THE DEVELOPMENT OF INTERFACE AND SIMULATION FOR INDUSTRIAL CASCADE LEVEL SYSTEM

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MEI 2009

"I hereby verify that I have read this report and I find it sufficient in terms of quality and scope to be awarded with the Bachelor's Degree in Electric (Mechatronics) Engineering."

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"I hereby declared that this FYP report is a result of my own work, as clearly stated in the sources of reverences and sources is explained and stated."

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ABSTRACT

This project is about to develop a user interface for an Industrial Cascade level System using pre-defined development tool. The software for user interface is interacting with the system in a real time basis. Level control systems are commonly used in many process control applications to control, for example, the level of liquid in a tank. In this system, liquid enters the tank using a pump, and after some processing within the tank the liquid leaves from the bottom of the tank. The requirement in this system is to control the rate of liquid delivered by the pump so that the level of liquid within the tank is at the desired point. In this project the system will be identified from a simple step response analysis. A constant voltage will be applied to the pump so that a constant rate of liquid can be pumped to the tank. The height of the liquid inside the tank will then be measured and plotted. A simple model of the system can be derived from this response curve. After obtaining a model of the system, a suitable controller will be designed to control the level of the liquid inside the tank.

ABSTRAK

Projek ini adalah untuk membina antaramuka pengguna bagi mengawal paras cecair seperti dalam industry dengan menggunakan peralatan yang telah dikenalpasti. Perisian untuk antaramuka pengguna yang berinteraksi dengan sistem dalam satu asas masa sebenar. Sistem kawalan aras biasanya banyak digunakan dalam aplikasi-aplikasi kawalan proses untuk mengawal, sebagai contoh, tahap cecair dalam sebuah tangki. Dalam sistem ini, cecair masuk ke dalam tangki menggunakan sebuah pam, dan selepas beberapa proses, cecair di dalam tangki akan dipam dari tangki bawah ke tangki atas. Keperluan dalam sistem ini adalah untuk menguasai kadar cecair dihantar oleh pam supaya paras cecair yang dikehendaki akan diperoleh. Sistem dalam projek akan dikenalpasti melalui analisis graf tindak balas yang ringkas. Voltan yang stabil akan dikenakan kepada pam, maka kadar alir cecair yang stabil juga akan dipam ke tangki. Ketinggian cecair dalam tangki akan diukur dan dicatat. Sebuah model ringkas sistem akan diterbitkan daripada tindak balas graf lengkung. Selepas memperolehi model sistem, kawalan yang sesuai akan direka untuk mengawal paras cecair dalam tangki.

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CHAPTER 1

INTRODUCTION

1.1 Introduction of Water Tank

Liquid level control systems are commonly used in many process control applications to control, for example, the level of liquid in the water tank. The water tank is a storage container that is usually storing water for human consumption. The need for water tanks is as old as civilized man. Water tanks provide for the storage of drinking water portable, irrigation agriculture, fire suppression, agricultural farming and livestock, chemical manufacturing, food preparation and many other applications. Also, human life needs to be protected against excess of water caused by heavy precipitation and floods. People have formed water management organizations to guarantee these necessities of life for communities.

Various materials are used for constructing water tanks such as plastic, polyethylene, polypropylene, fiberglass, concrete, steel (welded or bolted, carbon or stainless). Earthen ponds designed for water storage are also often referred to as tanks. The profile of water tanks begins with the application parameters. Thus, the type of material is used and the design of the tank was dictated by these variables:

(a) Location of the water tank (indoors, outdoors, above ground or underground).
(b) Volume of water tank will need to hold.
(c) Type of water (hot water or cold water).
(d) Temperature of area where water will be stored, concern for freezing.

(e) Pressure required delivering water.
(f) Mechanism a water to be delivered to the water tank.
(g) Design consideration of water tanks to survive in disaster.

Materials used in the manufacture of these water tanks like chemical contact tanks of polyethylene construction, allows retention time for water and chemicals to be in contact and mix. Ground water tank is made of lined carbon steel, it may receive water from water well or from surface water allowing a large volume of water to be placed in inventory and used during peak demand cycles.

The examples such as Elevated Water Tanks by elevating the water tank, the increased elevation creates a distribution pressure at the tank outlet of 1 psi per 2.31 feet of elevation, thus a tank elevated to 70 feet creates about 30 psi of discharge pressure, 30 psi is sufficient for most house hold requirements.

1.1.1 Applications of Water Tank

Space flight simulator use elaborate water tanks for the simulation of weightlessness. Water tanks fabricated to resemble space craft interiors are suspended in large swimming pool like environments, giving astronauts the feeling approximating zero gravity. The Airline industry uses elaborate water tanks to simulate, aircraft emergency water landings and the performance of the airplane upon entry to the water.

The basic system water tank can see in the figure 1.1(a), 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.

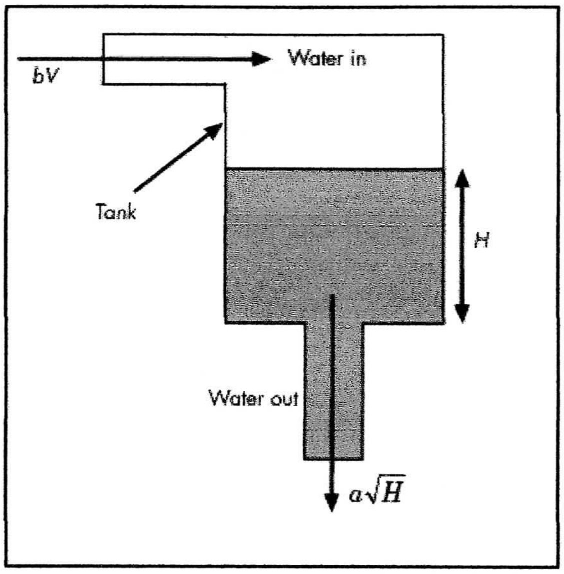

Figure 1.1(a): Schematic Diagram for the Water-Tank System (The MathWorks, Inc 2004–2008).

1.1.2 Model Equations of Water Tank

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

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

Figure 1.1(b): The Model Equation of Water Tank System (The MathWorks, Inc 2004–2008).

Where ***Vol*** is the volume of water in the tank, ***A*** is the cross-sectional area of the tank, ***b*** is a constant related to the flow rate into the tank, and ***a*** is 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.

1.2 Objective of Project

The objective of the project such as:

(a) To fabricate the Industrial Cascade Level System.
(b) To develop the user interface data for Industrial Cascade Level System by using the LabView software.
(c) To simulate the Industrial Cascade Level System in LabVIEW enviroment.

1.3 Scope of Project

The scope of the Development of Interface and Simulation for Industrial Cascade Level System project is to control water level at the desire point either high and low by using a level sensor. The projects also use the DAQ card as measurement of physical quantities in this system and connected with LabView software to show the simulation result. The figure 1.3(a) shows the process of this system.

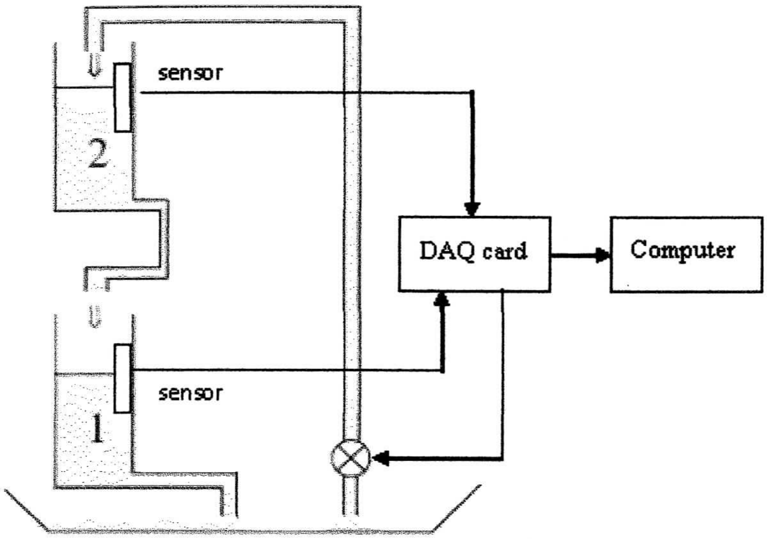

Figure 1.3(a): CascadeTank Control System.

(a) In this system, liquid enters the tank using a pump.

(b) And after some processing within the tank the liquid leaves from the bottom of the tank to the tank 2.

(c) The requirement in this system is to control the rate of liquid delivered by the pump.

(d) So that the level of liquid within the tank is at the desired point. The sensor will detect and give data to DAQ card.

(e) From the DAQ card after receive the data it will send data to computer as interface by using LabView software.

(f) Lastly, the simulation process of this system display like the real one and we can show the reading such as real time response and other reading.

1.3.1 Software Part

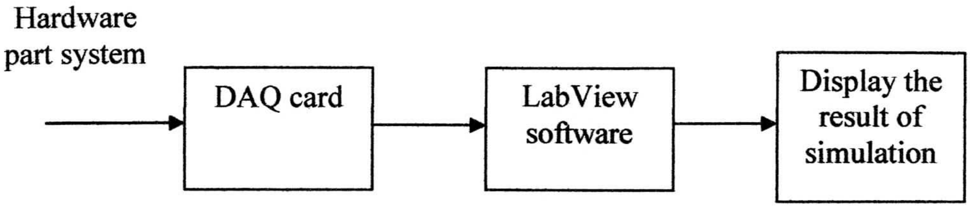

Figure 1.3(b): Block Diagram of the Last Process.

1.3.1.1 DAQ Card

A DAQ card converts analog signals into a digital output form, which can be manipulated with software. By using software in conjunction with a personal computer, analog data can be displayed, logged, charted, graphed, or stored in memory as needed.

1.3.1.2 LabVIEW Software

LabVIEW is programmed with set of icons that represents controls and functions; available in the menu of the software. The driver software is a lower level driver that interfaces LabVIEW software with the DAQ boards. As a user of LabVIEW one does not have to worry about configuration and control of components within DAQ boards. LabVIEW identifies each board by a device number and therefore one can have as many devices as many as the computer can accept on their expansion slots. LabVIEW can also combine and display inputs from various sources like inputs from serial and parallel port.

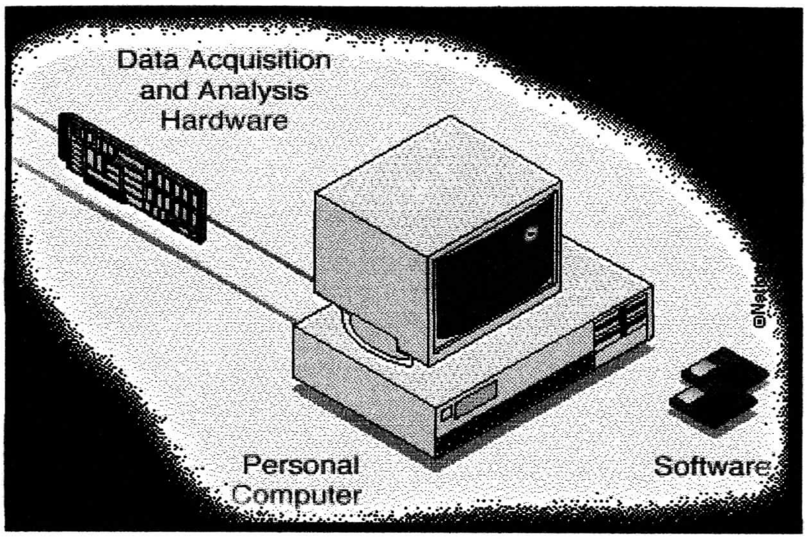

Figure 1.3(c): A typical Data Acquisition System.

1.4 Problem Statement

In many cases, the control methods described can satisfy the specification that are given for a controlled open or close 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. These limited capacities are referred to as constraints on the system. The limited capacity can also become relevant if the specifications of the controlled system become more stringent over time. This higher requirement is unavoidable, as history has shown that the socioeconomic demands of the society in which the water system functions increase 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. It is clear that for complex water systems with interacting subsystems, water management including feedback, feedforward, weighing of small water level deviations against minimal structure adjustments and constraints on structures become a difficult, if not impossible task. Here, control theory comes into play to support the water manager in a formalized and systematic way. To effectively control water systems that are characterized by optimization problems and more advanced control methods are required.

Finally, it is important that the solution to a control 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. A selection procedure for the most appropriate controller is part of this analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Water System

The use of automatic control in managing water systems has evolved slowly over the last decades. Two types of automation can be distinguished namely mechanical automation and electrical automation. The first type utilizes structures that are composed of floaters and levers attached to gates in such a way that a certain water management objective is achieved. These hydro-mechanical structures, such as Begemann-gate, Vlugter-gate and Neyrpic-AMIL gate (Brouwer 2004), are able to maintain local upstream or downstream water levels close to a pre-defined target level.

The choice of the configuration of the management system and of the appropriate control method to function adequately depends completely on the specifications of the controlled water system. These specifications include the following demands, the range of regular operating points, an indication of how many the water levels and flows may fluctuate around setpoint within these operating points, how long water levels and flows may be off target and how often structures may be adjusted. Even though the operators are often vague about what the exact specifications are, after some discussion the specifications are in general stipulated as keeping the water levels as close to target level as possible with a minimum and maximum allowable water level as range around the target level and as few adjustments to the structures as possible with a minimum time.
According to Burt and Piao (2002); the full automation is configured as follows automatic water level sensors, cable lines to a Programmable Logic Controller in which