UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Design and Modeling of Multiple Tank Control for Fluid Circulation System Using PI, PD&PID Controller

Thesis submitted in accordance with the partial requirement of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Manufacturing Engineering (Robotic & Automation) with honours

By

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This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic &Automation) with honours. The members of the supervisory committee are as follow:

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(Muhamad Arfauz A Rahman)

(Official Stamp & Date)

DECLARATION

I hereby, declared this thesis entitled “Design and Modeling of Multiple Tank for Fluid Circulation System Using PI, PD and PID Controller” is the results of my own research except as cited in references.

Signature : …….

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ABSTRACT

Nowadays tank level control is one of the important system which been used widely in industry. There are many applications in industry that uses this system such as waste water treatment, food processing beverage, dairy, filtration, effluent treatment, and nuclear power generation plants, pharmaceutical industry, water purification system, industrial chemical processing and spray coating, boilers and automatic dispensing and replenishment devices. Many weaknesses have been found especially when come to overflow, leakage and others.

However this control system keeps developed to replace ordinary system which applies mechanical function in controlling in order to improve system's reliability. From the project, the comparisons between the system without controller and the system by using three controllers that are PI, PD and PID is shown in the graph plotted for each. The comparisons also strengthen by the overflow graph, which shows whether or not the system is having overflow.

The report started with the introduction to the project, literature review, methodology, case study, system design and simulation, result and discussion, and conclusion and suggestions.

ABSTRAK

Pada masa kini , kawalan paras air merupakan salah satu sistem yang penting yang digunakan secara meluas di industri. Terdapat pelbagai aplikasi di dalam industri yang menggunakan sistem ini seperti loji rawatan air,kawalan tangki industri dan lain-lain. Pelbagai kelemahan telah dikenalpasti terutama apabila melibatkan lebihan aliran, kebocoran dan lain-lain

Walaubagaimanapun , sistem kawalan ini terus berkembang untuk menggantikan sistem yang sedia ada dimana fungsi mekanikal telah diaplikasikan untuk mengawal sistem dan penambahbaikan kebolehan fungsi sesuatu sistem. Daripada projek yang dijalankan, perbandingan antara sistem yang tidak mempunyai *controller* dan sistem yang telah ditambah dengan penggunaan tiga *controller* iaitu PI, PD dan PID telah ditunjukkan di dalam setiap satu graf. Perbandingan ini juga dikukuhkan dengan graf lebihan aliran, yang menunjukkan sama ada sesuatu sistem itu mengalami lebihan aliran atau tidak.

Laporan ini dimulakan dengan pengenalan kepada tajuk, kajian literature, kaedah kajian,kajian kes, pembangunan rekabentuk, keputusan dan analisis, rumusan dan cadangan.

DEDICATION

I dedicated this PSM thesis to my beloved parents ,Harun B. Hj Ismail and Zaleiha Hj Ahmad , my siblings and not forgotten to my sources of inspiration Mohd Sallehin Hj Othman.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

FKP - Fakulti Kejuruteraan Pembuatan

PSM - Projek Sarjana Muda

PID - Proportional-integral-derivative controller

PI - Proportional –integral

PD - Proportional –Derivative

UTeM - Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.1 Project Introduction

Nowdays industrial application of liquid level control abound example in waste water treatment food processing beverage,dairy,filtration,effluent treatment,and nuclear power generation plants, pharmaceutical industry, water purification system, industrial chemical processing and spray coating, boilers and automatic dispensing and replenishment devices.

Level and flow control system is a technique used to control the level and flow of circulation systems for variety of purposes such as to pretend from overflow. Most of field in the fluid level and flow system are still applying the mechanical control devices, but the most probably problem comes to overflow.

In this project, starting from conducting case study at Bukit Sebukor Water Treatment Plant and the implementation of three controllers to see the better performances have been done.

1.2 Problem Statements

Most of field in the fluid level and flow systems are still applying the mechanical control devices such as valves,flowmeter,pump,water tank and the most probably problem comes to overflow .

In this project, there are three controllers will be used to control the level water tank to the desired value. A performances of water level by adding the three controllers will be analyzing by using SIMULINK software.Moreover,the analyze result will also compared with the theoretical result.

1.3 Objectives of project

The objectives of this project basically can divide into four, which are:

a) To conduct case studies that using this system.
b) To improve the water level tank by using PI,PD &PID.
c) To evaluate current designed fluid circulation systems for Bukit Sebukor Water Treatment Plant.
d) To apply the knowledge gained from the research studies to improve the current system.

1.4 Scopes and Limitations of Project:

The scopes of this project are :

a) Collect Data

Before starting the project, a case study will be done to collect the information about the fluid system. One of suitable place to conduct the case study at Bukit Sebukor Water Treatment Plant. Some of information will be getting by interview the technician on duty. The limitation of the current system will be identify and consideration for improvements later.In other study on internet,books,journal also be done to collect the information.

b) Develop Block diagram and Simulation

Block diagram and simulation were developed on PSM 2 by the aid of Simulink.The block diagram including basic system and by adding three controller to see the performances.

The limitation of this project included:

a) Limitations

The system concentrated only on controlling the desired value at the water tank level.

b) Controller:

The systems will be adding by PI,PD&PID controllers to see the performances of result.

1.5 Thesis Outline

Thesis outline is a summary of every chapter was described to introduce about the chapter. Chapter one (1) introduced about the basic theory, the objectives of this project, problem encounter, and the content of the project. Chapter two (2) is about literature review about control system design,waste water treatment,PI,PD and PID,SIMULINK.Chapter three(3) it will desribe about the whole method of process that used throught this project.Chapter (4) will explain about case study have been conducted at Bukit Sebukor Water Treatment Plant.Chapter five(5) will perform with design development and step design development with simulation.Chapter six(6) will continue with result and discussion about performances of three controllers. Moreover, a comparison between the simulation result and also will discuss in this chapter. The final chapter (7) will be the conclusion for this project, where further recommendation and conclusion will explain in the end of this chapter.

1.6 Summary

The project title as “Design and Modelling Of Multiple Tank Control by using PI,PD and PID controllers. The project objective is to improve the design for water level tank by using PI,PD &PID . Besides, it also involves the simulation of design . In order to complete this project, many journals have to go through, SIMULINK simulation study and conducted the case study at Bukit Sebukor also be done.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter consists of literature review about a control system design,water treatment plant,PID controller and SIMULINK software. The concluding remarks is included in the last section.

2.2 Control System Design

A Control system consists of subsystems and processes (or plants) assembled for the purpose of controlling the outputs of the processes. Advantages of control systems likes can move large equipment with precision that would otherwise impossible, elevators carry us quickly to our destination, automatically stopping at right floor. Control systems build for four primary reasons like power amplification, remote control, convenience of input from and compensation for disturbances. [S.Nise,2004]

a) Power amplification –A radar antenna, positioned by the low power rotation of the knob at the input, requires the larger amount of power for its output rotation. A control system can produce the needed power amplification, or power gain.

b) Remote Control-Robots designed by control systems principles can compensate for human disabilities. Control systems also useful in remote or dangerous locations. For example remote-controlled arm can be used to pick up material in radioactive environment.

c) Convenience of input form-Control systems can also be used to provide convenience by changing the form of the input. For example in a temperature control systems, the inputs is heat. Convenient position input yields a desired thermal output.

d) Compensation for disturbances-The systems must be able consider an antenna that points in a commanded direction.

2.3 Responses characteristics and systems configurations

Two major configuration of control systems are open loop and closed loop:

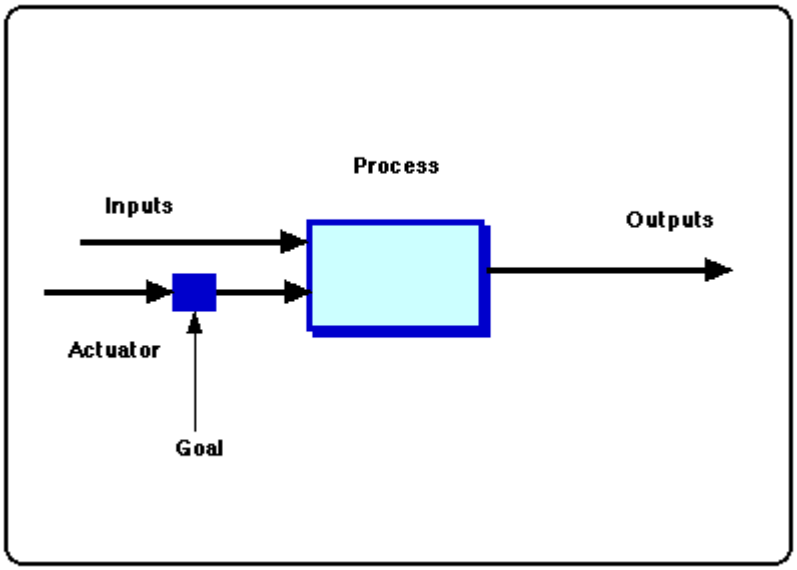

Figure2.3(a): Open loop system

a) Open- loop

Open-loop systems its start with a subsystem called subsystems called an input transducer by refering to figure 2.3(a), which converts the form of the input to that used by controller. The controller drives a process or plant. The input sometimes called the references, while the output can call the controlled variable. The disturbance called signals besides controller and process output also is added via summing junctions, which

yield the algebraic sum of their input signals using associated signs. Example of open-loop systems are mechanical system consisting of a mass, spring, and hammer with a constant force positing the mass, spring, and damper with constant force positioning.

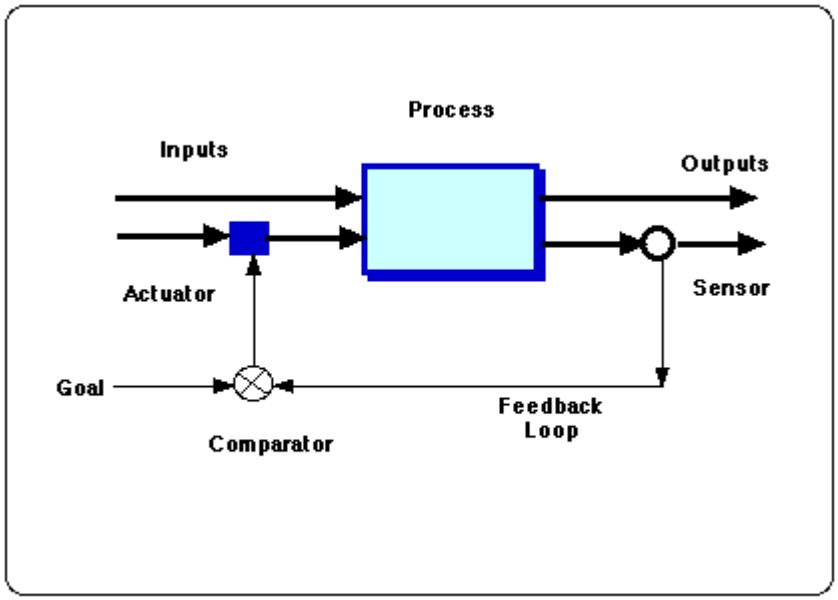

Figure2.3(b):Closed Loop Systems

b) Closed-loop

Closed loop namely very sensitive to disturbances and inability to correct for disturbances may be overcome in closed systems. The input transducer converts the form of the input to the form used by the controller. The first summing junction algebraically adds the signal from the input to the signal from output, which arrives via the feedback path, the return path from the output to the summing junction. Refer to the figure 2.3(b) the output signal is subtracted from the input signal. The result is generally called the actuating signal, but both the input and output transducer have unity gain (that is the transducer amplifies its input by 1), the actuating signal value equal to the actual difference between the input and output. Under this condition the actuating signal called the error.

2.4 Trasient Response

In electrical engineering and Mechanical Engineering, a transient response or natural response is the response of a system to a change from equilibrium. Specifically, transient response in Mechanical Engineering is the portion of the response that approaches zero after a sufficiently long time (i.e., as t approaches infinity). (Contrast with steady-state response) by referring to the figure 2.4 below.

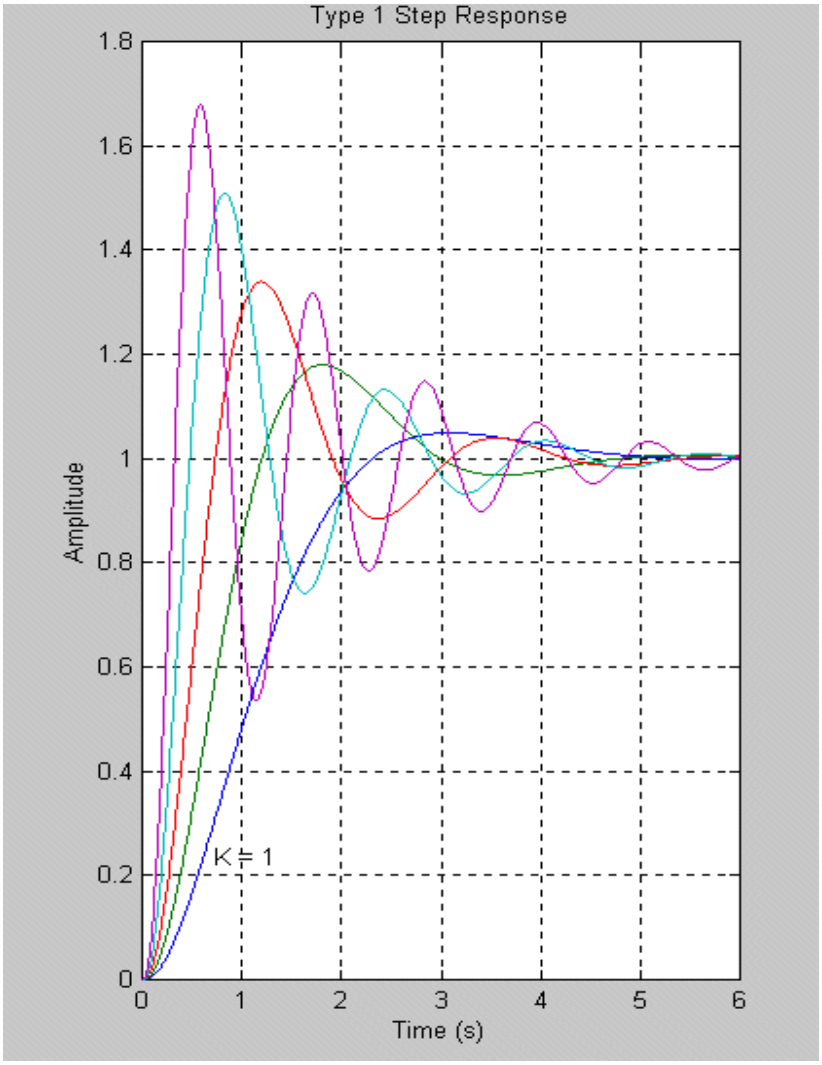

Figure 2.4:Trasient Responses

.

a) Underdamped

An underdamped response is one that oscillates within a decaying envelope. The more underdamped the system, the more oscillations and longer it takes to reach steady-state. Here Damping Ratio is always < 1 as refer to the figure 2.4 below.

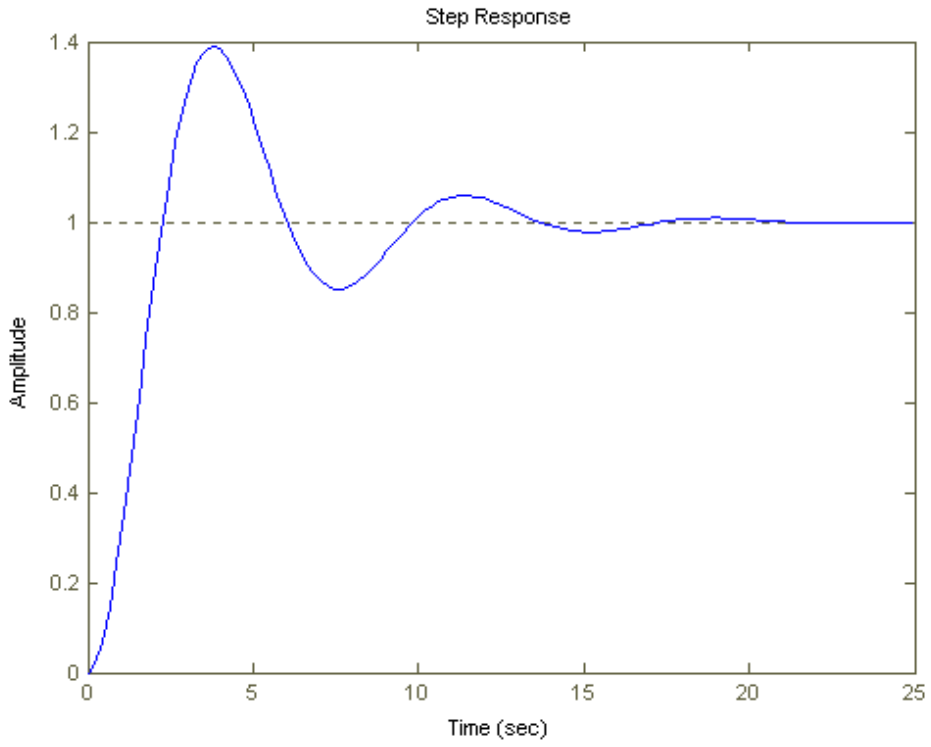

Figure 2.4 (a):Underdamped

b) Undamped

This function has pole at the origin has comes from the unit step input and two imaginary input and two imaginary poles that comes from system by referring to the figure 2.4 (c) below.