CONTROL OF A FLUID MIXER

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To my beloved parents and family, who had strongly encouraged, guide and inspired me throughout my journey of education

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I am very grateful to God because with His blessing, I am able to complete my final year project successfully. First and foremost, I would like to take this opportunity to thank my supervisor, Mdm. Noor Asyikin binti Sulaiman for her guidance and motivation throughout my graduate career. I am deeply grateful to my family for their love and support in my whole life. They make me confident to finish my study and my final project. Lastly, I would like to thank and express my appreciation to all the people who help, guide and cooperate with me when I need it the most. Thank you.

ABSTRACT

This project is about to control a fluid mixer using fuzzy logic controllers. The system consists of two auxiliary tanks that have two different colours and one main tank as the result of mixer. This system should control the water level and the colouration of the mixer fluid. Thence, two controllers are used to control both of water level and colouration of a fluid mixer. Output flow from the auxiliary tank is controlled by q1 and q2, and the output flow from the main tank is controlled by q0. So at the end of this project, the water level and the colouration of the fluid mixer can be controlled.

ABSTRAK

Projek ini berkenaan pengawalan campuran cecair menggunakan pengawal logik kabur. Sistem ini terdiri daripada dua tangki tambahan yang mempunyai dua warna berbeza dan sebuah tangki utama sebagai hasil campuran cecair. Sistem ini seharusnya mengawal paras air dan warna bagi campuran cecair. Dua alat kawalan digunakan untuk mengawal paras air dan warna campuran cecair. Keluaran bendalir dari tangki tambahan dikawal oleh q_1 dan q_2, dan keluaran bendalir dari tangki utama dikawal oleh q_0. Akhirnya, paras air dan warna bagi campuran boleh dikawal.

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LIST OF ABREVIATION

B	-	Big
FIS	-	Fuzzy Inference System
FL	-	Fuzzy Logic
GUI	-	Graphical User Interface
M	-	Medium
NB	-	Negative big
NM	-	Negative medium
NS	-	Negative small
NVB	-	Negative very big
PB	-	Positive big
PID	-	Proportional Integrate Derivative
PM	-	Positive medium
PS	-	Positive small
PVB	-	Positive very big
S	-	Small
VB	-	Very big
Z	-	Zero

CHAPTER I

INTRODUCTION

This chapter will discuss about the introduction, objectives, scope and methodology of the project.

1.1 Introduction

Nowadays, various parameters in a process of industrial are controlled, for example temperature and level. Fluid mixer is a common process in industries such as painting and coating industry and complex chemical plant. The implemented fuzzy logic is widely used in process control such as the temperature, pressure and level control.

In this project, two fuzzy logic controllers are designed to control a fluid mixer. Fluid mixer consists of mixing tank and two auxiliary tanks as shown in Figure 1.1. The controllers are designed to control the water level and the colour of the fluid mixer. The first controller has two input which is height error,e_h and the output flow,q_0. And the output of controller is q, which is the output from the auxiliary tank to the mixing tank. The first controller is designed to control the water level.

For second controller, the input of controller is colouration error,e_c and change in colouration error, Δe_c ; and the proportion q_r of colour water in the total flow as the output of the controller. This controller is designed to control the colouration of the fluid mixer.

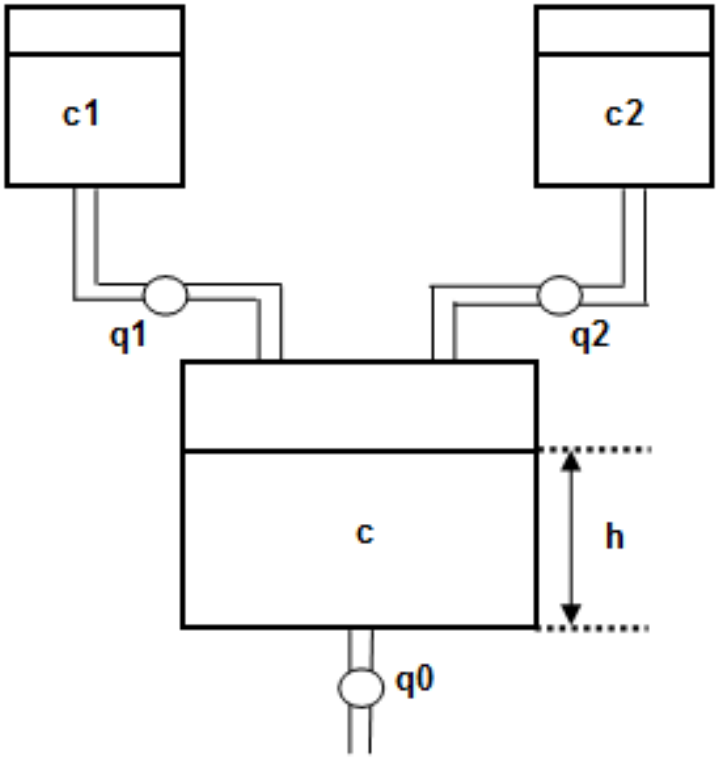

Figure 1.1 The Fluid Mixer System

1.2 Objectives

A few objectives are determined as guidance through out the completion of this project in order to achieve the desired output. The objectives of this project are:

i. To design a fuzzy logic controller
ii. To control the water level, h and colouration, c of the mixer

1.3 Problem Statement

In fluid mixer, the multivariable process can be more complex during the process of designing control strategy and rule-base. By manually control, sometimes it may cause an overflow in the mixing tank or colouration is out of specs. Furthermore, it requires extra cost to hire a worker to monitor the system. This project attempts to control both height and colouration of the mixer simultaneously. Thus, the errors can be reduced or eliminated. In addition, this project can reduce manpower usage; hence it can reduce production cost.

1.4 Scope of Project

This project is focusing on the controllers and the variables that need to be controlled. The controllers used in this project are two fuzzy logic controllers.

The variables that need to be controlled are the water level, h and the colouration, c_0 of the mixing fluid. All simulation is performed using MATLAB Simulink software.

1.5 Methodology

In methodology a flowchart is used to explain the design steps to accomplish this project.

The important steps to complete this project are to design proper input and outputs, FIS (Fuzzy Inference System) and the block that can implement the function of the fluid mixer tank system. At the end of this project the complete design is come out.

The details methodology will be explained in chapter 3.

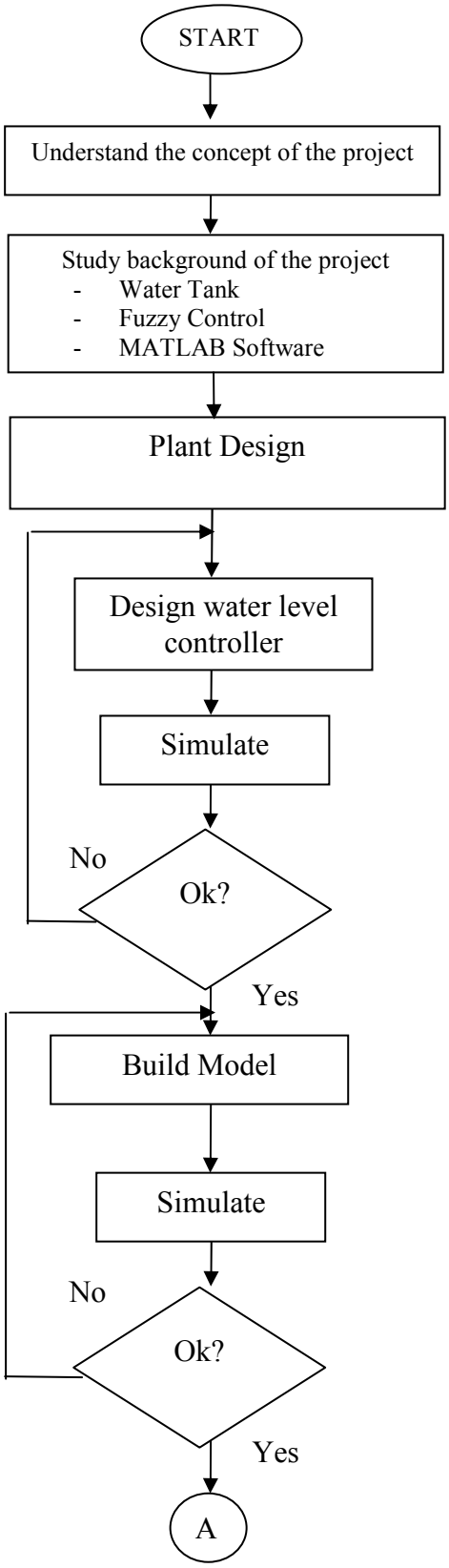

Figure 1.2 Flow Chart of Methodology

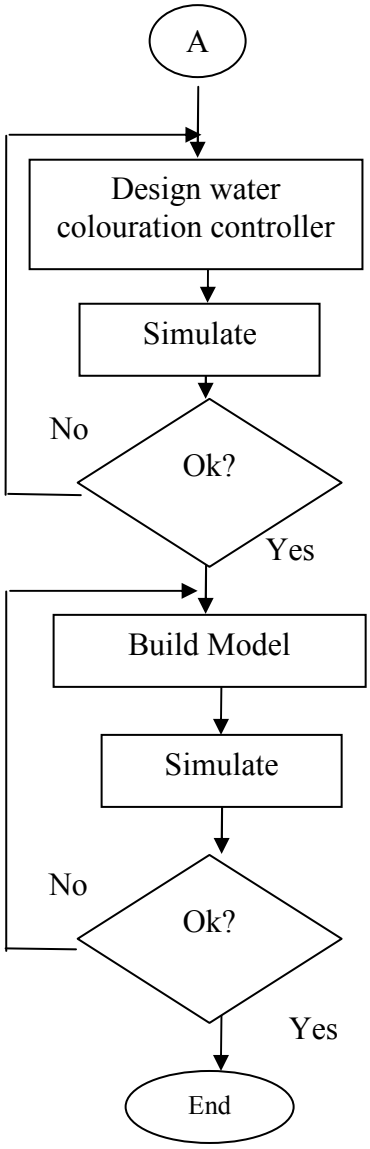

Figure 1.3 Flow Chart of Methodology (continue)

1.6 Report Structure

This thesis contains of five chapters. The first chapter is about the introduction of this project. This chapter will explain the objectives, scope of project and problem statement that related to control a fluid mixer system.

The second chapter is literature review. All the background study that relates to this project will discuss here. This chapter explain about definition and theory of the fuzzy logic.

The third chapter is about methodology of the project. This chapter will discuss about the method that used to complete this project. Design step of fuzzy logic controller are shown through this chapter.

The fourth chapter explains about the result and discussion of the project. The simulation results are discussed further in this chapter.

The fifth chapter is about the conclusion and suggestion of the project. It presents a full summary of the project and the suggestion to other researcher on how to improve the efficiency and accuracy of this controller.

CHAPTER II

LITERATURE REVIEW

The concept of fuzzy logic was conceived by Lotfi Zadeh, a professor at the University of California at Berkley [1]. The word fuzzy means blurred, fluffy, frayed or indistinct.

2.1 Introduction

2.1.1 What is Fuzzy Logic

Fuzzy logic is a problem-solving control system methodology which implements in systems starting from simple, small, embedded micro-controllers to large, networked and control systems. It can be implemented in hardware, software, or a combination of both.

Fuzzy logic provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information.

The relationship between precision and uncertainty, the more uncertainty in a problem, the less precise can be known in understanding of that problem. Fuzzy logic system is a nonlinear mapping of input data vector into a scalar output case decomposes into a collection of independent multi-input/single-output systems [1].

One of the objectives of fuzzy logic control is to control complex processes by using knowledge-based control strategy from human experience. The control design in fuzzy logic controller is based on empirical knowledge regarding the behaviour of the process, and does not use a strictly analytic framework. In other word fuzzy logic copy the human action regarding to solve a problem.

Fuzzy controllers apply fuzzy sets and operations on fuzzy sets to model process nonlinearity are to establish a link between linguistic information and mathematics of the controllers, to capture heuristic knowledge and rules of thumb, and to model the approximation behaviour of systems [1].

2.1.2 Characteristic of Fuzzy Logic

Fuzzy controller is able to design along linguistic lines-usage of rules based on experience. It is suitable for complex system like complex chemical plant. In addition, it has a better performance than the conventional PID controllers and it is simple to design. Here are the general observations about fuzzy logic;

1) It is inherently robust since it does not require precise, noise-free inputs and can be programmed to fail safely if a feedback sensor quits or is destroyed. The output control is a smooth control function despite a wide range of input variations [2].

2) Since the Fuzzy logic controller processes user-defined rules governing the target control system, it can be modified and tweaked easily to improve or drastically alter system performance. New sensors can easily be incorporated into the system simply by generating appropriate governing rules [2].

3) Fuzzy logic is not limited to a few feedback inputs and one or two control outputs, nor is it necessary to measure or compute rate-of-change parameters in order for it to be implemented. Any sensor data that provides some indication of a system's actions and reactions is sufficient. This allows the sensors to be inexpensive and keeps the overall system cost and complexity low [2].

Fuzzy logic can control nonlinear systems that would be difficult or impossible to model mathematically.

2.1.2.1 Fuzzy Logic Advantages

Fuzzy logic is a great problem-solving methodology with wide applications in industrial control and information processing. It provides a simple way to draw definite conclusions from fuzzy and confusing information. It used human decision making with its ability to work from approximate data and fine exact solutions.

In addition fuzzy logic combine an alternative way of thinking, which allows modelling complex systems using a higher level of idea originating from our knowledge and experience.

State that fuzzy logic mimic human decision making to handle unclear concepts. Here are the general observations about fuzzy logic. Firstly, the fuzzy logic is modelling of complex and non-linear problems. The user can create a fuzzy system to match any set of input-output data.

Next, fuzzy logic has ability to deal with imprecise or imperfect information. Fuzzy sets provide a mathematical way to represent vagueness and fuzziness in humanistic system.

Fuzzy logic improved knowledge representation and uncertainty reasoning.

2.1.2.2 Fuzzy Logic Disadvantages

Fuzzy logic is depending very much on the type of the application. So the several limitations has been identified, fuzzy logic has highly abstract and heuristic and need experts for rule discovery which is data relationships. Each fuzzy fact is a declaration of the degree of membership in fuzzy set; it is difficult to estimate membership function.

A fuzzy limitation includes lack of self-organizing and self-tuning mechanisms of Neural Network. There are many ways of interpreting fuzzy rules, combining the outputs of several fuzzy rules and defuzzify the output.

2.1.3 Application of Fuzzy Logic

Fuzzy systems have been used in a wide variety of applications in engineering, science, business, medicine, psychology, and other fields. In addition, the fuzzy logic system is widely used in fuzzy logic controller and signal processing applications.

The application of fuzzy logic is widely used in engineering, science, business, medicine and psychology. In engineering fields, the fuzzy logic is widely used such as in Aircraft/spacecraft which is related to the Flight control, engine control, avionic systems, failure diagnosis, navigation, and satellite attitude control. Automated highway systems one of the application of fuzzy logic, which automatic steering, braking, and throttle control for vehicles well known as Cruise Controlled.

Fuzzy logic also has been implemented in power industry. It is used in motor control, power control/distribution, and load estimation. Fuzzy logic is widely used in process control which is the temperature, pressure and level control.