UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SIMULATION AND CONTROL OF WATER TANK SYSTEM USING LABVIEW AND AUTOMATION STUDIO

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

by

ALWI BIN ZULKEFLI

FACULTY OF MANUFACTURING ENGINEERING

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APPROVAL

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

.....

(Mr. Lokman bin Abdullah)

LOKMAN BIN ABDULLAH
Pensyarah
Fakulti Kejuruteraan Pembuatan
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ABSTRACT

This project name is "Simulation and Control of Water Tank System Using LabVIEW and Automation Studio". Simulation of water tank control using two program simulations software such as LabVIEW 8.5.1 and Automation Studio 5.0. For LabVIEW simulation, it is using the PID controller to pump water and to maintain water level in the tank. PID controller has ability to measure water level in the tank at required value. In industry, this situation is important especially in industry process and application. Many case in industry occur when the function controller to control water in the tank it not function as well. The type of PID controller using in this project exactly aim for system feedback. The operation of PID controller function when the pump gets the signal from controller, pump will operate and inhale the water into the tank at the desired setpoint. The pump will automatically stop operation when water level reaches the setpoint (maximum) value and will function again when the water level reach at minimum level of setpoint. Second one is simulation by using PLC controller software. The function is same like LabVIEW to control the water level in the tank so the differential only is more based on the control mechanical part component like actuator, valve, pump, relay, coil and others like the same function in control application such as water tank controller in industry.

ABSTRAK

Projek ini bertajuk "Simulation and Control of Water Tank System Using LabVIEW and Automation Studio". Simulasi pengawalan air di dalam tangki ini menggunakan dua program simulasi iaitu menggunakan LABVIEW 8.5.1 dan Automation Studio 5.0. Untuk LabView program, ia menggunakan pengawalan "PID" untuk mengawal pengepam air dan menstabilkan paras air. Selain itu, ia berupaya mengukur paras air di dalam tangki pada takat yang dikehendaki dan sesuai digunakan di dalam industri terutama dalam industri proses dan aplikasi. Terdapat banyak kes yang berlaku di industri yang mana melibatkan pengawal pada tangki air tidak berfungsi dengan sebaiknya. Jenis pengawal 'PID' yang digunakan didalam projek ini bertujuan untuk sistem suapbalik. Cara pengawal ini menjalankan operasi ialah apabila pam mendapat signal daripada pengawal, pam akan mula beroperasi dan menyedut air masuk kedalam tangki sehingga paras yang dikehendaki. Pengepam akan berhenti operasi apabila paras air mencapai nilai maksimum yg dikehendaki dan beroperasi apabila mencapai nilai yang minimum yg dikehendaki. Manakala untuk simulasi menggunakan Automation Studio ia menggunakan pengawal 'PLC' untuk mengawal air di dalam tangki. Sistem operasi dan pengawalan air adalah hampir sama dengan program LabView yang membezakan adalah penggunaan pengawal komponen mekanikal seperti 'actuator', 'valve', 'pump', 'relay' 'coil' dan sebagainya yg mempunyai fungsi yg sama dalam pengawalan proses aplikasi seperti tangki air di dalam industri.

DEDICATION

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CHAPTER 1

INTRODUCTION

Nowadays, the process industries such as petro-chemical industries, paper making and water treatment industries require water to be pumped, stored in tanks, and then pumped to distribution or to another tank. The control of water level in tanks and flow between tanks is a basic problem in the process industries. The above mentioned industries are the vital industries where water level and flow control are essential. Many times the water will be processed by chemical or mixing treatment in the tanks, but always the water level in the tanks must be controlled, and the flow between tanks must be regulated. Level and flow control in tanks are the heart of all process application engineering like storages and chemical manufacturing.

The title of this project is 'Simulation and Control of Water Tank System Using LabVIEW and Automation Studio'. Water level control is commonly used in many process control applications to control, for example, the level of water in a tank. The system consists of a water tank, a water pump, a water level sensor, a controller and valve. Main objective this project is to simulate of water tank system and to control it at a required value or set point as needed. Automatic control is a useful tool in many fields and it is also learned by the students in majors of biotechnology, food engineering and chemical engineering, besides the automation related majors in some universities. Automatic control laboratory is needed for the students to have a deeper and more

complete understanding of control system design and implementation, but it will be of high cost and need more hours of course time. In order to lower the cost and save the course time, an internet based water level control system will be constructed, which will enable the students to conduct the control experiment at any time using a remote computer that is connected to the internet.

Simulation of water tank will be using with two software. One is by using LabVIEW software. The simulation of water level is control by using PID Controller and simulating with LABVIEW software. The LABVIEW software will appear the interface for the start the system. When the system is start water enters the tank using a pump and connected to the valve, water from the main source tank will inhale by pump and water will enter to tank. The requirement in this system is to control the rate of water delivered by the pump so that the level of water within the tank is at the desired point. A constant voltage will be applied to the pump so that a constant rate of water can be pumped to the tank. The height of the water inside the tank will then be measured and plotted. An output simulation of the water system can then be derived from this response curve.

Second one is using Automation Studio software. The function of water level in the tank is same as LabVIEW simulation. The different by using Automation Studio software is this software is more based on the mechanical part hardware. So, to do this simulation wills using by PLC Programming to control the water level in the tank. With PLC programs, the mechanical component part will be combining to control the water level into the tank with the system safety to maintain and stable the water level into the tank. The PLC In – Out will show the flow how the system function. For more detail about LabVIEW and PLC Programming using will describe in methodology on Chapter 3.

1.1 Theory of Water tank

The basic theory system water tank can see below, where water enters a tank from the top and leaves through an orifice in its base. The rate that water enters is proportional to the voltage, V, applied to the pump. The rate that water leaves is proportional to the square root of the height of water in the tank. There are basic diagrams of water tank system,

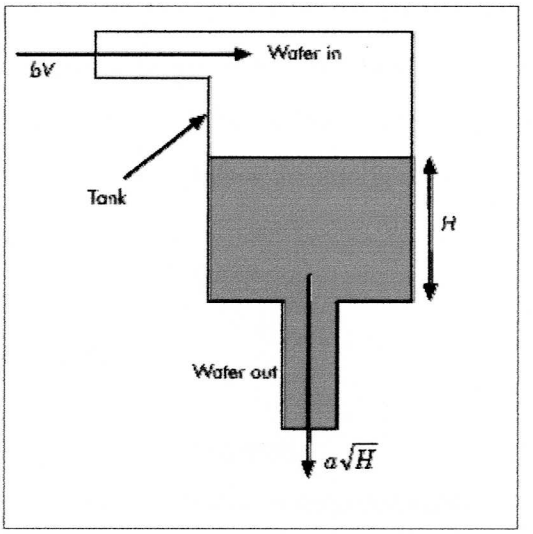

Figure 1.1: Schematic Diagram Water-Tank System (The MathWorks, Inc 2004–2008).

1.2 Model Equations of Water Tank

A differential equation for the height of water in the tank, H, is given by,

$$\frac{d}{dt}Vol = A\frac{dH}{dt} = bV - a\sqrt{H}$$

Figure 1.2: The Model Equation of Water Tank System (The MathWorks, Inc 2004–2008).

Where;

Vol - Volume of water in the tank.

A - Cross-sectional area of the tank.

b - Constant related to the flow rate into the tank.

a - Constant related to the flow rate out of the tank.

The equation describes the height of water, H, as a function of time, due to the difference between flow rates into and out of the tank. The equation contains one state, H, one input, V, and one output, H. It is nonlinear due to its dependence on the square-root of H. Linearizing the model simplifies the analysis of this model.

1.4 Objective of Project

a) To simulate water tank control system.
b) To control water level into the tank at required value.

1.5 Scope of Project

This project scope is to understand the basic simulation and make analysis control water level that is created in LabView and Automation Studio. The understanding is to control the water level by using PID and PLC controllers. In addition, this project simulation also to match the design tank use in industry and make a simulation that is user friendly and easy to use. It is also to understand the application of LabVIEW and Automation Studio (PLC) as the software to simulate, design and interfacing.

1.6 Problem Statement

In many cases, the control methods described can satisfy the specification that are given for a controlled open water system. However, in other cases there is a limiting factor that makes it impossible for these control methods to function in a satisfactory manner. This factor is the limited capacity of the structures and transport water tank that are used. The limited capacity become relevant if the specifications of the controlled system become more stringent over time. In many examples of close loop control, the operator's use the effect a prediction has on their control target and the fact that the controllability is limited by the constraints on the structures they operate.

As the example, many cases in industry the water level always over flood. It always gives a problem for operator to solve it. Many factor have be considered before solved the problem as a factor the design water tank is not suit or not compactable with their environment. So, it can be effect the tank like corrosion, algae and others. Besides that, it is important to find solution to control the problem has to be as simple as the requirements on the controlled water system and the characteristics of the water system. In many cases, local feedback controllers have sufficient performance. In addition, many cases water level sensor in industry are expensive then application and demand on the use water level sensor in industries now is increasing. If water level sensor which were relatively cheaper produce it would be able soften the blow consumer. In now, hard industry to get water level sensor can keep tank water level on one level that the desired. So, by using PID or PLC controller for water level control system to obtain exactly measure water in the tank.

The foremost important step before formulating a controller, a mathematical relationship or the governing dynamics between the input and the output of the system should be known. The underlying principle and knowledge of the system should be investigated to comprehend the occurrence of nonlinearity in the system dynamics. There are wide arrays of control techniques that can be applied to meet the control objective of the system and these depend on the factors of which the proposed design objective might rely on. There are factors such as tracking, reducing the effects of adverse conditions

and uncertainty, behaviors in terms of time response (e.g., stability, a certain rise-time, overshoot, and steady state tracking error) and lastly engineering goals such as cost and reliability which is vital in industrial perspective.

Sophistication of controller scheme primarily depends on the degree of how the nonlinearity can be tolerated and assumed using the linearization theory. Moreover, apart from nonlinearities, there may be a consequence of unknown parameters which hinders the objective to obtain a complete detail model of a process available for control purpose. The factors that abstained many researchers to use conventional control theory and techniques can be listed as follows. Systems are nonlinear and may contain unknown parameters. That unknown parameters may not be estimated accurately if reliable experimental data is absent. The delays present in the process of system (water tank system specifically) might complicate achieving high performance control.

There are several cases such as that of water level digital control tank in industry where the process or disturbance characteristics are changing continuously. This requires simultaneous regulation of various variables in order to maintain the desired water level. Thus, a model must account for all of the most significant variables of the process. Due to the above mentioned factors, it might be difficult to formulate a control strategy based on the analytical model because the mathematical model is usually linearised to account for complexity and nonlinearity which are inevitable in a complicated system. PID (proportional-integral-derivative) control is one of a kind of control scheme that uses the approach of linearised model. However, the PID controller might not capable to satisfy the control objectives or requirement at all times as it need to be regularly tuned due to the varying system dynamics. Hence, it is desirable to have a robust and reliable control technique for modeling the complex and nonlinear system that prevails in all industrial process.