UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CONTINUOUS WATER LEVEL CONTROL USING ULTRASONIC SENSOR WITH 45 DEGREE CUT PIPE INSERTION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Electrical Engineering Technology (Industrial Automation and Robotic) (Hons.)

by

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APPROVAL

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

……

(Ahmad Muzaffar Bin Abdul Kadir)

ABSTRAK

Dalam persekitaran industri, tahap ultrasonik sensor juga dipengaruhi oleh kelajuan bunyi yang berubah-ubah disebabkan oleh kelembapan, suhu, dan tekanan. Faktor pembetulan boleh digunakan untuk pengukuran tahap bagi meningkatkan ketepatan pengukuran. Pergolakan, buih, wap, dan perubahan dalam kepekatan bahan proses juga memberi kesan kepada tindak balas sensor ultrasonik ini. Pergolakan dan buih menghalang gelombang bunyi daripada dikesan oleh sensor, wap dan kimia kabus menganggu atau menyerap gelombang bunyi dan variasi dalam kepekatan menyebabkan perubahan dalam jumlah tenaga dalam gelombang bunyi yang kembali kepada sensor. Untuk mengatasi masalah ini, pengesanan sensor paras air ultrasonik dengan 45° memotong paip sisipan, kaedah peningkatan ultrasonik untuk kawalan paras air dan skim kawalan berkadaran dan integeral untuk pemantauan dan kawalan paras air berterusan dilaksanakan. Sebelum sistem dilaksanakan, beberapa langkah prosedur perlu diikuti untuk memastikan pembangunan berterusan kawalan paras air menggunakan sensor ultrasonik dengan 45° memotong paip sisipan dijalankan secara sistematik. MyRIO merupakan peralatan yang digunakan sebagai pengawal untuk mengawal sistem. Injap kawalan dan pam air arus ulang alik digunakan sebagai elemen kawalan. Sebagai keputusan projek ini adalah proses paras air menggunakan sensor ultrasonik akan memberi maklumbalas kepada pengawal apabila hasil ukuran nilai masa yang diambil untuk gelombang bunyi untuk memancarkannya dari pemancar ke arah tangki dan memantulkan gelombang bunyi dengan antara paras cecair di dalam tangki.

ABSTRACT

In industrial environment, Ultrasonic level sensors are also affected by the changing speed of sound due to moisture, temperature, and pressures. Correction factors can be applied to the level measurement to improve the accuracy of measurement. Turbulence, foam, steam, and changes in the concentration of the process material also affect the ultrasonic sensor's response. Turbulence and foam prevent the sound wave from being properly reflected to the sensor, steam and chemical mists and vapours distort or absorb the sound wave and variations in concentration cause changes in the amount of energy in the sound wave that is reflected back to the sensor. To overcome these problems, the ultrasonic water level sensor detection with the 45° cut pipe insertion, the ultrasonic improvement method for water level control and PI control scheme for continuous water level monitoring and control is implemented. Before the systems implemented, a few steps of procedure have to be followed to ensure the development of Continuous Water Level Control Using Ultrasonic Sensor With 45 Degree Cut Pipe Insertion conducted systematically. The MyRIO is used as the controller to control the system. The control valve and the AC water pump is used as the control element. As result, for this project is the process of water level using Ultrasonic Sensor will give feedback to controller when the yield measurements is that of evaluating the time taken for the sound wave to travel from transmitter towards the tank and reflects the sound wave back with the liquid level interface in the tank.

DEDICATION

To my beloved husband,

Izfahmi Farhan Bin Mohd Basuki

My beloved parents,

Abu Talib Bin Kassim and Rokiah Binti Haji Ismail

My families member, the love one and friends, thanks for all the supports, encouragements, and advices.

To the lecturers, technicians and staffs of UTeM who were involved in this project especially to my supervisor and co-supervisor.

My supervisor,

Mr Ahmad Muzaffar Bin Abdul Kadir

My co-supervisor,

Mdm Rosnaini Binti Ramli

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As this project is my last task before I finish my journey as a bachelor student, I fell honoured to express my appreciation to all those who gave me the possibility to comprehend this project report especially my dear course mate. They keep reminding me to settle down my work in an appropriate way and also help me in generating a new idea for analysis of the mould base weight optimization.

Furthermore, I also want to deliver a special thanks to my classmate that helps me in making this project done. I also would like to thanks to the other supervisors as well as the panels especially in my project presentation in helping me to improve my presentation skills with their statement, comment, and tips.

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m	-	Meter
cm	-	Centimetres
mm	-	Millimetres
s	-	Second
W	-	Weight
L	-	Length
W	-	Watt
C	-	Celsius
UTeM	-	Universiti Teknikal Malaysia Melaka
AO	-	Analog Output
AI	-	Analog Input
DC	-	Direct Current
AC	-	Alternative Current

CHAPTER 1

INTRODUCTION

1.0 Introduction

In industrial applications where fluids or bulk material are used, storage tanks or silos are used for processing or storing. Sensors are used to detect levels. Even critical process conditions such as emptying a hydraulic tank or the unintentional overspill of a tank are monitored using level sensors.

The title of this project is Continuous Water Level Control Using Ultrasonic Sensor With 45 Degree Cut Pipe Insertion. This chapter will briefly discuss the project overview on how the project is developed. The background of the project, problem statement, objective, scope will be presented in this chapter.

1.1 Project Background

Process level measurement is the measurement of the height of particular with respect to a reference point or the base of the containing vessel. In continuous level measurement, the actual level of the media is known at all times from a level transmitter or transducer. In addition, to improve the development of process of continuous water level with the continuous water level control using ultrasonic sensor with 45 degree cut pipe insertion.

Level transmitters most often provide an output of a linear 4 to 20 mA signal proportional to the media height. The level measurement can also be transmitted via a communication protocol to a control system. Often this continuous level output is used to control a pump or valve that maintains the level or it used to report the level status at all times.

In this project, ultrasonic level sensors are used for non-contact level sensing applications. The ultrasonic transducer transmits ultrasound wave pulses through air directed towards the media of which the level is desired. The ultrasound waves then reflect off of the material as an echo and travel back to the transducer. The level of the media is determined by the transit time of the ultrasound wave pulse from the sensor to material and for the echo to come back to the sensor.

The major sensors used in the process industries are temperature sensors, flow sensors, level sensors, pressure sensors and proximity switches. Position sensors, proximity sensors and load cells, too, are of importance. Chemical sensors for liquids and gases as well as humidity sensors and industrial cameras are on the rise. Sensors for condition based monitoring are getting more important. The demand for sensors in the process industries is stimulated by production plants with higher degrees of automation, higher productivities, better availabilities as well as plants with improved energy and resource efficiencies.

In the mining sector, sensors are increasingly used in harsh environments; they are mounted on underground or surface mining equipment to increase machine accuracy and improve energy efficiency. Here, automation in conjunction with sensors will contribute to improve mine safety and equipment utilization rates. Iron and steel plants as well as aluminium plants use sensors to increase automation, to improve product quality and enhance plant safety and plant availability. Wireless and smart sensors will grow in importance.

Sensors in the chemical and petrochemical industries help to enhance automation, safety and plant availability. Here, smart sensors that not only generate but also analyse and convert the raw data taken from the environment are on the rise. They tend to be more accurate and reliable than traditional process sensors and are crucial not only for automation but also for safety, condition monitoring and asset management purposes.

In the food and beverages industry, process sensors help manufacturers to increase plant productivity and to reach higher product qualities. Cameras in conjunction with machine vision systems are growing fast. So do material quality sensors for monitoring the quality of incoming products. Power plants are major users of process sensors. Pressure sensors and temperature sensors are used as well as flow and level sensors and many more. Sensors are used for automation, safety and condition monitoring purposes. High-end position sensors and proximity sensors as well as anemometers and wind direction sensors are increasingly used in wind power plants

1.2 Problem Statement

In industrial environment, Ultrasonic level sensors are also affected by the changing speed of sound due to moisture, temperature, and pressures. Correction factors can be applied to the level measurement to improve the accuracy of measurement. Turbulence, foam, steam, chemical mists (vapours), and changes in the concentration of the process material also affect the ultrasonic sensor's response.

Turbulence and foam prevent the sound wave from being properly reflected to the sensor, steam and chemical mists and vapours distort or absorb the sound wave and variations in concentration cause changes in the amount of energy in the sound wave that is reflected back to the sensor.

The measurement of water level by ultrasonic level sensor might be improved by application of 45 Degree Cut Pipe Insertion as in this project.

1.3 Work Scope

The scope of the project is to design a system for the Continuous Water Level Control Using Ultrasonic Sensor With 45 Degree Cut Pipe Insertion. Basically, the systems are using MyRIO as the controller to control the system of the Continuous Water Level Control Using Ultrasonic Sensor With 45 Degree Cut Pipe Insertion via PI Control Scheme.

The function of control valve using in this project is, to control the flow rate of water flowing in and out of the water tank. By using 45 degree cut pipe insertion in this project, it is expected to reduce the effects of the ultrasonic sensor's response. The ultrasonic sensor will measure the water level in the water tanks more accurate compared to conventional method.

1.4 Objective

There are several objectives need to achieve in this project:

1. To compare the accuracy of ultrasonic water level sensor detection with and without the 45° cut pipe insertion.
2. To apply the ultrasonic improvement method for water level control.
3. To implement the PI control scheme for continuous water level monitoring and control.

1.5 Report Outline

This report is organized into six chapters and the outline of each chapter is explained briefly as follows.

In chapter 1, the objectives, project advantages, problem statement and scope of the project is discusses in the introduction.

For chapter 2, the idea for the project and all theoretical are explained in the literature review.

In chapter 3, the methodology of the project described. In this chapter shows the planning of project implementation. This chapter also explains in detail the methods that have being selected.

At Chapter 4, the development process for the project was explained. This chapter also will show the equipment involve to accomplish this project.

Chapter 5 is the project result. This chapter consists of discussion and analysis of the project results.

The last chapter is chapter 6, conclusion for the project. The whole project was summarized in this chapter. Some additional idea is discussed to implement in the actual field.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, all components and all information that involve in the Continuous Water Level Control Using Ultrasonic Sensor With 45 Degree Cut Pipe Insertion are described.

This chapter reviews on the conventional method of the level measurement and related devices.

2.1 Process Of Level Measurement

Level measurement devices can detect, indicate, and control liquid or solid levels. Level measurement devices can be separated into two categories: direct, or mechanical, measurement and electronic measurement. Level measurement devices can be used for continuous monitoring of fluid level, or for point-level monitoring. In point-level monitoring they are used to determine if the fluid level has exceeded a high point, which could cause a spill, or gone below a low point, which could mean the system is close to running on empty.

2.2 The Type Of Level Measurement

Basically, the measurement of level of liquid and solid in a container falls into two categories, which is Continuous Level Monitoring and Single Point Sensing.

Continuous Level Monitoring measures the level of the liquid on an uninterrupted basis. In this case the level of the material will be constantly monitored and hence, the volume can be calculated if the cross-sectional area of the container is known.

The Single Point Sensing is the actual level of the material when it reaches predetermined level, so that the appropriate action can be taken to prevent overflowing or to refill the container.

2.3 Continuous Level Sensing Devices

There are two categories of level sensing devices, among which are Direct Sensing and Indirect Sensing. For direct sensing in which case the actual level is monitored and these devices are Radar Level Transmitter, Capacitance Level Transmitters, Guided Radar level transmitters and Ultrasonic Level Transmitter.

For indirect sensing is property of the liquid such as pressure is sensed to determine the liquid level. This is most common type of Level Transmitter and these device are Differential Pressure Transmitters.

2.4 Direct Sensing

2.4.1 Radar Level Transmitters

Radar level transmitters work with high-frequency radar pulses which are emitted by an antenna and reflected from the product surface. The time of flight of the reflected radar pulse is directly proportionate to the distance travelled. If the tank geometry is known, the level can be calculated from this variable.(Anon n.d.)

Figure 2.1 : Radar Level Transmitters(Anon n.d.)

2.4.2 Capacitance Level Transmitters

The principle of capacitive level measurement is based on the change in capacitance of the capacitor due to the change in the level formed by the probe and the container wall. When the probe is in the air, a low capacitance is measured. When the container is filled, the capacitance of the capacitor increases the more the probe is covered. A capacitance probe may be compared to an electric condenser. As the tank is filled, the probe capacity increases. This change is electrically analysed.(Anon n.d.)