SIMULATION OF FUZZY LOGIC FOR WATERING PLANT USING SPRINKLER

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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)."

Signature
Name of Supervisor: MR. WAN MUHAMMAD SYAHRIR B. WAN HUSSIN
Position:
Date: 30 MEI 2012

STUDENT'S DECLARATION

I declare that this thesis entitled "Simulation of Fuzzy Logic for Watering Plant Using Sprinkler" 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.

Signature
Name: NURUL IDAYU BT MOHAMAD
ID Number: CD09041
Date: 30 MEI 2012

DEDICATION

First of all,

I would like to dedicate this dissertation to my family, especially my parents,

Mohamad Bin Yusof and the only mom that I have,

Zaharah Bt. Sulong.

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

for his guidance and inspirational instruction.

Besides that, I would also thank my lecturers from my faculty that have contributed ideas, feedback and advices.

Not forgotten Mohd Syamil Bin Mohd Kassimi for his support and motivation.

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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My sincere thanks go to all my friends from the faculty of computer system and software engineering, UMP, who helped me in many ways and made my stay at UMP pleasant and unforgettable. Many special thanks go to my friends who a same supervisor with me for her inspirations and supports during this project.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I am also grateful to my siblings for their supported. I cannot find the appropriate words that could properly describe my appreciation for their support in my ability to attain my goals. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

Project of simulation of fuzzy logic for watering plant using sprinkler is about simulate the total water that sprinkler needs to spray to the plants based on the inputs of the project. The inputs of the project are weather temperature and soil moisture temperature. This project is developed because to help the farmers to control the total of water for watering their plants. This system is suitable for users who use the sprinkler to watering their plants like farmers. The project actually created for Kuantan Department of Agriculture, Pahang to help them to control the total water of watering the plant. The system can use when user inserts the value of input; weather temperature and soil moisture temperature. After that, the total of water that watering plant will be calculated when the user clicks the calculate button. Then, user needs to click's simulation button to see the simulation of this project. From the system, hopefully can help the farmers and the other user to use this system to control their total of water of watering plant.

ABSTRAK

Projek simulasi fuzzy logic untuk menyiram tanaman menggunakan pemercik tanaman tentang simulasi jumlah air yang diperlukan untuk disembur oleh pemercik untuk menyiram tanaman berdasarkan input projek. Projek ini dibangunkan untuk membantu para petani untuk mengawal jumlah air untuk menyiram tanaman mereka. Sistem ini sesuai bagi pengguna yang menggunakan pemercik untuk menyiram tanaman merka seperti petani. Projek ini sebenarnya dicipta kepada Jabatan Pertanian Kuantan, Pahang untuk membantu mereka mengawal air untuk penyiraman tanaman. Sistem ini boleh digunakan apabila pengguna memasukkan nilai input iaitu suhu cuaca dan suhu kelembapan tanah. Selepas itu, jumlah air untuk menyiram tanaman akan dikira apabila pengguna klin pada butang kiraan. Kemudian, pengguna perlu klik pada butang simulasi untuk melihat simulasi projek ini. Dari sistem ini, diharapkan dapat membantu para petani dan pengguna lain untuk mengguna sistem ini untuk mengawal jumlah air untuk menyiram tanaman.

CHAPTER 1

INTRODUCTION

This chapter briefly discusses 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 those are the scopes of the system and lastly is the thesis organization which briefly describes the structure of this thesis.

1.1. Background

Simulation is the process of imitating a real phenomenon with a set of mathematical formulas. Advanced computers programs can simulate weather conditions, chemical reactions, atomic reactions, even biological processes.

Fuzzy logic is not logic that is fuzzy, but logic that is used to describe fuzziness. Fuzzy logic is that theory of fuzzy sets, sets that calibrate vagueness. Fuzzy logic is based upon the idea that all things admit of degrees of temperature, height, speed, distance, and beauty.

Simulation of fuzzy logic for watering plant using sprinkler is the form of computer based simulated environment through which user can control their watering plant from waste the water for their plants. Besides that, they do not have to about their fertility.

By developing this can be improved the system, that earlier have. From the system that earlier has, we know that sprinkler only can set their time for ejection; it is automatic splash when we set their time. From developing new system, we can save water for wasting. This system wills automatic watering the plants depend of weathers and soil moisture. If the weather that day was heavy rain, the system will not be watering plants and vice versa.

1.2. Problem Statement

In a current practice, watering sprinkler that uses in watering plant is a manual way. People need set up timer for sprinkler spray water for watering. There are few problems that need to be concern. One of the problems is when the hot days; plants need more water and sprinkler only watering the plant at the time set. This cause's plant growth is retarded, and some survive for long time.

The other problem is when the rainy day; the sprinkler still watering the plant at the time is set-up is usually two times a day; morning and evening. This cause of water wastage occurs, and the plants damaged due to excessive water.

1.3. Objective

The objectives of the project are:

i. To develop a prototype to simulate a sprinkler.
ii. Apply fuzzy logic technique to the simulation.

1.4. Scope

The scope for the project is:

i. The system is developed for reduce wastage of water and control the spraying time.
ii. The target user for this system is farmers.
iii. Input of watering sprinkler are weather temperature and soil moisture temperature.

iv. Output for watering sprinkler is total water that spray by sprinkler.
v. The device will be used to run the system is Visual Studio 2008.

1.5. Thesis Organization

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

Chapter two (2) is Literature Review that will discuss more on the research for 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 discuss. The content consists of the approach and framework for the project that used for 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 are discussed thoroughly. The constraints of this project are also stated clearly.

CHAPTER 2

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 Review

An interview has been conducted with Mr. Azmi bin Abd. Aziz, Assistant of Agriculture Department Kuantan, Pahang. There are several types of plants that have different quantity of water was needed water normally used for crops was excavated from the pond. Agriculture department has planted a crop that uses water as a way to splash the plants. Cucumber crops is an area is 6x10 meters. Cost of water for the crops is in the estimated RM300 per month. It used to sprinkler the cucumber plants should be set twice a day, morning and evening. Crops generally use a sprinkler is all kinds of plants except for fruit. Fruit normally drops way. Waste water will be sprayed during the day when the sprinkler was raining. Amount of sprinkler water spray is the same every day. Methods to reduce wastage of water that Agriculture Departments are using the droplet. The method is not very helpful because only certain crops can use the method.

2.2. Existing Systems Review

This section is reviewed the current system and the existing system that related to simulation of fuzzy logic for watering plant using sprinkler.

2.2.1. Garden Water Dispersal Controller

Sprinklers are used on farms, golf courses, and yards, to provide water to vegetation and plants in the event of drought. They may also be used for recreation, as a cooling system, or to keep down the amount of airborne dust. There have 4 types of sprinkler; Industrial, Residential sprinklers, Underground sprinklers and Farm sprinklers. Most sprinklers are used as part of a sprinkler system, consisting of various plumbing parts, piping and control equipment. Piping is connected to the water source via plumbing fittings and the control system opens and closes valves to provide water on a schedule. The control provided varies depending on the equipment used; some systems are fully automated and even compensate for rain, runoff and evaporation, while others require much more user attention for the same effectiveness. [1]

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. The intention is to see which system is better in optimizing water usage. Lastly, a simulation system was built to demonstrate the soil moisture content of the lawn, the percentage pattern of soil moisture and daily data involved in the system. [2]

2.2.2. Air-conditioning System

The fuzzy controlled of automobile air-conditioner was designed to establish fuzzy membership, fuzzy output and translated fuzzy outputs to precise value. The simulation frame of automobile air-conditioner compartment temperature was built to simulated which under summer environment and the temperature automobile can be controlled in the expected scope. [1]

The Fuzzy logic system is used to design this algorithm. Two inputs and one output are designed with an industrial application in mind. This system consists of two sensors for feedback control: one to the monitor of temperature and another one to the monitor of humidity. There are three control elements: cooling valve, heating valve, and humidifying valve, to adjust the temperature and humidity of the air supply. Fuzzy rules are formulated by temperature and humidity. The model of this controller algorithm has been simulated using MATLAB simulation. [3]

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 in account. Therefore, the objective of this paper is to study the implementation of fuzzy logic control in automobile climate control system compared to the existing state flow controller. [4]

2.2.3. Controller for HVAC Systems

HVAC (Heating, Ventilating and Air Conditioning) systems controller which employs a control algorithm using these either fuzzy logic reasoning or rough set theory. The controller deduces the appropriate control outputs from sensor readings. The system is capable of controlling temperature and humidity. To maintain temperature at the reference point, the controller adjusts the flow of hot water in a heating coil for heating operation or the flow of chilled air through the air duct for cooling operation.

To control humidity, the controller turns on and off a humidifier. The fuzzy logic reasoning shows better performance in both temperature and humidity control than the rough set method. In particular, for humidity control, the method of fuzzy logic reasoning shows better performance than the rough set method. [5]

This system has been embedded in microprocessors with interfaces to the sensors, compressor, and air circulation fan and installed in a test building for performance evaluation. Some results of the analysis and performance evaluation for the fuzzy logic control system are presented as well as a discussion of the performance of the system from a subjective point of view of humans living in the facility. [6]

2.2.4. Water Level Control

Synthesis water level control by fuzzy logic focuses on evolving of two type's 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). 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). Because this is a more complex task than just inserting a few control parameters we use a special user interface (FIS) for designing fuzzy logic applications. [7]

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. [8]

The purpose of this project is to design a simulation system of fuzzy logic controller for water tank level control by using simulation package which is Fuzzy Logic Toolbox and Simulink.in MATLAB software. In order to find the best design to stabilize the water level in the system, some factors will be considered. For this project, the water level was controlled by using three rules of membership function which then extended to five rules and seven rules for verification purpose and further improvement of the system. Besides that, several of different methods also been used in order to design the most stabilize system and this project was focused to the software part only. By doing some modification of this project, the design will be very useful for the system relates to liquid level control that widely use in industry nowadays. [9]

2.2.5. An Introduction to Fuzzy control System

A fuzzy control system is a control system based on fuzzy logic. Fuzzy logic is widely used in machine control. The term itself inspires a certain skepticism, sounding equivalent to "half-baked logic" or "bogus logic", but the "fuzzy" part does not refer to a lack of rig our in the method, rather to the fact that the logic involved can deal with fuzzy concepts—concepts that cannot be expressed as "true" or "false" but rather as "partially true". [10]

Fuzzy controllers are very simple conceptually. They consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value. The most common shape of membership functions is triangular, although trapezoids and bell curves are also used, but the shape is generally less important than the number of curves and their placement. From three to seven curves are generally appropriate to cover the required range of an input value, or the "universe of discourse" in fuzzy jargon. As discussed earlier, the processing stage is based on a collection of logic rules in the form of IF-THEN statements, where the IF part is called the "antecedent" and the THEN part is called the "consequent". Typical fuzzy control systems have dozens of rules. [11]

2.2.6. 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. [12]

A fuzzy traffic lights controller to be used at a complex traffic junction in the middle of Kuala Lumpur city, Malaysia was proposed. The proposed fuzzy traffic lights controller is capable of communicating with neighbor junctions and manages phase sequences and phase lengths adaptively. A real case study of a complex traffic junction is simulated having 4 intersections. Average flow density, average delay time and link overflow of all the 4 intersections are used as performance indices when comparing the fuzzy controller with two other existing traffic lights controllers in Malaysia, namely the preset cycle time and vehicle-actuated controllers. A simulator has been developed to show the effectiveness of the fuzzy traffic controller which can also be used for teaching purposes. [13]

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. The second experiment shows that using co-learning vehicles avoid 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%. [14]

2.2.7. How Irrigation Works

Water is essential to plants. It carries important nutrients from the soil and is an important trigger for germination and the process of photosynthesis. Without water, plants simply won't grow. Irrigation systems provide water. When it comes to watering plants in our yards or gardens, most of us don't always like to rely on the weather -- we may use watering cans or sprinkler systems. This is irrigation at its simplest level. [15]

Many drip irrigation management schemes rely on frequent monitoring of soil water content and matric potential using various sensors. The information is used either for scheduling irrigation, or for adjusting schedules based on evapotranspiration measurements. Most soils exhibit spatial variations in their hydraulic properties, which in turn, induce spatial variations in wetting patterns about the drippers. The objective of this study was to quantify effects of mild spatial variation in soil hydraulic properties on the mean and variance of soil water content and matric potential distribution about point sources and the consequences on soil water sensor placement and interpretation. [16]

The system can call a preset number at a set time with a message that irrigation is proceeding as scheduled. The system significantly reduces human labor. It is automatic. Human inputs are required only as crop water needs change. Growers will use automotive resource management to remain competitive, reduce labor and meet environmental requirements. [17]

2.3. Tool and Equipment

2.3.1. MATLAB/Simulink tool

Most of the existing systems use the MATLAB/Simulink tool to design the prototype system. The existing systems are Automobile Air-conditioner, Traffic Light Controller, 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. [15]

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. [2]

2.3.2. Visual Basic 6 (VB6) environment

Function of visual basic 6 (VB6) is same with Matlab tool; it is to design the prototype system. Typically, designer uses the Matlab tools to design their prototypes than VB6 because Matlab tools easier to use.

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. [2]

2.4. Techniques

2.4.1. Fuzzy Logic

2.4.1.1. Fuzzy Set

The concept of a set is fundamental to mathematics. However, our own language is also the supreme expression of sets.

The simulation will display the animation of the water tank level that controlled based on the rules of fuzzy sets. This project covers the processes of developing the application of fuzzy expert system in water tank level control. It starts from the theory until it implemented into the simulation environment. [15]

2.4.1.2. 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. [8]

2.4.1.3. 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.

After a minimum green (5 s)

If Arrival is few AND Queue is (few OR small OR medium OR many) then Extension is zero.

Else if Arrival is small AND Queue is (few OR small) then

Extension is short.

Else if Arrival is small AND Queue is (medium OR many) then Extension is zero.

Else if Arrival is medium AND Queue is (few OR small) then Extension is medium.

Else if Arrival is medium AND Queue is (medium OR many) then Extension is short.

Else if Arrival is many AND Queue is few then Extension is long.

Else if Arrival is many AND Queue is (small OR medium) then Extension is medium.

Else if Arrival is few AND Queue is many then Extension is short. [2]

Beside that fuzzy rule also in the table such as in existing system:

Table 2. GreenPhase Module Fuzzy Rules.

RULE	INPUTS		OUTPUTS
	QueueNum	FrontNum	Extend
1.	Z		Z
2.	S	S	S
3.	S	M	S
4.	S	L	S
5.	M	S	L
6.	M	M	M
7.	M	L	S
8.	L	S	VL
9.	L	M	VL
10.	L	L	L

This is example of fuzzy rule base table. [3]

2.5. 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 3

METHODOLOGY

In this chapter will discuss about the methodology that will be using in the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler. For Simulation of Fuzzy Logic for Watering Plant using Sprinkler, the **Rapid Application Development (RAD) method** was choosing because RAD has several characteristic that is suitable for the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler. 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 of Fuzzy Logic for Watering Plant using Sprinkler development. The last section will elaborate the hardware and software that was used in the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler.

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:

a. Requirement Planning
b. User Design
c. Construction
d. Cutover

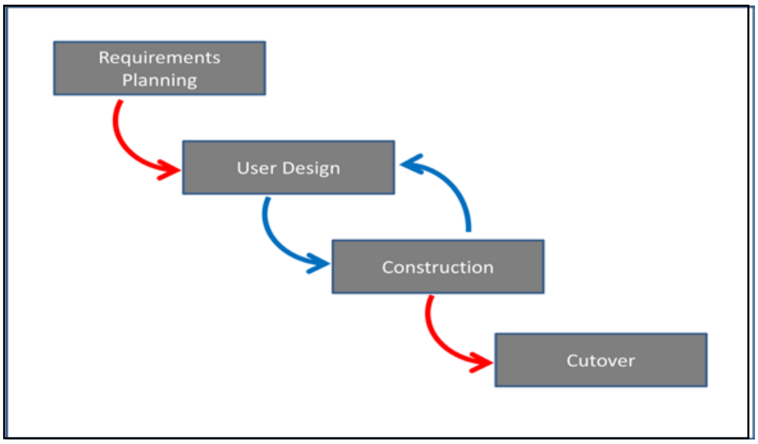

Figure 3.1 Rapid Application Development Lifecycle

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. Azmi bin Abd. Aziz, Assistant of Agriculture Department Kuantan, Pahang. There are several types of plants that have different quantity of water was needed water normally used for crops was excavated from the pond. Agriculture department has planted a crop that uses water as a way to splash the plants. Cucumber crops is an area is 6x10 meters. Cost of water for the crop is in the estimated RM300 per month. It used to sprinkler the cucumber plants should be set twice a day, morning and evening. Crops generally use a sprinkler is all kinds of plants except for fruit. Fruit normally drops way. Waste water will be sprayed during the day when the sprinkler was raining. Amount of sprinkler water spray is the same every day. Methods to reduce wastage of water that Agriculture Departments are using the droplet. The method is not very helpful because only certain crops can use the method.

3.3.1.2 Hardware and Software Tools

This Simulation of Fuzzy Logic for Watering Plant using Sprinkler 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 fulfill 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 in table 3.1:

Table 3.1: Hardware specification

Hardware	Description
Laptop	Compaq Presario CQ40
Processor	Intel Core Duo, 2.00GHz
Printer and Scanner	Canon PIXMA MP287
Hard disk	Seagate 320 GB
Pen drive	Kingston 4GB

3.3.1.2.2 Software

Below 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 3.2:

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 Power Point 2007	Produce slide presentation
4.	Microsoft Office Project 2007	Produce Gantt chart
5.	Paint	Edit screenshot
6.	Mozilla Firefox	Internet browser used during the finding of information
7.	Matlab	Create fuzzification process
7.	Visual Basic	As platform to create 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.

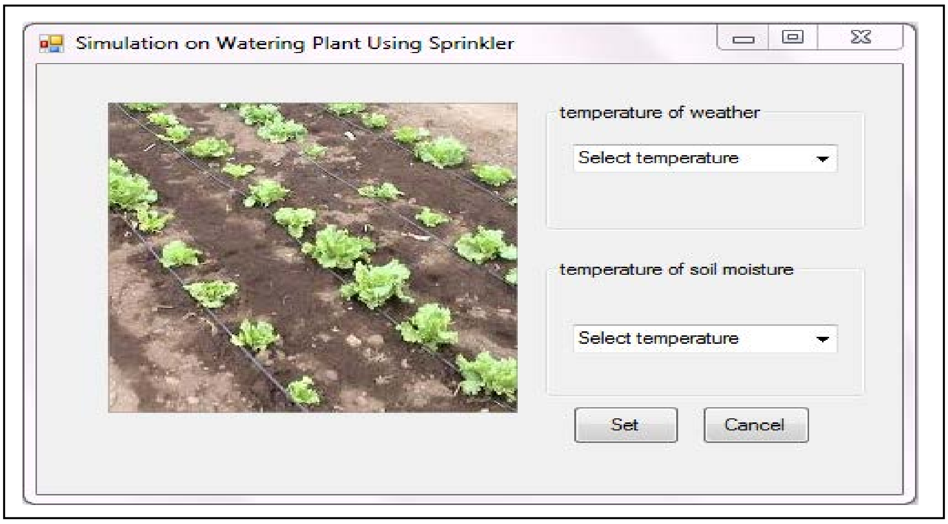

Figure 3.2: Example of Interfaces

3.3.2.1 Fuzzification Process

In fuzzification 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]. Table 3.3 and table 3.4 shown the linguistic variable for each input for temperature based on range from 18˚c to 35˚c. Table 3.5 shown the linguistic variable for output of total water based range 0 ml to 1000 ml of water.

3.3.2.2 Linguistic Variable And Fuzzy Set

Table 3.3: Fuzzy set of Moisture Temperature domain

Linguistic variable : input moisture_temp, y1		
Linguistic value	Notation	Numerical range (˚c)
Wet	C	18 to 24
Medium	M	26 to 28
Dry	H	30 to 35

Table 3.4: Fuzzy set of Weather Temperature domain

Linguistic variable : input weather_temp, y1		
Linguistic value	Notation	Numerical range (˚c)
Rainy	C	18 to 24
Medium	M	26 to 28
Hot	H	30 to 35

Table 3.5: Fuzzy set of Total Water domain

Linguistic variable : output total_water, z1		
Linguistic value	Notation	Numerical range (ml)
Little	L	0 to 200
Medium	MD	300 to 600
Many	M	700 to 1000

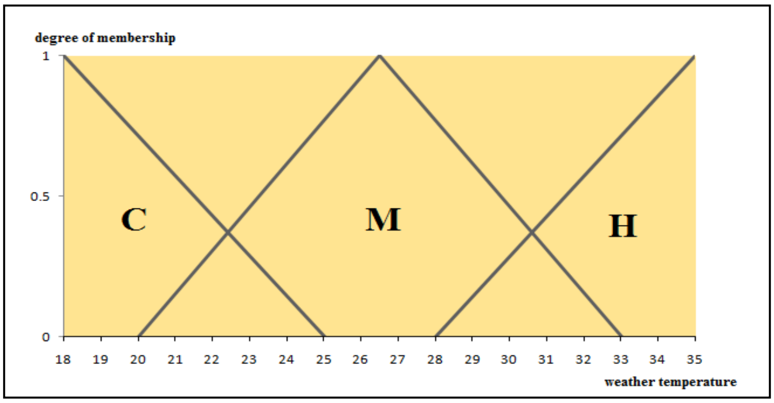

Figure 3.3: Graph of degree membership for weather temperature

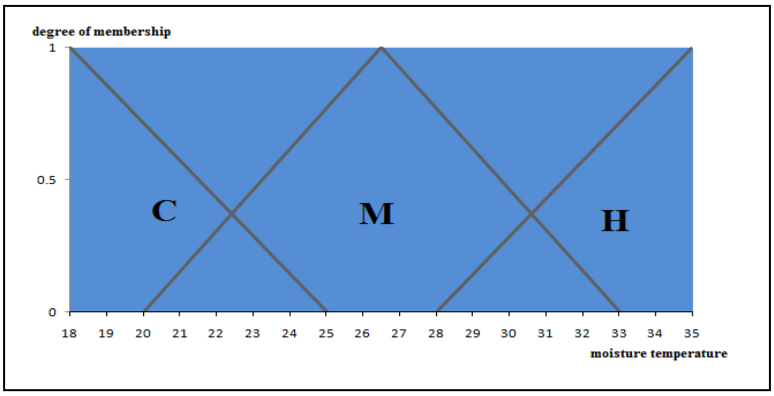

Figure 3.4: Graph of degree membership for soil moisture temperature

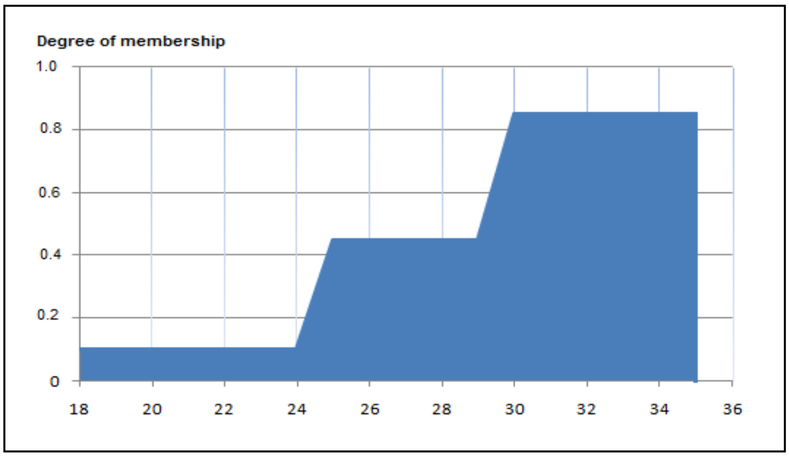

Figure 3.5: Graph of degree membership for total water of watering plant

3.3.2.3 Rules Evaluation Process

There are nine rules involved on this project. The rules are shown in table 3.6:

Table 3.6: Fuzzy rule table

input	Moisture temperature		
Weather temperature	C	M	H
	M	M	C
	H	C	C

Table 3.7: nine Fuzzy Rules

rules	Weather _temp	weight	Moisture _temp	weight	Total _water	weight
1	C	1	C	1	L	2
2	C	1	M	2	L	3
3	C	1	H	3	M	4
4	M	2	C	1	L	3
5	M	2	M	2	MD	4
6	M	2	H	3	M	5
7	H	3	C	1	MD	4
8	H	3	M	2	MD	5
9	H	3	H	3	M	6

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.

From one example, weather temperature is 21˚c and soil moisture temperature is 26.5˚c, and it will fulfill in graph figure 3.6 and 3.7 respectively. From the graph, it will fulfil the rule 2 in the table 3.8 and the expected output for total water in figure 3.8

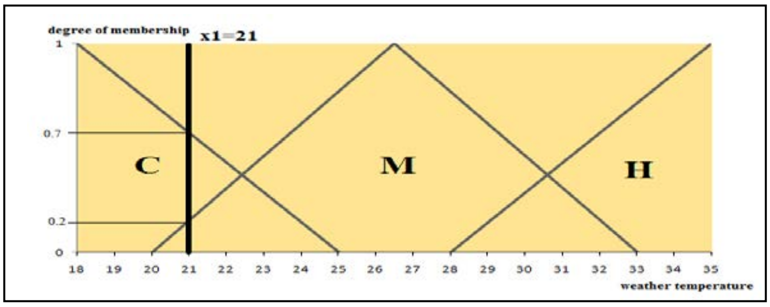

Figure 3.6: weather temperature for 21˚c

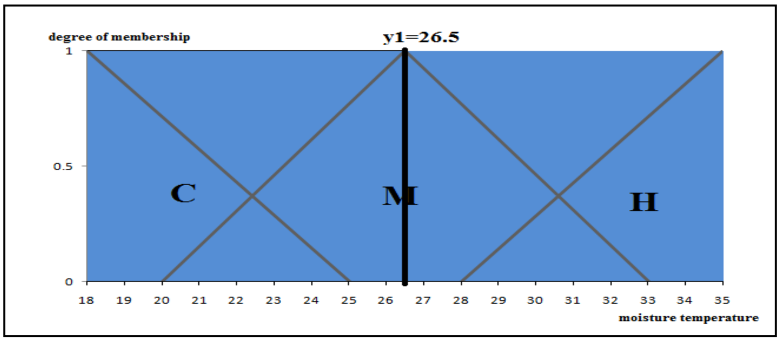

Figure 3.7: soil moisture temperature for 26.5˚c

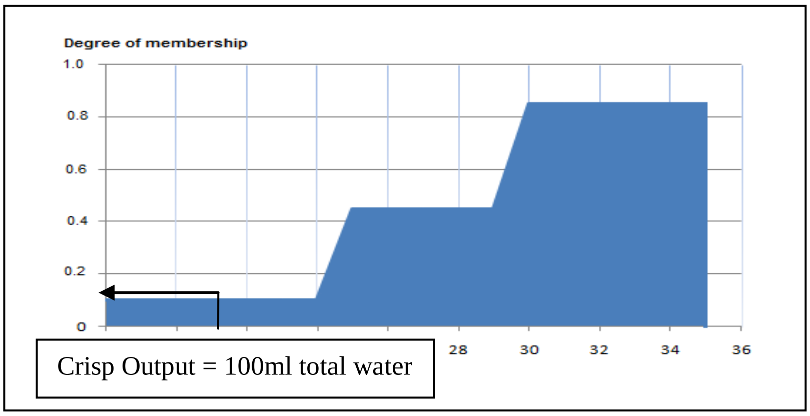

Figure 3.8: Expected output for total water in graph form

Table 3.8: The rules that fulfilled with the examples.

rules	Weather _temp	weight	Moisture _temp	weight	Total _water	weight
1	C	1	C	1	L	2
2	C	1	M	2	L	3
3	C	1	H	3	M	4
4	M	2	C	1	L	3
5	M	2	M	2	MD	4
6	M	2	H	3	M	5
7	H	3	C	1	MD	4
8	H	3	M	2	MD	5
9	H	3	H	3	M	6

Rule 2

IF weather_temp (x1) is rainy (C)

AND moisture_temp (y1) is medium (M)

THEN total_water is little (L)

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.

3.3.2.5 Defuzzification Process

The last step in the fuzzy inference process is defuzzification. Figure 3.7 show the calculation of the output value by using COG formula.

$$\text{COG} = \frac{((0+100+200)*1) + ((300+400+500+600)*0) + ((700+800+900+1000)*0))}{((1*3) + (0*4) + (0*4))}$$

$$= 100$$

Figure 3.9: Expected output by using of COG

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 of Fuzzy Logic for Watering Plant using Sprinkler. 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 4

IMPLEMENTATION

4.0 Introduction

This chapter explains the implementation process of Simulation of Fuzzy Logic for Watering Plant using Sprinkler 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 main page and the explanation of the process particularly the simulation of Fuzzy Logic for watering plant using Sprinkler. Other explanation includes the rules, interfaces and source code.

4.1 System Implementation Environment

The development environment using windows operating system has been choose for the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler. This window is selected because it is easy to use and compatible with Microsoft Visual Studio 2008. Thus, the user can use this simulation of Fuzzy Logic to get the total water of spray by sprinkler based on the weather temperature and the moisture temperature.

4.2 System Implementation Process

This section explains the implementation process of Simulation of Fuzzy Logic for Watering Plant using Sprinkler that consists of calculation of total water of watering plant and the simulation of the watering plant. The main processes in this system are calculation total water of watering plant using sprinkler and fuzzy logic steps that include the fuzzification, evaluation rules, aggregation and defuzzification to produce simulation of watering plant. The flow of implementation of simulation of watering plant is based on the flow chart for Simulation of Fuzzy Logic for Watering Plant using Sprinkler which is shown in Figure 4.1.

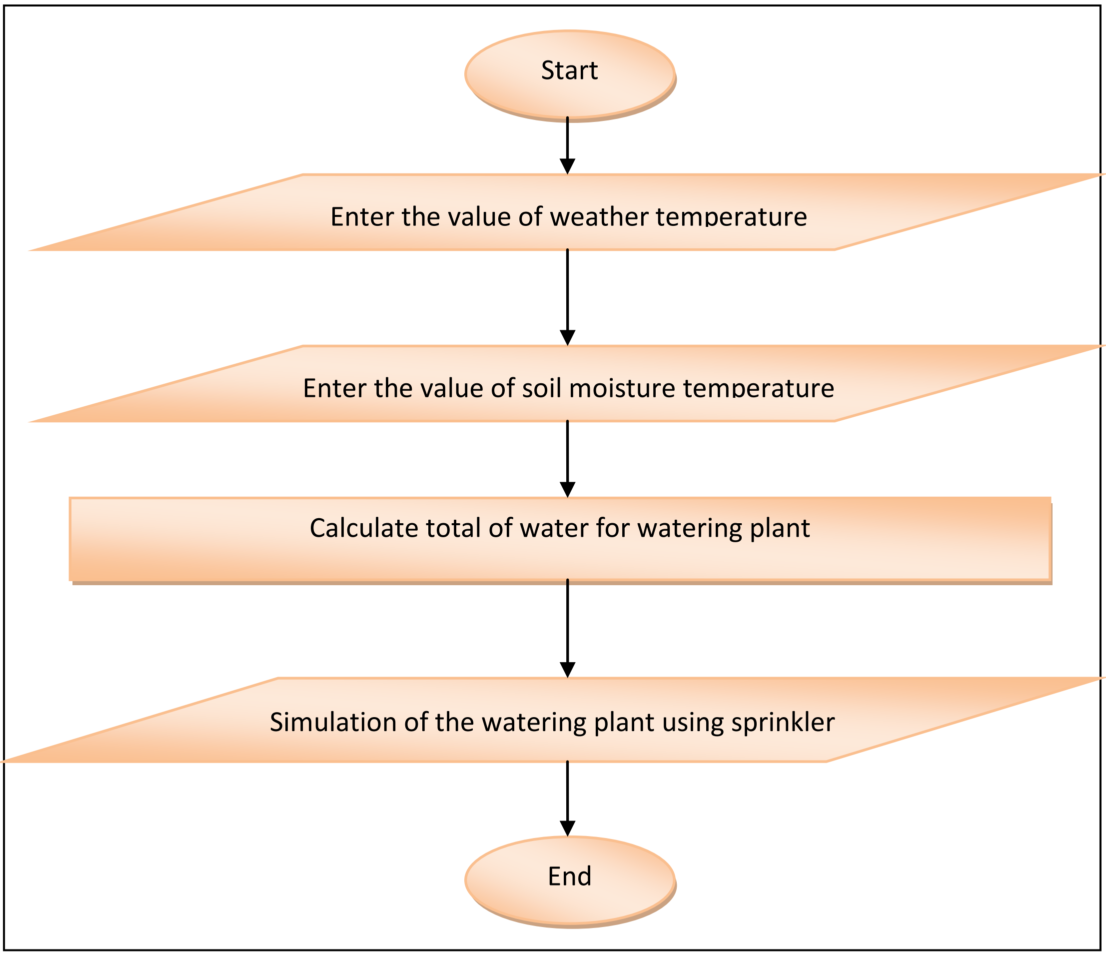

Figure 4.1: Flow Chart for Simulation of Fuzzy Logic for Watering Plant using Sprinkler

4.2.1 Main Page of Simulation of Fuzzy Logic For Watering Plant Using Sprinkler

Figure 4.2 shows the interface of the home page of Simulation of Fuzzy Logic for Watering Plant using Sprinkler. 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 of Simulation of Fuzzy Logic for Watering Plant using Sprinkler

4.2.2 Calculation Of Total Water For Watering Plant

Figure 4.3 show the interface of the input form. Where the user needs to key in the weather temperature and soil moisture temperature and the system will run and produce the total water of watering plant after conversion. User only can key in the range of input only 18 degree Celsius until 35 degree Celsius. There is a Calculate Button, when the user clicks on it the system will calculate the total water of watering plant. Home button is function as navigation to go back to the home page. Reset button to clear all the data and Simulation button is use to go simulation form.

Figure 4.3: Input Page of Simulation of Fuzzy Logic for Watering Plant using Sprinkler

Figures 4.4 is show the source code of calculation of total water for watering plant in millimeter (ml).

```
Public Class Form2

    Dim x1 As Double
    Dim y1 As Double
    Dim W1 As Double
    Dim W2 As Double
    Dim W3 As Double
    Dim M1 As Double
    Dim M2 As Double
    Dim M3 As Double
    Dim R1 As Double
    Dim R2 As Double
    Dim R3 As Double
    Dim category_x1 As Double
    Dim category_y1 As Double
    Dim category_z1 As Double
    Dim VarAggregate As Double
    Dim VarDefuzzify As Double
```

```
Private Sub Button2_Click_1(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        x1 = inputBox1.Text
        y1 = inputBox2.Text

        fuzzification()
        evaluateRules()
        aggregation()
        defuzzification()

        OutputBox.Text = Format(VarDefuzzify, "0")
    End Sub
```

Figure 4.4: Source code of calculation of total water for watering plant.

4.2.3 Fuzzy Logic Process

There are four stages in fuzzy logic which are fuzzification, evaluate rules, aggregation and defuzzification. When user clicks on Calculate Button on the input form, the total water for watering plant will display. Figure 4.5 show the last output of the system after clicks on the Calculate button after key in the temperature value.

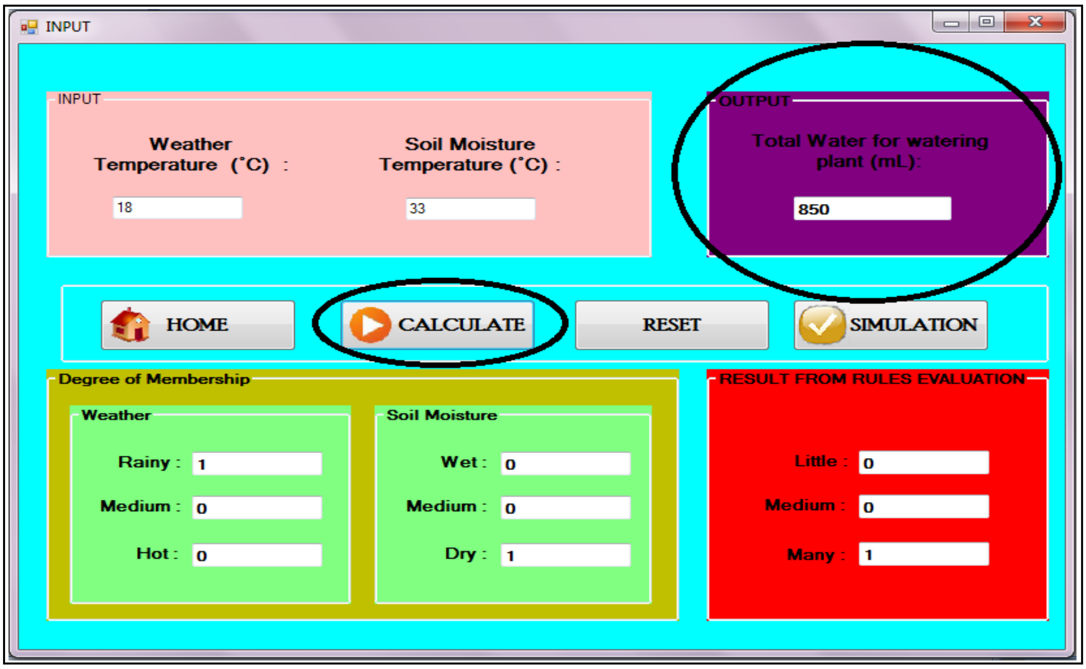

Figure 4.5: Interface of the result form where all the value are displayed

In the Figure 4.5 show the result of the calculation and the total water for watering plant is 850 ml. 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.

4.2.3.1 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 weather temperature, and soil moisture temperature. Figure 4.7 and Figure 4.8 shows the source code of fuzzification process where the conditions and formulae were included. Figure 4.6 shows the interface of the application with the value of the fuzzification output.

Figure 4.6: Interface of fuzzification process.

Figure 4.7 shows the fuzzification coding of weather. In the Figure 4.7, there are two parts which is part 1 and part 2. Part 1 is the condition of weather. Checking the condition of weather input is belonging to which cases. For the example, the case 0 was selected the formulae to change the crisp value into fuzzy shows in the sign of part 2.

In the Figure 4.8, there are also two parts which is part 3 and part 4. Part 3 is the condition of soil moisture. Checking the condition of soil moisture input is belonging to which cases. For the example, the case 2 was selected the formulae to change the crisp value into fuzzy shows in the sign of part 4.

```
If (x1 >= 18 And x1 < 25) Then
    category_x1 = 0
ElseIf (x1 >= 25 And x1 < 30) Then                1
    category_x1 = 1
ElseIf (x1 >= 30 And x1 < 36) Then
    category_x1 = 2
End If
Select Case category_x1
    Case "0"
        W1 = 1
        W2 = 0                      2
        W3 = 0
    Case "1"
        W1 = 0
        W2 = 1
        W3 = 0
    Case "2"
        W1 = 0
        W2 = 0
        W3 = 1
  End Select
```

Figure 4.7: Fuzzification coding for weather temperature.

```
If (y1 >= 18 And y1 < 25) Then
    category_y1 = 0
ElseIf (y1 >= 25 And y1 < 30) Then
    category_y1 = 1
ElseIf (y1 >= 30 And y1 < 36) Then                3
    category_y1 = 2
End If
Select Case category_y1
    Case "0"
        M1 = 1
        M2 = 0
        M3 = 0
   Case "1"
        M1 = 0
        M2 = 1
        M3 = 0
   Case "2"
        M1 = 0
        M2 = 0              4
        M3 = 1
   End Select
```

Figure 4.8: Fuzzification coding for soil moisture temperature.

4.2.3.2 Evaluation Rules

After defuzzification process, the system will automatically find the evaluate rules function that fulfill with the input. Figure 4.9 shows the coding for result from rules evaluation that fulfills the condition of the input. By checking the condition of soil moisture input and weather input are belonging to which cases, the part 5 shows the condition of rules evaluation for this system. The case 0 is fulfilling the condition of input and it shown as part 6.

```
      If (category_x1 = 0 And category_y1 = 0) Then    '1
            category_z1 = 0
        End If
        If (category_x1 = 0 And category_y1 = 1) Then    '2
            category_z1 = 0
        End If
        If (category_x1 = 0 And category_y1 = 2) Then    '3      5
            category_z1 = 2
        End If
        If (category_x1 = 1 And category_y1 = 0) Then    '4
            category_z1 = 0
        End If
        If (category_x1 = 1 And category_y1 = 1) Then    '5
            category_z1 = 1
        End If
        If (category_x1 = 1 And category_y1 = 2) Then    '6
            category_z1 = 2
        End If
        If (category_x1 = 2 And category_y1 = 0) Then    '7
            category_z1 = 1
        End If
        If (category_x1 = 2 And category_y1 = 1) Then    '8
            category_z1 = 1
        End If
        If (category_x1 = 2 And category_y1 = 2) Then    '9
            category_z1 = 2
        End If
        Select Case category_z1
            Case "0"
                R1 = 1
                R2 = 0            6
                R3 = 0
            Case "1"
                R1 = 0
                R2 = 1
                R3 = 0
             Case "2"
                R1 = 0
                R2 = 0
                R3 = 1
        End Select
```

Figure 4.9: Source code of rule evaluation that fulfill with input

4.2.3.3 Aggregation

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 4.9 shows how the output of each rule which are the output of rule number 2 and number 5 is aggregated into a single fuzzy set. The output of aggregation will be used as an input of defuzzification process. Figure 4.10 shows the coding of aggregation.

```
Public Sub aggregation()
        VarAggregate = ((0 + 100 + 200) * R1) + ((300 + 400 +
                  500 + 600) * R2) + ((700 + 800 + 900 +
            1000) * R3)

       End Sub
```

Figure 4.10: Source code of output of aggregation.

4.2.3.4 Defuzzification Process

The last step in the fuzzy inference process is defuzzification.

Figure 4.11 show the calculation of the output value by using COG formula.

```
Public Sub defuzzification()
        VarDefuzzify = VarAggregate / ((R1 * 3) + (R2 * 4) + (R3 * 4))
    End Sub
```

Figure 4.11: Source code of output of value by using COG formula.

4.3 Simulation

After the system finish the calculation of the total water of watering plant, the user need click the button simulation and the simulation will appear based on the value of input that we inserted. Figure 4.12 and figure 4.13 show the interface of simulation.

Figure 4.12: Interface of simulation process.

Figure 4.13: example of one simulation.

Figure 4.15 show the source code for simulation process for different value of input of temperature. Part 1 in the figure 4.14 shows the source code for example of simulation in figure 4.13.

```
Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button5.Click

If (category_x1 = 0 And category_y1 = 0) Then    '1
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene1new_Scene 1.swf")
                                                        1
ElseIf (category_x1 = 0 And category_y1 = 1) Then    '2
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene2new_Scene 1.swf")

ElseIf (category_x1 = 0 And category_y1 = 2) Then    '3
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene3new_Scene 1.swf")

ElseIf (category_x1 = 1 And category_y1 = 0) Then    '4
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene4new_Scene 1.swf")

ElseIf (category_x1 = 1 And category_y1 = 1) Then    '5
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene5new_Scene 1.swf")

ElseIf (category_x1 = 1 And category_y1 = 2) Then    '6
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene6new_Scene 1.swf")

ElseIf (category_x1 = 2 And category_y1 = 0) Then    '7
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene7new_Scene 1.swf")

ElseIf (category_x1 = 2 And category_y1 = 1) Then    '8
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene8new_Scene 1.swf")

ElseIf (category_x1 = 2 And category_y1 = 2) Then    '9
System.Diagnostics.Process.Start("C:\Users\aa\Desktop\My_Psm\Backup\scene9new_Scene 1.swf")
        End If

    End Sub
```

Figure 4.14: source code of the simulation.

4.4 Testing

A testing has been conducted after the completion of the development this system.The purpose of this testing is to check the error 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.

CHAPTER 5

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 Fuzzy Logic for Watering Plant Using Sprinkler 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 Fuzzy Logic for Watering Plant Using Sprinkler. 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 Fuzzy Logic for Watering Plant Using Sprinkler, 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 Fuzzy Logic for Watering Plant Using Sprinkler 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 a sprinkler.
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 Fuzzy Logic for Watering Plant Using Sprinkler.

5.2.1.1 To develop a prototype to simulate a sprinkler.

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 CS5 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 total water for watering plant must be done.

Designing the simulation in Flash CS5 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 Fuzzy Logic for Watering Plant Using Sprinkler.

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 total water of watering plant by entering two inputs that are weather temperature and soil moisture 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 sprinkler. With the total water according to the inputs that user set earlier.

5.4.2 Disadvantages

The disadvantage of this system are, it can only show the total water of watering plant 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 Fuzzy Logic for Watering Plant Using Sprinkler which is as below:

1. Animate the simulation. For example show exchange of the plant from wilted plants to fertile plants.

2. Apply the simulation to the sprinkler.

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 of Fuzzy Logic for Watering Plant Using Sprinkler is a prototype to simulate the total water of watering plant using sprinkler based on the two types of temperature that are weather temperature and soil moisture temperature. This simulation is developed to be use or implement at the plants in farms of Kuantan Agriculture Department, Pahang that uses sprinkler system.

The fuzzy logic technique is used in developing this system to represent value of total water of sprinkler. 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 the plants exchange from wilted to fertile.

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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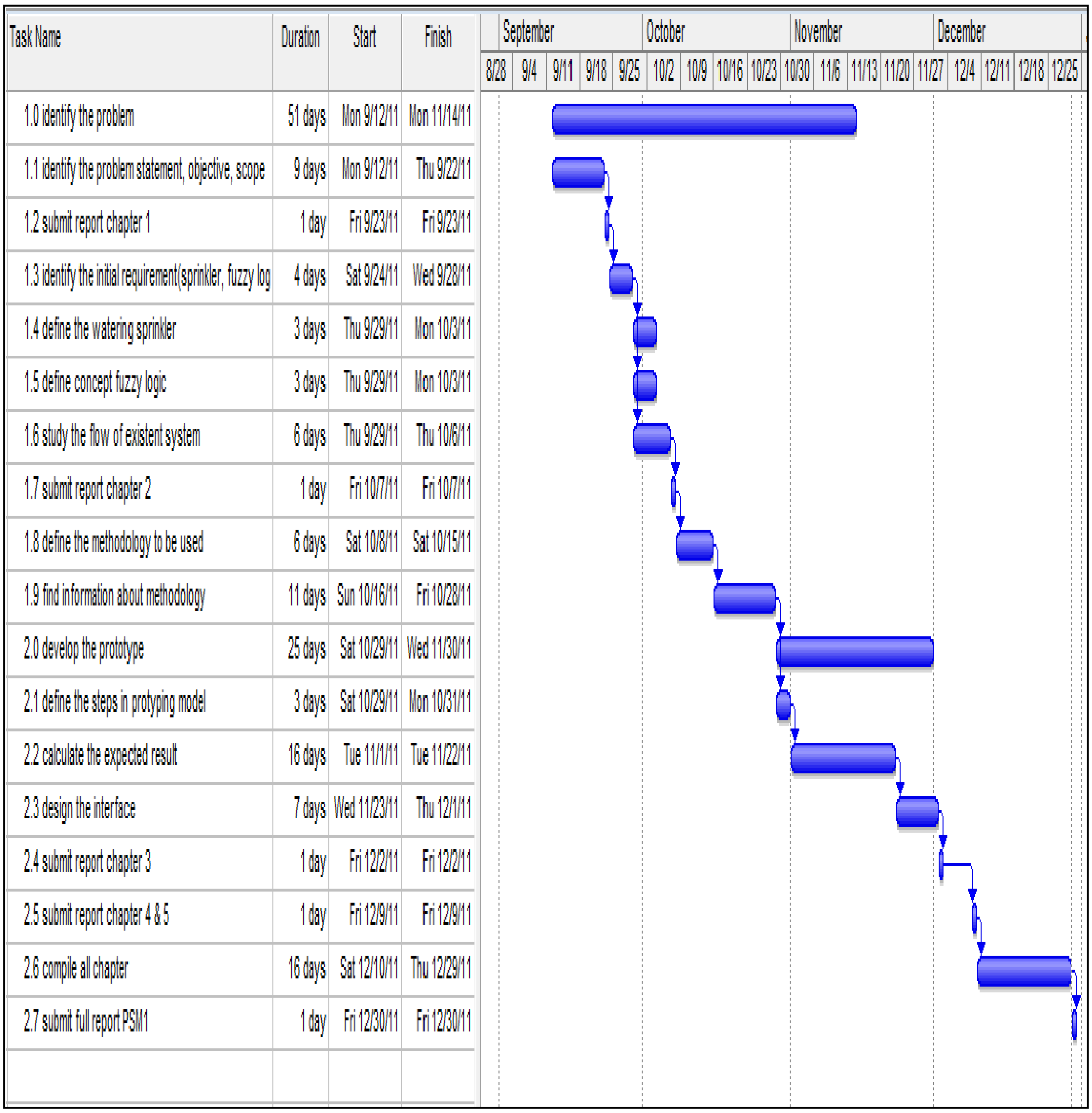
APPENDIX A

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 watering sprinkler	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

9 SIMULATIONS

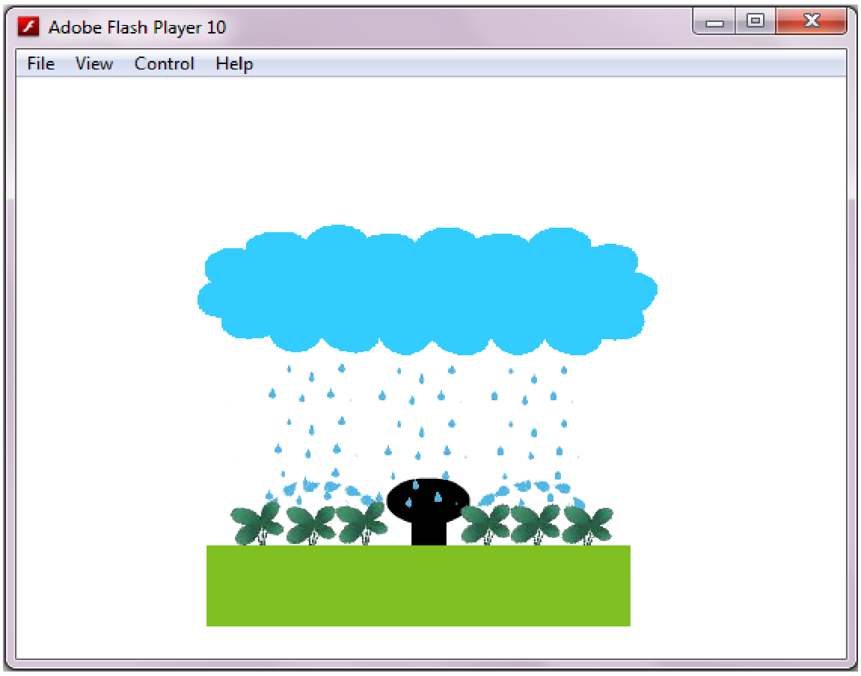


Figure B1: Simulation for rainy day and wet soil

Figure B2: Simulation for rainy day and medium soil

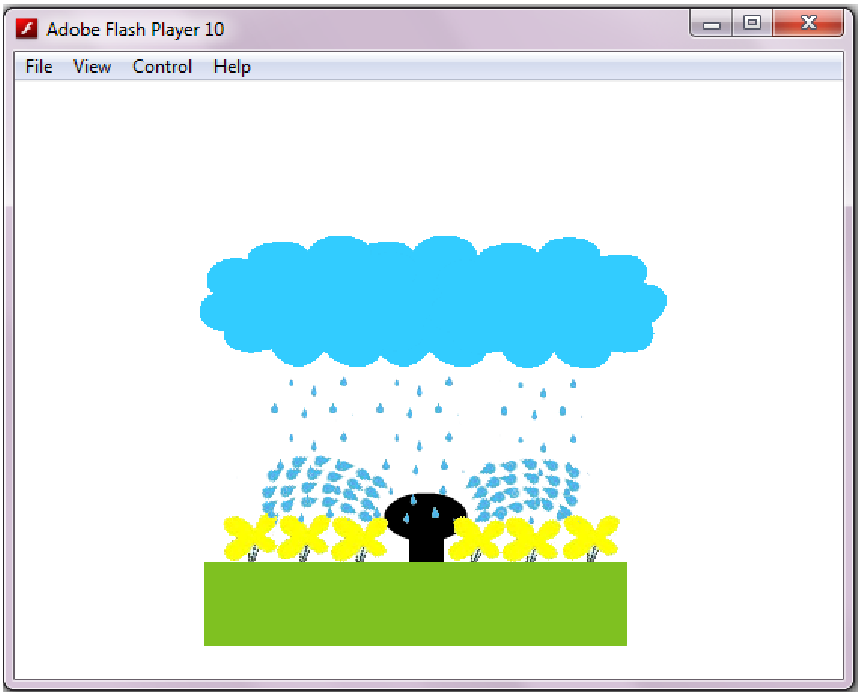


Figure B3: Simulation for rainy day and dry soil

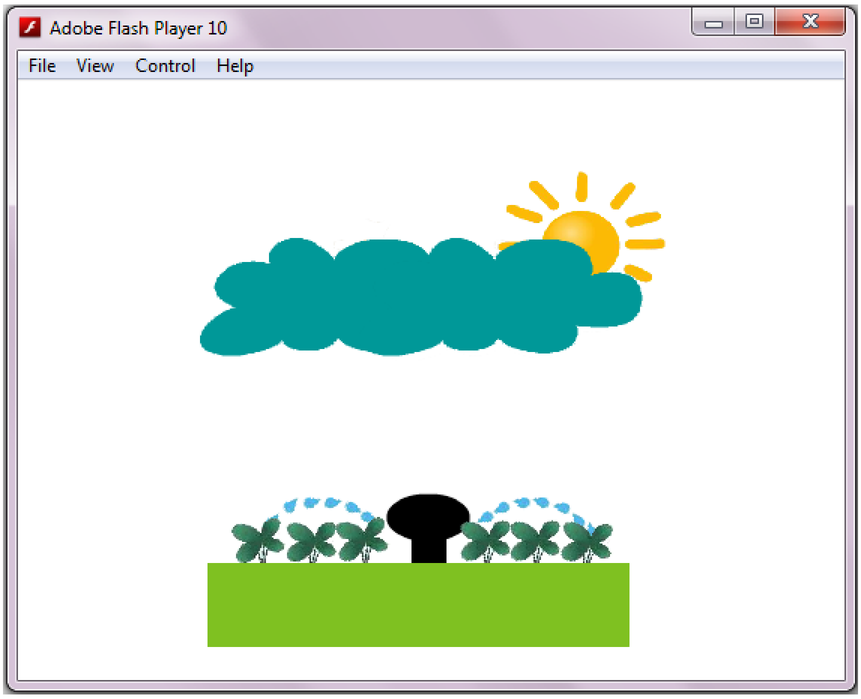


Figure B4: Simulation for cloudy day and wet soil

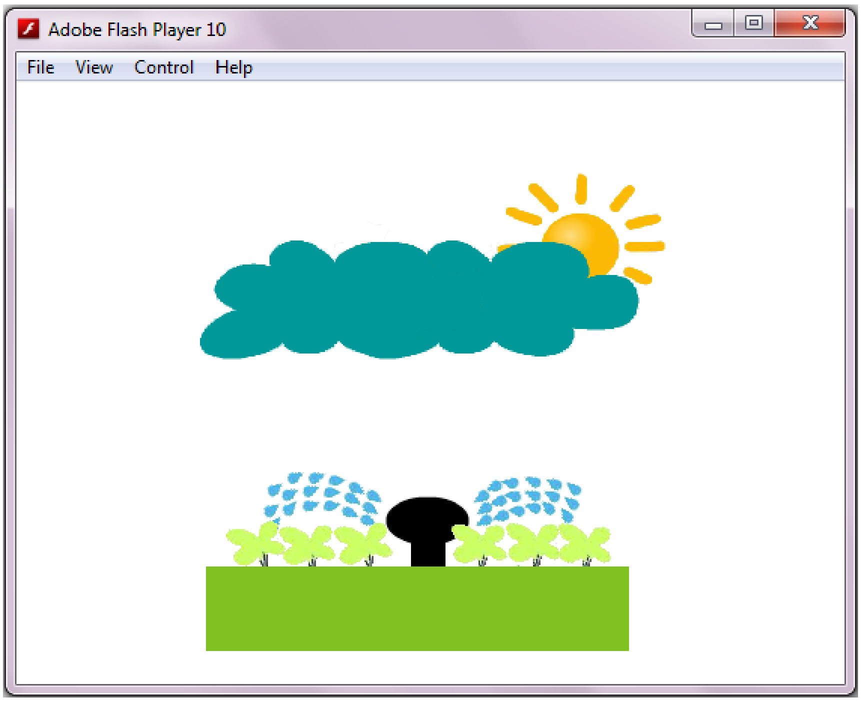


Figure B5: Simulation for cloudy day and medium soil

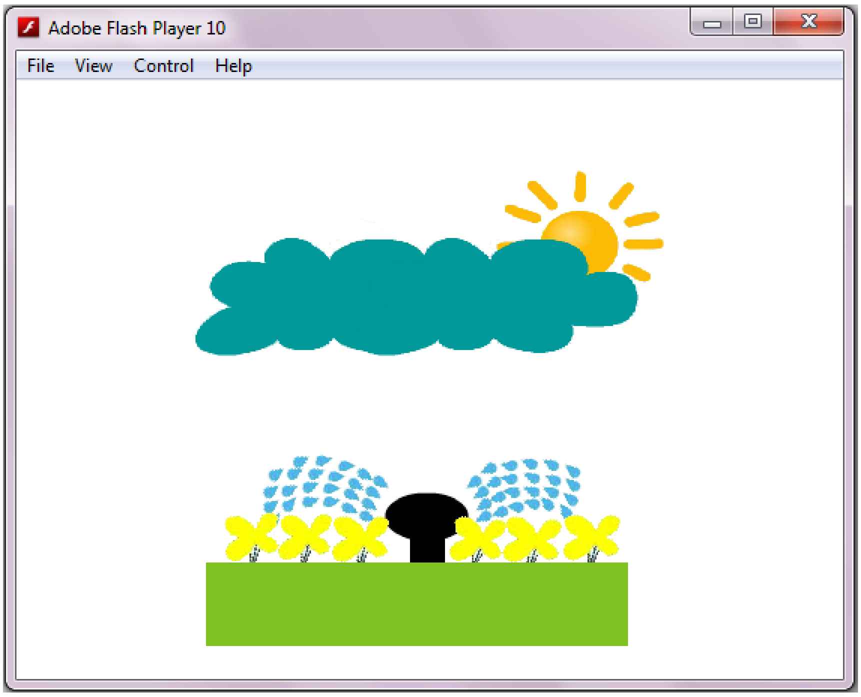


Figure B6: Simulation for cloudy day and dry soil

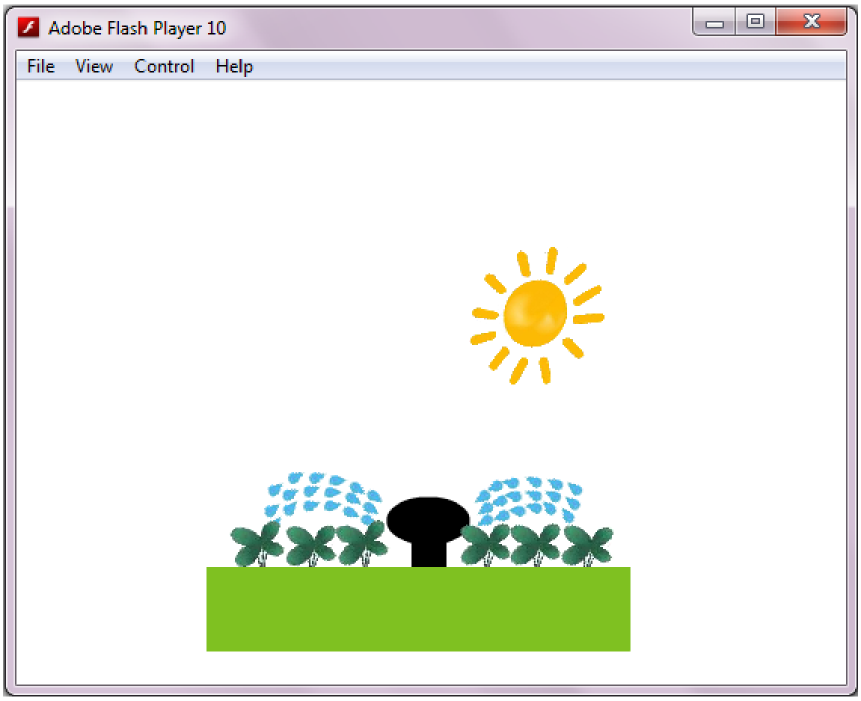


Figure B7: Simulation for hot day and wet soil

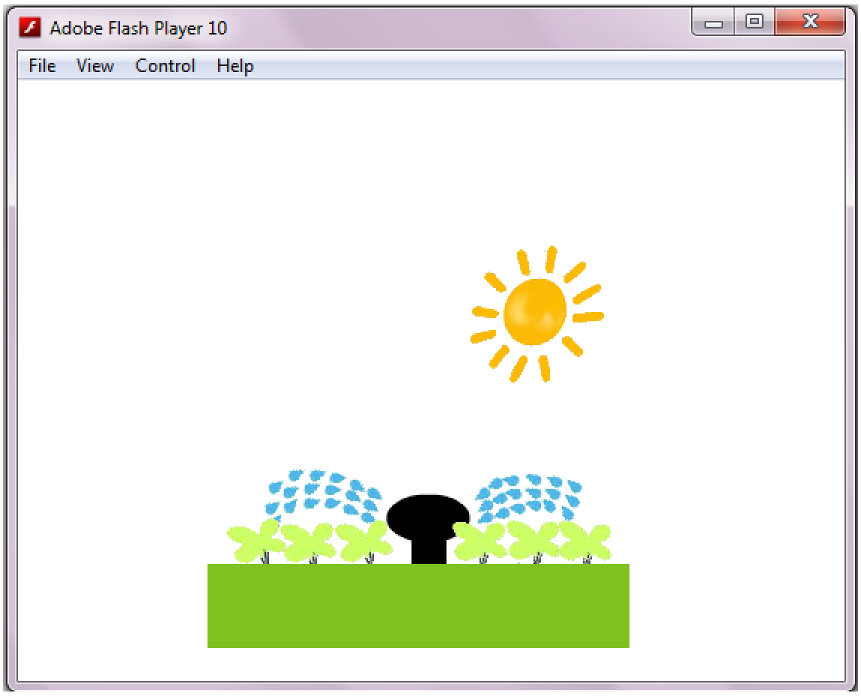


Figure B4: Simulation for hot day and medium soil

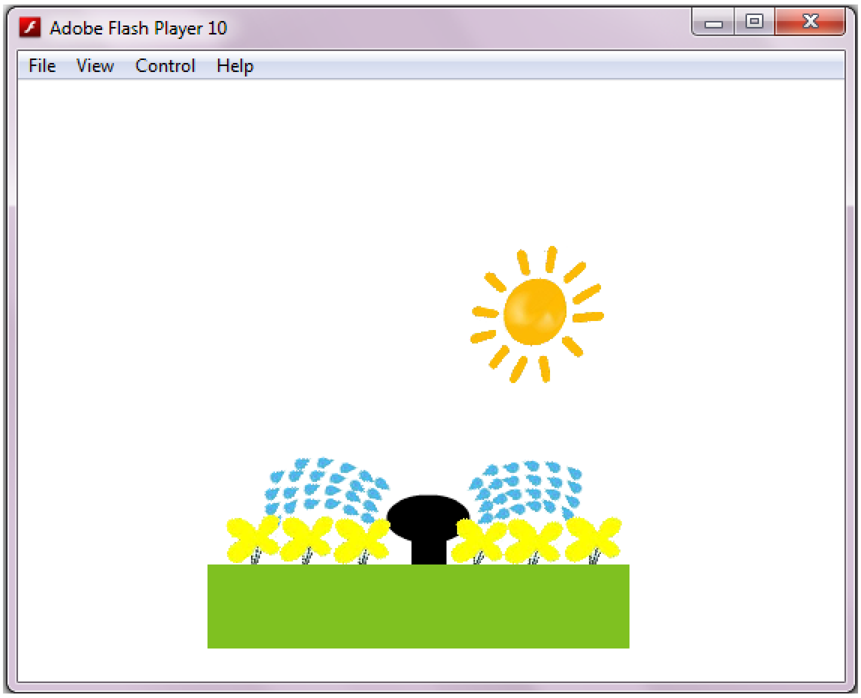


Figure B4: Simulation for hot day and dry soil

APPENDIX C

USER MANUAL

SIMULATION OF FUZZY LOGIC FOR WATERING PLANT USING SPRINKLER

USER MANUAL

Figure C1 is shows the home page of the system. If the user wants to use the system, they can proceed by clicks on the NEXT Button. If not, clicks on the EXIT Button on the form.

Figure C1: Home page

Figure C2 is shows the input form of the system. User need to key in the inputs of the system which is the value of temperature. The inputs of the system are categorized into two which are weather temperature and soil moisture temperature. User need to key in the inputs as shown in Figure C2 and clicks on CALCULATE Button to calculate the total water. Figure C3 shows the value of calculation the inputs.

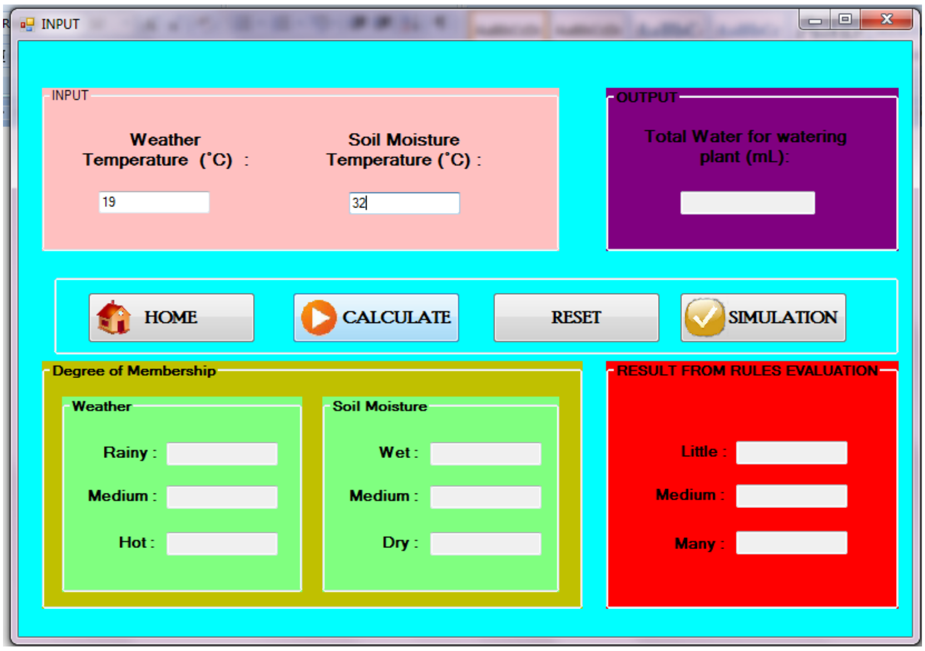


Figure C2: Input page

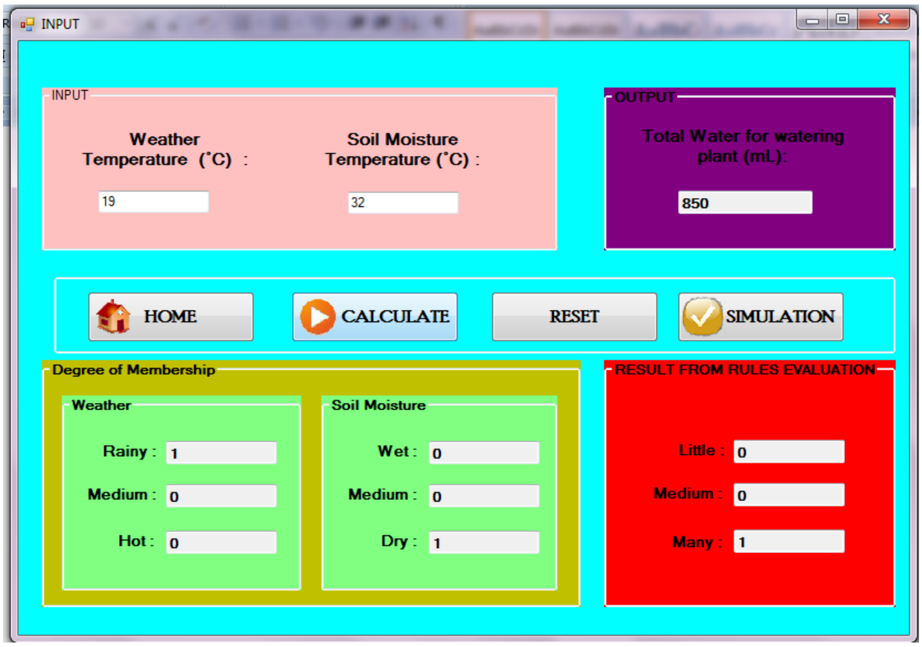


Figure C3: Calculation of the total water

Figure C4 is shows when the user clicks on the SIMULATION Button on the input page. Figure C4 is the form of the simulation where the result and total water are listed.

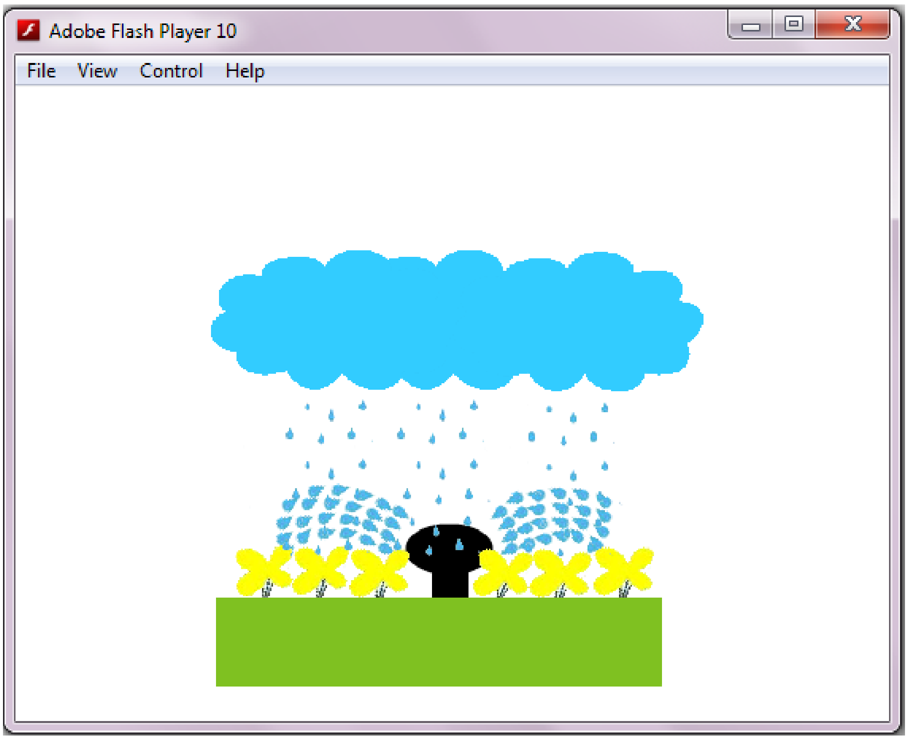


Figure C4: Simulation