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Monitoring and Control of Three Phase Induction Motor Using Iota Based Concept

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Abstract: *The three phase squirrel cage induction motors are widely used motor in industry because of its simple maintenance. The Variable Frequency Drive controls the speed of the machine to maintain its constant speed characteristics. To have reliable operation its performance must be monitored continuously.This monitoring of induction motor can also be monitored and control using mobile communication with IoT concept.This operation is monitored and controlled by the Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) are two new approaches to control a Variable Frequency Drive (VFD) whose output is fed to an induction motor and driving a conveyor belt. The necessary instructions are programmed in the form of ladder logic programming to the PLC through the medium of a personal computer (PC). The SCADA software installed in the PC in turn enables the human operator to control the entire operation away from the plant and just by using the virtual inputs designated on his computer screen. This SCADA screen which has been created using PC it can also operate using mobile communication for wireless purpose this mobile communication concept which has been done based on the IoT(Internet of things).*

Keywords*-Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA), Variable Frequency Drive (VFD), Internet of things(IoT), and Personal computer(PC).*

I. Introduction

The induction motor (IM) should have protection to overcome against the possible problem such as overvoltage, over current, overload, over temperature and under voltage occurring in the course of its operation is very important because of it is used intensively in industry as an actuator. The induction motor's new protection method is based on the automation technology of Programmable Logic Controller (PLC) has been introduced.

In this method all timers, contactors, relays and conversion card can be eliminated. Moreover, the voltage, current, speed, temperature value of the motor.The problems occurred in the system are monitored and warning messages are shown on computer screen. PLC provides higher accuracy as well as safe and visual environment.

This technique makes use of Variable frequency drive to measure the parameters of induction motor and the data is transmitted to the SCADA base station by using the RS485 interfaced with PLC.

The motor can be started, stopped and it is also possible to protect the motor against some faults such as over current, over heating in windings, under/over voltage. The SCADA system saves all received parameter data of the motor in Historical database. Controlling, monitoring, and protection of the system are realized in real time.

A. PLC as system controller

A PLC is a microprocessor-based control system, designed for automation processes in industrial environments. It uses a programmable memory for the internal storage of user-orientated instructions for implementing specific functions such as arithmetic, counting, logic, sequencing, and timing.

A PLC can be programmed to sense, activate, and control industrial equipment and, therefore, incorporates a number of I/O points, which allow electrical signals to be interfaced. Input devices and output devices of the process are connected to the PLC and the control program is entered into the PLC memory.

In our application, it controls through analog inputs and outputs the varying load-constant speed operation of an induction motor. Also, the PLC continuously monitors the inputs and outputs activities according to the control program.

This PLC system is of modular type composed of specific hardware building blocks (modules), which plug directly into a proprietary bus: a central processor unit (CPU), a power supply unit, input-output modules I/O, and a program terminal. Such a modular approach has the advantage that the initial configuration can be expanded for other future applications such as multi machine systems or computer linking.

B. Supervisory control and data acquisition

SCADA is a system which exercises supervisory control of a particular device from a remote area and the human operator is able to monitor and control the device from his computer screen without operating the device manually near to the plant.

A PLC based control system was set up comprising of a Delta PLC, a Delta Variable Frequency Drive, a three-phase induction motor, workstation (personal computer) and the mobile communication has been delivered, configured and integrated together for the monitoring and control of a three phase induction motor driving a conveyor load.

Various control schemes have been used to operate the induction motor in speed and position control modes of operation using PLC programming developed on the workstation.

C. Variable frequency drive

A Variable Frequency Drive is used in the applications where the speed control isessentially required. importance due to load changes wherein the speed needs to be increased or decreased accordingly.

Traditional methods in existence have addressed this issue, each with their own drawbacks such as high motor starting current, lower power factor, energy losses, etc. To address these problems, VFD provides a flexible approach as compared to traditional methods of speed control especially for certain applications which do not require a constant speed at all times.

To name an example, a pump delivering cooling liquid supply may require peak load operation only for a requisite period of time and may require only much less amount during the remainder of the day. VFD will allow the speed of the pump to run at a lower rate in such case thereby enabling energy saving benefits

D. Three phase induction motor

Three phase induction motors are most commonly used in industry. Because they are simple, strong, low amount, and easy to maintain. They run at essentially steady speed from no-load to full-load. The speed of the motor is frequency-reliant.so, these motors are not easily adapted to change the speed. However, VFD are being used to control the speed of induction motors.

II. Hardware Description

The technical specifications of components are given in below Table I,II,III. The three-phase power supply is connected to a three-phase main switch and then to 3 pole MCB which provides protection against current overloads.

Then it is connected to variable frequency drives(VFD) which control speed of motor and we can change the direction of motor through PLC and this is interface on SCADA. Due to its versatility and compact dimensions the frequency inverter(VFD) solving most effectively your individual drive tasks. Its extensive functions allow flexible applications.

1. The Delta AC drive is the smallest and most cost effective drive which provides powerful motor speed control in a compact, space saving design. This Delta AC drive will convert the 230v single phase AC into 230v three phase AC.

Table I shows the specifications of VFD used in the experiment.

Table I
VARIABLE FREQUENCY DRIVE
SPECIFICATION:

Model	Delta
Power	0.75KW
Input	1PH,9.7A/3PH,5.1A
Output	3PH,0-240V, 4.2A,16KVA
Frequency	1-400Hz

2. The PLC used in this project isDelta series. The basic parts of a PLC are Power Supply, CPU, Input Module and Output Module.

Table II shows the specifications of PLC used in the experiment.

TABLE II
PLC
SPECIFICATION:

Model	Delta
input	24V DC,1.5W
output	0.5A,30V DC RES load

III. Control System Of Induction motor

1) A closed-loop control system used for constant speed operation of the motor, It has been configured with speed feedback and load current feedback. The induction motor drives a variable load, is fed by an inverter, and the PLC controls the inverter V/f output.
2) 2) An open-loop control system is used for variable speed operation of the motor. The induction motor drives a variable load and is fed by an inverter in constant V/f control mode. The PLC is inactivated.
3) 3) The standard variable speed operation. The induction motor drives a variable load and is fed by a constant voltage-constant frequency standard three-phase supply.
   The open-loop configuration (2) can be obtained from the closed-loop configuration (1) by removing the speed and load feedback. On the other hand, operation (3) results if the entire control system is bypassed.

IV. Objectives and Overview of the Proposed Mechanism

A. Objectives

A PLC-SCADA based monitoring and control system for a Variable Frequency Drive system was developed which controls a three-phase induction motor attached to a conveyor belt.PLC was introduced in the 1970's for the automotive manufacturing industry to provide a replacement for large relays, timers, contactors based control panels. With the advent of the microprocessor, PLCs have been enhanced to accomplish more complex industrial applications over the years.

SCADA is a type of industrial control system which are computer controlled systems for monitoring and control of industrial processes. A distinct advantage of SCADA lies in the control ability of large scale processes which includes multiple sites and large distances.

This integrated system provides a platform for developing the concepts for thorough understanding of how an industrial automated system works comprising of all the above components.

B. Overview of the proposed mechanism

A Variable Frequency Drive is a device used in a drive system consisting of the following three main sub-systems:

AC motor, main drive controller assembly, and drive operator interface. The AC electric motor used in a VFD system is a three-phase induction motor which is generally the most economical motor choice.

The VFD controller is a solid state power electronics conversion system consisting of three distinct sub-systems: a rectifier bridge converter, a direct current link, and an inverter. In a VSI drive, the DC link consists of a capacitor which smoothens out the converter's DC output ripple and provides a stiff input to the inverter.

This filtered DC voltage is converted to quasi-sinusoidal AC voltage output using the inverter's active switching elements. VSI drives provide higher power factor and lower harmonic distortion than phase-controlled Current Source Inverter.

VFD control has been chosen specifically because they provide the advantages of energy savings, low motor starting current, reduction of thermal and mechanical stresses on motors and belts during starts, simple installation, high power factor and lower KVA.

A PLC-SCADA based control system has been set up comprising of aDelta PLC, a Delta Variable Frequency Drive, a three-phase induction motor and the workstation has been developed, configured and integrated together for the monitoring and control of the motor driving a conveyor belt load.

Various control schemes have been used to operate the induction motor in Speed and Position control modes of operation using PLC programming and through animated SCADA screens developed on the workstation.

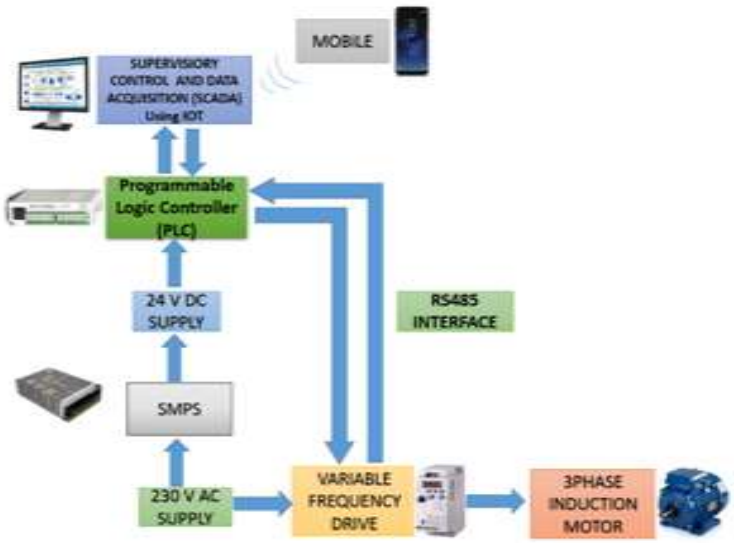

Fig.1 Overview of proposed system

Variable Frequency Drives are generally required because many applications are not run at the same speed all of the time due to surrounding circumstances. The revolutions per minute of the driven shaft need to be increased or decreased depending on load changes, application requirement or other circumstances.

The PLC has been connected to control and monitor a VFD which is the acts as a go-between the three-phase induction motor and the PLC. A conveyor load is connected to the induction motor.

The ladder logic programming and initiates corresponding output to the VFD. The VFD in turn once again processes the PLC input to it and accordingly controls the speed and position of the three-phase induction motor. Ladder logic programming is carried out in Delta software in the personal computer.

SCADA elements are written into the ladder logic program itself by assigning a tag or point which represents a single input or output value monitored or controlled by the system. With the help of SCADA system, labor costs are reduced by minimizing site visits for inspection, data collection and making rectifications. User defined controls such as start, stopis developed on the software window in order to control the system remotely.

This system is further monitored and controlled by using the method based on internet of things(IoT). With the internet facilities the whole system is controlled from mobile communication by providing a separate page from SCADA software.

V. Result and Discussion

A. Ladder Logic Programming

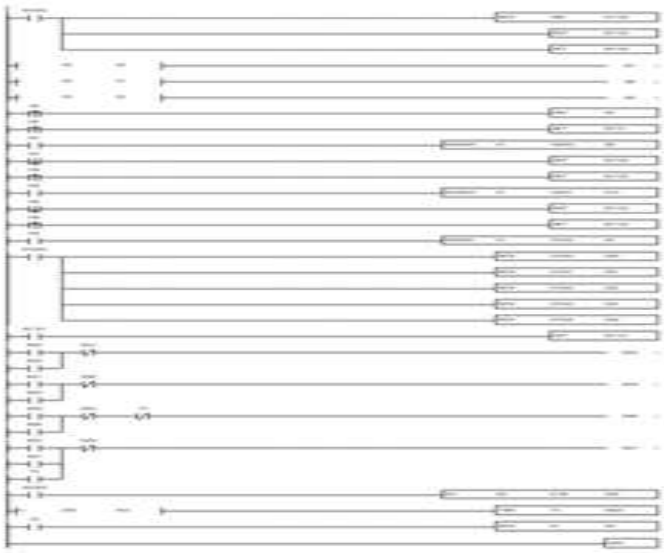

Fig.2 Ladder logic programming

The experiments were conducted based on ladder logic programming which is a software installed on a personal computer according to which the PLC takes the inputs, processes them according to the program and gives the output to the VFD which again processes this input within the drive and finally controls the speed and position of the motor.

B. SCADA program output

The SCADA program was also written using ladder logic and then run simultaneously from the SCADA screen developed by Indu Soft Software The SCADA software enables human operator to control the entire operation away from the plant and just by using the virtual inputs designated on his computer screen. Figure 2 shows the SCADA screen shot of animation of the control and monitoring system which was previously controlled by the ladder logic program. This type of motor control is helpful when the operator has to control the motor from a remote location directly through the screen of the workstation.

Fig. 3SCADA screen shot of animation of real-time control setup

VI. Conclusion

The present work was motivated to develop a scheme and PLC is used to monitor and control a Variable Frequency Drive. A thorough study of all the hardware machinery was done including their functioning, specifications and overall performance. A 0.75 KW three-phase induction motor was fully computerized and automated using a VFD and PLC.

The drive used in this set-up offered different control modes of motor operation. The pattern and settings to run the motor in two control modes viz., speed and arrangement were completed systematically. A ladder logic program was developed using software which enabled the motor to obtain two different positions in order with a specified time interval between the positions. A complete study and useful hands on the PLC and the drive process have imparted a fairly good idea about the industrial automation systems.

References

[1] N. Sadeesh , P. Hema , E. Prasannakumar , S. Leelakrishnan,"Automation of VFD Based Sugarcane Crusher with PLC and SCADA Control" IJRASET,Volume 4 Issue V, May 2016 IC Value: 13.98 ISSN: 2321-9653

[2] RinchenGeongmitDorjee, "Monitoring and Control of a Variable Frequency Drive Using PLC and SCADA "IJRITCC, Volume: 2 Issue: 10, October 2014.

[3] JigneshaAhir, "Design and Development of PLC and SCADA Based ControlPanel for Continuous Monitoring of 3-Phase Induction Motor" National Conference on Recent Trends in Engineering & Technology, 13-14 May 2011.

[4] Maria G. Ioannides, "Design and implementation of PLC based monitoring control system for induction motor" IEEE Transactions on EnergyConversion, Vol. 19, No.3, pages 469-476,September 2004.

[5] K Gowri Shankar, "Control of boiler operation using PLC-SCADA" International MultiConference of Engineers and Computer Scientists, Vol. 2, ISBN: 978- 988-17012-1-3, 19-21 March 2008.

[6] William J Weber, Robert M Cuzner, Eric Ruckstadter, Jim Smith,"Engineeringfundamentals of multi-MW Variable Frequency Drives"Proceedings of the thirty-first Turbomachinery Symposium, pages177-194,2002.