UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF INTELLIGENT MULTIPLE GANTRIES SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotic and Automation) with Honours.

by

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2009

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Intelligent Multiple Gantries System**

SESI PENGAJIAN: 2009/10 Semester 2

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DECLARATION

I hereby declare that this report entitled **"**Intelligent Multiple Gantries System**"** is the result of my own research except as cited in the references.

Signature	:	
Author's Name	:	Muhammad Izzat Bin Ramlan Ross
Date	:	14 May 2009

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation). The members of the supervisory committee are as follow:

.....

(Main Supervisor)

.....

(Co-Supervisor)

ABSTRACT

This report is about the intelligent multiple gantry system. It is an improvised system from the previous types of gantry system. With intelligence implemented in the system, the rules been set in the microcontroller will be executed and the system will be able to make decisions based on a certain situations and problems. The project will be discussed from its previous researches and comparative made by the past and present type of gantry system and the design of the prototype. There are 6 chapters will be covered in this report. Firstly is the chapter 1 which is the introduction of the project. Then, it will also include the history, objectives, the scope and the problem statement regarding this project. Next, the second chapter will discuss the literature review about the project, and also the description about the details of the project. The third chapter will be the project methodology. It covers the project planning, the material selections, the initial design, and the process flow chart. After that, chapter 4 will cover the design and development process of the project. In addition, procedures on how to fabricate the structures will be shown. Then, chapter 5 will compile the results of the intelligent multiple gantry system and the discussion regarding the problems faced during the fabricating and programming processes of the project. Finally, conclusion will be made in chapter 6.

ABSTRAK

Keseluruhannya, informasi tentang projek ini iaitu sistem pemindah barang pintar (intelligent multiple gantry system) akan dibincangkan di dalam laporan ini. Ia merupakan suatu teknologi yang diperbaharui, dengan meambahkan elemen kepintaran di dalam program system tersebut. Ini bertujuan agar pemindah barang tersebut dapat bertindak dengan reaksi yang berdasarkan tindakan pemikiran manusia, di mana ia dapat membuat keputusan yang sesuai dengan keadaan yang sedang dialami di dalam sesuatu situasi yang memerlukan penyelesaian logik akal manusia. Topik-topik yang akan dibincangkan terbahagi kepada 6 bahagian. Bab 1 akan menceritakan tentang pengenalan, sejarah, objektif, skop serta pernyataan masalah system ini. Bab 2 pula akan lebih menekankan kajian lepas yang telah dibuat oleh penyelidik-penyelidik. Semua informasi yang berkaitan dengan sistem ini akan dinilai kesahihan dan dinilai agar ia dapat membantu memilih kriteria yang berguna supaya boleh diterapkan di dalam projek ini. Bab 3 akan menerangkan langkah-langkah yang akan diambil semasa projek ini berjalan. Ia merangkumi perancangan projek, pemilihan bahan mentah, lakaran awal dan rajah langkah-langkah proses. Selepas itu, Bab 4 akan melaporkan tentang proses mereka dan mencipta. Tambahan lagi, langkah-langkah tentang bagaimana membina struktur akan ditunjukkan. Bab 5 akan membincangkan keputusan projek ini dan juga perbiincangan mengenai masalah-masalah yang mungkin dihadapi semasa membuat projek ini. Akhir sekali, kesimpulan akan dipersembahkan di dalam bab terakhir, iaitu Bab 6.

DEDICATION

Specially dedicated to
my beloved parents who have encouraged, guided and inspired me
throughout my learning process

ACKNOWLEDGEMENTS

I will take this opportunity to express my gratitude to all people who have helped me in completing this report. Firstly, I would like to thank my project supervisor, Mr. Hisham Bin Nordin for providing lots of help to guide me to complete this report. With his teachings that have been giving me opportunity to carry out my research about the intelligent multiple gantry system. Not to mention the amount of time spend by him to meet and discuss about the details of my project.

Next, I also want to thank my family, especially my parents for giving me support to do the research for the project. Without their help, it will be difficult to achieve what should be done to get the necessary information about this project. Besides that, my friends also have gladly helped me especially in how to make the good project report. With the reference from the senior I have been able to know the criteria that should be included in the report.

Finally, I also want to thank others that their names may not be mentioned. Although small contribution, but it is necessary for all of them to guide me during challenging situation that may restricted my research.

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LIST OF ABBREVIATIONS, SYMBOLS, NOMENCLATURES

AC	-	Alternating current
EOT	-	Electrical Overhead Travelling
AI	-	Artificial Intelligence
LIFE	-	Laboratory for International Fuzzy Engineering
CCD	-	charge-coupled device
CPU	-	Central Processing Unit
MCU	-	Microcontroller Unit
NPN	-	Negative – Positive – Negative
PNP	-	Positive – Negative - Positive

CHAPTER 1
INTRODUCTION

1.1 Background

Gantry systems can be widely used for a range of applications, from assembly and electronic manufacturing, to vision systems and industrial automation. In semiconductor assembly and packaging, positioning systems using gantries are useful where a work space spans a predefined area and it is necessary to position a device accurately at various positions within the area.

Travel distance, speed, acceleration, accuracy of placement and reliability are relevant factors for consideration in the design of gantry systems. Accuracy of placement and repeatability are especially critical for demanding applications where a tool or device must be positioned accurately with only a small margin for error. Conventionally, gantry systems utilized ball screw-based mechanisms and AC servomotors for driving the gantry. However, ball screws have inherent drawbacks such as relatively slow speed and lower precision.

A gantry is defined as a frame on which barrels can be set horizontally. While a gantry is define as:

a) A framework that spans a distance, often moving on wheels at each end, used for carrying a traveling crane
b) A bridge-like framework over railroad tracks, for supporting signals or for loading

c) A wheeled framework with a crane, platforms at different levels, etc., used for assembling, positioning, and servicing a large rocket at its launching site.

Basically, a gantry system is used to transfer big and heavy load or parts from a place to another. Usually, this machine is use in factories and other industrial sites. Its size is big because in the industrial sites, it is important for the gantry crane to be able to pick a large amount of load in order to save time and cost for the transfer work to be done.

The purpose for this project is to find the way to create a model of gantry system that can transfer the payload more than one round in a certain time. Furthermore, the system should be able to think and make decisions simultaneously on how to pick and transfer a load when there will be obstacles that hinder the gantry system movements.

The intelligent system that can control the decision of the gantry crane will be design as a microcontroller. It is because using the microcontroller, the cost of burning the chip from the program is affordable and not very complicated. Besides that it is to build the program of the gantry system using the microcontroller software.

1.2 Problem Statement

The problem statement of the gantry system: how to make the gantry system that have 3 units of crane that have intelligent on how to make preferable choice of decision when 2 of the crane unit move at the same time and same path. The decision should be based on the distance of both cranes and the coordinate movement whether which one of the 2 cranes should be given the right to move first by the decision made by the intelligent system in the gantry system.

1.3 Objectives

The objectives of this project are:

a) To develop a mini-sized model of an intelligent multiple gantry system.
b) To implement an intelligent system into the model so that it can operate according the rules created.

1.4 Scope

In this project, the scope will be covered in the topics such as:

a) Programming the controller. By using the Matlab software, the sets of rule will be create in order for the gantry system to display its operations.
b) Construction of the gantry system model. The design will be according the choices from the design layout that will be drawn, with its dimensions.
c) Interfacing of the program to the model. The programming can be apply to the system after the interfacing is been done to the controller.
d) Testing and analysis. It is to determine whether the program will run according to the desired output. Then some analysis will be made to improve the results of the testing of the programming.

1.5 Intelligent Multiple Gantries System

1.5.1 Overview

The intelligent multiple gantries system is the project that is proposed to show how a multiple gantry system can use intelligence to make its own decision during the operations. By applying the concepts of artificial intelligence, a program can be developed that covers all the movements of the gantry system in the workstations. During some incidents in the workstation, for example when the gantry sets have a high probability to collide, the rules that used the concepts of fuzzy logic will help to solve the

problems. It is hope by designing such intelligence that can help in such operations, the manufacturing industries will gain benefits from the proposal of this project.

1.5.2 Project description

The intelligent multiple gantries system is a project that is build for the purpose to implement the intelligence in the gantry system so that it can do multi task operations based on the programming that has been design using fuzzy logic controller. Besides that, this project also aims to show that using a mini model of the gantry system, a simple programming can be executed using the rule develop based on the distance of the gantry crane from the workplaces involve and the priorities set by the controller.

The basic implementation of artificial intelligence will be essential in developing the intelligent multiple gantry system. In order to create a simple but effective rule so that the system will do its operations as desired, the rules regarding the movements of the gantry must be created. First and foremost, the rules must apply the concepts that the gantry must be able to process and make specific decisions when facing incoming or unknown obstacles. The consideration of the rule for the multiple gantry system operations must be based on the distance of the gantry from its programmed destination and the priorities of the operations. Some scheduling example that have been analyzed are also been used as a reference of the concept of how the gantry system will operate according what is programmed by the microcontroller.

First, the plan of the workplace with the intelligent multiple gantry system must be sketch so that the brief view of how the orientations and the transferring of the load will operate. The basic working principles of the system will be based on the sketch below. Although it does not give the clear indication of how the actual model works, but it will be improved as the project progress further.

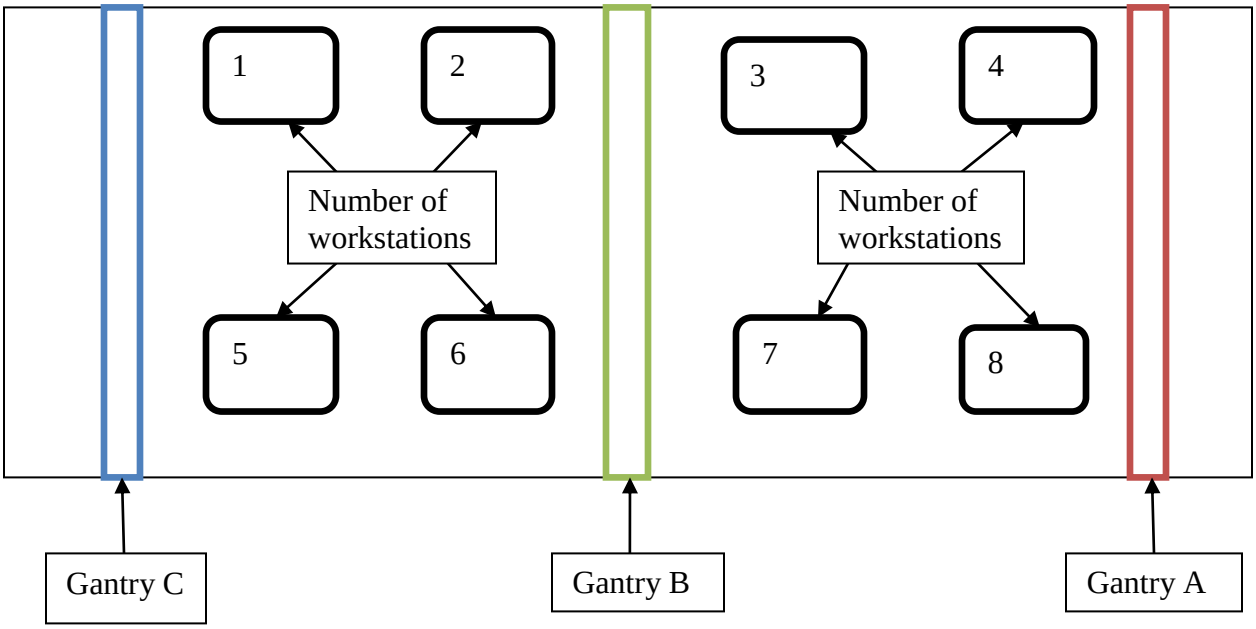

Figure 1.1: A simple sketch of intelligent multiple gantry system workplace

From the sketch, we can identify there are three sets of gantries, which is identified as Gantry A, Gantry B and Gantry C. The different colors are used to identify all three of gantries. Then, in the workplace there will be at least 8 different workstations for the loads to be place. The denoted numbers in the rectangular boxes shows the number of the workstations where the load will be transferred according to its desired place according to the program being executed by the microcontroller.

The three sets of gantries will be equipped with a controller that programs the destinations of each gantry in the workplace. Then, the railings of the gantry will be design so that it will be able to change direction courses during some of the operations that may include complicated situation. Considerations of how the gantry can change places during some situation must also been included, so that there will not be any collisions happened during a cycle of operations where the probability of the gantry to meet at the same path during some intervals is high. Besides that, each of the gantries will

be given its own travelling area that covers the transfers of the load at the workplace which situated near the areas that the gantries position. For the area covers, it is set that:

a) Gantry A will cover the transferring of loads at workplaces number 3, number 4, number 7 and number 8;

b) Gantry B will cover the transferring of loads at workplaces number 2, number 3, number 6 and number 7; and

c) Gantry C will cover the transferring of loads at workplaces number 1, number 2, number 5 and number 6.

The reason for the setting of each set of gantries with its own covering area is to make the basic transferring of loads more easy. Moreover, it is productive and save time as all the three sets of gantries will be able to perform its tasks in its own areas, providing that no complicated rule come up from the controller.

During some cycle of operations, some difficulties may occur of the gantries to move. For example, the rules of operations may come up such as the commands above:

a) The gantry A wants to transfer a load to the workplace number 6. But, at the same time the gantry B also wants to transfer a load to workplace number 8.

b) The gantry B wants to transfer a load to workplace number 5. At the same time, the gantry C also wants to transfer a load to workplace number 7.

c) Both of gantry A and gantry C wants to transfer a load at workplace number 5 and number 8 respectively.

So, the commands must be design to have intelligence in making suitable decisions if the operations if the example such as above appears. Therefore, the rule of operations must be design based on logic input and outputs where the decisions will appear based on some criteria been considered in order to come up with the suitable rule for the gantry system operations.

The criteria to design a rule that obeys the operation flow must be based on the initial and final positions of the gantry system during a cycle of operations. Besides that, the positions of the gantries must also influence the decision making of the output results. It means that the output will be determined based on the distance of the gantries from its respective positions. For example:

a) If the gantry A is assign to transfer a load to workplace number 6 while the gantry B also at the same time is assign to transfer a load to workplace number 7, a priority rule based on the comparative distance between both gantry and its respective destinations will be design so that the gantry B will move first because the distance between it and the workplace is shorter than the distance of the gantry A and its destination.

b) The gantry C wants to transfer a load to workstation number 6 and at the same time the gantry A also wants to transfer a load to the workstation number 6. The decision can be made in two types of movements which considers whether the distances between the gantry and workplace or the changing of gantry sets at its railing. Therefore, the results will be:

i) Gantry C will transfer the load to workstation number 6 first; then gantry A will move after the gantry C comes back to its initial position and will begin to transfer the load at the same workstation.

ii) Gantry B will transfer the load to workstation number 6 in place of Gantry A after a signal was send by the sensor at Gantry A to help transfer the load. As a result, the Gantry B will move first according to its distance priorities and then the Gantry C will move after Gantry B return to its initial position.

So, it is important for the multiple gantry system to be able to function according to its set of rules programmed into the controller. The intelligence of the program must be able to practically think like a human, as it will not be necessary for a supervisor or technician to inspect the system every time the system operates.