DESIGN AN AUTOMATED STORAGE SYSTEM

CHONG PEI CHING

APRIL 2009

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic and Drive)"

Signature : 

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Date : 6/5/09

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This Report is Submitted In Partial Fulfillment of Requiremants For The Degree of Bachelor In Elctrical Engineering (Power Electronic and Drive)

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"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references"

Signature : Chong.

Name : CHONG PEI CHING

Date : 5/5/09

To my dearly loved father and mother

To all my teachers and friends

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CHAPTER 3 THEORY AND DESIGN

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my profoundest gratitude and deepest regards to all those who are responsible and support me in this project.

First and foremost, I wish to express million of thanks to my project supervisor, En. Mohd Shahrieel Bin Mohd Aras for his guidance, monitoring and constant encouragement during project development. I was deeply indebted from his guidance given from time to time.

Sincere appreciation is also extended to my helpful coursemate and friends who had gave suggestion, idea and guide me in this project development. They have been help me a lot when I was trying to solve problem related to project during weekend.

Last but not least, to all my well-wishers who had contributed their help in both directly and indirectly, I virtually fall to short words to express my gratitude. Hope all of your kindness will be rewarded. I hope that all of the knowledge I had gain in this project will help me in the future.

ABSTRAK

Laporan ini membincangkan tentang perkembangan projek tahun akhir yang bertajuk Reka cipta sistem automatik penyimpanan di mana ia mempunyai pemuatan yang lebih ringkas, senang, sistem kawalan yang jitu, dan sesuai digunakan di gudang-gudang yang kecil and sederhana. Sistem ini dirujuk kepada menyimpan beban dari sesuatu tempat yang tertentu secara automatic dengan kepelbagaian cara kawalan komputer. Reka cipta yang baru ini dihasilkan dengan penggabungan dan pengubahsuaian sistem automatic penyimpanan yang telah muncul di pasaran. Sistem ini mempunyai tiga pergerakan yang lurus iaitu, pergerakan di paksi X, Y dan Z, dan 180° putaran pencengkam. PIC teknologi akan digunakan dalam sistam kawalan untuk menerima data input dan melaksanakan output mengikut set suruhan yang diberikan kepadanya. MikroC adalah digunakan dalam pengaturcaraan PIC dengan menggunakan bahasa C.

ABSTRACT

This report shows the progress of my final year project which is to design an Automated Storage System which has simper installation, easy, accurate control system and suitable to be used in for a small and medium warehouse. This system refers to a variety of computer-controlled methods for automatically depositing and retrieving loads from defined storage locations. This new design is created by combining and modifying the automated storage system which is exists in the market. It consists of three linear movements which are, X, Y and Z-axis movement, a 180°rotational movement at the support shaft and a gripper movement. The PIC technology will be used in the control system to accept the random inputs and work in sequence. MikroC is used to program the PIC by using C language.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Automated Storage and Retrieval System (ASRS) is not a new technology in industrial. The existing system already applied in many industries such as manufacturing warehouse, food product warehouse, toiletries warehouse, library and medical centre.

Early attempts in library storage automation (circa 1960-1070) included the "RandTriever" which required human users to transcribe sequences of numbers, letters and symbols to paper, perform a lookup of that "string" in another set of papers, write down the "string" indexed by the previous lookup, enter this "string" into another system that would pull a kind of shelf forward, and allow the user to pick an item. These "RandTrievers" were expensive to maintain, and workloads imposed upon them to access most items caused wear and stress on the machinery. But after improvements had been done, it is widely used in California State University at Northridge (first to go live with an ARS in a library setting), Eastern Michigan University, University of Nevada Las Vegas, Simon Fraser University - British Columbia, Canada, and a Depotbibliotek in Norway.

There are also competitors which produce similarly technology such as a flexible manufacturing system, consisting of a closed-loop conveyor system serving a CNC milling machine and a CNC turning machine. This system allows the study and development of work relating to FMS, such as communication and networking of manufacturing environment. But most of ASRS only widely used at Canada, Norway, Northridge and US. In Malaysia, the system still at the development stage.

1.1 Problem Statement

A new design of Automated Storage System is created by combining and modifying forklift operation which are available in the market Forklift operations are not fully automated, thus it

- Manual intervention, needs labor for material storage activities
- dangerous, causes personal injury
- significantly less loads is stored and retrieved per hour
- lower inventory accuracy, unavoidable misplacing
- needs longer time for material handling and re-handling, ineffective way to manage a warehouse system

1.2 Project Objective

The objective of the project is to design and establish a new and low cost automated storage system for small and medium warehouse management systems which have a tremendous range of automated capabilities, simpler installation, easy and accurate control system.

1.3 Project Scope

The scopes of the project are

- To study the PIC microcontroller
- Design and construct a prototype robot, controller board
- Develop a program by using MicroC
- Download the program into PIC.

1.4 Methodology

The flow chart in Figure 1.1 shows the entire process of the project development.

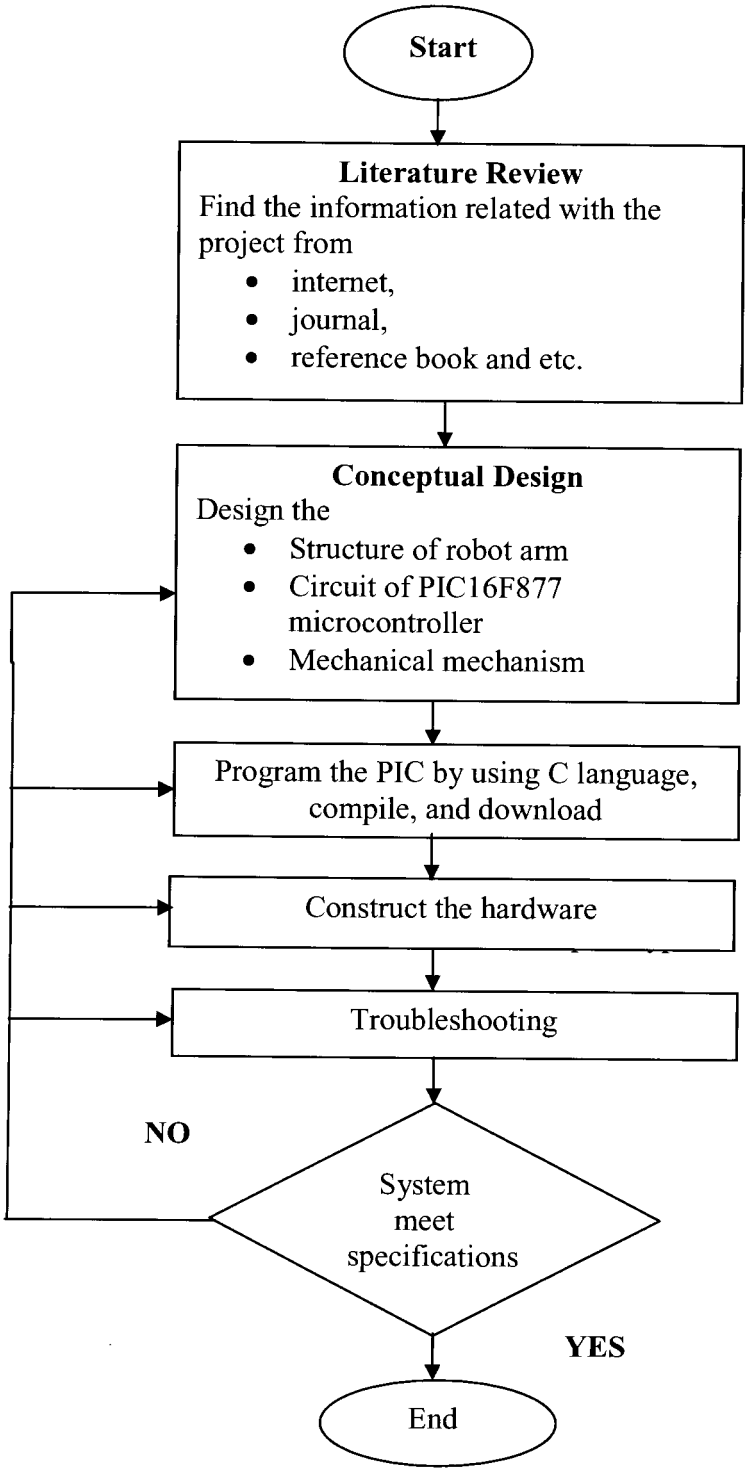

Figure 1.1: Flow chart of project

In the beginning, information related to this project is gathered from difference sources such as internet, journals, and references book. It is the most important step in generate ideas for this project.

Next, design the conceptual structure of the robot arm, mechanical mechanism, and circuit of PIC microcontroller. After that, develop a program by using mikroC, compile the program and download the program into PIC microcontroller. Then, construct the robot's hardware. After the construction, test and troubleshoot the hardware. If the hardware does not meet application specifications, design process must study again to find out the problem of failure and modify it. In contrast, the process of the project development will be end.

1.5 Summary

In this chapter, project background, problem statement, project objective, project scope and project methodology are discuss.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Some of literature review is done on the existing automated storage and retrieval system so that became more understand and familiar with the system operation. These are importance in generating ideas and concepts as a starting point to design the project.

2.1 California State University

A unique feature of the Oviatt Library, California State University is the Automated Storage and Retrieval System (ASRS) in the east wing. The ASRS consists of 13,260 steel bins, each 2' x 4', on a rack structure that occupies an 8000 sq. ft. room forty feet high as shown in Figure 2.1. The ceiling of the room is at the level of the ceiling of the main floor of the Library. The bins are arranged on both sides of six aisles, each of which has a "mini-load crane" guided by rails at top and bottom.

Older periodicals (all before 1990 except for a limited number of very high use titles) and books that have been used infrequently are stored in the bins. Their bar codes are mapped to their bin locations in the ASRS Manager computer system. Requests retrieval items are entered on the Innovative on line catalog and are transmitted electronically to the ASRS Manager, which directs the automatic crane in the appropriate aisle to deliver the bin to a pickup station on the mezzanine at main floor level. The approximate location of the book in the bin is displayed on a terminal at the pickup station, along with author, title, and bar code.

The last two digits of the bar code of each book were written on the top edge when it was stored, allowing the ASRS operator to find the book easily. The operator reads the bar code in the book with a light pen, to confirm that it has been picked up, and places the book, along with a delivery ticket printed by the ASRS computer, in an electric track vehicle (ETV) that carries it through the ceiling to the Circulation desk. Time from initial request to availability at the circulation desk is under ten minutes. [1]

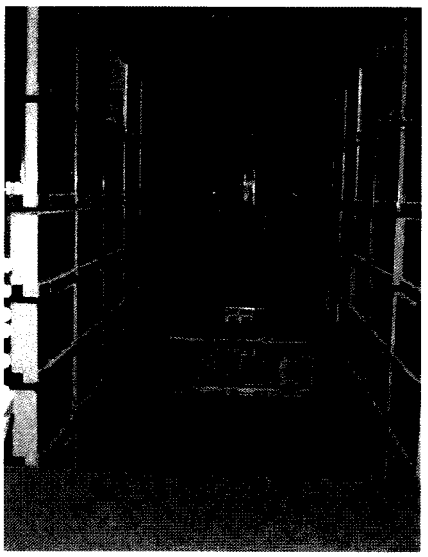

Figure 2.1: ASRS in California State University

2.2 Bridgford Foods

Bridgford Foods produces frozen bread dough, luncheon meats, dry sausages and an assortment of frozen microwave-ready sandwiches as shown in Figure 2.2. The company's goals included maximizing storage volume within a specified area, increasing productivity by eliminating routine warehouse operations, providing an efficient order pick area for prepicking less than full pallet order quantities, automatic sequencing of picked pallets and full pallets deliveries to the shipping dock, and reducing truck loading time.

Bridgford decided to install an automatic high-density storage system and chose a compact automated storage and retrieval system (AS/RS) from Westfalia. The system measures 155 feet long, 70 feet wide and 73 feet high, and contains 2,500 pallet locations. With a storage density of 4.34 square feet per pallet position, it can store or retrieve more than 70 pallets per hour.

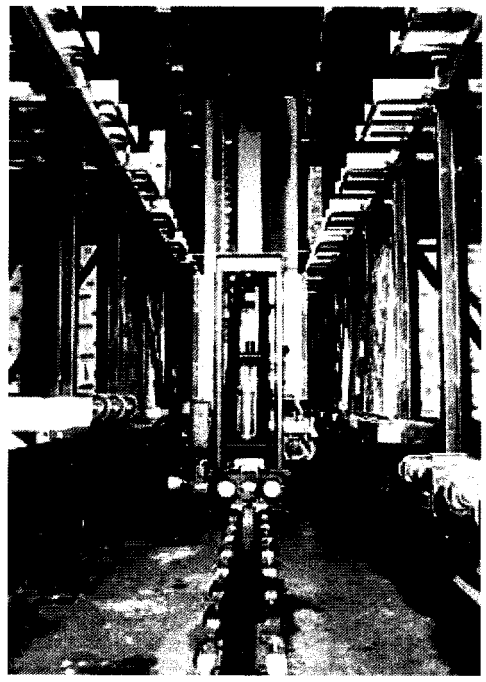

Figure 2.2: Storage and Retrieval Machine (SRM) in Bridgford Foods [2]

The storage and retrieval machine (SRM)

- moves between two storage blocks. One is five pallets deep; the other is ten pallets deep.
- There are 17 bays (storage rows) and ten levels.
- equipped with Westfalia's Satellite device, which separates from the SRM to move individual pallets in and out of the storage rack. Pallets automatically enter the system

with a computer-to-computer handoff from the automatic palletizing system. Pallets can also be manually entered from both the palletizing room and the shipping dock.

The new storage approach was designed to have less workers in the deep-freeze area. Unjamming a stuck pallet high up in a freezer is dangerous, and conventional pallets, with the odd semi-broken board or a protruding nail, are subject to jamming. This system replaces the conventional pallets with 40 x 48-in. slave pallets made of 1-in. plywood.

The SRM automatically replenishes the pick lanes for 34 of Bridgford's fastest moving items. Two and three-deep flow racks feeding these positions guarantee that the picker never runs out of product. There are also 76 manually loaded pick locations on the pick floor. A pick-and-return function handles very slow moving SKUs. Here the pallet is brought to the pick floor, cases are removed for shipping, the inventory is updated and the pallet is returned to the original location.

A time-saving feature is the ability to prepick loads. Instead of rushing to assemble orders when the truck is waiting, less than full pallet quantities are pre-assembled for later shipping. This allows a truck to be loaded in about 20 minutes, and provides smooth workloads for the case pick workers. The Westfalia system automatically sequences the output of picked pallets and full pallets to a shipping spur in truck loading order.

The system is operated by Westfalia's Warehouse Management System (WMS) software, which directs the storage and loading process, automatically interfacing with the palletizing equipment to track production. It has a "Hold" system for quality control purposes. It tracks aging of the inventory, alerting the company of product that will expire soon and is the basis of Bridgford's product recall system at this location. [2]

2.3 Automated Self Storage Systems

Westfalia Technologies, Inc. has partnered with Automated Self Storage Systems, LLC provide Automated Storage and Retrieval Systems (AS/RS or ASRS) for the self storage

industry. The facilities are equipped with an AS/RS capable of handling loads up to 16,000 pounds (including the storage module itself). Each customer's storage module is delivered to its prompted location without requiring the customer to enter the building.
Figure 2.3(a) and (b) shows a larger size unit load AS/RS to handle storage container.

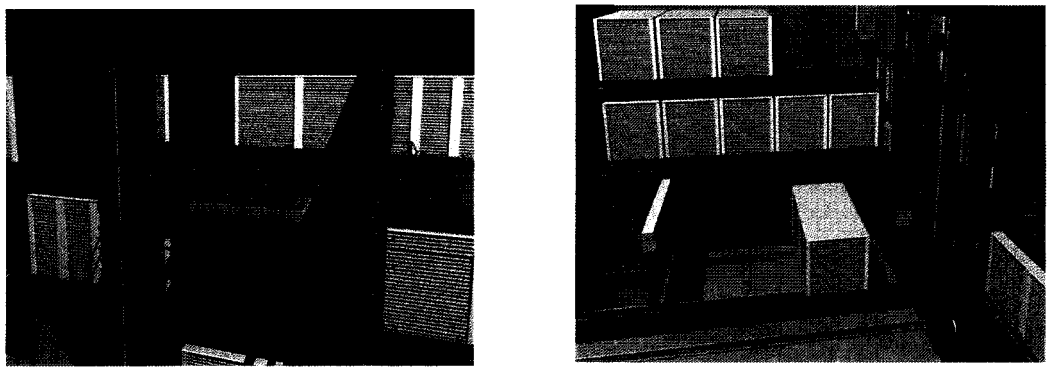

Figure 2.3(a) & (b): Large Size Unit Load AS/RS to Handle Storage Containers [3]

An Automated Self Storage System consists of

- Westfalia's Automated Storage and Retrieval Machine (S/RM or SRM) - quickly, smoothly and quietly moves storage modules in and out of the system with our patented Satellite rack entry vehicle technology
- Standardized Storage Modules - 10' x 20' maximum module which can be subdivided into standard industry sizes (Example: 5' x 5'; 5' x 10'; 5' x 15'; 10' x 10'; 10' x 15'; and 10' x 20')
- Racks Store Modules - 2 to 15 levels high, fully meeting fire and building codes
- Warehouse Management System (WMS) - Westfalia's logistics software controls, manages and records all module movements within the facility
- Turntable - to turn containers, if needed, to face appropriate loading area
- Inner Security Doors - limiting access, maintaining facility pressurization, and keeping valuables safe

How an Automated Self Storage System Operates

Access to a storage unit is triggered through a keypad/card reader/biometric device at each loading area. Once a unit is leased, the customer is provided with the code/card which allows access to his/her unit 24 hours a day. The Warehouse Management System (WMS) is activated by the security device to bring the containing to the loading area. It controls, manages and verifies the movement of the container in and out of its storage position.

At the loading area, an interior door to the inner AS/RS rolls up, and the container is placed within the loading area. Only after the roll door closes, sealing the building's pressure, is access to the container granted to the customer by the opening of an exterior sliding door. This two door system heightens the level of security for the building, while at the same time maintaining the climate controls, and minimizing dust particle movement throughout the building.

Once loading/unloading is complete, the customer locks the unit and re-enters their PIN code, the exterior door closes, and the AS/RS & WMS return the container to storage. The WMS recalculates the weight, completes a series of security checks, and records the placement of the unit back in the system until it is called for again. [3]

2.4 Storage Retrieval Machine (S/RM)

The Storage / Retrieval Machine (S/RM) is designed to cover large horizontal and vertical distances in a storage system. Westfalia S/RM's are able to have precise positioning of the horizontal and vertical axis through laser and final positioning as shown in Figure 2.4.