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Review Article

Design and Implementation of Motor Speed Control Model by Using PLC

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Abstract

This paper has presented the design and implementation of motor speed control model system. The proposed model were designed using PLC (Programmable Logical Controller) to be as the most sophisticated automatic control system. Which is used in power generation and distribution automation for quality power. As a result, our proposed system is designed to control the station extensions and remote control of other systems or other stations where orders and instructions are transferred accurately and at great speed in addition to the details of the systems whether the speed of rotation devices and hence could achieve higher reliability and efficient system.

Keywords: PLC (Programmable Logical Controller); Motor Speed Control Model; SCADA System; Data Networks

Introduction

Control systems could be represented as a "computer-based systems utilized within several critical infrastructures and industries. For example, electric grid, natural gas, water, and wastewater industries, which has been used to monitor and control sensitive process. To deploy the smart grid system, there is a trend toward interconnecting SCADA system and data networks. Typically control systems collect field measurement and operational data from the field stations, process and display this information. The relay control commands to local or remote outstations are issued from the control center. Control systems may perform additional functions of operating switches, circuit breakers and adjusting valves to regulate the fuel flow [1-3].

"Control systems have been utilized since the 1930s, "where there are two fundamental types which are the distributed control systems (DCS) and SCADA systems. Typically, DCS systems are used within a single processing or generating plant or over a small geographic area. SCADA systems usually used for large, extended electricity distribution or generation operations. For example, a utility company may use a DCS to generate power and an SCADA system to distribute it. But nowadays SCADA is more reliable and applicable in large scales renewable energy systems such as the wind and solar farms. In this thesis we will concentrate on SCADA systems for electrical controlling station, and our discussion is generally applicable to DCS systems [4]".

"An SCADA system should have all of the required elements to support the multifaceted nature of distribution procedure and the higher level applications of a Distributed Management System (DMS). A smart grid SCADA system's main function is in assisting of distributed generation operations, alarming, telemetry, event logging recording, and remote control of outstation field equipment. A modern system should support the planning of engineering and budgeting functions by providing an entrance to power system data without having to face the procurement of an operational workstation [5]. Earlier, SCADA systems have been known for their surplus support for the importation, and more importantly, the exporting

of power system data values. The evolving changes in recent power system operational needs demand a distributed control center that is decentralized, flexible, integrated, and opened. Present-day control centers are moving in that direction with varying degrees of success [6]. The technologies of SCADA utilized in today's control centers to enable them to be more distributed are briefly reviewed. With the rising of the Internet age, the trend in technology based information and communication issues, which is moving toward micro grid and grid computing and web services, or micro grid services. A micro grid service-based future control center is specified [7]".

Literature survey

Several proposed method were presented by many authors and manufactures for example: Yasmin Musa., *et al*. exhibited two utilizations of a minimal effort remote supervisory control and information obtaining framework in two models. The primary model is exhibited with a Profibus-DP convention-based framework in an ace PLC unit with control sources of information and show yields controls the speed and screens the over-burden state of a DC engine that is associated with a slave PLC progressively. In the updated model, a Profinet convention is utilized to associate PLCs, and an electrical cable correspondence interface is utilized to remotely associate the control HMI to the system. In the two models, remote Supervisory control is accomplished utilizing client characterized control works that demonstrate by and large as a square situated capacity library or tool compartment. Elevated levels of execution are accomplished by progressively control and information securing in the two models. However, their proposed two models have not been considered the reliability of such systems [8].

Jaekyu Lee., *et al*. presented, designed and implemented a SCADA system which is a vital piece of vitality activity for an independent seaward wave-wind half breed power age framework. The half and half force age framework has four 2 MW-class wind turbines and twenty-four 100 KW-class wave power generators. The SCADA framework is structured dependent on IEC61850 which is a global standard for merchant freethinker designing of the setup of intelligent electronic devices for electrical substation robotization frameworks for speaking with every generator. Furthermore, the researchers have showed that the planned SCADA framework is executed appropriately as per the order of the transmission framework's administrator in a recreation-based testing condition [9].

R Subramani and C Vijayalakhsmi Proposed the structure and examination of an Energy Management model for a SCADA system framework. Each force framework is confined by its material control authority, shaping a decentralized structure by utilizing a steady system. A focal ideal force stream issue is deteriorated into appropriated sub problems to acquire the ideal arrangement. Another vitality the executives' model is structured which empowers an adaptable and productive activity of different force plants. A set of numerical calculations and graphical figuring portrayals the sustainable power sources in the two arrangements is free of the suffering or discontinuous principle vitality asset accessibility, which prompts compelling creation. However, the utilization of such numerical and graphical calculation has been reported to be increased the computational complexities [10].

Danny Aguirre., *et al*. presented a development methodology for a low-cost industrial software that castrates on the industrial section with a limited capability. The aim of this work was to present a SCADA system integration in the field of small and medium size industries. The proposed software have been designed based on the use of both Modbus communication application and an HMI approach based on the web server application for the implementation of the SCADA system. It is worth to mention, that the final view of their development method have been resulted in a lower-cost method to be implemented in different industries. However, such industries should be satisfy the consideration of lower purchasing power. Meanwhile, the platform performance have not been evaluated in a proper manner in the practical process [11].

SCADA system

SCADA represent the abbreviated words for Supervisory-Control and Data-Acquisition. Such frame-works have been utilized to control a plant or hardware in businesses, such as, communications of different media, the water and waste control, the vitality, oil and gas refining and transportation [12]. These frame-works present the exchange procedure between a SCADA focal (or disseminated) have PC and various Remote-Terminal-Units (RTUs) or potentially -Programmable- Logic- Controllers (PLCs). A SCADA frame-work accumulates data, return the data back to a focal site, at that point cautions the home station that a break has been happened, doing the significant examination and control, for example, deciding if the hole is in basic manner, and illustrating the data in a sensible and sorted out style [13]. These frame-works can be moderating in a straightforward manner [14]. Customarily, SCADA frame-works have utilized the Public Switched Network (PSN) for checking and controlling purposes. Today numerous frame-works are checked utilizing the foundation of the Local Area Network (LAN)/Wide

Area Network (WAN). Remote advances are presently being generally conveyed for reasons for checking and controlling [15,16]. Figure 1 clarify the concept of SCADA system.

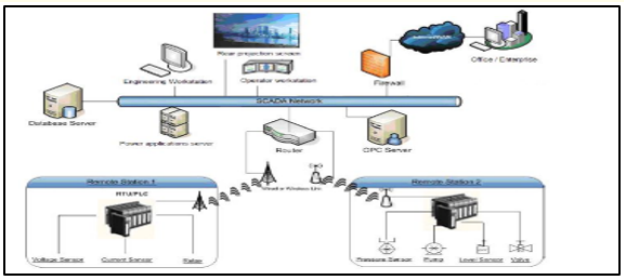

Figure 1: SCADA system.

System model component

Variable frequency drive (VFD)

Is a sort of customizable speed drive utilized in electro-mechanical drive frameworks to control AC engine speed and torque by changing engine input recurrence and voltage and as can be seen in figure 2 [17]. VFDs are utilized in applications going from little machines to huge blowers. About 25% of the world's electrical vitality is devoured by electric engines in modern applications [18]. Frameworks utilizing VFDs can be more productive than those utilizing throttling control of liquid stream, for example, in frameworks with siphons or fans. In any case, the worldwide market entrance for all utilizations of VFDs is generally small. VFDs are utilized in applications running from little machines to enormous blowers. About 25% of the world's electrical vitality is devoured by electric engines in modern applications [19]. Frameworks utilizing VFDs can be more productive than those utilizing throttling control of liquid stream, for example, in frameworks with siphons or fans. Be that as it may, the worldwide market infiltration for all uses of VFDs is generally little. Figure 3 clarify the operational procedure of VFD system [20].

Human machine interface (HMI)

SCADA framework incorporates a rule called HMI. The HMI of a SCADA framework is the place information is handled and introduced to be seen and checked by the human administrators [21]. This interface as a rule incorporates controls where the individual can interface with the SCADA framework. An example of HMI can be seen in figure 4.

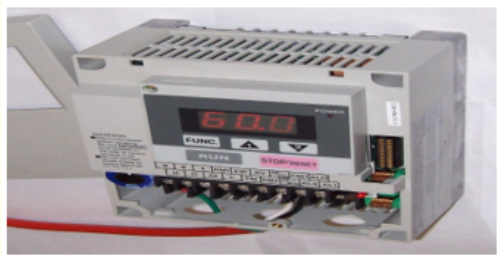

Figure 2: Main view of VFD system.

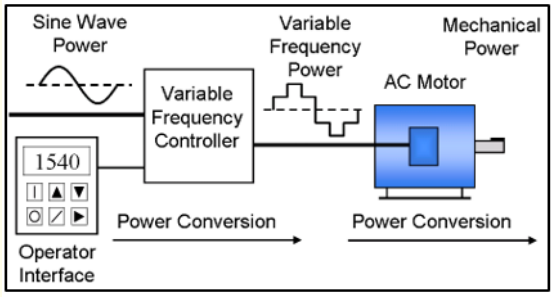

Figure 3: VFD system operation.

Figure 4: Example of HMI.

Programmable logical controller

The PLC is a special purpose computer with no display, keyboard, printer, hard drive, but it is still a can be represented as a computer. PLC was a replacement for panels of relays, devices that turn on and off. Relays also fail far more than computer components, so that relay logic required more downtime to keep it running than newer PLC-based controls and require a lot of electricity, make lots of heat and soot, and take up lots of space. An installed PLC is deceptively simple in appearance [22,23]. It has a CPU module and input/output devices, referred to as I/O. The CPU commu-

nicates with the I/O, so in most systems they share a backplane that physically holds them in place and electronically connects them. The I/O modules can be separated from the CPU and connected with data cables [24].

Design of motor speed control system model

In this work it has been designed a small module for controlling the speed of motor by depending on the frequency for controlling its rotation speed, where in real stations a large and expensive motors would be utilized for controlling and performing different tasks as seen in figure 5. Such motors would require an efficient management in the turn on duration and number of rotational cycles. For that reason, there is a need for efficient controlling for such motors. In addition, the data storage and splitting timing of different working units would be controlled by using the PLC system. The proposed model of PLC in our work was PLC S7-300. Furthermore, in this work it has been utilized the VFD as a regulator for the speed of the three phase induction motor with a rotational speed of 300 rpm, the structure of connecting VFD with PLC can be seen in figure 6.

The control of the motor speed would be based on the utilized frequency, where it has been found that the speed would be in direct correlation with the source power. This scenario has been carried out based on the use of the program tiaportal. In the beginning, the frequency would be zero Hz, which is the same as in the VFD device, then an order would be taken for the three phase. So, the SCADA system would respond to this order by replying signal back to VFD from AC motor. Then this signal would be back to the PLC and finally to the SCADA system to read the current frequency. Increasing the frequency by the system we proposed and from the HMI screen we will see that the speed of the motor would be increased.

It is worth to mention, that the system screen of the SCADA has been designed using the program of WINCC of tiaportal. Figure 7 clarify the design of the regular motor work within the SCADA system. Additionally, if the motor has stopped from working, the representation in the system would be as seen in figure 8. When an error would be occur for the proposed system then the SCADA system would give an indication for that error and as seen in figure 9.

Figure 5: The utilization of large motors inside different stations.

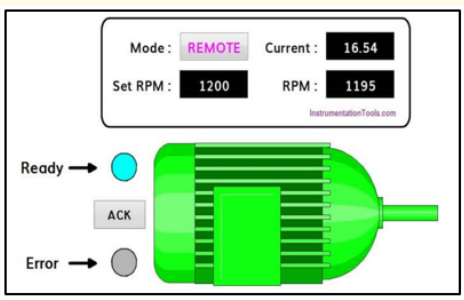

Figure 7: The status of regular motor working within SCADA system.

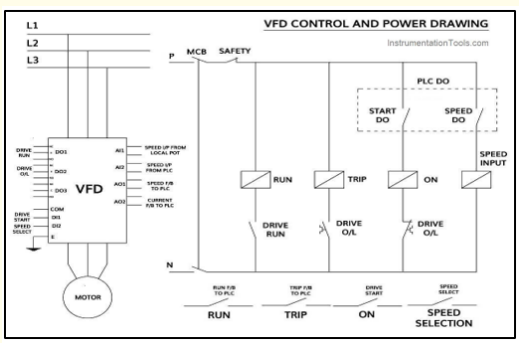

Figure 6: The connecting of VFD and PLC system.

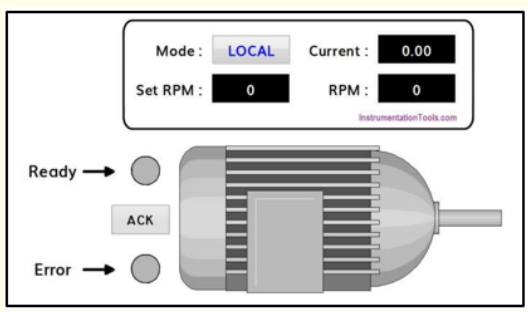

Figure 8: The status of stop working motor within SCADA system.

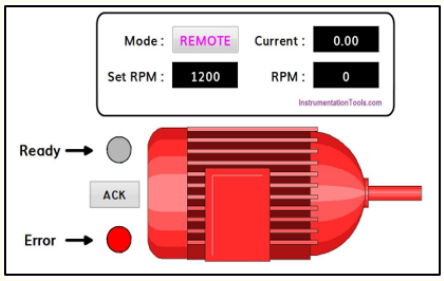

Figure 9: The status of error with motor working within SCADA system.

The final view for the entire system can be seen in figure 10, where the connection of MHI, PLC, VFD and the induction motor can be represent our proposed scenario in this work.

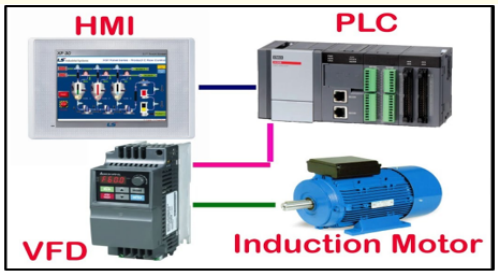

Figure 10: Our proposed connected system and with the utilization of HMI screen.

Conclusion

Previously, the idea of smart controlling for different industrial equipment's and stations was regarded as the dream of manufacturers and owner of factories because the management of the factory has been never an easy thing. Also, the amount of error that may be occurs during the hours of works is very high. As a result, in this work it has been proposed a mini-system which is designed to work as a model for the development of old stations in design and work in Iraq where it relied on an old and worn system that relied on analog systems other than the design of systems to control these units are characterized by large size and slow in the instructions and orders. As a result, our proposed system is designed to control the station extensions and remote control of other systems or other stations where orders and instructions are transferred accurately and at great speed in addition to the details of the systems whether the speed of rotation devices. For the future, Adding additional sensor equipment which makes the work more accurate knowing that the design that was performed was miniature. In order to make the factory.

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