first experiment, which uses a large grid, shows that reinforcement learning is efficient in controlling traffic, and that the use of co-learning further improves performance. The second experiment shows that using co-learning vehicles avoid crowded intersections. This way, vehicles avoid having to wait, and actively decrease pressure on crowded intersections. The third experiment shows that RL algorithms on more complex and city-like infrastructure again outperform the fixed controllers by reducing waiting time with more than 25%. The third experiment also shows that in some situations a simplified version of the reinforcement learning algorithm performs as well as the complete version, and that co-learning not always increases performance. [7]

This journal presents a fuzzy logic-based adaptive traffic signal controller for an isolated intersection. The controller has the ability to make adjustments to signal timing in response to observed changes in the approach flows. Using upstream vehicle detectors, the controller measures approach flows and estimates approach queues at regular time intervals. This information is used in a fuzzy logic procedure to determine, at any given time, whether to extend or terminate the current signal phase for through movements. In the first stage, the controller estimates the traffic intensity on each approach. The duration of the green is based on traffic-actuated control. [8]

2.3.4. Water Level Control

Synthesis water level control by fuzzy logic focuses on evolving of two type that are fuzzy and classical Proportional, Integral and Derivative(PID) liquid level controller and examining whether they are better able to handle modeling uncertainties. A two stage strategy is employed to design the synthesis fuzzy and classical PID controller with the process of the first and second order and implement s disorder quadratic function.[9]

It is proved that fuzzy logic controller is useful in applications of nonlinear static characteristic, where classical methods with usually classical PID controllers cannot be a satisfactory outcome. Fuzzy controller allows the user apply their knowledge of the problem and transfer it to an appropriate system environment, which is close to the human way of thinking (liquid level tank control). Fuzzy PID controller in a liquid level control process applications was proved as a very good choice, because the planning process of fuzzy controller is relatively simple and suitable for engineering practice. [10]

An optimization method for the operation of conditioning system is achieved by fuzzy control system and implemented automation system. The fuzzy control system determines required water ratio precisely to regulate the temperature instead of using trials for adjusting the water ratio when applying conventional control. It is an important factor of the given control system eventually reaches an equilibrium state, after which the temperature barely needs to be adjusted anymore. A conventional control method causes the waste of hot or cold water, which means not optimal utilization of energy. The fuzzy logic control means: accuracy of temperature control and saves energy by rationing the cold or hot water streaming. [11]

One of the most important elements in lawn maintenance is the moisture adequacy. For this reason, irrigation, done by manual or automated sprinkler system, has been applied. However, both systems may use excessive amount of water and the amount dispersed may not be suitable for the moisture level of the lawn. Therefore, there is a need to develop an irrigation system that can measure and monitor the soil moisture through data acquired from the soil and also from the climatologic factors that will help to decide when to water and how much water is needed. Once the actual rules and fuzzy sets are determined, the comparison of the conventional irrigation system with all four fuzzy inference methods was conducted with each other. [12]

2.3.5. Fuzzy Logic in Lift / Elevator System Control

Fuzzy logic approach is used to control elevators used in tall buildings. The method of fuzzy logic control of the elevators will be provided economically.. Time and energy can be save and will be provided by providing the elevator first, 49th and then 1st floor coming down. Performance criteria and conditions of the building as a result of fuzzy inference by examining the characteristics of the current directed to the appropriate cabinet. The fuzzy logic controlled studies on this subject before new ones are added to the linguistic variables, the system will control operation of certain time periods during the day differentiated human interpretations and experiences of the effects of fuzzy control algorithm was investigated. The system is given to mathematical calculations, priority call routing function and the elevator cab to a cab floor system call for each coefficient indicating the importance of proximity to fuzzy logic is described extraction method. [13]

Implement fuzzy logic controller (FLC) on a Field-programmable Gate Array (FPGA) system for intelligent control of elevator system. The approach is based on algorithm which is developed to reduce the amount of computation required by focusing only on the relevant rules and ignoring those which are irrelevant to the condition for better performance of the group of elevator system. Simulation was carried out by considering two inputs i.e. elevator car distance and number of stops. Based on these data the Fuzzy Controller can calculate the Performance Index (PI) of each elevator car and the car which has maximum PI gives the answer to the hall calls. This would facilitate reducing the average waiting time (AWT) of the passenger. [14]

2.3.6. Fuzzy Logic Control of Washing Machine

Fuzzy logic control has enabled to obtain a wash time for different type of dirt and different degree of dirt. The conventional method required the human interruption to decide upon what should be the wash time for different cloths. In other words this situation analysis ability has been incorporated in the machine which makes the machine much more automatic and represents the decision taking power of the new arrangement. The fuzzy controller takes two inputs that are degree of dirt and type of dirt processes the information and outputs a wash time. How to get these two inputs can be left to the sensors (optical, electrical or any type). [15]

2.3.7. Fuzzy Logic Real World Example

Most of big companies such as Panasonic, Hitachi, Canon and Mitsubishi have applied Fuzzy logic into their product. For air conditioner, Fuzzy Logic was used to control the temperature based on certain rules that has been set while for vacuum fuzzy control is adapt together with microprocessor to detect dust based on condition of the floor. Famous use of fuzzy logic is washing machine where the control system senses both quality and quantity of dirt, load size, and fabric type, and adjusts the washing cycle and detergent amount accordingly. Television (Sony): A fuzzy logic scheme uses sensed variables such as ambient lighting, time of day, and user profile, and adjusts such parameters as screen brightness, colour, contrast, and sound. There are lots more product that uses fuzzy logic nowadays. [16]

Soft computing (SC) is an evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost. Fuzzy logic (FL), neural networks (NN), and evolutionary computation (EC) are the core methodologies of soft computing. However, FL, NN, and EC should not be viewed as competing with each other, but synergistic and complementary instead. Soft computing is causing a paradigm shift (breakthrough) in engineering and science fields since it can solve problems that have not been able to be solved by traditional analytic methods [Tractability (TR)]. In addition, SC yields rich knowledge representation (symbol and pattern), flexible knowledge acquisition (by machine learning from data and by interviewing experts), and flexible knowledge processing (inference by interfacing between symbolic and pattern knowledge), which enable intelligent systems to be constructed at low cost [high machine intelligence quotient (HMIQ)]. This paper reviews applications of SC in several industrial fields to show the various innovations by TR, HMIQ, and low cost in industries that have been made possible by the use of SC. [17]

2.4. Tool and Equipment

2.4.1. MATLAB/Simulink tool

Most of the existing systems use the MATLAB/Simulink tool to design the prototype system. The existing systems are Development of Fuzzy Logic Control for Vehicle Air Conditioning System, Traffic Light Controller, Fuzzy Logic Control of Air Conditioners Water Level Control, Intelligent Traffic Light Control, Control the Extension Time of Traffic Light in Single Junction, Air-conditioning System, Control for Non Linear Car Air Conditioning, and Water Tank Level Control.

By using MATLAB/Simulink, Fuzzy Logic Toolbox packages and MATLAB programming for stabilizing the water tank level control, it is a simple and easy approach to know more about water level system, including its level movements, valve setting, data consistency, and also about the rules of the variables. [13]

A prototype system for controlling traffic at an intersection is designed using VB6 and Matlab tool. The traffic intersection is simulated in VB6 and the data regarding the traffic parameters is collected in VB6 environment. The decision on the duration of the extension is taken using the Matlab tool. This decision is based on the Arrival and Queue of vehicles, which is imported in Matlab from VB6 environment. The time delay experienced by the vehicles using the fixed as well as fuzzy traffic controller is then compared to observe the effectiveness of the fuzzy traffic controller. [6]

2.4.2. Visual Basic 2008 (VB 2008) environment

Function of visual basic 2008 is same with Matlab tool; it is to design the prototype system. Typically, designer uses the Matlab tools to design their prototypes than VB 2008 because Matlab tools easier to use.

A prototype system for controlling traffic at an intersection is designed using VB 2008 and Matlab tool. The traffic intersection is simulated in VB 2008 and the data regarding the traffic parameters is collected in VB 2008 environment. The decision on the duration of the extension is taken using the Matlab tool. This decision is based on the Arrival and Queue of vehicles, which is imported in Matlab from VB 2008 environment. The time delay experienced by the vehicles using the fixed as well as fuzzy traffic controller is then compared to observe the effectiveness of the fuzzy traffic controller. [6]

2.5. Techniques

2.5.1. Fuzzy Expert Systems

2.5.1.1. Fuzzy Logic

2.5.1.1.1. Fuzzy Set

Fuzzy sets are sets whose elements have degrees of membership. In fuzzy set theory, classical bivalent sets are usually called crisp sets. The fuzzy set theory can be used in a wide range of domains in which information is incomplete or imprecise, such as bioinformatics. [20]

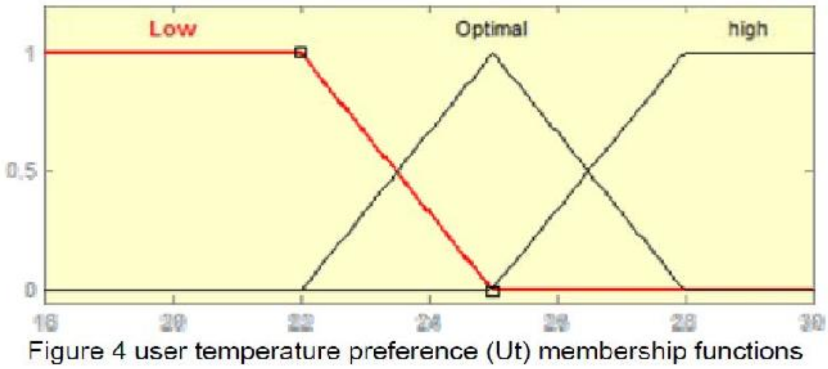

Figure 2.1: Example of Membership Function [2]

2.5.1.1.2. Linguistic Variable and Hedges

At the root of fuzzy set theory lies the idea of linguistic variables. A linguistic variable is a fuzzy variable. For example, the statement “John is tall” implies that the linguistic variable *John* takes the linguistic value *tall*.

The linguistic description of expert can be set as rules (IF…THEN). These rules of control system can be written as following:

IF the temperature is mild and the change of temperature is zero THEN the conditioning system must be stopped.

IF the temperature is mild and the change of temperature is big positive THEN the cold water streaming must be increased (Normal Cooling).

IF the temperature is cold and the change of temperature is zero THEN the hot water streaming must be increased (Normal Heating).

The other rules can be written in the same manner. [10]

2.5.1.1.3. Fuzzy Rule

A fuzzy rule can be defined as a conditional statement in the form:

IF *x* is *A*

THEN *y* is *B*

Where *x* and *y* are linguistic variables; and *A* and *B* are linguistic values determined by fuzzy sets on the universe of discourses *X* and *Y*, respectively.

Example of fuzzy rule:

1. If dirtness_of_clothes is Large and type_of_dirt is Greasy then
   wash_time is VeryLong;
2. If dirtness_of_clothes is Medium and type_of_dirt is Greasy then wash_time is Long;

3. If dirtness_of_clothes is Small and type_of_dirt is Greasy then
   wash_time is Long;

4. If dirtness_of_clothes is Large and type_of_dirt is Medium then
   wash_time is Long;

5. If dirtness_of_clothes is Medium and type_of_dirt is Medium then wash_time is Medium;
6. If dirtness_of_clothes is Small and type_of_dirt is Medium then
   wash_time is Medium;

7. If dirtness_of_clothes is Large and type_of_dirt is NotGreasy then wash_time is Medium;
8. If dirtness_of_clothes is Medium and type_of_dirt is NotGreasy then wash_time is Short;
9. If dirtness_of_clothes is Small and type_of_dirt is NotGreasy then wash_time is VeryShort. [14]

Type	Number	Quantization level
Input 1: Heat (N)	5	- 1 (Very small) - 2 (Small) - 3 (Medium) - 4 (Large) - 5 (Very large)
Input 2: Temperature difference	7	- Negative large (NL) - Negative medium (NM) Negative small (NS) - Zero (ZR) - Positive small (PS) - Positive medium (PM) - Positive large (PL)
Output: Blower speed	7	- Negative fast (NF) - Negative medium (NM) Negative slow (NS) - Zero (ZR) - Positive slow (PS) - Positive medium (PM) - Positive fast (PF)

TD\N	VS	S	M	L	VL
NL	PS	PS	PM	PM	PF
NM	PS	PS	PS	PM	PM
NS	PS	PS	PS	PS	PS
ZR	ZR	ZR	ZR	ZR	ZR
PS	NS	NS	PS	NS	NS
PM	NS	NS	PS	NM	NM
PL	NS	NS	PM	NM	NF

Figure 2.2: This is example of fuzzy rule base table [5]

2.6. Summary

From this chapter is to discuss the existing system and discuss the tools and techniques used in existing systems. From the existing system of fuzzy logic related control and simulation, we can concluded that apply the systems from the real system into simulation system using a fuzzy expert system. To generate the real system, it requires high cost and long time.

CHAPTER III

METHODOLOGY

In this chapter will discuss about the methodology that will be using in the development of Simulation on Air Conditioning using Fuzzy Logic. For Simulation on Air Conditioning using Fuzzy Logic, the **Rapid Application Development (RAD) method** was choosing because RAD has several characteristic that is suitable for the development of Simulation on Air Conditioning using Fuzzy Logic. There have three section consists in this chapter. The first section explains about the introduction of the RAD development method and the reason to choosing the RAD approach. The next section discuss about the implementation of RAD method in Simulation on Air Conditioning using Fuzzy Logic development. The last section will elaborate the hardware and software that was used in the development of Simulation on Air Conditioning using Fuzzy Logic.

3.1 Rapid Application Development (RAD)

Methodology of the project to develop this fuzzy logic system is Rapid Application Development model (RAD). RAD is a software development methodology that uses minimal planning in favour of rapid prototyping. The planning of software developed using RAD is interleaved with writing the software itself. The lack of extensive pre-planning generally allows software to be written much faster, and makes it easier to change requirements. In rapid application development, structured techniques and prototyping are especially used to define users' requirements and to design the final system. The development process starts with the development of preliminary data models and business process models using structured techniques. In the next stage, requirements are verified using prototyping, eventually to refine the data and process models. These stages are repeated iteratively; further development results in a combined business requirements and technical design statement to be used for constructing new systems.

RAD approaches may entail compromises in functionality and performance in exchange for enabling faster development and facilitating application maintenance.

There are four phases in RAD model. First phase is requirement planning where elements of the system planning and systems analysis phases in System Development Life Cycle (SDLC) were combining together. Second phase is user design, where users interact with systems analysts and develop models and prototypes that represent all system processes, inputs, and outputs. Third phase is construction that tasks are programming and application development, coding, unit-integration and system testing where users were still involved to improve the system developed. Lastly forth phase is cutover where the new system is built, delivered, and placed in operation much sooner than SDLC it also includes data conversion, full-scale testing, system changeover and user training. [21]

3.2 The Justification of Rapid Application Development (RAD)

The method of the project methodology that has been chosen is Rapid Application Development (RAD). As has been explained briefly earlier, RAD consists of four phases that has been shortened from the traditional method, waterfall. It compresses the planning, analysis, designing for logical and physical, implementation and maintenance phases to shorter method but iteratively development. It is an efficient methodology which can assist faster software development, and at the same time ensure maximum quality of the project.

This methodology has been chosen as it is more reliable in developing the project has brings advantages such as it could fastened the development where quicker visualization of the end-design were enabled and allow rapid software testing and rectifying steps. [22]. RAD can deliver a very high quality system and the cost needed for it is low and compatible when compare to other factors.

3.3 Implementation of Rapid Application Development (RAD) in Simulation of Air Conditioning using Fuzzy Logic Development

There have four main life cycle phases in the RAD life cycle as refer to Figure 3.1, which is:

i. Requirement Planning
ii. User Design
iii. Construction
iv. Cutover

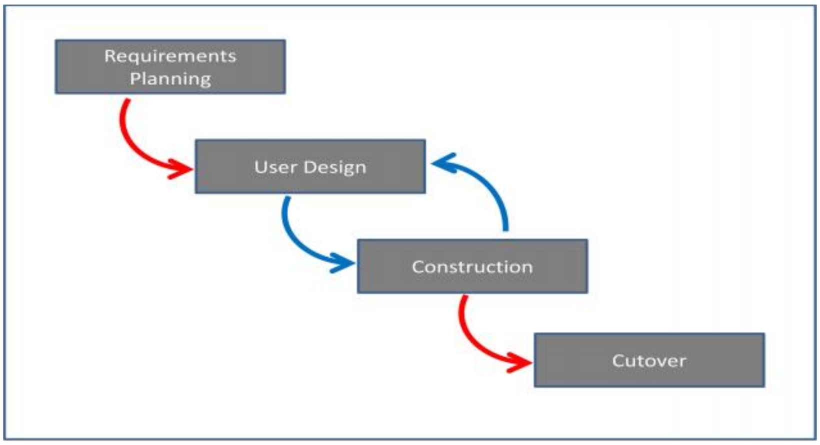

Figure 3.1 Rapid Application Development Lifecycle

3.3.1 Requirement Planning Phase

All the information that is related and needed for this project was gathered starting from the time when this project title was chosen. The information gained from the internet, books, research paper, brainstorming with supervisor and other lectures and so on. The collected information is not limited to beginning after the project title chosen only.

3.3.1.1 Research On Current Situation

An interview has been conducted with Mr. Azizan b. Jernia, Assistant of Mechanical Department. There are several rooms that have different types and total of air conditioner. A system have been develop for air conditioning control in WDK block where it is been monitored through a computer in a control room. This system is still under supervision and tested within 70% – 80% in a month. On/Off control is in the control room means, even there is an air conditional remote control in the class, student or lecturer cannot change the temperature because it has been set default to 24˚C in the system. The air conditioner used is Acson that have fuzzy logic technology built in.

3.3.1.2 Hardware and Software Tools

This Simulation on Air Conditioning using Fuzzy Logic project need the main requirements like hardware and software to make sure all the process involve in developing this project run smoothly. The hardware and software that fulfil the requirement will be considered.

Following are the system requirement that have been chosen in developing this system.

3.3.1.2.1 Hardware

The hardware specification required is shown as in Table 3.1:

Table 3.1: Hardware specification

No.	Hardware	Description
1	Laptop	Asus-Model A42J
2	Processor	Intel Core i5, 2.53GHz
3	Printer and Scanner	HP DeskJet F4185
4	Hard disk	320 GB
5	Pendrive	Kingston 2GB

3.3.1.2.2 Software

Table 3.2 is the software that has been used throughout the process of developing this project. The purposes of using that particular software are stated as in the table:

Table 3.2: Software specification

No.	Software	Description
1.	Microsoft Window 7	As operating system for the laptop
2.	Microsoft Office Word	Produce documentation
3.	Microsoft Office PowerPoint2007	Produce slide presentation
4.	Microsoft Office Project 2007	Produce Gantt chart
5.	Google Chrome	Internet browser used during the

		finding of information
6.	Matlab	Create fuzzification process
7.	Visual Basic 2008	As platform to show fuzzy logic
8.	Flash CS4	As platform to create the simulation

3.3.2 User Design Phase

This phase is also known as Functional Design Stage. At this stage, the system analysis requirements activity consists of requirement model of the system's data and the processes and transition to the system design. For this user design phase, it will be divided into two categories, analysis and design.

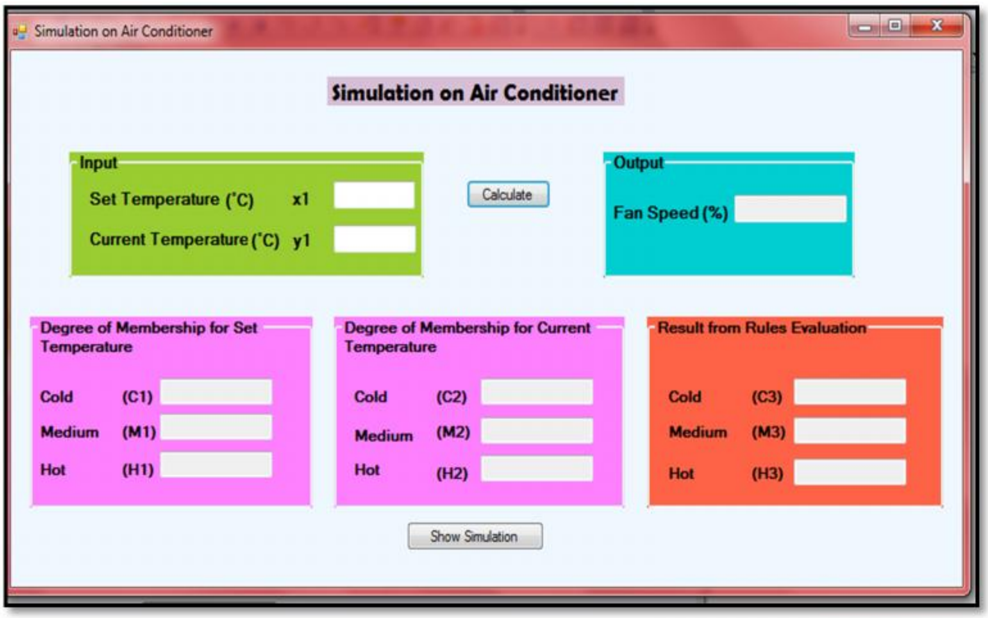

Figure 3.2: Example of Interfaces

3.3.2.1 Fuzzification Process

In fuzzication process, fuzzy set and linguistic variables must be defined for each crisp input to determine the degree to which these input belong to each of the appropriate fuzzy sets. [5]. The table 3.3 and table 3.4 shown the linguistic variable for each input for total person and temperature based on range from 0 to 100 and 20˚c to 30˚c. There are five edges for total person fuzzy set, which are E, AE, M, HF and F and four edges for temperature fuzzy set, which are VC, C, D and H.

3.3.2.2 Linguistic Variable And Fuzzy Set

Table 3.3 shows the fuzzy set of set temperature that consists of three partitions which are cold, medium and hot. The range of the fuzzy set is from 20 to 30.

Table 3.3: Fuzzy set of Set Temperature domain

Linguistic variable : input set_temp, x1		
Linguistic value	Notation	Numerical range (˚c)
Cold	C	20 to 22
Medium	M	23 to 24
Hot	H	26 to 30

Table 3.4 shows the fuzzy set of current temperature that consists of three partitions which are cold, medium and hot. The range of the fuzzy set is from 20 to 30.

Table 3.4: Fuzzy set of Current Temperature domain

Linguistic variable : input current_temp, y1		
Linguistic value	Notation	Numerical range (˚c)
Cold	C	20 to 22
Medium	M	23 to 24
Hot	H	26 to 30

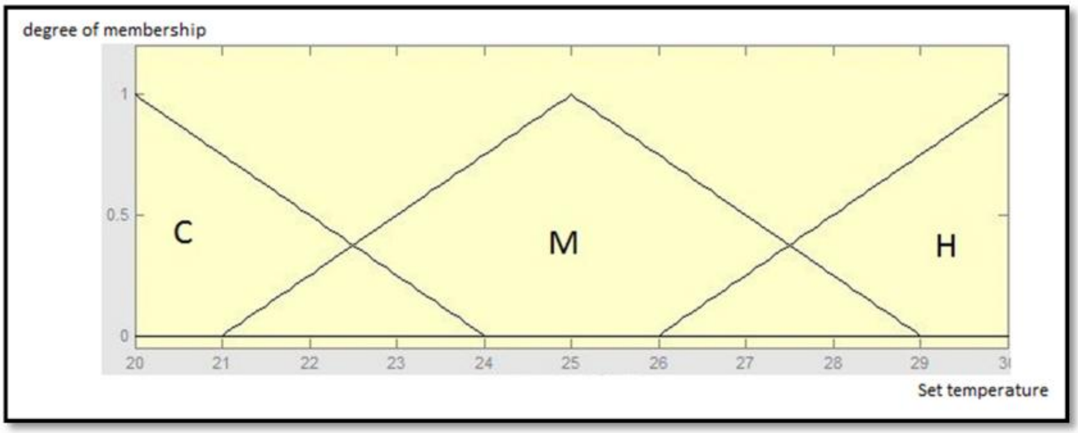

Figure 3.3: Graph of degree membership for set temperature

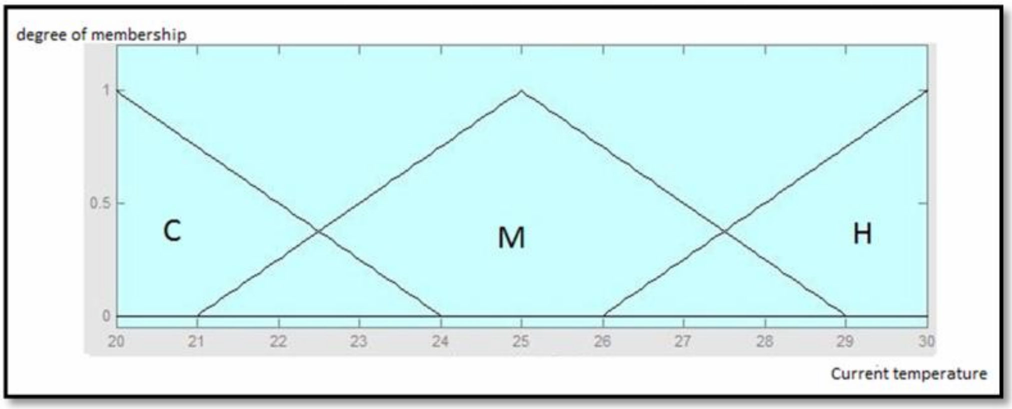

Figure 3.4: Graph of degree membership for current temperature

3.3.2.3 Rules Evaluation Process

There are nine rules involved in this project. The rules are shown as in Table 3.5 and Table 3.6.

Table 3.5: Fuzzy rule table

Types	current_temp		
set_temp	C	M	H
	M	M	C
	H	C	C

Table 3.6: 9 Fuzzy Rules

Rules	Set_temp	weight	Current_temp	weight	Fan_speed	weight
1	C	1	C	1	S	2
2	C	1	M	2	S	3
3	C	1	H	3	F	4
4	M	2	C	1	S	3
5	M	2	M	2	S	4
6	M	2	H	3	F	5
7	H	3	C	1	ST	4
8	H	3	M	2	ST	5
9	H	3	H	3	ST	6

If a given rules has a multiple antecedents, the fuzzy operator (AND or OR) is used to obtain a single number that represent the result of the antecedent. This number (truth value) is then applied to the consequent membership function. In order to evaluate the conjunction of the rule antecedents for this project, need applied the AND fuzzy operation intersection. Fuzzy operations is function when an element may party belong to the both sets of element which one value to take as an output. How to decide the rules is by declare the weight for each variables.

In this application, AND operators has been used. The minimum input value is chosen and its membership value is determined as membership value of the output for that rule. This method is repeated, so that output membership functions are determined for each rule. Rules that had been fired by the output of fuzzification are rule number 3 and 7.

Rule 3

IF set_temp (x1) is cold (C)

AND current_temp (y1) is hot (H)

THEN fan_speed is fast (F)

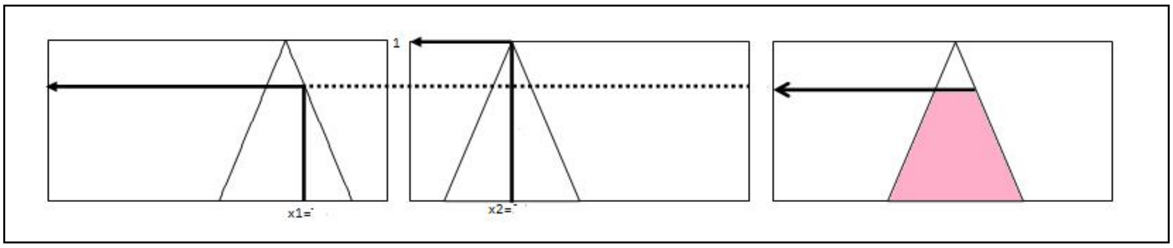

Figure 3.5: Rule evaluation for rule number 3

Rule 7

IF set_temp (x1) is medium (M)

AND current_temp (y1) is cold (C)

THEN fan_speed is slow (S)

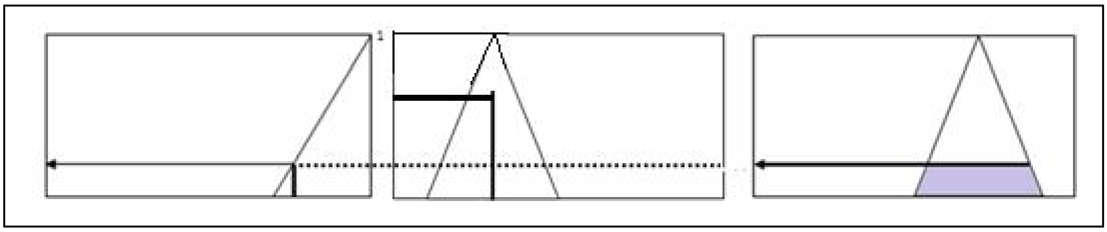

Figure 3.6: Rule evaluation for rule number 7

3.3.2.4 Aggregation Process

Aggregate is the process of unification of the outputs of all rules. Take the membership functions of all rules and combine them into a single fuzzy set. Output of aggregation is one fuzzy set for each variable.

Figure 8 shows how the output of each rule which are the output of rule number 3 and number 7 is aggregated into a single fuzzy set. The output of aggregation will be used as an input of defuzzification process.

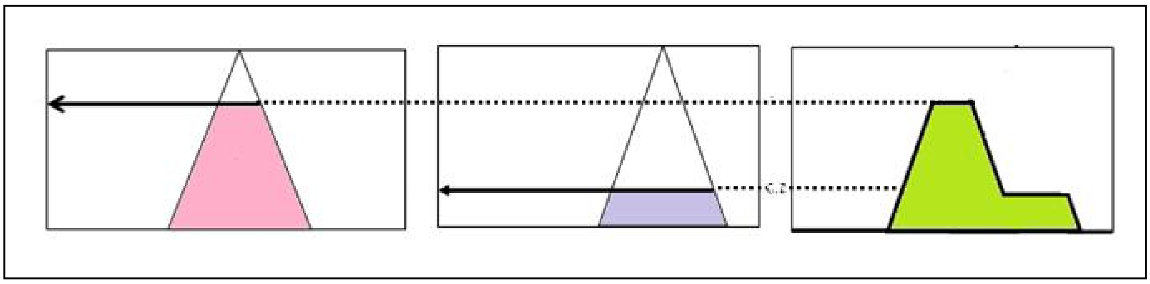

Figure 3.8: Aggregation of the rules (average and good fuzzy set)

3.3.2.5 Defuzzification Process

The last step in the fuzzy inference process is defuzzification. Fuzziness helps us to evaluate the rules, but the final output of a fuzzy system has to be a crisp number. The input for the defuzzification process is the aggregate output fuzzy set and the output is a single number by using centre of gravity (COG) formulae.

Figure 3.10 show the calculation of the output value by using COG formula. Output from the aggregation process is been used and applied in the formulae to get the crisp value of output.

$$COG = \frac{((0 + 10 + 20 + 30) * H3) + ((40 + 50 + 60) * M3) + ((70 + 80 + 90 + 100) * C3)}{((H3 * 4) + (M3 * 3) + (C3 * 4))}$$

$$= \frac{((0 + 10 + 20 + 30) * 0) + ((30 + 40 + 50 + 60) * 1) + ((70 + 80 + 90 + 100) * 0)}{((0 * 4) + (1 * 3) + (0 * 4))}$$

$$= 50$$

Figure 3.9: Expected output by using of COG defuzzification for fan speed

Figure 3.11 show the graph of defuzzification of output. The range of temperature is between the 20 and 30. From the graph, the output value is 50 fan speeds (%) for the temperature 24˚C.

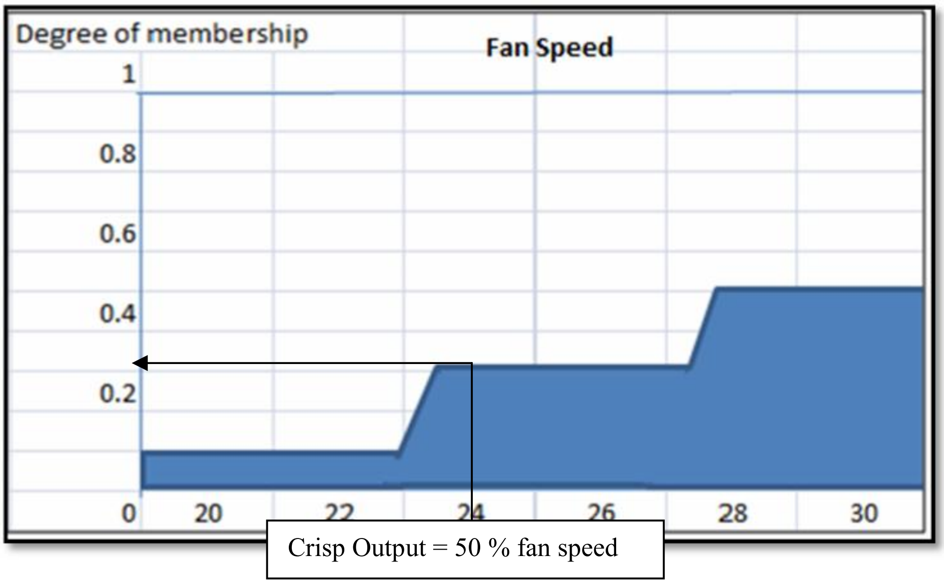

Figure 3.11: Expected output for fan speed in graph form

3.3.2.6 Linguistic Variable and Fuzzy Set for Output

Table 3.7 shows the fuzzy set of set temperature that consists of three partitions which are cold, medium and hot. The range of the fuzzy set is from 20 to 30.

Table 3.7: Fuzzy set of Fan Speed

Linguistic variable : output fan_speed, %		
Linguistic value	Notation	Numerical range (˚c)
Stop	ST	0
Slow	S	50
Fast	F	100

3.3.2.7 Rules Evaluation Process

The rules to show output are shown in Figure 3.12, Figure 3.13 and Figure 3.14.

Rule 3
IF set_temp (x1) is cold (C)
AND current_temp (y1) is hot (H)
THEN fan_speed is fast (F)

Rule 7
IF set_temp (x1) is medium (M)
AND current_temp(y1) is cold (C)
THEN fan_speed is slow (S)

Rule 8
IF set_temp (x1) is hot (H)
AND current_temp (y1) is medium (M)
THEN fan_speed is stop (ST)

The process of evaluation rules that had been fired (rule 3, 7, and 8) are shown in Figure 3.12, Figure 3.13, and Figure 3.14. Figure 3.12 is show how the rule number 3 is being evaluation. The output of fuzzification is function as the input of rules evaluation. Compared the value for the input and choose the minimum and maximum value because of use the AND operator. The output of the rule is 100%

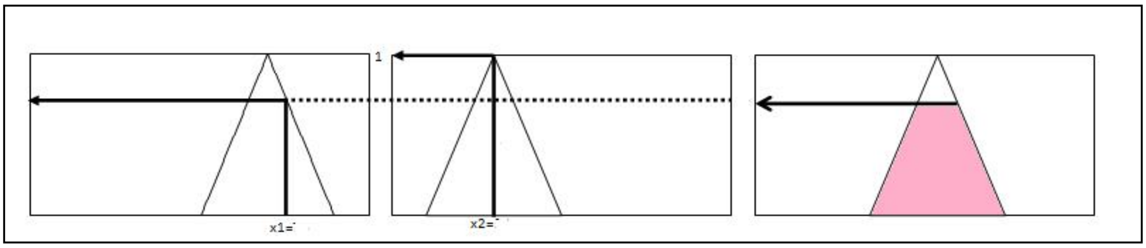

Figure 3.11: Rule evaluation for rule number 3

Figure 3.13 is show how the rule number 7 is being evaluation. The output of fuzzification is function as the input of rules evaluation. Compared the value for the input and choose the minimum and medium value because of use the AND operator. The output of the rule is 50%.

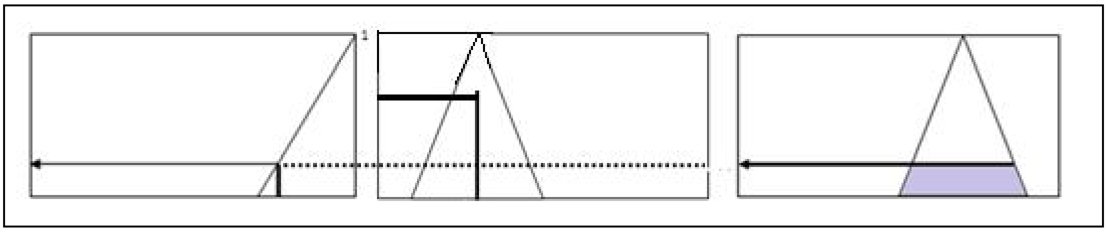

Figure 3.12: Rule evaluation for rule number 7

Figure 3.14 is show how the rule number 8 is being evaluation. The output of fuzzification is function as the input of rules evaluation. Compared the value for the input and choose the minimum and medium value because of use the AND operator. The output of the rule is 0%.

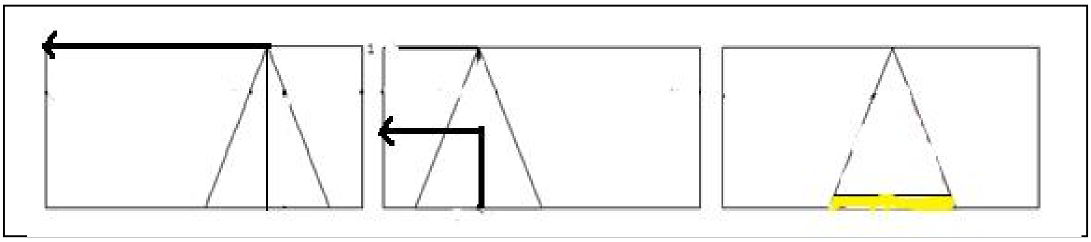

Figure 3.13: Rule evaluation for rule number 8

3.3.2.8 Aggregation Process

The process of combination of the outputs of all rules also knows as aggregation process. Taking the membership functions of all rules and combine them into a single fuzzy set by choosing the bigger value for each variable. Output of aggregation is one fuzzy set for each variable.

Figure 3.15 shows how the output of each rule which is stop = 0%, slow=50% and fast=100% are aggregated into a single fuzzy set for the overall fuzzy output.

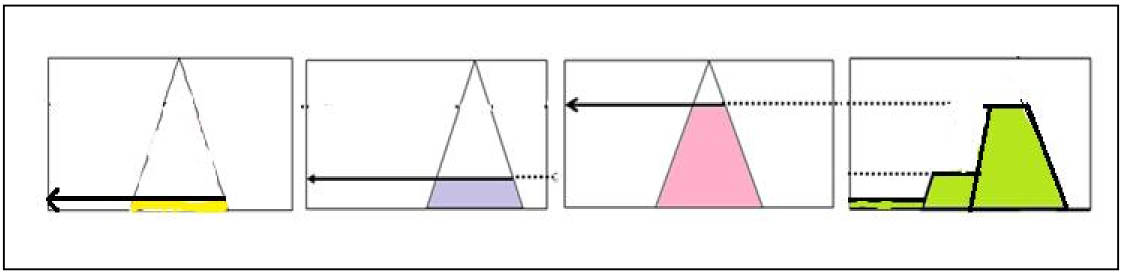

Figure 3.14: Aggregation of rules sequence based on the output of rules evaluations

3.3.2.9 Defuzzification Process

The last step in the fuzzy inference process is defuzzification. Fuzziness helps us to evaluate the rules, but the final output of a fuzzy system has to be a crisp number. The input for the defuzzification process is the aggregate output fuzzy set and the output is a single number by using centre of gravity (COG) formulae.

3.3.3 Construction Phase

To develop this project, the main software that was used is Matlab and Visual Basic.Net. Matlab is used to create the fuzzification process such as linguistic variable and fuzzy set, rule base, aggregation and defuzzification.

The design for the simulation is using Visual Basic.Net. Three interfaces were design for the simulation. The coding will be entered to combine and simulate all the three interfaces according to the technique choose that is Fuzzy Logic.

3.3.4 Cutover Phase

This project only develops for the development of Simulation on Air Conditioning using fuzzy logic. The front end of the system was build simply using Visual Basic.Net. The system will be deployed as a window application running in any operating system environment.

CHAPTER IV

IMPLEMENTATION

This chapter briefly discusses the expected results of the proposed project and following by discussion.

4.1. Introduction

This chapter explains the implementation process of Simulation on Air Conditioning using fuzzy logic after the system design was completed. This chapter was done to document the function that had been developed which consists of user interfaces and its source code. The topic that will be explained is system implementation environment which consists of the explanation of the fuzzy page and the explanation of the process particularly the simulation part. Other explanation includes the rules, interfaces and source code.

4.2. System Implementation Environment

The development environment using windows operating system has been choose for the development of Simulation on Air Conditioning using fuzzy logic. This window is selected because it is easy to use and compatible with Microsoft Visual Studio 2010. Thus, the user can use simulation to show the simulation of the air conditioning fan speed according to its temperature.

4.3. System Implementation Process

This section explains the implementation process of Simulation on Air Conditioning using fuzzy logic that consists of simulation and decides the level of fan speed. The main process in this system is fuzzy logic steps that include the fuzzification, evaluation rules, aggregation and defuzzification to produce percentage of fan speed. The flow of implementation of simulation on air conditioning is based on the flow chart for Simulation on Air Conditioning using fuzzy logic which is shown in Figure 4.1.

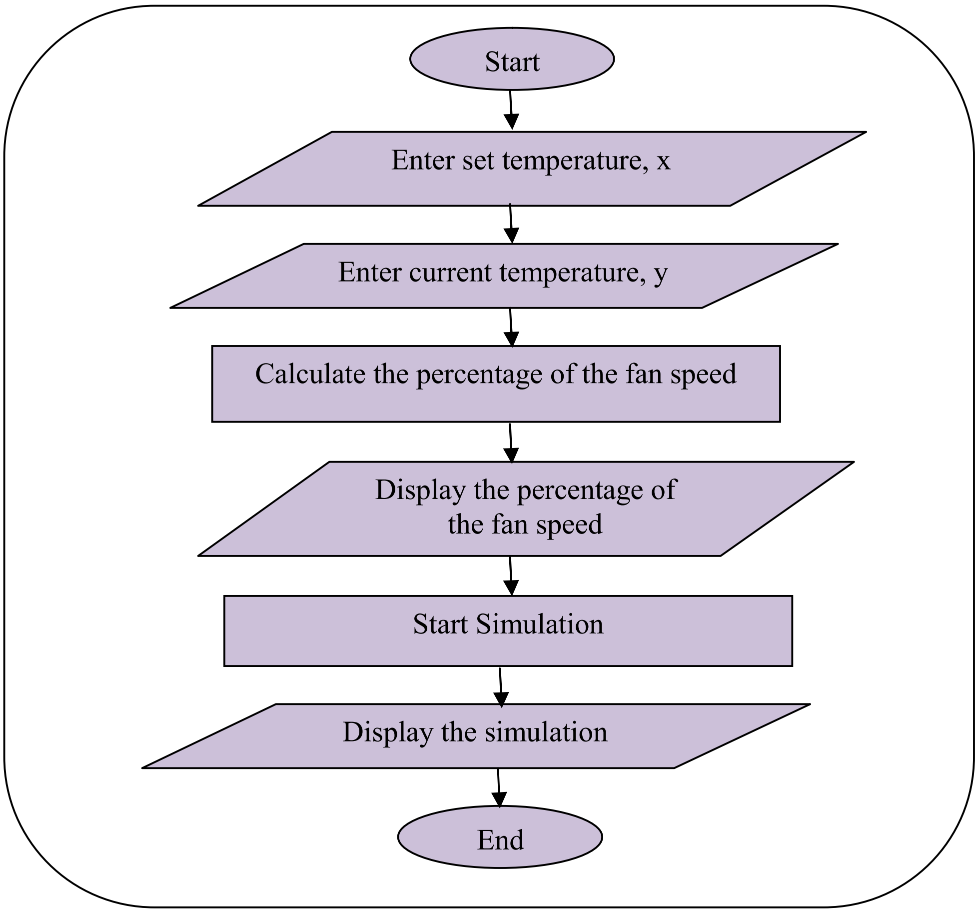

Figure 4.1: Flow chart for Air conditioning Simulation Using Fuzzy Logic

4.3.1. Main Page of Air conditioning Simulation Using Fuzzy Logic

Figure 4.2 shows the interface of the home page of Simulation on Air Conditioning using fuzzy logic. There is a Next Button, when the user clicks on it the system will go to the second next page. The design is simple yet easier to user to use it.

Figure 4.2: Home Page

4.3.2. Fuzzy Logic Process

There are four stages in fuzzy logic which are fuzzification, evaluate rules, aggregation and defuzzification. User entered two inputs that are set temperature, x and current temperature, y. When clicks on Calculate Button the result or output will be display along with the rules that have been set earlier. Figure 4.3 shows the result after user enters inputs.

Figure 4.3: Input and Output

In the Figure 4.3 show the result of the calculation and the percentage of the fan speed are 100. The result is the output of defuzzification. Let's discuss one by one steps of how to produce the last answer based on fuzzy logic process once user clicks on the Calculate button.

4.3.3. Fuzzification Process

Fuzzification is the process of converting the crisp value into fuzzy value so that the system cans the system correctly. Based on the input on Figure 4.3, there are two were involves which is set temperature = x1, and current temperature = y1. Figure 4.4 and Figure 4.5 shows the source code of fuzzification process where the conditions and formulae were included.

Figure 4.4 shows the fuzzification coding of set temperature, x1. In the Figure 4.4, there are two numbers which is number 1 and number 2. Number 1 is the condition of x1. Checking the condition of set temperature input is belonging to which cases. For the example, the case three was selected the formulae to change the crisp value into fuzzy shows in the sign of number 2.

In the Figure 4.5, there are two numbers which is number 3 and number 4. Number 3 is the condition of y1. Checking the condition of set temperature input is belonging to which cases. For the example, the case two was selected the formulae to change the crisp value into fuzzy shows in the sign of number 4.

```
Public Sub fuzzification()
    'fuzzification for x1
    If (x1 >= 20 And x1 <= 22) Then
        category_x1 = 0
    ElseIf (x1 >= 23 And x1 <= 24) Then
        category_x1 = 1
    ElseIf (x1 >= 26 And x1 <= 30) Then
        category_x1 = 2
    End If

    Select Case category_x1

        Case "0"                '(x1 >= 20 And x1 <= 22)
            C1 = 1
            M1 = 0
            H1 = 0

        Case "1"                '(x1 >= 23 And x1 <= 24)
            C1 = 0
            M1 = 1
            H1 = 0

        Case "2"                '(x1 >= 26 And x1 <= 30)
            C1 = 0
            M1 = 0
            H1 = 1
    End Select
```

Figure 4.4: Source code of Fuzzification for x1

```
If (y1 >= 20 And y1 <= 22) Then
    category_y1 = 0
ElseIf (y1 >= 23 And y1 <= 24) Then
    category_y1 = 1
ElseIf (y1 >= 26 And y1 <= 30) Then
    category_y1 = 2
End If

Select Case category_y1

    Case "0"        '(y1 >= 20 And y1 <= 22)
        C2 = 1
        M2 = 0
        H2 = 0

    Case "1"        '(y1 >= 23 And y1 <= 24)
        C2 = 0
        M2 = 1
        H2 = 0

    Case "2"        '(y1 >= 26 And y1 <= 30)
        C2 = 0
        M2 = 0
        H2 = 1
End Select
```

3

4

Figure 4.5: Source code of Fuzzification for y1

4.3.4. Evaluation Rules

After defuzzification process, the system will automatically run the evaluate rules function. Here is the example of the rules that had been fired based on the example on previous section. In Figure 4.6 show the source code to evaluate the rule involved.

```
Public Sub evaluateRules()

    If C1 = M2 Then
        C3 = C1
    End If

    If C1 = H2 Then
        C3 = C1
    End If

    If M1 = C2 Then
        M3 = M1
    End If

    If M1 = H2 Then
        M3 = M1
    End If

    If H1 = C2 Then
        H3 = H1
    End If

    If H1 = M2 Then
        H3 = M2
    End If
```

Figure 4.6: Source code of rule evaluation

4.3.5. Aggregation

Aggregation is the process of unification of the outputs of all rules. Take the membership functions and combine into a single fuzzy set. Figure 4.7 shows the source code of aggregation. The VarDefuzzify value will be used for the output of percentage of the fan speed. Only three values involved that are 0, 50 and 100.

```
Public Sub aggregation()



    'if x1 is >= y1
    If x1 <= 24 And y1 <= 24 Then
        VarDefuzzify = 50
    ElseIf x1 >= 24 And y1 >= 24 Then
        VarDefuzzify = 50
    ElseIf x1 < 24 And y1 > 24 Then
        VarDefuzzify = 100
    ElseIf x1 > 22 And y1 < 30 Then
        VarDefuzzify = 0
    End If

    If x1 = y1 Then
        VarDefuzzify = 0
    End If
```

Figure 4.7: Source code of aggregation

4.3.6. Defuzzification

After get the value of aggregation, calculate the defuzzification using COG. For example just now, production of defuzzification value or output of fan speeds by using COG formulae in Figure 4.8.

```
Public Sub defuzzification()
    VarAggregate = ((0 + 10 + 20 + 30) * H3) + ((30 + 40 + 50 + 60) * M3) + ((70 + 80 + 90 + 100) * C3)
    VarDefuzzify = VarAggregate / ((H3 * 4) + (M3 * 4) + (C3 * 4)
End Sub
```

Figure 4.8: Source code of defuzzification using COG function

4.4. Testing

A testing has been conducted after the completion of the development this system. The purpose of this testing is to check three common problems which are incorrect answers, inaccurate answers and inconsistent answers and determines if the problem due to either fuzzification process or evaluate rules process or aggregation process or formulae of defuzzification or all causes. The testing is begin by enter the random value and its satisfied with the rules that had been build. Thus, there are 50 testing process. All the testing has been successfully conducted and problems occur have been corrected once detected during the testing.

Figure 4.9 shows the source code that used to call the simulations that were debugging by the Flash CS4. The rule have been define according to the input that user entered.

Figure 4.10 is an example of simulation part using Flash CS4 that was saved in .SWF file.

```
If x1 <= 24 And y1 <= 24 Then
    System.Diagnostics.Process.Start("C:\Users\user\Documents\E-Book\Degree\Sem 6\BCC 3024 - PSM 2\Rumah-maintain.swf")

ElseIf x1 >= 24 And y1 >= 24 Then
    System.Diagnostics.Process.Start("C:\Users\user\Documents\E-Book\Degree\Sem 6\BCC 3024 - PSM 2\Rumah-slow.swf")

ElseIf x1 < 24 And y1 > 24 Then
    System.Diagnostics.Process.Start("C:\Users\user\Documents\E-Book\Degree\Sem 6\BCC 3024 - PSM 2\Rumah-fast.swf")

ElseIf x1 > 22 And y1 < 30 Then
    System.Diagnostics.Process.Start("C:\Users\user\Documents\E-Book\Degree\Sem 6\BCC 3024 - PSM 2\Rumah-slow.swf")

ElseIf x1 = y1 Then
    System.Diagnostics.Process.Start("C:\Users\user\Documents\E-Book\Degree\Sem 6\BCC 3024 - PSM 2\Rumah-stop.swf")
End If
```

Figure 4.9: Source code of testing the Simulation

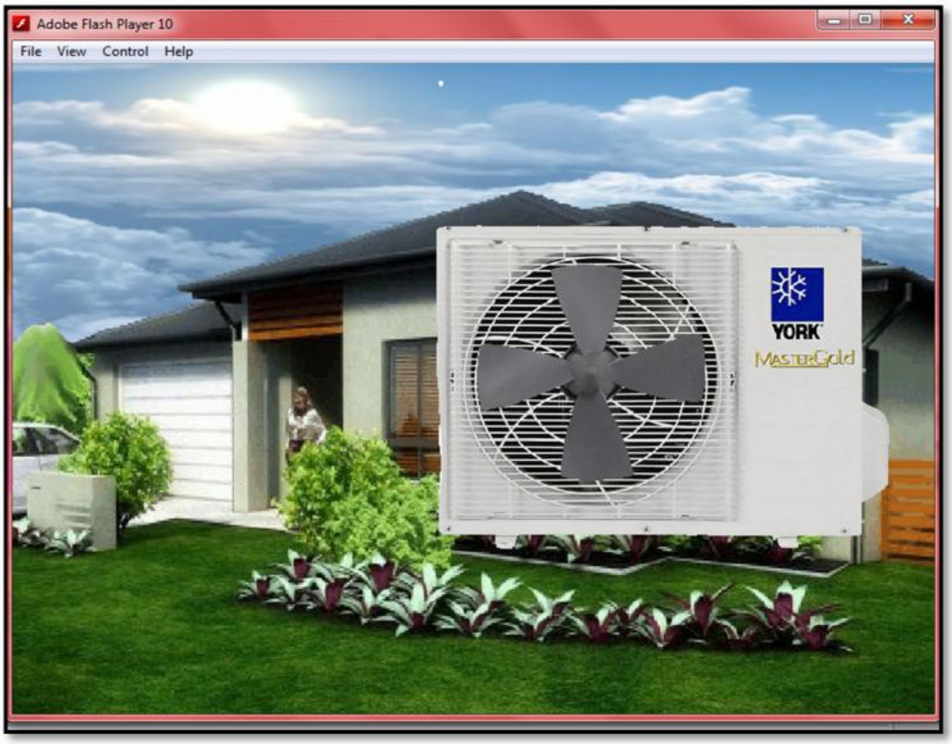

Figure 4.10: Example of the Simulation

CHAPTER V

RESULT, DISCUSSION AND CONCLUSION

This chapter briefly discusses the result, discussion and conclusion of the proposed project.

5.1. Introduction

This chapter will explain the result obtains from the implementation of Simulation of Air Conditioning using Fuzzy Logic and discussion on each of the result produces. The analysis of the result is done after the system development is completed and has been testing by the user. The purpose of this chapter is to identify and discuss the result of implementation of Simulation of Air Conditioning using Fuzzy Logic. There are three subtopics to be explained in doing the analysis of result which are detail explanation on the achievements of the project objectives based on the result of Simulation of Air Conditioning using Fuzzy Logic, the explanation on the development constraints encountered during developing this system and improvement of implementation.

5.2 Result Analysis

This section explains the results that have been achieved from the development of the system. Analysis of result can be done by analyzing the objective of the system, the development constraints and suggestion and improvement suggested by the user. Testing process is done randomly based on rules and the result show 90% the value is accurate. The system is not produce

100 % of the accurate value because of certain problems. One of the problems is the defuzzification techniques. Maybe for the certain value, the current techniques cannot function efficiently, however 90% value is efficiently to use current techniques.

The purpose of analysis of result is to ensure the development of the system has meets the user requirement and has successfully being developed and implemented as requested by the user and completed within the time duration given. Simulation of Air Conditioning using Fuzzy Logic has been developed based on the two objectives which have been met in this system as shown below:

i. To develop a prototype to simulate an air conditioner.
ii. Apply fuzzy logic technique to the simulation

5.2.1 Objective Achievement

This section explains the achievement of the system objective after the development of Simulation of Air Conditioning using Fuzzy Logic.

5.2.1.1 To develop a prototype to simulate an air conditioner.

The objective to develop a prototype using fuzzy logic has been met by the development of this system. This prototype implements the process of fuzzy logic that consist 4 steps which are fuzzification, evaluation rules, aggregation and defuzzification. Fuzzy logic will produce a crisp set number.

5.2.1.2 Apply fuzzy logic technique to the simulation.

The objective to apply the fuzzy logic technique to the simulation has met by the development of this system. Based on the inputs, outputs and rules, the simulation can run smoothly.

5.3 Project Constraint

This section will discussed about the constraint arise during the development of the system. The constraint arises due to process of the designing the rules and the techniques of defuzzification process which has been applied for this system. The constraint consists of two sections which are the development constraint and the system constraint.

5.3.1 Development Constraint

For the development the constraints are lack of system source code example using vb.net language that implements the fuzzy logic concept and source code for Action Script 3 for flash CS4 to create the simulation. The testing of this prototype is important in order to obtain a confirmation from the system either the output value is accurate or not accurate. However, the result of testing the prototype is not produce 100% of accurate value.

5.3.2 System Constraint

This system is stand alone application that uses fuzzy logic techniques. However, the result or output of the defuzzification is not accurate. Only 90 % is accurate value. There are lot of techniques defuzzification such as smallest of max (SOM), Mean of max (MOM), largest of max (LOM) and many more. Still confused to choose which one is better and will produce the accurate value. However, for this prototype only implement COG and still cannot produce the accurate value and because of that the assumptions of the fan speed percentage must be done.

Designing the simulation in Flash CS4 and trying to embed it into Microsoft Visual Basic cannot be done. The solution for it, the simulation has to be call or link outside of the VB.

5.4 Advantage and Disadvantage

This section will discuss the advantages and disadvantages of Simulation of Air Conditioning using Fuzzy Logic.

5.4.1 Advantages and Contribution

In this system, one of the advantages is user able to see the effectiveness of this system used fuzzy logic techniques to calculate the percentage of fan speed by entering two inputs that are set temperature and current temperature. The fuzzy logic techniques were considered all the categories to produce an output.

The system is not complicated and easy to use especially for users who have less knowledge in computer field because no high skill needed to operate the system. User only need to key in the value of the inputs and the all the calculation will be done by the system.

The after done with the calculation, user can show the simulation of the spinning fan blades. With the speed according to the inputs that user set earlier.

5.4.2 Disadvantages

The disadvantage of this system are, it can only show the percentage of the fan speed and to run the simulation it take awhile for it to load.

5.5 Suggestion and Improvement

The section discuss on the suggestions and improvements for this system. These suggestions and improvements are for future enhancement to increase the effectiveness of this system. There are several suggestions and improvements can be carried out for future enhancement of Simulation of Air Conditioning using Fuzzy Logic which is as below:

i. Animate the simulation. For example show students enter and/or exit the class room.
ii. Apply the simulation to the air conditioner.

The system should be more professional and formal. Upgrade the interface of the prototype and use Human Computer Interaction (HCI) techniques but still use the main concept which is fuzzy logic.

5.6 Assumption

This section explains about the assumptions of the new user who are going to use the system after it is completed. Before using the system, user may assume that:

i. The system will produce accurate value however the release prototype cannot give 100% accurate value.
ii. This system is the one of the simplest application where the user only need to key in the temperatures.
iii. The simulation will be very complicated but it is not.

5.7 Conclusion

As a conclusion, the development of this simulation based on fuzzy logic has satisfies the objectives, scope and problem statement mentioned. Simulation on Air Conditioning using Fuzzy Logic is a prototype to simulate the speed of air conditioner fan based on the two types of temperature that are current temperature and set temperature. This simulation is developed to be use or implement in the classes, halls and offices in University Malaysia Pahang that uses air conditioner system.

The fuzzy logic technique is used in developing this system to represent value of air conditioner fan speed. The fuzzy logic process begins with fuzzification functions and continues with evaluation rules, aggregation and lastly is defuzzification which is the most important part in fuzzy logic. IF-THEN structure and AND operator was implemented during creating the rules.

A Rapid Application Development (RAD) methodology is applied to develop this fuzzy logic system. The methodology applied the concept of fuzzy logic on each of the stages to ease the system development and fulfil the system requirements.

The development constraint of this system is lack of example of source code that using vb.net and while the system constraint is the system produces inaccurate value. The suggestions and improvements for future enhancement is creating a simulation that has animation for example, show animation when students enter or leave the hall or class room.

There are few lessons that had been learnt within the time spent to complete this project. Time management is one of most important skill in developing of software. Time must be divided fairly for developing this system and other tasks. If the time management is not right, this project might not be able to be finished within duration.

Working under pressure also is one of the lessons learnt when developing this system. This lesson teaches how to handle and survive the pressure. It gives experiences that help students when come to working environment in future.

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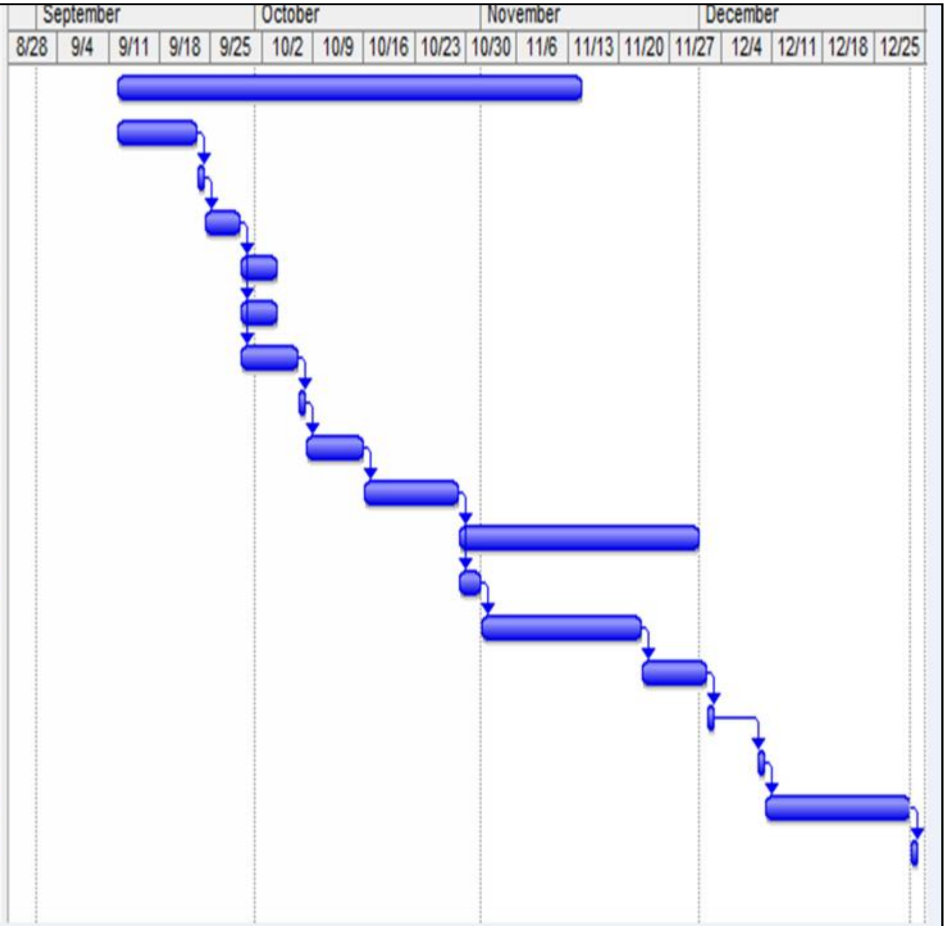
APPENDIX A
Gantt chart

Task Name	Duration	Start	Finish
1.0 identify the problem	51 days	Mon 9/12/11	Mon 11/14/11
1.1 identify the problem statement, objective, scope	9 days	Mon 9/12/11	Thu 9/22/11
1.2 submit report chapter 1	1 day	Fri 9/23/11	Fri 9/23/11
1.3 identify the initial requirement(sprinkler, fuzzy log	4 days	Sat 9/24/11	Wed 9/28/11
1.4 define the air conditioner	3 days	Thu 9/29/11	Mon 10/3/11
1.5 define concept fuzzy logic	3 days	Thu 9/29/11	Mon 10/3/11
1.6 study the flow of existent system	6 days	Thu 9/29/11	Thu 10/6/11
1.7 submit report chapter 2	1 day	Fri 10/7/11	Fri 10/7/11
1.8 define the methodology to be used	6 days	Sat 10/8/11	Sat 10/15/11
1.9 find information about methodology	11 days	Sun 10/16/11	Fri 10/28/11
2.0 develop the prototype	25 days	Sat 10/29/11	Wed 11/30/11
2.1 define the steps in protyping model	3 days	Sat 10/29/11	Mon 10/31/11
2.2 calculate the expected result	16 days	Tue 11/1/11	Tue 11/22/11
2.3 design the interface	7 days	Wed 11/23/11	Thu 12/1/11
2.4 submit report chapter 3	1 day	Fri 12/2/11	Fri 12/2/11
2.5 submit report chapter 4 & 5	1 day	Fri 12/9/11	Fri 12/9/11
2.6 compile all chapter	16 days	Sat 12/10/11	Thu 12/29/11
2.7 submit full report PSM1	1 day	Fri 12/30/11	Fri 12/30/11



APPENDIX B

Interfaces

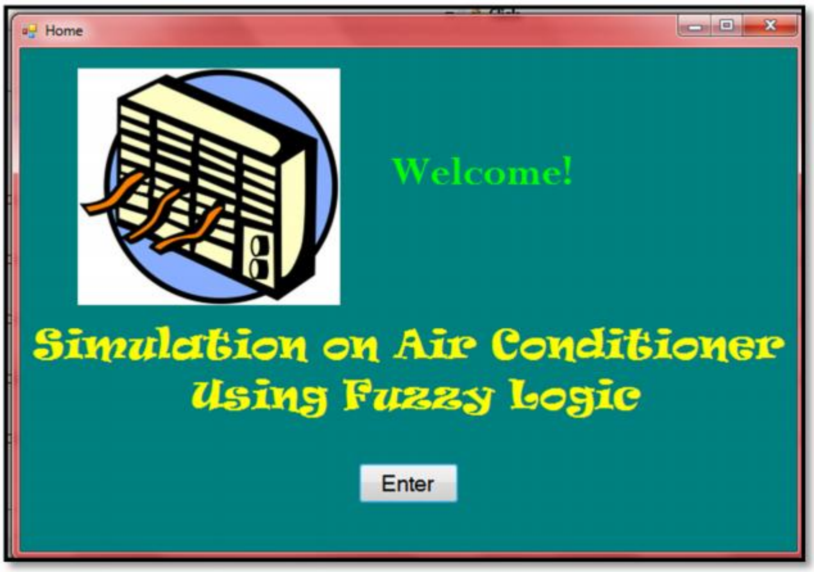


Figure 1: Home Page

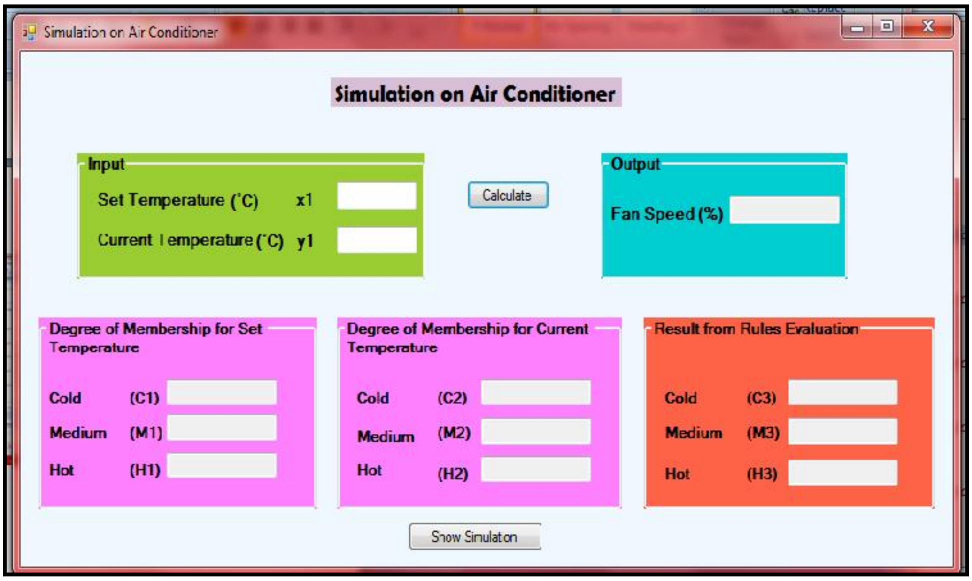


Figure 2: Fuzzy Interface

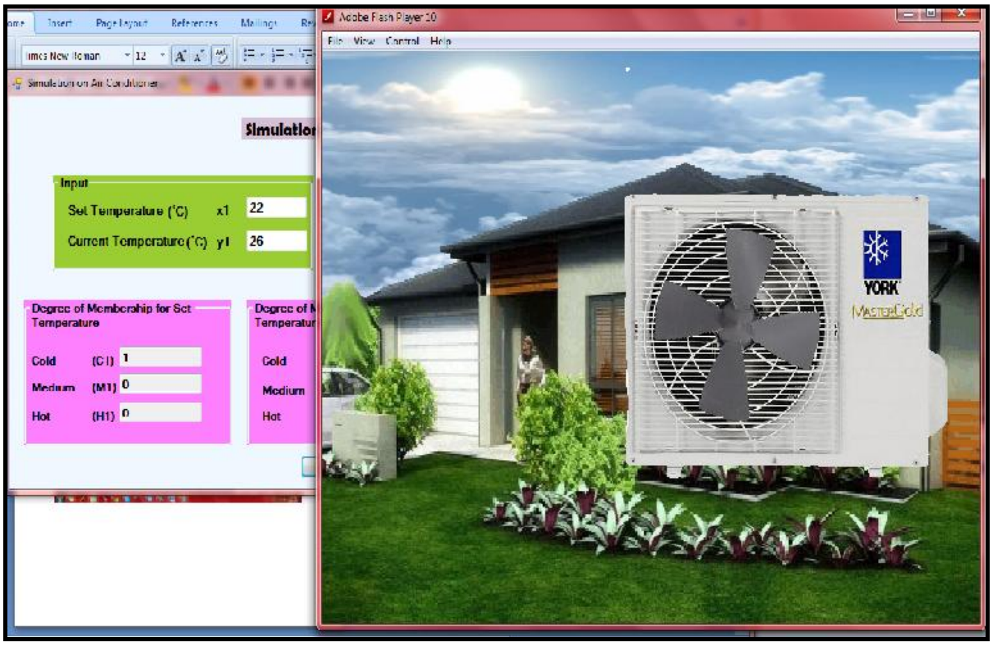


Figure 3: Simulation Interface (Hot Weather)

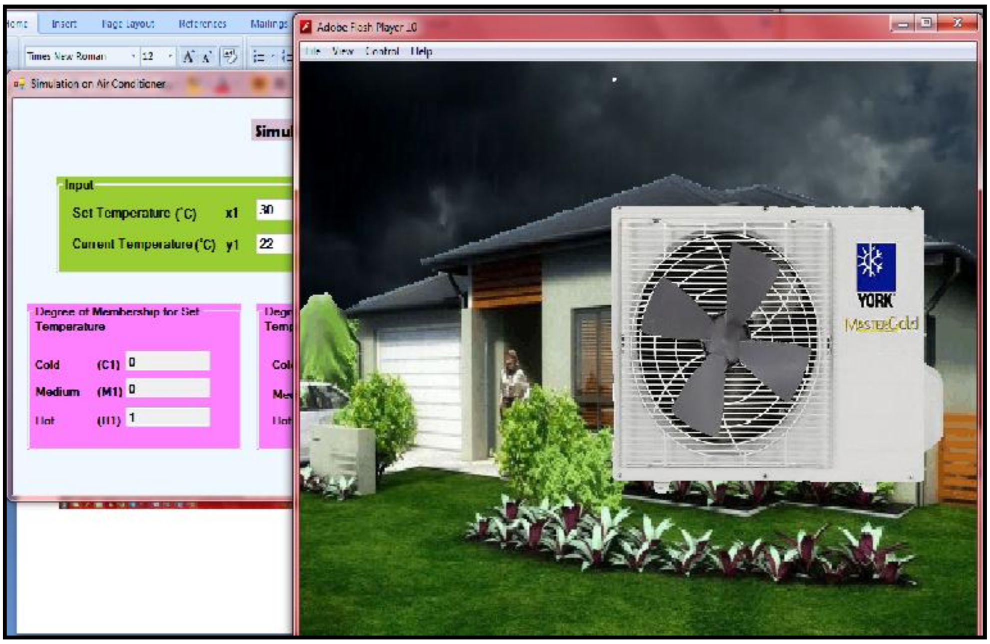


Figure 4: Simulation Interface (Cold Weather)