DEVELOPMENT OF DISTRIBUTED CONTROL SYSTEM USING SERVO DRIVEN POSITION CONTROL PLANT

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May 2009

" I hereby declare that I have read through this report entitle Development Of Distributed Control System Using Servo Driven Position Control Plant and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

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Date : 22nd April 2009

DEVELOPMENT OF DISTRIBUTED CONTROL SYSTEM USING SERVO DRIVEN POSITION CONTROL PLANT

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A report submitted in partial fulfillment of the requirements for the degree
Of Bachelor In Electrical Engineering (Control, Instrumentation and Automation)

Faculty Of Electrical Engineering
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MAY 2009

I declare that this report entitle Development Of Distributed Control System Using Servo Driven Position Control Plant is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: …….

Name : MOHD HADAR BIN JAAFAR

Date : 22nd APRIL 2009

Dedicate to my beloved parents, family…

ACKNOWLEDGEMENT

First and foremost, I thank Allah the Almighty for blessing me to complete my Final Year Project 2. I want to take this opportunity to record my utmost and sincere gratitude to my supervisor, En. Ahmad Zubir bin Jamil. Without him, I can never start work on my project and to proceed until this point of development. He has shown me guidance, important advice, and inspiration throughout my project. He has also given me knowledge essential in doing this project.

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ABSTRACT

This project is about to design and develop of Supervisory Control and Data Acquisition (SCADA) system using existing PLC controlled servo driven position control. It will involve the integration of Graphical User Interface (GUI) that will be built using CX-Designer in the master terminal unit (MTU) workstation or PC with that process plant. The Human Machine Interface (HMI) will allow data exchanging between PLC as well as that workstation (Master Terminal Unit). Features that will be included in this system such as mimic diagram, process flow diagram, alarms and others appropriate features for data management.

ABSTRAK

Projek ini merupakan kerja mereka bentuk dan membangunkan Sistem Kawalan Penyeliaan dan Pemerolehan Data (SCADA) kawalan kedudukan servo yang menggunakan Pengawal Logik Boleh Aturcara (PLC). Ia akan melibatkan integrasi Antara Muka Pengguna Grafik (GUI) yang akan dibina menggunakan perisian sama ada Citect SCADA atau CX-Designer dalam unit terminal (MTU) stesen kerja atau PC dengan proses itu. Antara Muka Mesin Insani (HMI) akan membenarkan pertukaran data antara PLC serta stesen kerja itu (Unit Terminal Tuan). Ciri-ciri yang akan dimasukkan dalam sistem ini gambarajah mimik, gambar rajah aliran proses, penggera dan lain-lain ciri-ciri sesuai untuk pengurusan data.

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CHAPTER 1

INTRODUCTION

DCS is a distributed control system. It generally refers to an industrial control system: a computer system monitoring and controlling a process. This project will create a DCS system using Supervisory Control and Data Acquisition (SCADA) as a base to create GUI (Graphical user interface). The plant that will be controlled is a servo driven position control plant. Servomotors are often use to control sensitive adjustment such as steering, remoter and also in other uses in robotic and positioning control system. Servo systems use a weak control signal to move a large load to a desired position but with great accuracy. The most suitable key words that can define these servo mechanisms are move and great accuracy. The Smartstep servo driver has ability to control speed, direction, acceleration and position of servo motor. This project is been developed to view a presentable GUI for a servo motor to pick and place process on X-axes and Y-axes position with better process flow diagram, mimic diagram, alarms for system diagnosis as well as other data management systems.

1.1 Project Objective

There are two main objectives to be achieved in this project. They are:

1. To develop a SCADA system that can be controlled via several workstations.

2. To develop system that will include features such as alarm, mimic diagram, process flow diagram, thus make system more efficient and presentable.

1.2 Scope of the Project

The scope of this project will cover on:

i. The development of GUI by using Citect SCADA / CX-Designer.
ii. The process plant controlled by PLC.
iii. Proper interfacing between hardware, software and PLC.

1.3 Problem Statement

Presently, the process plant is the most popular industry in any country. However, they may have encountered so many problems in their processes. With the conventional monitoring system such as Programmable Logic Controller (PLC), it didn‟t allow for the proper process control management. When it comes to gather, recording and accessing the data, the conventional system doesn‟t provide a proper method to be implemented. Thus, it is not a user friendly system.

The DCS system that will be developed mainly used for monitoring and it can be done remotely. The user will have the privileges to monitor the system from outside of the plant or somewhere else using the communication protocol available for DCS system.

1.4 Project Background

This project is about to design and develop of SCADA system using existing PLC controlled servo driven position control. It will involve the integration of GUI that will be built using CX-Designer in the master terminal unit (MTU) workstation or PC with that process plant. Features that will be included in this system such as mimic diagram, process flow diagram, alarms and others appropriate features for data management. The developed GUI can be integrating with a PLC OMRON CJ1G-H, process control plant, CX-Programmer and CX-Designer. CX-Programmer is uses as interface software to give a command to process control plant and CX-Designer as software to develop a SCADA system. This system will allow controlling the direction, acceleration and speed of a servo motor.

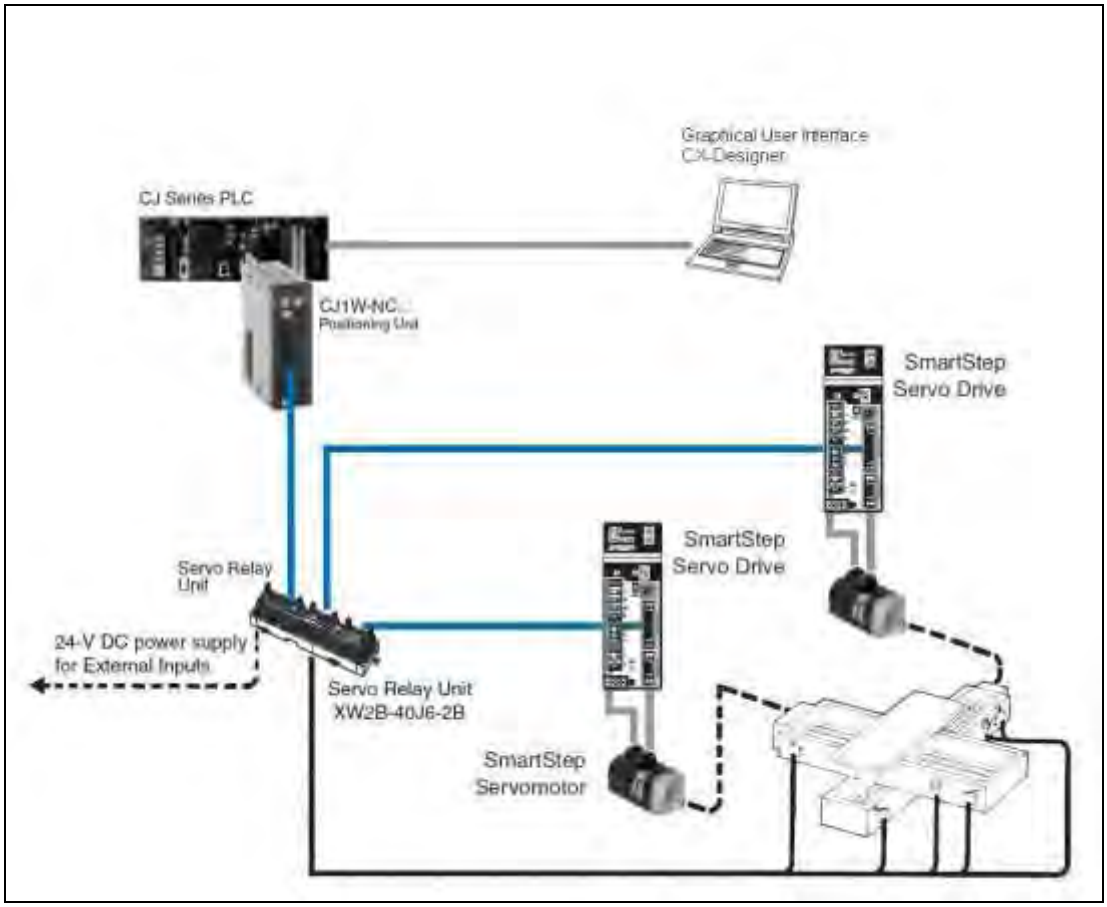

Figure 1.1: System Configuration Using Position Control Unit

CHAPTER 2

LITERATURE REVIEW

2.1 Distributed Control System (DCS)

The distributed control system (DCS) refers to a control system that available in manufacturing system, process or any kind of dynamic system, in which the controller elements are not central in location (like the brain) but are distributed throughout the system with each component sub-system controlled by one or more controllers. The entire systems of controllers are connected by networks for communication and monitoring.

DCS is a very broad term used in a variety of industries, to monitor and control distributed equipment.

1. Electrical power grids and electrical generation plants.
2. Environmental control systems.
3. Traffic signals.
4. Water management systems.
5. Oil refining plants.
6. Chemical plant.
7. Pharmaceutical manufacturing.
8. Sensor networks.
9. Dry cargo and bulk oil carrier ships.

The classical measurement, control and actuator devices were

based on simple physical principles (mechanical, hydraulic, pneumatic and electrical). Often they were used as stand-alone devices for relatively closed automation solutions. With the introduction of microprocessor technology and its fast spreading, the focus shifted from stand-alone devices to much more complex device systems. These systems of automation devices including their necessary communication systems are called Process Control Systems (PCS).

Process Control Systems provide control and supervision of production processes. They connect people (the operator) and machines. They consist of input/output devices, data processing units, human machine interfaces and communication systems.

First generation PCSs are characterized by a centralized structure. A central device scans all relevant process data and computes the actuator values. There are two basic types of PCSs, one for process control and one for manufacturing. Their internal structures are similar, the market (user) will decide about a possible fusion. This fusion and the transition from centralized to de-centralized systems based on serial communication systems (field bus) are milestones of the development towards second generation PCSs. This development hasn't been finished yet, but lots of solutions are emerging.

A non-interrupted engineering process on the basis of common information models and data exchange technologies is the primary requirement for the design of 3rd generation PCSs. These third generation PCSs are called Distributed Control Systems (DCS) here.

2.1.1 Elements Of DCS

A DCS typically uses customs designed processors as

controllers and uses both proprietary inter connections and protocols for communication. Input and output modules is a from component parts of the DCS. The processor receives information from input modules and sends information to output modules. The input modules receive information from input instruments in the process (field) and transmit instructions to the output instruments in the field. Computer buses or electrical buses connect the processor and modules through multiplexers or demultiplexers. Buses also connect the distributed controllers with the central controller and finally to the Human Machine Interface (HMI) or control consoles. Elements of a distributed control system may directly connect to physical equipment such as switches, pumps and valves or may work through an intermediate system such as a SCADA system.

2.1.2 Applications Of DCS

Distributed control systems (DCSs) are dedicated systems used to control manufacturing processes that are continuous or batch oriented. DCSs are connected to sensors and actuators and use set point control to control the flow of material through the plant. The most common example is a set point control loop consisting of a pressure sensor, controller and control valve. Pressure or flow measurements are transmitted to the controller, usually through the aid of a signal conditioning input and output (I/O) device. When the measured variable reaches a certain point, the controller instructs a valve or actuation device to open or close until the fluidic flow process reaches the desired set point. Large oil refineries have many thousands of I/O points and employ very large DCSs. Processes are not limited to fluidic flow through pipes, however, and can also include things like paper machines and their associated variable speed drives and motor control centers, cement kilns, mining operations, ore

processing facilities and many others.

A typical DCS consists of functionally and/or geographically distributed digital controllers capable of executing from 1 to 256 or more regulatory control loops in one control box. The I/O devices can be integral with the controller or located remotely via a field network. Today‟s controllers have extensive computational capabilities and in addition to proportional, integral and derivative (PID) control, can generally perform logic and sequential control.

DCSs may employ one or several workstations and can be configured at the workstation or by an off-line personal computer. Local communication is handled by a control network with transmission over twisted pair, coaxial or fiber optic cable. A server and/or applications processor may be included in the system for extra computational, data collection and reporting capability.

2.2 Supervisory Control And Data Acquisition (SCADA)

SCADA is the abbreviation for Supervisory Control And Data Acquisition. It generally refers to an industrial control system: a computer system monitoring and controlling a process. The process can be industrial, infrastructure or facility based as described below:

1. Industrial processes include those of manufacturing, production, power generation, fabrication and refining, and may run in continuous, batch, repetitive or discrete modes.
2. Infrastructure processes may be public or private, and include water treatment and distribution, wastewater collection and treatment, oil and gas pipelines, electrical

power transmission and distribution and large communication systems.

3. Facility processes occur both in public facilities and private ones. They monitor and control HVAC, access and energy consumption.

A SCADA System usually consists of the following subsystems:

1. A Human-Machine Interface (HMI) is the apparatus which presents process data to a human operator and through which the human operator monitors and controls the process.
2. A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the process
3. Remote Terminal Units (RTUs) connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.
4. Communication infrastructure connecting the supervisory system to the Remote Terminal Units.

There is, in several industries, considerable confusion over the differences between SCADA systems and Distributed control systems (DCS). Generally speaking, a SCADA system usually refers to a system that coordinates.

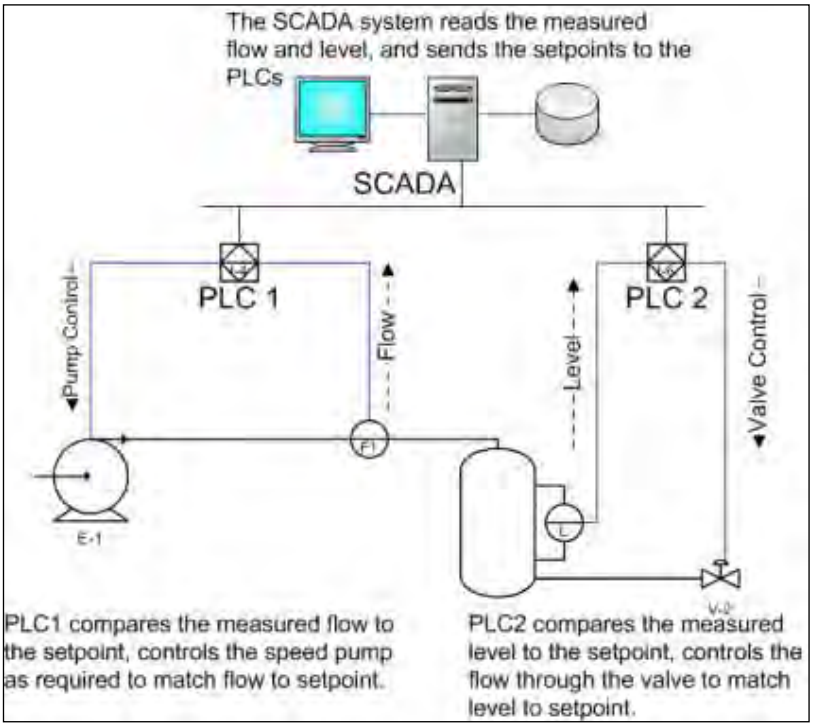

Figure 2.1: Example of SCADA Concepts

2.2.1 Human Machine Interface

Human Machine Interfaces (HMI) are operator interfaces terminal with users interact in order to control other devices. Some HMI include knobs, level, and controls. Other provides programmable function keys or a full key pad. Devices that include a processor or interface to personal computers (PCs) are also available. Many HMI include alphanumeric or graphic displays. For ease of use, these displays are often backlit or use standard messages. When selecting HMI, important considerations include devices supported and devices controlled. Device dimensions, operating temperature, operating humidity and vibration and shock rating are other important factors.

Many HMI include flat panel display (FPDs) that use liquid crystal display (LCD) or gas plasma technologies. In LCDs, an electric current through a liquid crystal solution that is trapped

between two sheets or polarizing material. The crystals align themselves so that light cannot pass, producing an image on the screen. LCDs can be monochrome or color. Color display can use a passive matrix or an active matrix.

Figure 2.2: Human Machine Interface (HMI)

Passive matrix display contains a grid of horizontal and vertical wires with an LCD element at each intersection. In active matrix displays, each pixel has a transistor that is switched directly on or off, improving response times. Unlike LCDs, gas plasma displays consist of an array of pixels, each of which contains red, blue, and green sub pixels. In the plasma state, gas reacts with the sub pixels to display the appropriate color.

Human machine interfaces differ in terms of performance specifications and I/O ports. Performance specifications include processor type, random access memory (RAM), and hard drive capacity, and other drive options. I/O interfaces allow connections to peripherals such as mice, keyboards, and modems. Common I/O interfaces include Ethernet, Fast Ethernet, RS232, RS422, RS485,