

AUTOMATIC WATER LEVEL CONTROL

RAHAYU BINTI ABD RAHMAN

This Report Is Submitted in Partial Fulfillment of the Requirements for the award of
Bachelor of Electronic Engineering (Industrial Electronic) With Honours

Faculty of Electronic Engineering and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2009



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : AUTOMATIC WATER LEVEL CONTROL
Sesi Pengajian : 2008/09

Saya**RAHAYU BINTI ABD RAHMAN**.....
(HURUF BESAR)

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 : 1176, Kg Durian Burung,
20050 Kuala Terengganu,
Terengganu.

Tarikh: 30 April 2009

Tarikh:

“I declared that this thesis is the result of my own work except the ideas and summaries which I have clarified their sources.”

Signature :

Writer : Rahayu Binti Abd Rahman

Date : 30 April 2009

“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 of Bachelor of Electronic Engineering (Industrial Electronic) With Honours”

Signature :

Supervisor's Name : En Chairulsyah bin Abdul Wasli

Date :

DEDICATION

My parents Abd Rahman bin Ismail, Salmah Binti Lateh and my brothers and sisters (aya, ain, atah, amira, amin & aqim) who has encouraged, guided and inspired me throughout my journey of education.

ACKNOWLEDGEMENT

First of all, I would like to thank Almighty Allah for His blessing and His power for me to complete this *Project Sarjana Muda*.

I would like to take this opportunity to express my deepest gratitude to my project supervisor En Chairulsyah Abdul Wasli who has persistently and determinedly assisted me during the whole course of this project. It would have been very difficult to complete this project without the enthusiastic support, insight and advice given by him.

My outmost thanks also go to my family who has given me support throughout my academic years. I would like to thank them for understanding and always giving me courage and the strength I need to carry on this project. Without them, I might be not being the person I am today.

It is too my advantage that I have received help and support from friends and staffs in the Faculty of Electronic and Computer Engineering. My special gratitude to my father and mother for giving me amount of budget and idea to support my project. My appreciation to Ruhairi Abd Rahim, Shatini Md Said, Zulhasnizam Hasan and Azira Abd Rahman, and all my friends for their cooperation and material aid. It is of my greatest thanks and joy that I had meets these people.

ABSTRACT

Automatic Water Level Control is a project that has been purpose to maintain the water at the certain level. The project has two actuator to control the water, which are pump and valve. The pump draws water to the tank and the valve can enable or disable the outflow from the tank. When the water is higher from the actual level, the valve will automatically on and the water will decrease to the actual level. But when the water is less than the actual level, the valve will off and the pump will draws the water until reach the level. This project uses the PLC as the controller to control the water in and water out. The CX-programmer software in PLC is used to draw the ladder diagram. The instruction such as jump, counter, timer, compare will be used in this system to function the water level control hardware. The Flash Software will be used to display the anime of water flow in the tank controlled by motor and valve.

ABSTRAK

“Automatic Water Level Control” adalah satu projek yang diusulkan untuk menseimbangkan air pada satu tahap tertentu. Projek ini menggunakan dua penggerak iaitu pam dan injap. Pam berfungsi memasukkan air dalam tangki dan injap berfungsi untuk mengawal keluar masuk air. Apabila air tinggi daripada tahap yang ditetapkan, maka injap akan berfungsi untuk mengeluarkan air sehingga tahap yang ditetapkan dan apabila air rendah daripada tahap yang ditetapkan, maka injap akan tertutup dan pam akan berfungsi untuk memasukkan air kedalam tangki sehingga mencapai tahap yang ditetapkan. Projek ini menggunakan PLC (*Programmable Logic Controller*) untuk mengawal air keluar masuk dan bila sepatutnya pam berfungsi. Perisian CX-programmer digunakan untuk membuat *ladder diagram*. Macromedia Flash 8 juga turut dibuat untuk menghasilkan animasi projek ini.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	PROJECT TITLE	i
	STATUS DECLARATION FORM	ii
	DECLARATION	iii
	DEDICATION	v
	ACKNOWLEDGEMENT	vi
	ABSTRACT	vii
	ABSTRAK	viii
	TABLE OF CONTENTS	ix
	LIST OF TABLES	xiii
	LIST OF FIGURES	xiv
	LIST OF APPENDIX	
I	PROJECT OVERVIEW	1
	1.1 Project Overview	1
	1.2 Project Objectives	3
	1.3 Scope of Work	2
	1.4 Problem Statement	4
	1.5 Methodology	4
	1.6 Thesis Outlines	5
II	LITERATURE REVIEW	6

2.1	Background Study	6
2.2	Control Theory	7
	2.2.1 Open Loop and Closed Loop System	8
	2.2.2 Application for Feedback System	10
	2.2.3 Advantages of Feedback Control	10
	2.2.4 Costs of feedback Control	11
	2.2.5 Stability of closed-loop systems	12
	2.2.6 Design	
2.3	Programmable Logic Controller	13
	2.3.1 Introduction	14
	2.3.2 Programming Language	15
	2.3.3 PLC Connections	20
	2.3.4 Ladder Logic Input	22
	2.3.5 Ladder Logic Output	23
	2.3.6 Function Block Diagram (FBD)	24
2.4	Hardware	24
	2.4.1 Solenoid Valve	24
	2.4.2 Submersible Pump	27
	2.4.3 Float Sensor	29
	2.4.4 Relay	35
	2.4.5 Seven Segment Display	40

III METHODOLOGY 43

3.1	Project Methodology	43
3.2	Methodology Flow chart	44
	3.2.1 The Literature	45
	3.2.2 Theory of The Calculation	50
	3.2.3 Animation	53
	3.2.4 Progress in Hardware and Software	55

	3.2.5 PLC program	57
	3.2.6 Hardware Development	61
IV	RESULTS AND DISCUSSIONS	
	4.1 Animation result	63
	4.1.1 To Reach Medium Level	64
	4.1.2 To Decrease from High level to Medium Level	64
	4.1.3 To Increase from Low level to Medium Level	65
	4.2 Calculation Result	67
	4.3 Measurement Results	68
	4.3.1 Comparison	69
	4.4 Discussions	70
	4.4.1 From Empty Tank to Medium Level	70
	4.4.2 From High Level to Medium Level	70
	4.4.3 From Low to Medium Level	71
	4.5 CX Programmer	72
	4.6 Mnemonics Code	73
	4.6.1 Ladder diagram Inputs and Outputs	74
	4.7 Hardware Results	75
V	CONCLUSIONS	78
	5.1 Discussion	78

5.2	Conclusion	80
5.3	Suggestions	80
	REFERENCES	81
	APPENDIXES	82

LIST OF TABLE

NO	TITLE	PAGE
2.1	The Reference T thesis from the previous year	7
2.2	Specification of float sensor	33
2.3	Configuration of Relay	38
3.1	Table of velocity	50
3.2	Time Taken According to Condition	53
3.3	Main Address	59
4.1	The calculation results	67
4.2	The Measurement Results	68
4.3	Comparison between Calculations and Measurement results	69
4.4	Address for Inputs	74
4.5	Address for outputs	74

LIST OF FIGURE

NO	TITLE	PAGE
1.1	The Automatic Water Level Control	2
2.1	Open Loop Systems	9
2.2	Closed Loop Systems	9
2.3	PLC Connections	14
2.4	Ladder diagram	15
2.5	Simple of Ladder Logic	16
2.6	Simple Relay Layouts and Schematic	18
2.7	A Simple Relay Controller	19
2.8	A PLC illustrated with Relays	20
2.9	The Separation of Controller and Process	21
2.10	The Scan Cycle of PLC	22
2.11	Ladder Logic Inputs	22
2.12	Ladder Logic Outputs	23
2.13	Solenoid Valve	25
2.14	The Solenoid Parker Valve	25
2.15	The Position of valve at the storage tank	26
2.16	Submersible pump	27
2.17	The Aquarium Motor	28
2.18	The Pump in the Water Supply Tank	28
2.19	Function of the sensor	31

2.20	Vertical float switch	31
2.21	Schematic of float switch sensor	32
2.22	Float sensor	33
2.23	The view of float sensor in the storage tank side	34
2.24	The Level of Each Sensor	35
2.25	Relay	36
2.26	Circuit symbols of relay	38
2.27	The Omron Relay	39
2.28	The Connection of the relay in the project	39
2.29	Seven Segment Display	41
2.30	Seven segment display high	42
2.31	Seven segment display medium	42
2.32	Seven segment display low	42
3.1	Flow Chart of Methodology	45
3.2	One-dimensional duct showing control volume	46
3.3	Bernoulli Equation	46
3.4	Illustration inside the nozzle flow meter	50
3.5	Calculation Model	50
3.6	Design of Hardware	55
3.7	PLC Ladder Diagram	57
3.8	Mnemonic Code	58
3.9	Address at the input	60
3.10	Address at the output	60
3.11	The full set of automatic water level control	61
4.1	From empty tank to the medium level	64
4.2	From high level to medium level	64
4.3	From low level to medium level	65
4.4	Design of animation at initial condition	66
4.5	Block Diagram from empty tank to the medium level	70
4.6	Block Diagram From high level to medium level	70
4.7	Block Diagram From low level to high level	71
4.8	Ladder Diagram for CX programmer	72

4.9	Mnemonic Code	73
4.10	The model of the project	75
4.11	Indicator lamp	76
4.12	Seven Segment Display	76
4.13	Connection Input and Output to the PLC	77
4.14	Connections to Relay	77

CHAPTER I

INTRODUCTION

Water is very important to human being. The management of water is very important to avoid it wasted. The *Automatic Water Level Control* is introduced to help the human being to manage the water in their life.

1.1 Project Overview

Automatic Water Level Control was used for on/off signal. The system is very useful to the house and the factory. The purpose of this project is to keep the water at the certain level. The water is set at three level which is high level, medium level and low level. The purpose of this project actually to keep the water stable at the medium level

But if there are any disturbances occurred, such as the water at the high level the water will decrease and stop at the medium level. Then when the water at low level, the pump will on and pump the water until it reaches the medium level. Then the pump will off. In this operation, when the manual valve is on, the pump will on until it the medium sensor is on. The seven segments will display low when the

\

pump is on. When the high level sensor on, the seven segment will display high but the seven segment will display

medium when the level of the water is higher than the low sensor and below the high sensor.

In this project, the types of system involve components such as process water holding tanks, actuators as valves and pumps and measured values as level, flow and composition. The flow of water into the tank is controlled by a valve. The control input signal to the valve is a current signal in mA which is converted into a pressure signal.

This pressure is applied to a valve and changes the valve stem position in mm. the valve position dictates the amount of flow passing through the valve into the tank. The height of water in the tank is measured by a transducer (gauge pressure) which produces an output in mA.

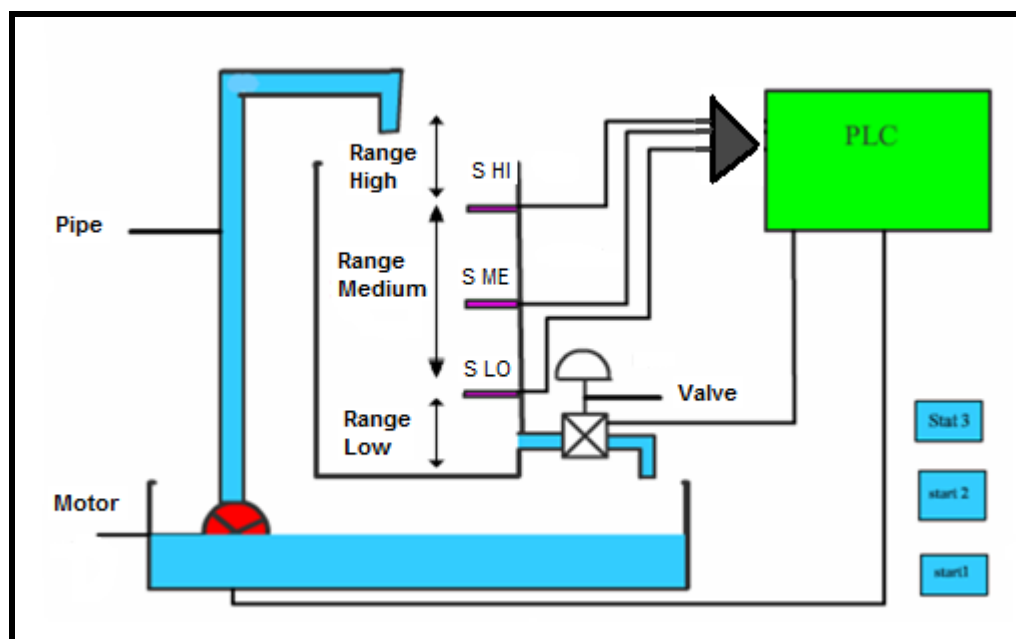


Figure 1.1 The Automatic Water Level Control

1.2 Objective

In order for the project to success and to be implemented, the following objectives have to be achieved:-

- 1) To design and develop an automatic water level control using PLC
- 2) To learn about the Macromedia Flash Software this can display the anime of the increasing or decreasing of the water in the tank.
- 3) To learn more about the characteristic of the sensor and others devices such as valve and motor

1.3 Scopes Of work

The scopes of works in this project are:

- 1) In this project the control system should be study to control the outflow of the water. The specification of the float sensor also must be study to use as a sensor.
- 2) In order to make this project successful, ladder diagram must be built using CX programmer.
- 3) After the theoretical, the development of PLC and the hardware will continue and be tested
- 4) Besides, the component such as valve and motor need to study.

1.4 Problem Statement

The traditional water tank had many disadvantages such as:

- 1) Traditional water level must draw the water manually to the tank when there is no water in the tank.
- 2) The problem of manual control is sometimes people forget to turn off or turn on the valve.
- 3) For the automatic water level control, if the manual float broken or damage, all the system can't function properly.
- 4) To avoid the overfilling of the open container in industrial

1.5 Methodology

There are a few methods that must be following to complete this project. The method is as below:

- 1) The project had started with study the literature of the project. It's including the operation of the project and the purpose of the project.
- 2) Then, it will continue to research about the calculation of the water flow including the water level, volume, velocity and the time its take to fill in the tanks and drain the tanks. The calculation should be including the area of the pipe and nozzle and the it should be affected by the gravity.
- 3) If the formula related enough, then can proceed to the animation. To create the animation, the Macromedia flash 8 had to study first. Then can create the water draws in the tank and the water decreasing when there are some disturbances. But if the formula does not enough, then the literature reviews need to be study again.
- 4) Then study about the Programmable logic controller and create the ladder diagrams. At the same time studies about the component such as valve and motor. Next, try to construct the hardware.

- 5) Test the functionality of the ladder diagrams and the hardware. Then integrate the hardware and the software. If it can't function, then try to construct the ladder diagram and the hardware again.
- 6) Then if the hardware and software is successfully done, then prepare for the final report and submit to the supervisor.

1.6 Thesis Outline

This thesis will be divided into 5 chapters to provide the understanding of the whole project.

Chapter 1 is introduction to the overview of this project and its objectives. It also explains the scopes of the project.

Chapter 2 describe about the literature review that has been studied to get information to complete the project. This study is focused especially on automatic level control.

Chapter3 covers up all the project methodology and a process this project implementation to achieve goal. Also hardware and software technical details are explained in this part.

Chapter 4 explains the results and discussions of the project and what had been done in the whole semester.

Chapter 5 certain conclusion of the project.

CHAPTER II

LITERATURE REVIEW

For complete this report, a few reference had been made. There are a few theses that had been referred as a literature review. The past year thesis that related with this title is the past year theses from the Faculty of Electric Engineering.

2.1 Background Study

The Automatic Water Level Control had a few most important actuators as the main of the process. The actuator will control the process of water level which is pump and valve. The pump draws water to the tank and the valve can enable or disable the outflow from the tank. When the water is higher from the actual level, the valve will automatically on and the water will decrease to the actual level. But when the valve is open, the water will decrease to the low level then the pump will keep running, until the valve is off. Then, the pump will automatically off when it reaches the manual level. This project uses the PLC as the controller to control the water in and water out. The CX-programmer software in PLC are used to draw the ladder diagram .The instruction such as jump, counter, timer, compare will be used in this system to function the water level control hardware. This project will also used the seven segment display to show the level of the water, so that the user will know the level of the water without check it.

Table 2.1 The Reference Thesis from the previous year.

Writer	Theses Title	Description
Mohd Firdaus Abd Ghani	Water Level Controller	<p>Use the PLC to controls the water level tank.</p> <p>The user key in the value of the water they want such as low, medium or high and the pump will on.</p> <p>The user key in will appeared then the user will switch on the controller by pressing the touch screen.</p> <p>After the desired level is reached the pump will off.</p>

2.2 Control Theory

Control theory is an interdisciplinary branch of engineering and mathematics, that deals with the behavior of dynamical systems. The desired output of a system is called the *reference*. When one or more output variables of a system need to follow a certain reference over time, a controller manipulates the inputs to a system to obtain the desired effect on the output of the system. [11]

In a closed-loop control system, a sensor monitors the output (the vehicle's speed) and feeds the data to a computer which continuously adjusts the control input (the throttle) as necessary to keep the control error to a minimum (to maintain the desired speed). Feedback on how the system is actually performing allows the controller (vehicle's on board computer) to dynamically compensate for disturbances to the system, such as changes in slope of the ground or wind speed. An ideal

Feedback control system cancels out all errors, effectively mitigating the effects of any forces that may or may not arise during operation and producing a response in the system that perfectly matches the user's wishes.

Interconnections of components forming system configurations which will provide a desired system response as time progresses. The steering of an automobile is a familiar example. The driver observes the position of the car relative to the desired location and makes corrections by turning the steering wheel. The car responds by changing direction and the driver attempts to decrease the error between the desired and actual course of travel. In this case, the controlled output is the automobile's direction of travel, and the control system includes the driver, the automobile, and the road surface.

The control engineer attempts to design a steering control mechanism which will provide a desired response for the automobile's direction control. Different steering designs and automobile designs result in rapid responses, as in the case of sports cars, or relatively slow and comfortable responses, as in the case of large autos with power steering.

2.2.1 Open Loop and Closed Loop Control Systems

The basis for analysis of a control system is the foundation provided by linear system theory, which assumes a cause-effect relationship for the components of a system. A component or process to be controlled can be represented by a block. Each block possesses an input (cause) and output (effect). The input-output relation represents the cause-and-effect relationship of the process, which in turn represents a processing of the input signal to provide an output signal variable, often with power amplification. An open-loop control system utilizes a controller or control actuator in order to obtain the desired response in figure 2.1.