UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DESIGN AND IMPLEMENTATION OF PLC BASED VFD SYSTEM FOR THREE PHASE INDUCTION MOTOR

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

by

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DECLARATION

I hereby, declared this report entitled "Design and implementation PLC of based VFD system for three phase induction motor" is the results of my own research except as cited in references.

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Date : **11 JANUARY 2016**

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 Engineering Technology (Industrial Power) (Hons.). The member of the supervisory is as follow:

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ABSTRACT

Water distribution system is important in our modern world. Consumer needs an adequate water to be supplied directly through pipes, storage facilities or component that conveys water in homes, school, hospital or industries. The public water system depends on distribution system that provide water carried from the treatment plant. There are normally going to have several issues in maintenance such as it is difficult to control the water speed and a higher tendency of easily malfunction when using DC motor to control the water flow. The operation of the water distribution is done manually and need human assistance so it tends to have an inconsistent water level. Besides that, when unpredicted situation happen, for instance, a worker of the station could hardly detect leaks or problem if there is no monitor system. The purpose of this project is to design and implement the PLC Based VFD System for Three-Phase Induction Motor. Besides that, the aim of this project is to identify the graphical user interface (GUI) using HMI Software. Then, develop the automation and monitoring system by using a SCADA system. The result of this project is the water distribution process improves and function in the best way.

ABSTRAK

Sistem pengagihan air adalah penting dalam dunia moden ini. Pengguna memerlukan air yang memadai untuk dibekalkan melalui paip, kemudahan simpanan atau komponen yang memindahkan air di rumah, sekolah, hospital ataupun industri. Sistem air awam bergantung kepada sistem pengagihan yang menyediakan air dibawa dari loji rawatan minuman. Kebiasaanya akan berlaku beberapa isu seperti sukar untuk mengawal kelajuan air dan kecenderungan yang lebih tinggi dengan mudah rosak apabila menggunakan AT motor untuk mengawal aliran air. Operasi pengagihan air itu dilakukan secara manual dan perlu bantuan manusia sehingga ia cenderung untuk mempunyai tahap air yang tidak konsisten. Di samping itu, apabila keadaan yang tidak dijangka berlaku misalnya, pekerja stesen tidak boleh mengesan kebocoran atau masalah apabila tiada sistem monitor. Tujuan projek ini juga adalah untuk merekabentuk dan melaksanakan PLC Sistem VFD Berdasarkan Tiga Fasa Induksi Motor. Selain itu, tujuan projek ini adalah untuk mengenal pasti antara muka pengguna grafik (GUI) menggunakan HMI Software. Kemudian, membangunkan automasi dan pemantauan sistem dengan menggunakan sistem SCADA. Keputusan daripada projek ini ialah untuk memperbaiki sistem pengagihan air ini dan berfungsi dengan lebih baik.

DEDICATIONS

I dedicated this research report affectionately to the following:

my beloved parents;

my brothers;

my loved ones;

my friends.

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First and foremost, I would like to thank my project supervisor En Ahmad Zubir Bin Jamil and my co-supervisor En Maslan Bin Zainon who believed in me and continually supporting me in every aspect while writing of this report. Without their guide and dedicated involvement in every step throughout the process, this paper will never be accomplished. I have many people to thank for listening and have to tolerate with me over past three years. Every work accomplished is a pleasure and I cannot begin to express my gratitude for their friendship. Most importantly, none of this could happen without my family. Thanks for believing in me, always there and will always be whenever I need them. This dissertation stands as a testament to your unconditional love and encouragement.

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LIST OF SYMBOLS AND ABBREVIATIONS

CPU	=	Central Processing Unit
GUI	=	Graphical User Interface
HMI	=	Human Machine Interface
I/O	=	Input and Output
MTU	=	Master Terminal Unit
PLC	=	Programmable Logic Controller
RTU	=	Remote Terminal Unit
SCADA	=	Supervisory Control and Data Acquisition System
USB	=	Universal Serial Bus
VFD	=	Variable Frequency Drive

CHAPTER 1
INTRODUCTION

1.0 Project Background

Water distribution system is important in our modern world. The consumer needs an adequate water to be supply direct through pipes, storage facilities or component that conveys water in homes, school, hospital or industries. The public water system depends on distribution system that provides water carried from the treatment plant. The implementation of the PLC based VFD system for the three-phase induction motor is needed in the water distribution system.

In order to control the water distribution system, the Supervisory Control and Data Acquisition (SCADA) system, the graphical user interface (GUI) and Programmable Logic Controller (PLC) is needed to develop an automation and monitoring system. The PLC and GUI will communicate through its input and output to send a data to the SCADA system for the monitoring system. Therefore, the PLC is able to change and copy the operation or process while collecting information. The SCADA system able to automate and monitor the device from computer screen by using the virtual input design. It also able to control of large scale processes which include many sites and large distance.

The VFD is category of motor control that drives an electric motor by changing the frequency and voltage provided to the electric motor. It used to control the speed limit of the three phase induction motors. VFD allowed the speed of the pump to go through at a lower rate in such case, so that provides an energy saving advantage. Control with a VFD gives the ability to soft start a motor that the motor can be brought to runs the speed slowly rather than sudden starts and stops. Automatic control of water level can work constantly and can give a precise amount of water in less time so there is no human error. The value of the product is good and the cost of production will reduce without human error occurs.

1.1 Problem Statement

There are normally going to have several issues. Firstly, it is difficult to control the water speed and higher tendency of easily condemn when used DC motor to control the water flow. Secondly, the operation of the water distribution is done manually and need human assists so it tends to have an inconsistent water level. Lastly, when something unpredicted situation happen for instance, worker of the station could hardly detect leaking or problem if there is no monitoring system.

1.2 Objective of Project

The objective of this project are:

i. To design and develop the PLC Based VFD System for Three-Phase Induction Motor.
ii. To design the graphical user interface (GUI) using CX-Designer.
iii. To develop the monitoring and control system by using a SCADA system.

1.3 Scope of Project

The work scope of this project is divided into two parts:

a) Software Development
   i. The operation of ladder diagram and GUI can be develop by SCADA system.
   ii. The SCADA system to monitor and control the operation of the distribution system.

b) Hardware Development
   i. The PLC type CP1E NA controller use to utilize the three-phase induction motor and sensors.

ii. The VFD application for controlling the speed limit of three-phase induction motor.

1.4 Structure of Report

This report will be conducted in a few chapters and each stated as follows. Chapter 1 describes the introduction of this research. First, the background study and then the problem statement are defined. The objectives of this project are stated and also the scope and the limitations of this project had been discussed. Chapter 2 provides details of the literature review, it shows about the studies and research relevant to this project. This will help to explain the boundaries of the project for better understanding. Chapter 3 illustrated the methodology of this project. This chapter explains the method and process that has been used for designing this project. Chapter 4 analyses the overall result and lastly Chapter 5 concludes the significance of project and the future works.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In this chapter, reviews of the previous research project that are related will help to explain the boundaries of the project for better understanding. The information is an additional knowledge for completing this project to becoming successful. Therefore, from previous researches it helps to do the future works and improvement.

2.1 Synopsis Journal

This part contains the detail information related to the project. The material includes from textbook, journal, manual and internet. Table 2.1 shows the summary of the journal.

Table 2.1: Synopsis of Journal

NO	JOURNAL TITLE	AUTHOR
1	Designs and Implementation of Water Level Controller	C.N. Anyanwu, C.C. Mbajiorgu and E.C. Anoliefo (2012)
2	Automated Water Supply System and Water Theft Identification using PLC and SCADA	Prof. Anubha Panchal, Ketakee Dagade, Shubhangi Tamhane, Kiran Pawar and Pradnya Ghadge (2014)
3	Automation of Tank Level using PLC and Establishment of HMI by SCADA	Rishabh Das, Sayantan Dutta, Anusree Sarkar and Kaushik Samanta (2013)
4	Automated Water Distribution System Using PLC and SCADA	T. Baranidharan, A. Chinnadurai, R.M. Gowri and J. Karthikeyan (2015)
5	Energy Saving Through Design Optimization of Induction Motors	Rini Nur Hasanah (2009)
6	Energy Saving Mechanism Using Variable Frequency Drives	Neetha John, Mohandas R and Suja C Rajappan (2013)
7	Water Pumping System with PLC and Frequency Control	Akayleh Ali, Mohammed Al-Soud, Essam Abdallah and Salah Addallah (2009)
8	Automation of Water Treatment Plant	Raj Shah, Aditya Vadalkar, Omkar Bengrut and Prof. Mrs. M.P. Sardey (2014)
9	Three-Phase Induction Motor Stator Current Optimization	Rateb H. Issa (2011)
10	Design of VFD Drive for a Three-Phase Induction Motor	M. Deepa (2015)

2.1.1 Designs and Implementation of Water Level Controller

This project was developed by (Anyanwu et al, 2012) from University of Nigeria. This paper used MC14066 integrated circuit with an automatic regulator for controlling and sensing the water level. It resides on the design and implementation of a simple but effective feedback regulator for use in water level controlling and sensing. The water level sensor was tested in real time application by using a single-phase 0.5HP AC pump to control the level of water.

The control system is classified as open loop or closed loop. The closed loop is known as a feedback control system. The concept of control system which forward path, but takes one or more feedback loops and automatically maintains the desired output. Besides that, the open loop known as a non-feedback system. It is a continuous control system that is the output do not effect on the control input signal. The model is set to the maximum and minimum levels of water with 50 liters and 10 liters correspondingly. Figure 2.1 and Figure 2.2 shows the diagram of closed loop system and open loop system.

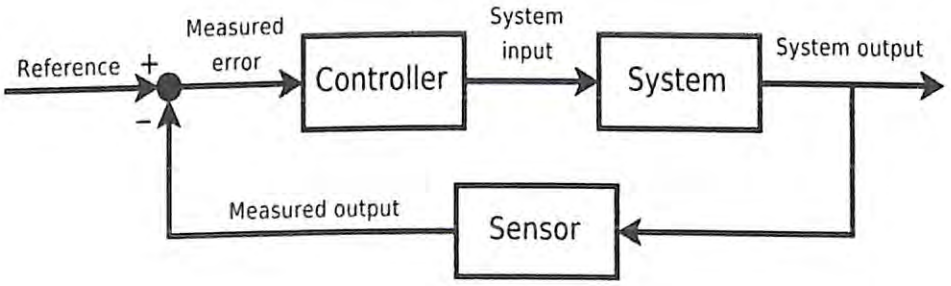

Figure 2.1: The Diagram of Closed Loop System

(Source: http://blog.identropy.com/IAM-blog/bid/31405/Identity-Activity-Monitoring)

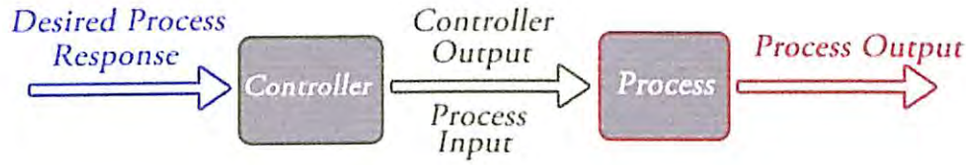

Figure 2.2: The Diagram of Open Loop System

(Source: http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/)

The Contemporary sequential control systems may use PLC to allow the sequence of control to be modified in the software rather than requiring hardware or connection changes. N D Ramesh (2012) has studied on PLC that used programmable memory to carry out particular purpose, such as timing, counting, logic sequencing and arithmetic control over digital or analog input and output modules. Almost every production line, machine function can be greatly enhanced using a PLC. Figure 2.3 below shows the schematic of the tank and regulator of the project.

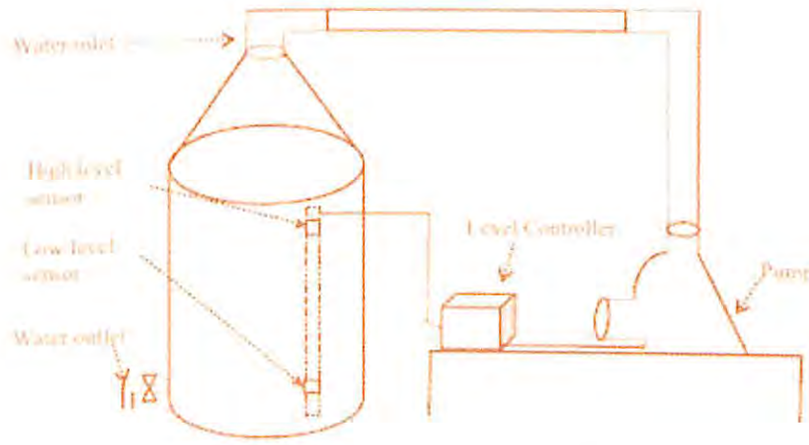

Figure 2.3: Schematic of The Tank and Regulator

(Source: Anyanwu et al, 2012)

2.1.2 Automated Water Supply System and Water Theft Identification using PLC and SCADA

This project was developed by (Engg & Sawant, 2014) from the Bhivrabai Sawant Institute of Technology, India. In this project the automatic system applied to the water delivery system to protect the update of refurbished water supply in a new way of monitoring. People are using suction pumps to extract the water directly from home street pipeline. Besides, it can destroy the water theft in government pipelines so people get an equal amount of water. The component used in this project such as a level sensor pressure transmitter, proximity sensor, smokes detector, pumping system and electronic valve.

The equipment installed in the pumping stations is controlled by PLC based equipment that develops all the hydraulic parameters and electrical parameters. The method used two thresholds to detect strong and weak edges it helps in filling gaps in the detected edges. In the proposed system, the PLCs system became more bright and smaller in size as the monitor and control in plant grew (D Bailey and E Wright, 2003). SCADA software is used to developed graphical user interface and it can record and store a very huge total of data. Figure 2.4 below shows the SCADA review.

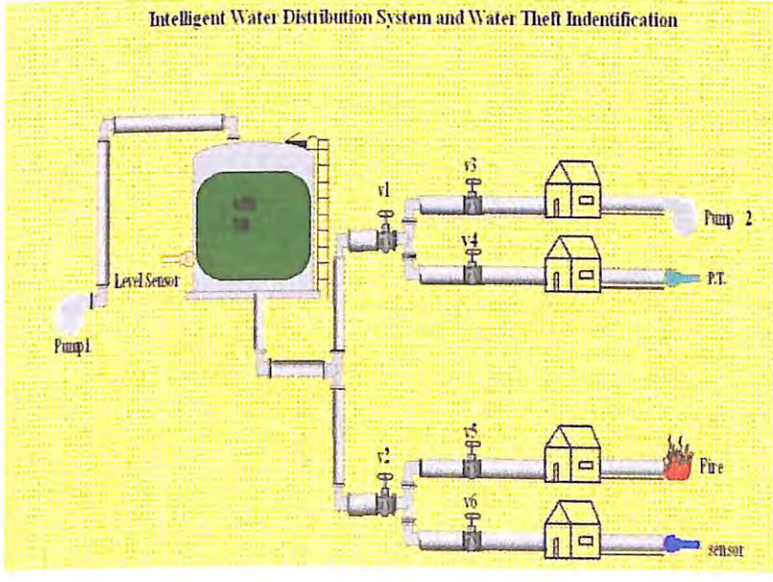

Figure 2.4: SCADA Review

(Source: Engg & Sawant, 2014)

2.1.3 Automation of Tank Level using PLC and Establishment of HMI by SCADA

This paper developed by (Das et al, 2013) from India. The purpose of this project is to provide an analysis of the simulation and components required to carry out an automated level control system using a PLC. The component used in this project is level sensor, PLC, relay and motor and HMI.

Focused on the SCADA system is to develop applications using an integrated automation system. The HMI can be linked to communicate with a PLC and to replace the push buttons or switches. It also gives the ability to operator and management to view the operation in real time. Real time control defined as a pertaining to the performance of a computation through the actual time that the connected physical process emerges (S.A. Boyer, 1999).

Extensive growth of population development and technology has led to the need of proper utilization of the natural resources especially water. The project objective is achieved by no human supervision was necessary and automatic control the tank level. Figure 2.5 and Figure 2.6 below shows the schematic design of the system and the SCADA interface for the water level.

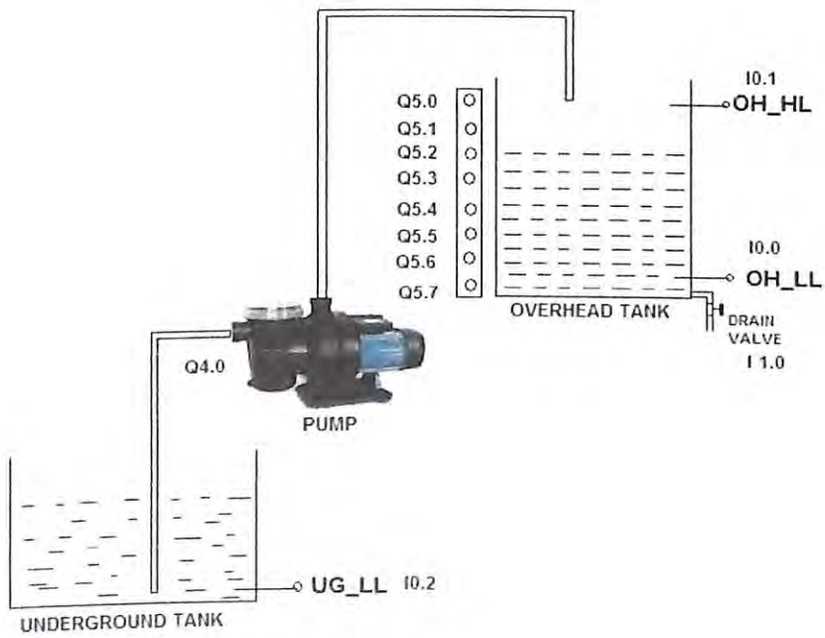

Figure 2.5: The Schematic Design of The System

(Source: Das et al, 2013)