



## UNIVERSITI TEKNIKAL MALAYSIA MELAKA

### BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL: “SEMI-AUTOMATED DISPENSING MEDICINE SYSTEM”

SESI PENGAJIAN: 2/2008-2009

Saya **MOHD MUHAYIDDIN BIN MUHAMMAD**

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. \*Sila tandakan (√)

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

(TANDATANGAN PENULIS)

Alamat Tetap:  
KG BUDI, MUKIM LESONG,  
06400 POKOK SEN, KEDAH DARUL AMAN.

Tarikh: \_\_\_\_\_

Disahkan oleh:

(TANDATANGAN PENYELIA)

Cop Rasmi:


**SILAH HAYATI BINTI KAMSANI**  
Pensyarah  
Fakulti Kejuruteraan Pembuatan  
Universiti Teknikal Malaysia Melaka  
Karung Berkunci 1200, Hang Tuah Jaya,  
Ayer Keroh, 75450 Melaka.

Tarikh: 13 MEI 2009

\* Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

## DECLARATION

I hereby, declare that this report entitled “Semi-Automated Dispensing Medicine System” is the result of my own research except as cited in the references.

Signature : 

Author's Name : Mohd Muhayiddin Bin Muhammad

Date : 12 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) with Honours. The members of the supervisory committee are as follow:



-----  
(Main Supervisor)

(Official Stamp & Date)

**SILAH HAYATI BINTI KAMSANI**  
*Pensyarah*  
Fakulti Kejuruteraan Pembuatan  
Universiti Teknikal Malaysia Melaka  
Karung Berkunci 1200, Hang Tuah Jaya,  
Ayer Keroh, 75450 Melaka.

13/5/2009

## **ABSTRACT**

In the automation industry, multiple automatic devices were used to ease and increase the manufacturing process of a product with the help of the latest technology invention. Nowadays, there are numbers of 'conveyor system' available in the market and designed in such a way to transport a product from a place to another place. This project is designed to be used in Poliklinik Ayer Keroh, Melaka. Through this system, it will help the pharmacy to increase the output level of productivity and transformed a traditional system to more efficient and systematic way of working. "Semi-automated dispensing medicine system" will be used in the pharmacy to reduce the back and forth movements of medical assistant from counter to the medicine rack. This system use conveyor as medium to transport the medicine from rack to the counter by controller with "programmable logic controller" base. This system will be manouvered by two medical assistant. One of the person will be based at the counter and transferred the related information to the other person at rack by using controller that readily available at the counter. By using this semi-automated system, the medical assistant movement will be greatly reduce to optimize the cycle time and indirectly reducing the patient waiting time. This design is fully based on the layout that readily setup at the Poliklinik Ayer Keroh, Melaka.

## **ABSTRAK**

Di dalam automasi industri, pelbagai peralatan automatik digunakan bagi memudahkan serta mempercepatkan proses pengeluaran sesuatu produk dengan sokongan teknologi moden. Pada masa kini, terdapat pelbagai jenis sistem “conveyor” dalam pasaran dan telah direka dalam pelbagai bentuk untuk memindahkan sesuatu produk dari satu tempat ke satu tempat yang lain. Projek ini direka untuk digunakan dalam farmasi Poliklinik Ayer Keroh, Melaka. Sistem ini dapat membantu sesebuah farmasi meningkatkan produktiviti pengeluaran dan menjadikan sesuatu sistem lebih sistematik berbanding dengan penggunaan kaedah tradisional. “Semi-automated dispensing medicine system” digunakan dalam farmasi untuk mengurangkan pergerakan pembantu farmasi bergerak dari kaunter farmasi ke rak ubat berulang-alik bagi mengambil ubat untuk pesakit. Sistem ini menggunakan “conveyor” untuk menghantar ubat dari rak ke kaunter yang dikawal oleh alat kawalan iaitu “programmable logic controller”. Sistem ini dikendalikan oleh dua orang pembantu farmasi. Seorang pembantu hanya menunggu di kaunter dan memberi isyarat kepada pembantu yang berada di rak ubat dengan menggunakan alat kawalan yang berada di kaunter. Manakala seorang lagi pembantu farmasi hanya perlu menunggu isyarat yang diberikan di rak ubat. Dengan menggunakan sistem separuh automatik ini, pergerakan pembantu farmasi dapat dikurangkan. Rekabentuk sistem ini berpandukan susun atur yang sedia ada pada farmasi Poliklinik Ayer Keroh, Melaka.

## **ACKNOWLEDGEMENTS**

Thanks to The God the All Mighty because with His Blessing, I managed to complete my report for the final year project (PSM) involving the topic of semi-automated dispensing medicine system.

I would like to convey my humble thanks to the university providing me the opportunity and place to study with good condition for a student to have a pre-learning center before getting involved the real career field. I would like to pay my thankfulness to my parents that always behind me in providing me with the moral support and everything they could.

To my lecturer that had been involved since early stage, thanks for all the material and support especially my supervisor Pn. Silah Hayati Binti Kamsani in ensuring the task can be done. Not to forget my entire friend for their help and support.

# TABLE OF CONTENTS

Abstract	i
Abstrak	ii
Acknowledgements	iii
Table of Contents	iv
List of Figures	viii
List of Tables	x
List of Abbreviations, Symbols, Specialized Nomenclature	xi
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Problem Statement	2
1.2 Objectives	2
1.3 Scope	3
<b>2. LITERATURE REVIEW</b>	<b>4</b>
2.1 Conveyor	4
2.1.1 Belt Conveyor	5
2.1.2 Chain Conveyor	8
2.2 Bearing	9
2.3 Pulley and Gear	13
2.3.1 Pulley	13
2.3.2 Gear	14
2.4 Conveyor Belt	15
2.4.1 Flat Belts	15
2.4.2 Rubber Belting	16
2.5 Aluminum	16
2.6 Shaft	17
2.7 Relay	18
2.7.1 Types of Relay	19

2.7.2 Advantages of Relay	22
2.8 Switch	23
2.8.1 Toggle Switch	24
2.8.2 Pushbutton Switch	25
2.9 Position Sensor	25
2.10 Indicator Lamp	28
2.11 Electrical Motors	29
2.11.1 DC Motor	29
2.12 Speed Controller	31
2.13 The Controller	32
2.13.1 Programmable Logical Control	32
2.13.2 PLC System Block Diagram	34
2.13.3 PLC Application	37
2.13.4 Advantages of Programmable Logical Control	37
<b>3. METHODOLOGY</b>	39
3.1 Methodology Flow Chart	39
3.2 Problem Statement	41
3.3 Planning process	41
3.4 Literature Review	43
3.5 Observation	43
3.6 Sketch and Design	44
3.6.1 Electrical Structure	44
3.6.2 Mechanical structure	44
3.7 Programming	45
3.8 Procurement	45
3.9 Fabrication and Testing	46
3.10 Modification	47



<b>4. DESIGN AND DEVELOPMENT</b>	<b>48</b>
4.1 Pharmacy Layout	48
4.2 Design of Mechanical Structure	50
4.2.1 Body or Frame of the Conveyor	50
4.2.2 Drive Shaft	51
4.3 Mechanical Construction	52
4.3.1 Body of the Conveyor	52
4.3.2 Drive Shaft	54
4.4 Electrical Structure	56
4.4.1 Forward Reverse Motor Circuit	57
4.4.2 DC Motor Speed Controller	57
4.4.3 PLC Wiring Diagrams	59
4.5 Development of the Controller	61
4.5.1 PLC Communication Cable	62
4.5.2 Electrical Wiring	66
4.6 PLC Ladder Diagram	67
4.6.1 Operation of PLC Ladder Diagram	68
<b>5. RESULT AND DISCUSSION</b>	<b>70</b>
5.1 Motor Selection	70
5.2 DC Motor Calculation	71
5.3 Semi-Automated Dispensing Medicine System	72
5.4 Sequence Operation of the Semi-Automated Medicine System	73
5.5 Programming Simulation	75
5.6 Ladder Diagram Simulation	76
5.7 Current Patient Waiting Cycles Time	77
5.8 Patient Waiting Time Improvement	79
5.9 Group Technology	81
5.10 Group Rack Arrangement and Line Layout	82

<b>6. CONCLUSION</b>	86
6.1 Conclusion	86
6.2 Suggestions for Further Works	87
<b>REFERENCES</b>	88

## LIST OF FIGURES

2.1	Flat belt conveyor	6
2.2	Telescoping belt conveyor	7
2.3	Steel hinge belt conveyor	7
2.4	Chain conveyor	9
2.5	Single-row, deep- groove ball bearing	10
2.6	(a) Sketching of double-row, deep- groove ball bearing (b) Double- row, deep-groove ball bearing	11
2.7	(a) Sketch of needle bearing (b) Needle bearing	12
2.8	(a) Spherical roller bearing (b) Spherical roller bearing E	13
2.9	Pulleys	14
2.10	Flat Belt	16
2.11	(a) Relay or contactor (b) Relay	19
2.12	Example of a simple low power electromechanical relay	20
2.13	Solid-state relay	21
2.14	Example of a solid state relay	21
2.15	Types of double-pole, single throw switch (a) Rocket switch (b) Toggle switch (c) Slide switch	23
2.16	Symbol of double-pole, single throw switch	23
2.17	(a) Types of single-pole, single throw switch: Toggle switch (b) Pushbutton switch	24
2.18	Symbol of single-pole, single throw switch	24
2.19	Toggle switch symbol	24
2.20	(a) A normally open pushbutton (b) A normally closed pushbutton symbol	25
2.21	Proximity sensor	27
2.22	Photoelectric sensor	28
2.23	The symbol of lamp indicator	28
2.24	Block diagram of the speed controller	32

2.25	Programmable controller	33
2.26	Block diagram of PLC	34
3.1	Methodology flow chart	40
3.2	Gantt Chart project planning	42
4.1	Front view for pharmacy layout	48
4.2	Back view for pharmacy layout	49
4.3	Suggestion pharmacy line layout	49
4.4	Design of frame conveyor	51
4.5	Drive shaft	52
4.6	Measurement and marking process	52
4.7	Vertical band saw machine	53
4.8	Drilling process	53
4.9	Welding process	54
4.10	Lathe machining process	55
4.11	The main body of conveyor	55
4.12	Attach the belting to the body	56
4.13	Forward and reverse motor circuit	57
4.14	DC motor speed controller	58
4.15	PLC wiring diagram	60
4.16	Communication port at PLC	62
4.17	Multi-core cable, RS323 female connector and 6 pin RJ11 Modular connector.	63
4.18	(a) Connector or pin position (b) Wire positions diagram	64
4.19	Soldering technique	64
4.20	Checking the wire connection	65
4.21	Finished communication cable	65
4.22	Electrical wiring of the system	66
4.23	The controller box	67
4.24	Output relay ladder diagram	68

4.25	Pulse generating from the PLC	69
5.1	Speed of pulley	72
5.2	The prototypes of Semi-Automated Dispensing Medicine System	73
5.3	Sequence operation of semi-automated medicine system	74
5.4	Ladder diagram simulation	77
5.5	Graph Patient Waiting Time versus Number of Patient	78
5.6	Patient waiting time versus number of patient graph	80
5.7	Current pharmacy line layout in Poliklinik Ayer Keroh pharmacy	82
5.8	Group rack arrangement for Poliklinik Ayer Keroh Pharmacy	84

## LIST OF TABLES

2.1	Types of belt conveyor	8
2.2	Types of gear and their advantages	14
2.3	Common aluminum alloys and their uses	17
2.4	List of advantages and disadvantages of relay	22
2.5	Category of the Stimulus and example of physical variables	26
2.6	Characteristic of position sensor	28
2.7	Types and characteristic of motor	30
2.8	Typical of classification PLCs by number of Input/Output terminals	33
2.9	Description of memory	35
2.10	Advantage of Programmable Logical Controller	37
3.1	Bill of materials	46
4.1	List of DC motor speed controller component	58
4.2	Component description	59
4.3	Components description for inputs	60
4.4	Components description for outputs	61
5.1	Motor criteria	71
5.2	Current patient waiting cycle time	78
5.3	Patient waiting time using semi-automated dispensing medicine system	80
5.4	Lists of medicine rack and types of medicine	83
5.5	Group of rack description	84

## LIST OF ABBREVIATIONS, SYMBOLS, NOMENCLATURES

PLC	-	Programmable Logic Controller
DC	-	Direct Current
PVC	-	Polyvinyl chloride
NO	-	Normally Open
NC	-	Normally Close
SPDT	-	Single Pole Double Through
DPDT	-	Double Pole Double Through
SPST	-	Single Pole Single Through
DPST	-	Double Pole Single Through
AC	-	Alternate Current
PCB	-	Printed Circuit Board
IC	-	Integrated Circuit
EMR	-	Electromechanical Relay
NEMA	-	National Electrical Manufacturers Association
RPM	-	Revolutions Per Minuets
CPU	-	Central Processing Unit
ROM	-	Read Only Memory
RAM	-	Read Access Memory
EPROM	-	Erasable Programmable Read Only Memory
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
$\Omega$	-	Ohm

# **CHAPTER 1**

## **INTRODUCTION**

Nowadays, the most popular use of conveyor system in industries is to transfer bulk material. Conveyor systems are materials handling equipment, where they are used primarily to transfer load from one area to another efficiently, reducing the need for manual involvement in the process. Some industries in which bulk material are conveyed include agriculture, mining, chemical, pharmaceuticals, paint manufacturer, and metal refining and processing (Groover, 2008). In pharmaceuticals, conveyor is used to help pharmacist or clinic assistant to convey such as pills bottle from the medicine rack to the counter. Conveyor system can make pharmacy process more efficient and reduce the pharmacist movement time from counter to another area to pick the pills bottle.

The suitable conveyor for moving small lightweight items such as pills bottle in pharmacy is light duty belt conveyor. This conveyor is not heavy but it must be suitable placed beside the medicine rack to transfer the bottle that they need. The conveyor also must have a controller to control the conveyor and signal such as the indicator lamp to inform other pharmacist when pharmacist at the counter needs the pill bottle.



Semi-automated medicine dispensing system is a system that must be conducted by two people. To ensure this semi-automated medicine dispensing system can be operated efficiently, the suitable controller and the suitable sensor such as capacitive sensor need to be attached with the conveyor to perform a smooth operation of the conveyor. Capacitive sensor must be used to detect the pill bottle when the bottle arrived at the end of conveyor.

## **1.1 Problem Statements**

Traditionally, a pharmacy operation is fully operated manually by pharmacists. When they want to take some drugs, they will do a lot of movements. For example, they must move from counter rack to medicine rack and take some medicine bottle before getting back to the counter. The main purpose of this project is to fabricate a semi-automated dispensing medicine system using conveyor system to help the pharmacist reduced their movement. With the use of this semi-automated dispensing system, the pharmacist will only need to push the controller at the counter to pick up the medicine bottle from the rack. This system must be controlled by two pharmacists. This will make it easier for the pharmacists, as it does not require a lot of movements.

## **1.2 Objectives**

- a) To fabricate a semi-automated dispensing medicine system using conveyor system for transferring the medicine from drug shelves to the counter.
- b) To develop a controller for controlling the conveyor and indicator signal that will be put on counter and drug shelves.

### 1.3 Scope

This project will focus on the conveyor that are use to transfer pill bottle or medicine from rack to the counter. It must consider several of the items or elements.

Semi-automated dispensing medicine system is designed to be used at the pharmacy to help reduce pharmacist movement from taking the drug to counter from drug shelves. This conveyor can move forward and reverse to bring drug from the drug shelve to counter and vise versa. The conveyor movement will be controlled by capacitive sensor at the end of conveyor in such a way when the capacitive sensor detect the medicine bin, the conveyor will immediately stop.

This conveyor movement is controlled by Programmable Logic Controller (PLC) to move the conveyor forward and reverse. Controller is also used to give signal to the pharmacist that stay near to the medicine rack, where for example when the toggle switch for antibiotic is depressed, light on the antibiotic rack will be ON. After the light is ON, the pharmacist will know that the pharmacist at the counter needs an antibiotic. The pharmacist will put the antibiotic bottle on the conveyer and the bottle is conveyed until it activates the capacitive sensor at the end of conveyor. The conveyor will stop immediately when the capacitive sensor is active.

A prototype model with the controller will be fabricated to display the function of the system. It is not a real system but the function of the prototype model is the same as the function of the real system.

## **CHAPTER 2**

### **LITERATURE REVIEW**

The first things to be done before fabricating the semi-automated dispensing medicine system, is to identify the components that will be used and involved in this project which must be identified by their function. The components used in this project are hollow square steel, shaft, gear, bearing, timing belt, pulley, conveyor belt, DC motor, switch, programmable logical controller (PLC), relay, speed controller, indicator lamp, and sensor.

#### **2.1 Conveyor**

According to Groover (2008), a conveyer is types of material handling basically use to transfer large quantity from one area to other area efficiently, and to reduce the need for manual involvement in the process. Conveyor system normally used more in industries operations, warehouse operations, manufacturing, pharmaceuticals, commercial and distributive applications and other applications where large amounts of material need to move quickly, safely and efficiently. For example in industries, conveyor use to convey the product to increase the productivity and to reduce the movements. Conveyers can be divided for powered conveyors or non-powered conveyors. In industries, today have variety of conveyor such as, belt conveyor, roller conveyor, skate-wheel conveyors, chain conveyors, and in-floor towline conveyor.

Conveyor gives more advantages such as:-

- a) More efficient usage of space
- b) Reduce manual labour involvement
- c) Increase production output
- d) More efficient production process
- e) Reliable and cost effective, and
- f) Reduce the worker movement

### **2.1.1 Belt Conveyor**

A belt conveyors is a continuous loop of material consist of two or more pulleys. The pulley is used to move the belt and the material on the belt forward and reverse. One or both of the pulleys must have a powered to drive the belt. The drive roll act as an activator to move the belt forward and reverse. Then, the idle roll is used beside the drive roll just to follow the drive roll. The movement of drive roll is control by DC motor. The belt conveyors are available in two common forms. First, the flat belts for pallets, individual parts, or even certain types of bulk materials and second, troughed belts for bulk material. The most popular belt conveyors types are flat belt conveyor, telescoping belt conveyor, trough belt conveyor, steel hinge belt conveyors (Groover, 2008).

### **(i) Flat Belt Conveyor**

A flat belt conveyor is a class from belt conveyor. A flat belt conveyor is normally use for light and medium weight loads between operations, departments, levels, and buildings. It is especially useful when an incline or decline include in the conveyor path. Because of the friction between the belt and the load, the belt conveyor provides considerable control over the orientation and placement of the load. However friction also prevents smooth accumulation, merging, and sorting on the belt. The belt is generally either roller or slider bed supported. If small and irregularly shape an item is being handled, then the slider bed would be use, otherwise, the roller support is usually more economical. This conveyor is suitable used for pharmacy area (Groover, 2008).



**Figure 2.1:** Flat belt conveyor (Elgun, 1999).

### **(ii) Telescoping Belt Conveyor**

A telescoping belt conveyor is a type of flat belt conveyor that operates on telescopic slider beds. Telescoping belt conveyor is popular at receiving and shipping docks where the conveyor is extend into inbound or outbound trailers for unloading or loading. This conveyor is not suitable to use for pharmacy area (Elgun, 1999).



**Figure 2.2:** Telescoping belt conveyor (Elgun,1999).

### **(iii) Steel Hinge Belt Conveyors**

Basically a steel hinge belt conveyor is easily to transport the material such as metal stamping, hot forging, quenched parts, flash, wet or dry chips, borings, turnings, frozen rubber parts, fasteners, and castings. The steel hinge belt conveyor is also suited for removing plastic, rubber, wood and steel parts from high-speed automatic presses or other machinery. The conveyors belt is constructed of heavy-gauge steel with rollers, and rods. The belt is driven by roller chain on both sides and bears all tension to allow the belt to float freely (Elgun, 1999).



**Figure 2.3:** Steel hinge belt conveyor (Elgun, 1999).

According to Groove (2008) and Elgun (1999), in belt conveyor, it can be further categorized as flat belt conveyor, steel hinge belt conveyors and telescoping belt conveyor. The advantages of belt conveyor described in Table 2.1.

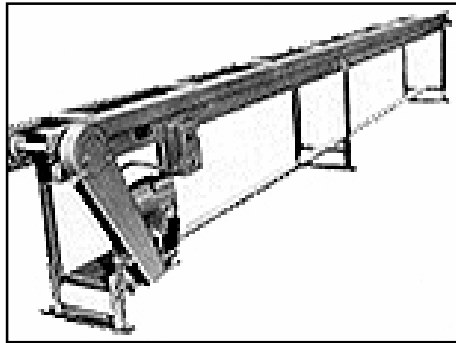
**Table 2.1:** Summary of belt conveyor

No.	Types of belt conveyor	Summary of belt conveyor
1	Flat belt conveyor	<ul style="list-style-type: none"> <li>(i) Friction are prevents smooth accumulation, merging, and sorting on the belt.</li> <li>(ii) The belt is generally either roller or slider bed supported.</li> <li>(iii) The roller support is usually more economical.</li> </ul>
2	Telescoping Belt Conveyor	<ul style="list-style-type: none"> <li>(i) Can operate at receiving and shipping docks where the conveyor is extended into inbound or outbound trailers for unloading or loading.</li> </ul>
3	Steel hinge belt conveyors	<ul style="list-style-type: none"> <li>(i) Can transport the material such as metal stamping, hot forging, quenched parts, flash, wet or dry chips, borings, turnings, frozen rubber parts, fasteners, and castings.</li> <li>(ii) Suited for removing plastic, rubber, wood and steel parts.</li> <li>(iii) Can operate from high-speed automatic presses or other machine.</li> </ul>

### 2.1.2 Chain Conveyor

A chain conveyor basically is often to transport tote boxes and pallets. The typical equipment of the chain conveyor consists of chain loops in an over-an-under configuration around power sprockets at the end of the pathway. This conveyor may operate by one or more chains in the parallel. A chain conveyor provides good positive drive and is an economical form of transportation of goods. A long run of chain

conveyor is more economical when compared with other conveyor styles (Groover, 2008).



**Figure 2.4:** Chain conveyor (Elgun, 1999).

## **MECHANICAL PARTS**

### **2.2 Bearing**

The purpose of a bearing is to support a load to permitting relative motion between two elements of a machine. The bearings have the wide of variety that use spherical balls or some other type of roller between the stationary and the moving elements. Bearing have many type such as single-row, deep-groove ball, double-row, deep-groove ball, angular contact, cylindrical roller, needle, spherical roller, and tapered roller. Basically type of bearing use to supports a rotating shaft, resisting purely radial loads or a combination of radial and axial load. Some of the bearings design to carry only thrust loads. Most bearing uses in applications involve the rotation, but some of bearing is used in linear motion applications. According to Mott (2006), Deep-Groove Ball bearing can be divide for two types such as single-row and double row.

#### **(i) Single-Row, Deep-Groove Ball Bearing**

The single-row, deep-groove ball bearing sometimes calls a Conrad bearing. The inner race is typically press on the shaft at the bearing seat with a slight