

AUTOMATIC REFILLING MACHINE

MOHAMMAD AL-AMIN BIN SALLEH

This Report Is Submitted In Partial Fulfillment of Requirements for the Degree of
Bachelor in Electrical Engineering (Power Electronic and Drive)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2009

“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:

Name:

Date:

DEDICATION

Specially dedicated to my beloved family especially my mother (Fatimah binti Hamat) and my late father (Allahyarham Salleh Bin Hussien); whose very concern, understanding, supporting and patient. Thanks for everything. To All My Friends, thanks for everything. This work and success will never be achieved without all of you.

ACKNOWLEDGEMENTS

Alhamdulillah, the highest thanks to God because with His Willingness, I possible to complete the final year project in time.

I would like to express my gratitude to my dedicated supervisor, En Ahmad Idil Bin Abdul Rahman for guiding this project with clarity and that priceless gift of getting things done by sharing his value able ideas as well as his knowledge.

I also like to thank to all UTEM lecturers and who had helped directly or indirectly in what so ever manner thus making this project a reality. Not forgotten are my best colleagues for their openhandedly and kindly guided, assisted, supported and encouraged me to make this project successful.

My heart felt thanks to my dearest family which always support and pray on me throughout this project. Their blessing gave me the high-spirit and strength to face any problem occurred and to overcome them rightly.

Nevertheless, my great appreciation dedicated to my best friends Mohd Raimi, Abdul Majid, Nur Azam, Ehsan, Khairul Adlan, Mohd Fahmi and SEI member's batch 2008 and those whom involve directly or indirectly with this project. There is no such meaningful word than.....Thank You So Much.

ABSTRACT

Automatic refilling machine (ARM) will be a new innovation in the manufacturing industry especially in the filling sector. An automatic refilling machine is a commercial refilling system that involves a Programmable Logic Controller (PLC) and a microcontroller. The system operates automatically in three stations, which are refilling, checking, and feedback. The filling system is operated automatically to follow the bottle height. While the system detector is operated to detect the depth of the contents of the bottle. In case an error occurs to the depth of the contents of the bottle, the bottle would be sent to the system replenishment through the system feedback. For the bottle, the surveillance process will be removed to place it in isolation. The PLC operates to control the DC motor as a conveyor and pneumatic valve through a signal forwarded by an IR sensor. The microcontroller will obtain a signal from the IR sensor and the data will be displayed on a Liquid Crystal Display (LCD). The LCD and a Light Emitting Diode (LED) will be used to display the amount of product produced, the throw, and the system security.

ABSTRAK

Automatic Refilling Machine (ARM) merupakan satu inovasi baru dalam sektor pembuatan terutamanya dalam sektor pengisian. Automatic refilling machine merupakan sistem pengisian komersil yang melibatkan “Programmable Logic Controller (PLC)” dan “microcontroller”. Sistem ini beroperasi secara automatik yang melibatkan tiga stesen iaitu pengisian, pengesanan dan suap balik (feedback). Stesen pengisian beroperasi secara automatik mengikut ketinggian sesuatu botol. Manakala pengesanan digunakan untuk mengesan isi kandungan cecair dalam botol. Sekiranya berlaku kesilapan pada isi kandungan botol tersebut, botol akan dihantar ke stesen pengisian semula untuk melakukan pengisian melalui stesen suap balik (feedback). Untuk pengisian yang mengalami kesilapan sebanyak 3 kali, botol tersebut akan dihantar ke stesen pengasingan. PLC beroperasi untuk mengawal DC motor sebagai penggerak dan juga “pneumatic valve” melalui isyarat yang hantarkan oleh “IR sensor”. “Microcontroller” menerima isyarat dari “IR sensor” dan segala data dipaparkan kepada Liquid Crystal Display (LCD). LCD dan “Light Emitting Diode (LED)” digunakan untuk memapar keseluruhan operasi, produk dan sistem keselamatan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	TITLE PAGE	i
	STUDENT DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENTS	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF FIGURES	xi
	LIST OF TABLES	xv
	LIST OF SYMBOL	xvi
	LIST OF APPENDICES	xvii
I	INTRODUCTION	
	1.1 Background of Project	1
	1.2 Problem Statement	1
	1.3 Objective of Project	2
	1.4 Scope of Project	3
	1.5 Outline of Thesis	4
II	LITERATURE REVIEW & THEORY	
	2.1 Introduction	5
	2.2 Literature review	5
	2.2.1 A Reliable Automatic Liquid Nitrogen Filling System	5
	2.3 Real-Time Implementation of a Fuzzy Logic Controller for Switch-Mode Power-Stage DC–DC Converters	7

2.2.3	Overflow filling systems	8
2.2.4	Piston filling systems	9
2.3	Hardware specification	10
2.3.1	Pneumatic Valve	10
	2.3.1.1 Electro-pneumatic trainer	12
	2.3.1.2 Single acting cylinder	13
	2.3.1.3 Double acting cylinder	14
2.3.2	Microcontroller	15
	2.3.2.1 I/O pin	17
2.3.3	DC motor	19
2.3.4	Proximity sensor	21
2.3.5	Capacitive Proximity sensor	22
2.3.6	Trough-beam sensor	23
2.3.7	Power Supply +5V	24
2.3.8	Liquid Crystal Display	25
2.3.9	Programmable Logic Controller	26
2.4	Software specification	29
2.4.1	Cx-programmer	29
2.4.2	Proteus 7.2 SP6	32
	2.4.2.1 ISIS 7 Professional	32
	2.4.2.2 ARES 7 Professional	33

III

METHODOLOGY

3.1	Introduction	38
3.2	Hardware Implementation	39
3.2.1	Mechanical part	40
	3.2.1.1 Design the model project	40
3.2.2	Electrical part	43
	3.2.2.1 Display part	43
	3.2.2.2 Input PLC	44
	3.2.2.3 Output PLC	43
3.3	Software implementation	47
3.3.1	Cx-programmer	47
3.3.2	Micro C programmer	55

	3.4	Flow chart	56
IV		TESTING AND RESULT	
	4.1	Introduction	57
	4.2	Experiment	57
	4.2.1	Determine connection between Transmitter and receiver infrared sensor.	57
	4.2.1.1	Procedures	58
	4.2.1.2	Result	59
	4.2.1.3	Simulation	59
	4.2.1.4	Experimental Result Analysis	60
	4.2.2	Determine +5V power supply using 7895	61
	4.2.2.1	Procedures	61
	4.2.2.2	Result	61
	4.2.2.3	Simulation	62
	4.2.2.4	Experimental Result Analysis	63
	4.3	Testing project	63
	4.3.1	DC Motor	63
	4.3.2	Solenoid valve	64
	4.3.3	Double acting cylinder	65
V		CONCLUSION AND RECOMMANDATION	
	5.1	Introduction	67
	5.2	Problem that occur	67
	5.2.1	Using the suitable sensor	68
	5.2.2	Research	68
	5.2.3	Problem	69
	5.2.4	Solution	69
	5.3	Discussion	70
	5.4	Recommendation project	71

	5.5	Conclusion	71
REFERENCES			72
APPENDICES			
APPENDIX A – C			-

LIST OF FIGURES

NO.	TITLE	PAGE
1.1	Scope of project	3
2.1	Drawing of automatic liquid nitrogen filling system	5
2.2	View of cross section of cap for supply Dewar	6
2.3	Fuzzy controller-based converter topology	7
2.4	Overflow filling system	8
2.5	Piston filling system	10
2.6	Single acting cylinder	12
2.7	Training for pneumatic and electro-pneumatic system	12
2.8	Design single acting cylinder	14
2.9	Symbol of single-acting cylinder	14
2.10	Design double acting cylinder	14
2.11	Schematic I/O pin of PIC16F877A	17
2.12	12V and 24V DC motor	20
2.13	Optical Wheel Rotation Sensor Circuit	21
2.14	Result of A/D conversion in two A/D registers	21
2.15	Capacitive Proximity Sensor	22
2.16	E3Z-TA	23
2.17	IC LM7805	24
2.18	Schematic circuit of +5V power supply	25
2.19	Liquid Crystal Display (LCD)	25
2.20	Programmable Logic Controller	27
2.21	Ladder diagram	27
2.22	Typical PLC Control system.	28
2.23	CX-programmer	29
2.24	Select CS1G/CJ1G	29
2.25	Program Diagram	30
2.26	The Toolbox	30
2.27	Example program	30
2.28	Transfer data	31

2.29	After transfer data.	31
2.30	Run the program	32
2.31	Proteus 7.2	32
2.32	Schematic diagram	33
2.33	Run the program	33
2.34	Schematic diagram	33
2.35	Click ARES	34
2.36	First Step	34
2.37	Second Step	35
2.38	Third Step	35
2.39	Four Step	36
2.40	Five Step	36
2.41	Six Step	37
2.42	Last Step	37
3.1	Block diagram of Automatic Refilling Machine	38
3.2	Design Automatic Refilling Machine	39
3.3	Picture of the project	39
3.4	Design of Automatic Refilling Machine.	40
3.5	Sketch of conveyer	41
3.6	Sketch DC motor couple with rod and bearing	41
3.7	Sketch of the conveyer from upper view	41
3.8	Sketch filling station	42
3.9	Part of filling station	42
3.10	Type of aluminum	42
3.11	Model of Automatic Refilling Machine	43
3.12	Circuit of display part	43
3.13	Input PLC	45
3.14	Output PLC	46
3.15	Circuit of relay connect to motor	46
3.16	Start condition	47
3.17	Sensor 1 detect condition	48
3.18	Bottle move checking station	48
3.19	Sensor 4 detect full condition	49
3.20	Valve 1 ON when full condition	49

3.21	Bottle move feedback	49
3.22	Limit switch 1 detect	50
3.23	limit switch 2 detect	50
3.24(a)	Flow chart for program PLC	51
3.24(b)	Flow chart for program PLC	52
3.24(c)	Flow chart for program PLC	53
3.25(a)	Program of display part	54
3.25(b)	Program of display part	54
3.26	Download files HEX for display part.	55
3.27	Display of program.	55
3.28	Flow Chart for this project.	56
4.1	Experiment with multimeter	57
4.2	Transmitter infrared sensor	58
4.3	Receiver infrared sensor	58
4.4	Switch OFF	59
4.5	Switch ON	59
4.6	Simulation circuit (OFF)	60
4.7	Simulation circuit (ON)	60
4.8	Circuit of power supply +5V	61
4.9	When switch ON	61
4.10	Wave output for power supply	62
4.11	Simulation circuit.	62
4.12	Ladder diagram for DC Motor	63
4.13	Diagram for DC motor moving.	64
4.14	Ladder diagram for solenoid valve.	64
4.15	Diagram for the solenoid valve.	64
4.16	Ladder diagram when switch ON	65
4.17	Diagram for advancing valve.	65
4.18	Ladder diagram when switch OFF	65
4.19	Diagram for retracting valve	66
4.20	Testing the project.	66
4.21	Testing the project	66
5.1	Manual Fiber Amplifier (E3X-NA)	68
5.2	Operation of E3X-NA	68

5.3	Price of E3X-NA	69
5.4	E3Z-TA	70
5.5	Sensor position	70

LIST OF TABLES

NO.	TITLE	
PAGE		
2.1	Type of Pneumatic valve	11
2.2	Advantages and disadvantages of various types of DC motor	19
2.3	Specification of the motor	20
2.4	Standard model of photoelectric sensor	23
2.5	Operation of NPN sensor	23
2.6	Operation of PNP sensor	24
2.7	Mechanical specification	25
2.8	Pin assignment	26
3.1	List component for display circuit	44
3.2	Port input PLC	44
3.3	Port output PLC	45
3.4	List of component Automatic Refilling Machine	47
4.1	Result experiment 1	60
4.2	Result experiment 2	63

LIST OF SYMBOL

ARM	- Automatic Refilling Machine
PLC	- Programmable Logic Controller
LCD	- Liquid Crystal Display
LED	- Light Emitting Diode
DC	- Direct Current
RAM	- Random Access Memory
ROM	- Read-Only Memory
PROM	- Programmable Read-Only Memory
EPROM	- Erasable Programmable Read-Only Memory
I/O	- Input/Output
IC	- Integrated Circuit
Vb	- Visual Basic

LIST OF APPENDIX

NO.	TITLE	PAGE
A	Project Planning	83
B	Picture model of Automatic Refilling Machine	84
C	Data Sheet PIC16F877	86
D	Data Sheet LCD	92

CHAPTER I

INTRODUCTION

1.1 Background of Project

Filling system is among the system in manufacturing sector for in Malaysia. The system can faster for the produce product in factory. In the industries, the filling used because the system to operated with automatic. All the operation in factory will be control through this system. But this system still need human for to look this operation system. This system must be to need human for to control system because the machine non-perfect.

Automatic refilling machine (ARM) wills a new innovation manufacturing industry especially sector filling. This system is commercial refilling system that involves Programmable Logic Controller (PLC) and microcontroller. The system operates automatically in three stations, which are refilling, checking, and feedback. PLC and microcontroller to using for control all process in this system.

The Liquid Crystal Display (LCD) and Light Emitting Diode (LED) will be used to display amount of product produce, throw and system security.

1.2 Problem Statement

In small industries, their refilling system usually operates in manual even though for other industries, they used automatic refilling system. By using manual processing method, it need take along time to produce a product. Caused use manually limited to singles only time.

In refilling sector, the process must done fast to ensure the efficient of the machine. It is a fact that when using refilling process manually needs many workers. This is because every section needs workers to make sure all the product that developed is working smoothly and to prevent any problems that may occur during the refilling process.

As a solution Automatic Refilling Machine will be made. It will solve the problems that small industries face today. With this system that operates automatically, every process can be smooth and the process of refilling can reduce workers cost and operation time. The system operates by the program that designed to do the operation

1.3 Objective of Project

There are four objective of this project:

- ❖ To design a system that operates automatically using PLC.
- ❖ To use a Microcontroller PIC16F877A to display the information about the process of refilling machine.
- ❖ To integrate the PLC and PIC system to operated the complete Automatic Refilling Machine.
- ❖ Make one system can do filling by quick, accurate and effective in Automatic Refilling Machine.

1.4 Scope Of Project

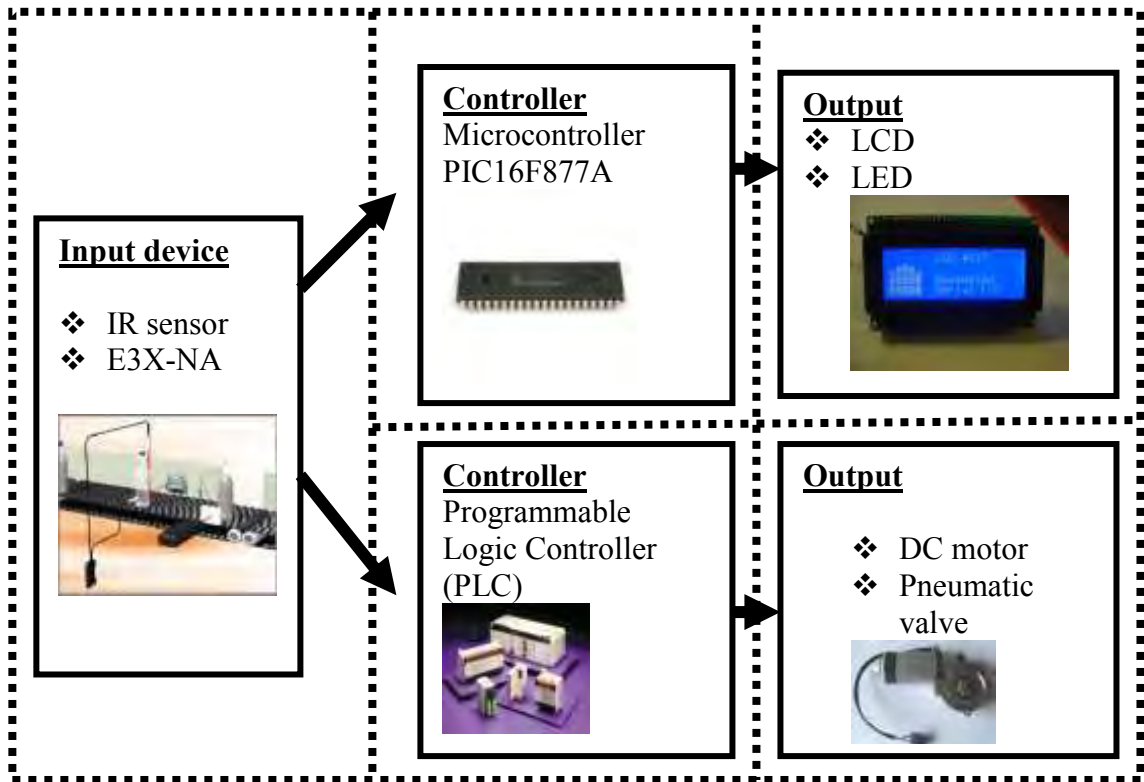


Figure 1.1: Scope of project

In system this, there were 3 part to control all Automatic Refilling Machine's whole operation. Among this parts are input device, controller and output device. This part important to system because can be control all operation with perfect. For this input device part, IR sensor and E3X-NA used to give signal for controller to operate this system. PIC16F877A and PLC used as controller for this system when accepted signal from input device. Microcontroller PIC16F877A used to control output through signal forwarded by sensor. The signal stated will be translated in language micro C to be sent to Liquid Crystal Display (LCD) for the all display process. For the PLC, signal from sensor will be translated in language from ex-programmer and sent to DC motor and pneumatic valve.

1.5 Outline Of Thesis

In this project, I would like to design the machine filling. In this report, I will discuss it in detail in five sections. There are introduction, literature review, methodology, results and discussions, and conclusion

In chapter one (introduction), I discussed about the major characteristics to be Automatic Refilling Machine. The problem statement, project objectives, scope and thesis outline are also included in this chapter.

In chapter two (literature review), the comparison is made by discussing the operation for automatic system and application of filling system. Later, each part of the Automatic Refilling Machine is discussed in detail.

In chapter three (methodology), I discussed about the techniques and consideration that I applied during I carried out my PSM1 and PSM2. Infrared sensor is an important part for the Automatic Refilling Machine to operate with successfully. In simulation part, Proteus software is used to simulate the design circuit before I proceed to the hardware part.

In chapter four (results and discussions), the results are obtained using the methodology discussed in previous chapter. Then, Proteus 7.2 SP6 simulation is done to the design circuit to ensure it functions probably. This is determined by looking at the data obtained during simulation. Finally, I proceed to the hardware part. Here all the obtained results are gathered. Finally, analysis is done according to the results.

In chapter five (conclusion), a brief summary and recommendation of this project are provided. Besides that, I also include my personal experiences during the Automatic Refilling Machine. Finally, I have finished all the parts in my project planning according to the objectives and scopes.

CHAPTER II

LITERATURE REVIEW & THEORY

2.1 Introduction

This chapter includes the study of different types of a reliable automatic liquid nitrogen filling system, real-time implementation of a fuzzy logic controller for switch-mode power-stage dc–dc converters and pneumatic valve. It also brief discuss about microcontroller, DC motor, proximity sensor and filling system.

2.2 Literature review

2.2.1 A Reliable Automatic Liquid Nitrogen Filling System

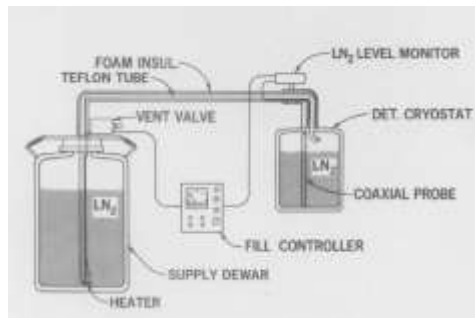


Figure 2.1: Drawing of automatic liquid nitrogen filling system

Figure 2.1 show the drawing of the automatic liquid nitrogen filling system. The system operational by automatic which all operation it control by detector cryostat. The level monitor supplies a continuous reading of the liquid nitrogen level in the detector cryostat to the fill controller. When the liquid nitrogen in the detector cryostat drops below a preset level as determined normally by the monitoring

computer, the fill controller activates the fill cycle. This closes the normally open vent valve on the supply Dewar and turns on the internal heater. The pressure build-up forces the liquid nitrogen through the foam insulated Teflon tube to the detector cryostat. When the liquid nitrogen in the detector cryostat reaches the preset stop fill level, the controller turns off the heater and opens the vent valve [1]. Figure 2.2 show the view of cross section of cap for supply Dewar.

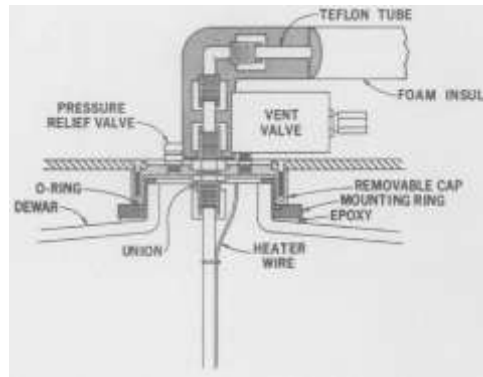


Figure 2.2: View of cross section of cap for supply Dewar

The advantages of this system are:

- a) The liquid nitrogen level monitor provides a continuous output of the level
- b) The probe does not require heating as resistor or thermister types do. This conserves liquid nitrogen in the cryostat.
- c) The fill and stop levels are set electrically in the controller and do not require mechanical.
- d) No valve is used in the liquid nitrogen line (The plague of most automatic liquid nitrogen filling systems).
- e) The fill tube made of Teflon is insulated with foam insulation and is more reliable than other plastic fill tubes. The fact that the thermal capacity is much lower than metal fill tubes means that much less liquid nitrogen is used to cool it down [1].

2.2.2 Real-Time Implementation of a Fuzzy Logic Controller for Switch-Mode Power-Stage DC–DC Converters

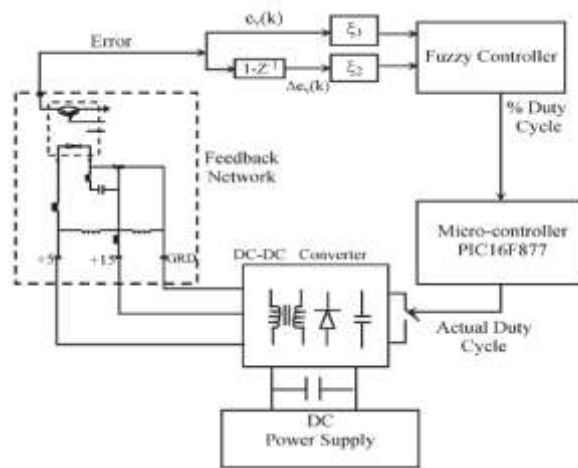


Figure 2.3: Fuzzy controller-based converter topology

Figure 2.3 show the fuzzy controller-based converter topology for this system. The structure built up here is a two-input single-output controller. The inputs are the variable voltage error $e(k)$ and the change in voltage error $\Delta e(k)$. Consequently, the input to the dc–dc converter would be the duty cycle, which is actually the output of the fuzzy controller. Fuzzification translates a numeric value for the error $e(k)$ or change in error $\Delta e(k)$ into a linguistic value such as big or small with a membership grade. Defuzzification takes the fuzzy output of the rules and generates a numeric value used as the control input to the dc–dc converter. The controller qualitatively captures the dynamics of the dc–dc converter and executes this qualitative idea in a real-time situation [2]. The dc–dc converter is equipped with a feedback network that provides the error value at the output [3].

This output voltage is then compared internally to the reference of the precision voltage reference, and any error difference detected is amplified and fed back. The controller provides a percentage duty-cycle signal for a peripheral interface microcontroller PIC16F877, which generates the converter actual duty cycle [3].

2.2.3 Overflow filling systems

This type of filler is perhaps the most widely used machine in small bottle filling operations because it handles a wide range of thin, free flowing liquids as well