ANTI-SWING AND POSITIONING CONTROL OF A GANTRY CRANE SYSTEM USING FUZZY LOGIC CONTROLLER

SITI SAEIDAH BINTI MOHD ZAKI

This report is submitted in partial fulfillment of the requirement for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

May 2008

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**ANTI-SWING AND POSITIONING CONTROL OF A GANTRY CRANE SYSTEM USING FUZZY LOGIC CONTROLLER**
Sesi Pengajian	:	**2007 / 2008**

Saya **SITI SAEIDAH BINTI MOHD ZAKI**

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: NO. 15, JALAN PINGGIRAN 5/30,
DESA PINGGIRAN PUTRA,
43000 KAJANG,
SELANGOR.

AZDIANA BT MD YUSOP
Pensyarah
Fakulti Kej Elektronik dan Kej Komputer (FKEKK),
Universiti Teknikal Malaysia Melaka (UTeM),
Karung Berkunci 1200,
Ayer Keroh, 75450 Melaka

Tarikh: 09·05·2008

Tarikh: 9 May 2008

"I hereby declared that this report entitled Anti-Swing and Positioning Control of a Gantry Crane System Using Fuzzy Logic Controller is a result of my own work except for the works that have been cited clearly in the references."

Signature : ....

Student : SITI SAEIDAH BINTI MOHD ZAKI

Date : 09.05.2008

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award the Bachelor of Electronic Engineering (Industrial Electronic) With Honours"

Signature : ....

Name : PN AZDIANA BINTI MD. YUSOP

Date : 9 May 2008

Special dedicated to my beloved parents, family and fellow friends, who had strongly encouraged and supported me in my entire journey of learning…

ACKNOWLEDGEMENT

First of all, I would like to be grateful Allah s.w.t with his bless I managed to complete this thesis. I also would like to show millions appreciation to all the people who helped to make this project a successful project especially to my supervisor Mrs. Azdiana binti Md. Yusop who shares her time and attention as well as her knowledge in modeling a gantry crane system in order to make sure that that my project is in the right track and finished for PSM 1 and PSM 2. In addition, I also would like to express my gratitude to my group members of gantry crane project for hardware part which are Mohammad Shah Izham bin Abdull, Nur Syahiran bin Nordin, Rustam bin Ramli and Esmie Khalik Mohammad bin Ismail. Not to forget, Mr. Saifullah bin Salam, our lab technician by sharing his time and knowledge about our lab scale gantry crane for the better performances. I also would like to express my appreciation to my parent who gave full support throughout doing this project. Last but not least I would like to express thanks for the contributions of my colleagues at Universiti Teknikal Malaysia Melaka who involved direct or indirect to this project. Without their support, this project may not be successful. Those who contributed to this project required special thanks here. Special thanks for those whom I did not have the pleasure of interacting personally, but whose contributions are extremely valuable nevertheless.

ABSTRACT

The use of gantry crane for transporting payload is very common in industrial application. However, a big problem is that the suspended load swing easily. This leads to the possibilities of collision of load with obstacle during the crane work. Emergency stop for collision avoidance is also dangerous because residual sways after the stop is easy to be caused by the stop. Therefore, this project presents a fuzzy logic controller based on the experience of skillful operator handling a crane. Thus, fuzzy logic controller is adopted, designed and implement to control payload position as well as the swing angle of the gantry crane. The results show that the gantry crane system with implementation of fuzzy logic is more stable than the automatic gantry crane.

ABSTRAK

Penggunaan kren pembawa beban dalam industri pengangkutan sangat meluas pada masa kini. Bagaimanapun, masalah besar yang dialami oleh mereka yang terlibat secara langsung dalam bidang ini adalah beban yang diangkut mudah bergoyang serta tidah stabil. Keadaan yang berlaku menyebabkan peratusan kemalangan sewaktu membawa beban meningkat. Kren juga tidak mampu untuk berhenti secara mengejut kerana keadaan tersebut amat berbahaya dan mampu mencederakan pekerja yang terlibat. Maka dalam projek ini, satu sistem baru iaitu pengawal fuzzy logik dapat mengurangkan masalah ini dengan berpandukan pengalaman dari pekerja yang mahir dalam mengendalikan kren supaya dapat mengawal pergerakan kren pembawa barang dengan mengurangkan ayunan yang terjadi. Dalam projek ini, satu sistem kren telah dicipta dan pengawal fuzzy logik telah diaplikasikan ke dalam sistem tersebut supaya sistem tersebut stabil dan sekaligus dapat mengurangkan ayunan beban tersebut. Hasil kajian telah berjaya membuktikan bahawa pengawal fuzzy logik dapat mengurangkan ayunan yang berlaku sewaktu kren membawa beban.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Introduction of the Project

This project is basically designing and implementing fuzzy logic control to control payload position as well as the swing angle for an intelligent gantry crane system. Throughout the world, there have been many researches about the concept and implementation of this system which is deemed suitable for all types of control application such as an inverted pendulum, cart ball and more. For this project, the implementation of fuzzy logic control is applied to a gantry crane model which controlling the payloads position as well as considering the swing angle. The fuzzy logic control is design and employ to gantry crane system.

Fuzzy logic is an extension of classical logic and uses fuzzy sets rather than classical sets. There are a few different explanations of what fuzzy logic is so rather than add our own explanation, will quote "In its narrow sense, fuzzy logic is logic of approximate reasoning which may be viewed as a generalization and extension of multivalued logic. But in a broader and much more significant sense, fuzzy logic is coextensive with the theory of fuzzy sets, that is, classes of objects in which the transition from membership to nonmember ship is gradual rather than abrupt. In its wider sense, fuzzy logic has many branches ranging from fuzzy arithmetic and fuzzy automation to fuzzy pattern recognition, fuzzy languages, and fuzzy expert systems."[1].

Fuzzy logic is a way of interfacing inherently analog processes, which move through a continuous range of values, to a digital computer, that likes to see things as well-defined discrete numeric values.

1.2 Objectives

The main objective of this project is to design and implement fuzzy logic control in order to control payload position as well as the swing angle for an intelligent gantry crane system. The objectives can be narrowed to many intentions:

i. To design and employ fuzzy logic controller to gantry crane system
ii. To control payload position as well as swing angle for a gantry crane system

1.3 Problem Statement

The purpose of this project is to certify that the crane should move the load as fast as possible without coursing any excessive movement at the final position. The disproportionate movement can cause industrial accident and it is very dangerous for workers in transporting heavy loads and hazardous materials in shipyards, factories, nuclear installations and high building construction [2].

Furthermore, the gantry crane needs a skillful operator to control manually to stop the swing immediately at the right position. As stated, the gantry crane needs a skillful operator to control manually based on their experienced in order to make sure that the load stop from swinging at the right position.

The proposed of fuzzy logic control is to have good positioning performance as well as good capability to suppress the swing angle [5]. The failure of controlling crane also might cause accident and may harm people and surrounding.

1.4 Scopes of Project

This project is a combination of hardware and software part. For the software part, MATLAB Mathworks is chosen to program the fuzzy logic controller and apply to the gantry crane system. The scopes of project for software are:

i. Literature study on the most appropriate programming that has been used in the project and in order to achieve high detection accuracy and satisfactory. For an example MATLAB has been chosen because it is easier design a gantry crane system.
ii. Analyze and study how to design a fuzzy logic controller.
iii. Apply fuzzy logic controller to the plant system of gantry crane.
iv. Run the simulation and fix the error.
v. Interface the software and hardware part by using Real Time Workshop and xPC Target.

As for the hardware part, it consists of many parts which lead to the gantry crane controlled by fuzzy logic controller. The scopes of work for hardware part are:

i. Search suitable component for designing a gantry crane model.
ii. Apply Fuzzy Logic Controller to the gantry crane model.
iii. Troubleshoot the hardware.

1.5 Methodology

In order to meet the objective of the project, the design of the system will consist of several parts. In the subsequent sections, each subsystem will be discussed in terms of criteria, calculations and selection of the project specifications. To achieve these, the following methods will be followed closely, if not entirely:

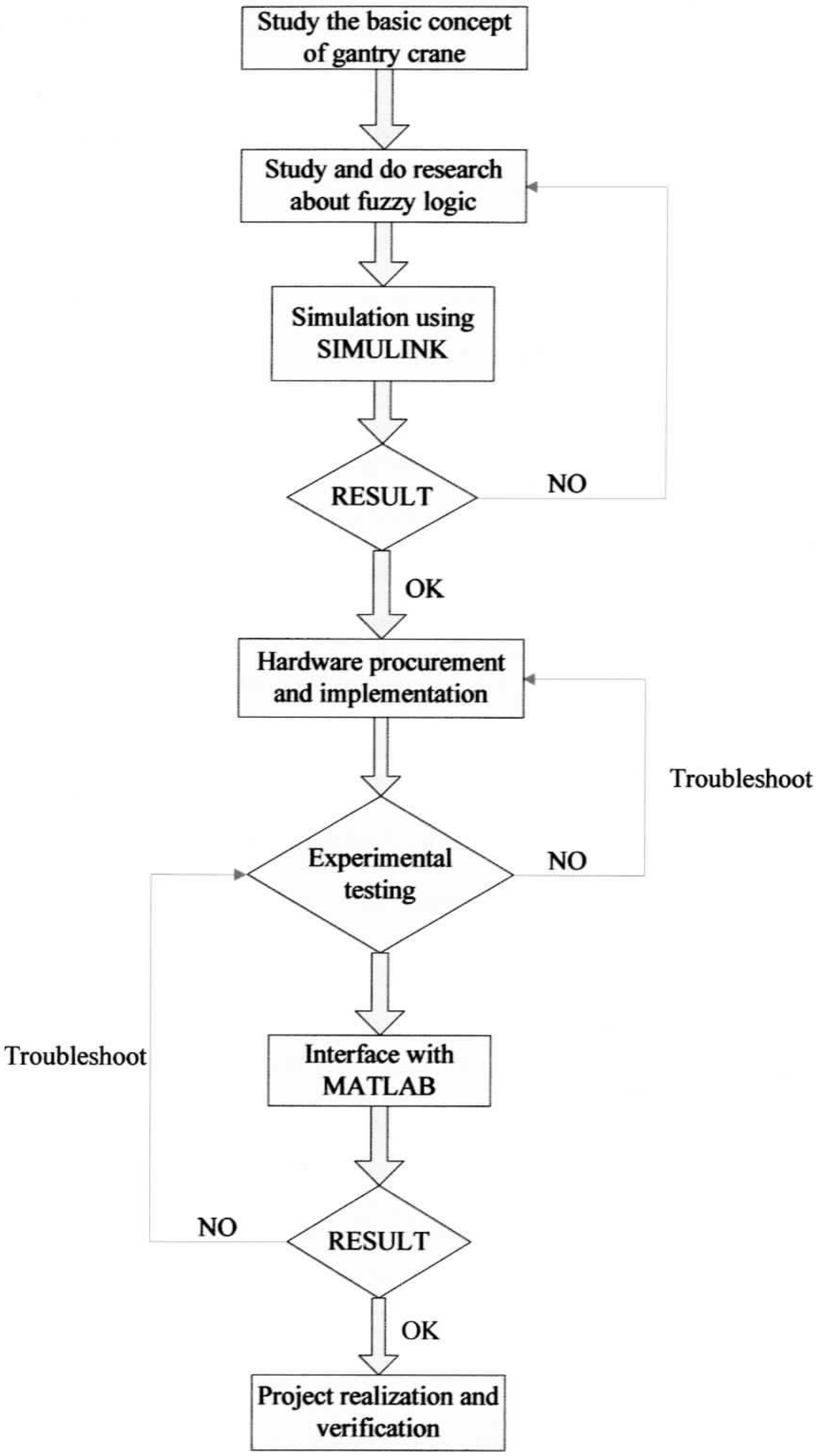

Figure 1.1: Flowchart Methodology of the Project

1.6 Thesis Outlines

This thesis is represented by five chapters. The following chapters are the outline of the implementation of fuzzy logic controller to gantry crane.

Chapter I discuss about the brief overview about the project such as introduction, objectives, problem statement and scope of the project methodology.

Chapter II describes about the research and information about the project. Every facts and information, which found through journals or other references, will be compared and the better methods have been chosen for the project. This literature review and the construction of the software use a fuzzy logic controller MATLAB 6.5 with the aid of Simulink in this chapter.

Chapter III defines and illustrates the steps employed in the fuzzy logic controller. Including detailed about methodology of hardware and software development in this project. All these methodology should be followed for a better performance.

Chapter IV describes about the discussion and project findings. The result is presented by figures. Also consist of how the components complete the tasks.

Chapter V describes about the hardware part. The dimension of the project is review in this chapter based on the lab-scale crane. All discussion and project findings is discussed in this chapter.

Chapter VI is about the conclusion of the project and the future recommendations.

CHAPTER II

FUZZY LOGIC CONTROLLER

2.1 Introduction of Fuzzy Logic Control

Fuzzy logic and the technique of approximate reasoning guide to new concepts in control theory and in the design of expert systems. These concepts imitate human thought processes better than do conventional methods. A logic which is "fuzzy" is useful. Professor Lotfi Zadeh, the inventor of fuzzy logic in 1965, vie that a computer cannot solve problems as well as human experts unless it is able to think in the characteristic manner of a human being [1]. Human beings often rely on imprecise expressions like "usually", "expensive", or "far". But the comprehension of a computer is limited to a black-white, everything-or-nothing, or true-false mode of thinking. In this context, Lotfi Zadeh stress the fact that human being easily let to be dragged along by a desire to attain the highest possible precision without paying attention to the unfocused character of reality.

There are many subjects that out of condition into the precise categories of the conventional set theory. The set of "all triangles" or "all the guys named John" is easy to handle with conventional theory. Either somebody's name is John or it is not. There is no other status in between. The set of "all intelligent researchers" or "all the people with an expensive car" however it is much more complicated and cannot be handled easily by a "digital" mode of thinking. This is because of the fact that there is no way to define a precise threshold to represent a vague and blurry boundary because there are some obviously expensive cars, like the Rolls-Royce, but many others could be fit into this category as well, depending on how much money you have, where you live, and how you feel actually.

A fuzzy logic system implements a control strategy by "if-then" fuzzy rules that use fuzzily defined expressions such as "pretty low" or "relatively high". The specification of these expressions is provided by the linguistic variables. More concisely, the linguistic variables are the "vocabulary" that the fuzzy rules use to express the strategy.

From all previous descriptions about fuzzy logic, it can be summarized that fuzzy logic is a new and innovative technology being used to enhance control engineering solutions. It allows complex system design directly from engineering experience and experimental results, thus quickly interpretation efficient solutions. It is not a complete alternative to the conventional methods but it is proven to be a good solution for system that full of uncertainties and non-linearity.

2.2 Fuzzy Logic Theory

In contrast to classical logic, which knows only two crisp truth values, yes or no, true or false, 0 or 1, the concept of fuzzy logic is based on so-called "membership functions", which can take arbitrary values from the interval [0,1]. The membership function describes the degree to which an object belongs to a certain set.

Let A, for example, be the set of all possible numbers of spots on a die; we can then define the set "high number of spots" by means of a membership function. In the case of classical logic, the corresponding membership function is depicted in Figure 2.1, where only the two crisp values 0 and 1 are admissible. In contrast to this, the fuzzy set "high number of spots", shown in Figure 2.2, coincides much better with the human concept of "high", since smooth transitions between membership and non-membership are possible.

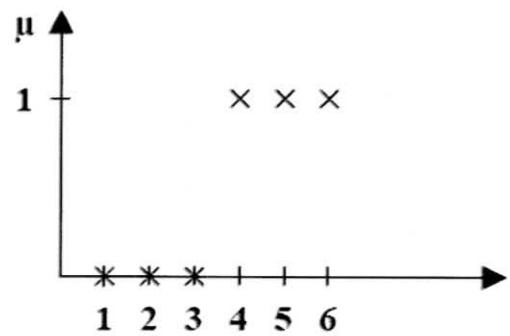

Figure 2.1: Crisp Set "High Number of Spots"

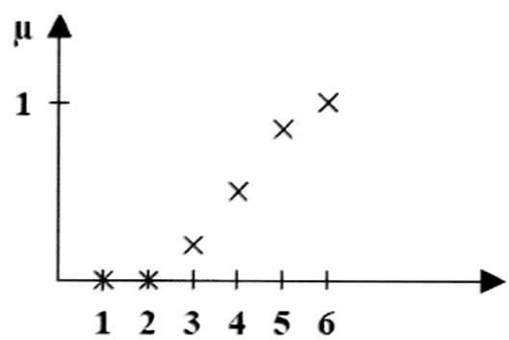

Figure 2.2: Fuzzy Set "High Number of Spots"

The membership function is the essential component of a fuzzy set. Thus, the operations "intersection", "union" and "complement" of fuzzy sets are defined via the membership functions of the sets involved. The number of operators proposed in the literature is large. The reason for the variety of definitions for the operations "AND" (intersection) and "OR" (union) is the context-dependent way in which these operations are performed in human thinking. The choice of the appropriate operator is not trivial in practical situations and needs much experience and a proper analysis of the underlying problem.