

Study of AC Motor Control System using PLC

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Abstract

The focus of this paper is on the control of AC motor using Programmable Logic Circuit. This project work covers PLC architecture, PLC programming basics and use of Human Machine Interface (HMI). Thus we will be implementing AC motor speed control system using the Variable Frequency Drive (VFD). Unlike in a DC motor, where you send power to the inner rotor, in an AC motor you send power to the outer coils that make up the stator. The coils are energized in pairs, in sequence, producing a magnetic field that rotates around the outside of the motor. The monitoring control system of the A.C. motor driven by VFD and controlled by PLC proves its high accuracy in speed regulation at constant-speed-variable-load operation.

Keywords- Programmable Logic Devices, Human Machine Interface, motor control.

I. INTRODUCTION

A programmable logic controller (PLC) can also be called an industrial digital computer that has been strengthened and adapted for the control of manufacturing processes. It is used in fields such as assembly lines, or robotic devices, or any activity that requires high reliability control, ease of programming and process fault diagnosis. PLCs can range from small modular devices with tens of inputs and outputs (I/O) enclosed in a housing integral with the processor. PLCs can also be large rack-mounted modular devices with a count of thousands of I/O, often networked to other PLC and SCADA systems. These PLCs can be designed for numerous arrangements of digital and analog I/O, extended temperature ranges, resistance to electrical noise, and resistance to vibration and impact. Battery-backed-up or non-volatile memory is typically used to store programs that control machine operation.

The development of PLCs replaced relay control logic in a lot of fields. That has resulted into a significant amount of cost savings. Which also lead to rare use of relay control, power applications being the only exception. PLCs help in eliminating the hard wiring that was associated with conventional relay control circuits, along with a drastic change in space utilization. The written and tested program using software can be downloaded to other PLCs too. The resident diagnostic and override functions of PLCs also allow the user to trace and correct software and hardware problems. A visual operation can be seen on the screen when a PLC program is running. This makes troubleshooting effortless and simple. Many machines can be run using one single PLC without a problem.

The expenses in today's industrial sector depends on various factors. These factors can be power consumption, raw material & man power. We have to work on the above factors in order to reduce the energy consumption which is an important area for cost reduction. This is also important because cost of energy is increasing day by day, and harms both financial and environmental factors. The unidirectional flow of energy in nature also makes it necessary for us to put more efforts into consciously saving the electricity for our future generation. So, it is necessary that overall efficiency of the system is maintained whilst making the system more efficient.

II. LITERATURE REVIEW

TABLE I: Literature review regarding motor control using PLCs

Sr. No.	Reference	Purpose	Merits	Demerits	Outcomes
[1]	Implementation of PLC Based Star delta starter for starting and direction control Of three phase induction motor. ShrutiKharait ,Prof. SudhirPhulambrikar.	The hardware set up of 3 phase star delta starting of induction motor using PLC is implemented.	Great flexibility is available in programming as any sort of changes can be done through only changing the prescribed commands in the ladder diagram.	The research and development cost of automating a process is difficult to predict accurately beforehand. Initial costs are relatively high.	PLC has proved to be universal controller and utilized for the growth of the automation technology.
[2]	Industrial Drives and Automation using PLC AmitNandgave, SaketKhandare ,HarshalDeshbhratar,ProfessorLokeshHeda	Discusses the role of PLC in efficient design and control of mechanical processes.Understanding of ladder logic and the programming involved with it, relay logic and the evolution that logic made from it.	PLCs replaces human operators in tedious task to be done in dangerous environment (i.e. fire, space, volcanoes, nuclear facilities, under the water, etc.). Also in handling too heavy loads, too large objects, too hot or too cold substances, too fast or too slow.	Technology limits. Current technology is unable to automate all desired tasks. Unpredictable development costs. The automation of a new product required a huge initial investments in comparison with the unit cost of automation is spread in many product batches.	A deeper insight into the inner workings of programmable logic is very simple to understand, but it is the complex programs that run in the ladder diagrams that make them difficult for the common user to fully understand
[3]	Monitoring and Controlling of Components in a Conveyor using PLC and SCADA by Eammaraja B, Vignesh M, Arikrishnan M, Shimoni M	To Monitor and Control the components that is being carried over the Belt Conveyers using PLC, SCADA(Supervisory	This system, collects raw data, process, and monitor it. Reduces labor cost	It is necessary that energy should be saved and overall efficiency of	Conveyors controlled by dc motor each fitted with a proximity sensor. The

		Control and Data Acquisition	and errors due to carelessness of the workers and increase its productivity increases efficiency and makes it cost effective.	the system is maintained.	conveyor running is started only when the object is detected in the proximity sensor and the conveyor is switched off after certain seconds of the object detected.
[4]	Paper Machine Automation using PLC, VFD's and HMI by Amanpreet Kaur. Er. Pardeep Singh	The modernization of the conventional system by replacing the command parts like relays, contactors, timers by a modern tool like Programmable logic controller, to run the motor at various speed VFD is used and Monitoring systems get information from a number of motors and VFD's which help to assure the balanced flow of production, this can be achieved by using HMI System.	This system work with the combination of hardware and software which help them to extended equipment life through reduced mechanical stress , high efficiency, energy saving and highest possible performance levels along with speed controls.	In Paper Machine, the major problems are mechanical wear and tear, motors run at fixed speed , load sharing and synchronizing the speed of different motor	A PLC is a real computer, which is also capable of receiving data via its inputs their sending command by its outputs. As soon as we launch the execution of the program, the Controller will carry out three phases cyclically: Phase 1: Snapshot of the status of its inputs Phase 2: Program execution Phase 3: Outputs activation or deactivation. At the end of Phase 3, the Controller returns to Phase 1.

III. GENERAL DESCRIPTION OF MOTOR CONTROL

A. Components Description

The main components of this project are as follows:

- 1) Programmable Logic Controller (PLC)
- 2) Variable Frequency Drive (VFD)
- 3) Human-Machine Interface (HMI)
- 4) A.C.MOTOR

1) Programmable Logic Controller (PLC):

A Programmable Logic Controller (PLC) is an industrialized and digitalized computer which was adopted for the control of manufacturing practices, such as robotic devices, or assembly lines, or any action that requires huge dependability control and easiness of programming and process fault analysis. PLC's are said to be initially developed in the automobile manufacturing industry to propose flexible and easily programmable controllers to change hard-wired relays, timers and sequencers. Since then, they have been broadly recognized as high-reliability automation controllers that is fit for extreme environments. A PLC is an illustration of a "hard" real-time system since output effects must be produced in response to input conditions within a limited time, else inadvertent operation will occur as a result.

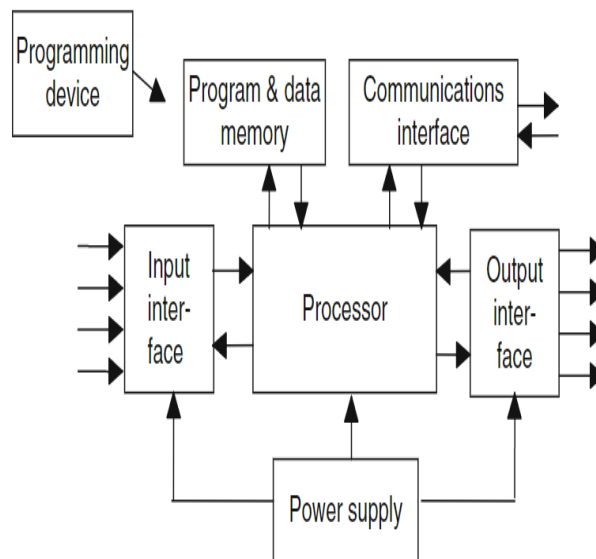


Fig 1: PLC block diagram

2) Variable Frequency Drive (VFD):

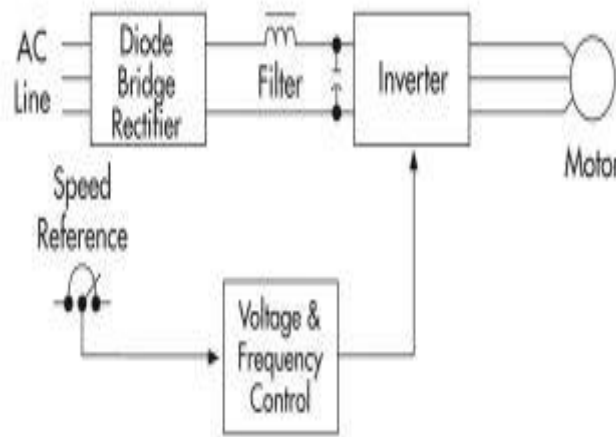


Fig 2: VFD block diagram

A variable frequency drive or Variable speed drive VSD is an electronic power unit which converts fixed mains voltage and frequency components into variable components and is used for the control of the speed of three phase AC. Given that infinite adjustable control should be such that a three phase motor Converts voltage and frequency Components of a VFD Rectifier. It also Changes the alternating current (AC) input power into direct current (DC) power DC link and stores the DC power that is consumed by the converter. At the back of VFD these capacitors are normally situated.

Converter – The IGBT (Inverse Gate Bipolar Transistor) inverter is its core’s converter provides the direction of the PWM output of the motor and also its controlled frequency.

3) Human Machine Interface (HMI) :

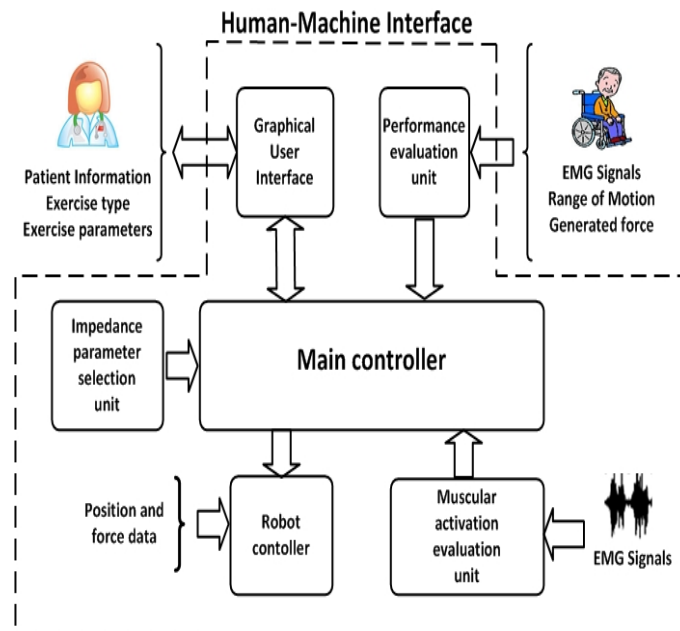


Fig 3: Human Machine Interface

It can be designed as an interaction medium between the operator and the machine. An HMI as a whole is a very broad term that includes MP3 players, industrial computers office equipment, and household appliances. But, an HMI is much more precise to process and manufacturing mechanisms.

An HMI provides a visual demonstration of a control system and provides real time data acquirement. An HMI have a centralized control centre that is really user-friendly and can help in increasing productivity manifolds. Primarily it consider the constituents that are essential to make a manufacturing control system in its operating state. The production line contains of all the machinery that does the work required in the construction of the product. Following, consider the various input/output sensors that monitors temperature, weight pressure, speed and feed rate. Third, we decide on the programmable logic controller (PLC) that will collect the data from the input/output sensors, and changes the data into logical arrangements. The highest advantage of an HMI is the accessibility of the graphical interface. The interface contains colour coding that allows for identification (for example: red for warnings). For fast recognition, easing the problems of illiteracy, Pictures and icons are used. HMI decrease the cost of product manufacturing, and increases profit margins and decreases production charges. HMI devices are now extremely advanced and they are capable of higher capacity and more interactive, elaborative functions than ever. Some of the technological benefits the HMI offers are: converting hardware to software, removing the need for mouse and keyboard, and provides interaction between computer/human.

4) A.C. Motor:

In an AC motor, there's a ring of electromagnets arranged around the outside (making up the stator), which are designed to produce a rotating magnetic field. Inside the stator, there's a solid metal axle, a loop of wire, a coil, a squirrel cage made of metal bars and interconnections (like the rotating cages people sometimes get to amuse pet mice), or some other freely rotating metal part that can conduct electricity. Unlike in a DC motor, where you send power to the inner rotor, in an AC motor you send power to the outer coils that make up the stator. The coils are energized in pairs, in sequence, producing a magnetic field that rotates around the outside of the motor.

B. Software Requirements and Description:

PLC PROGRAMMING SOFTWARE: GX WORKS 3

HMI PROGRAMMING SOFTWARE: GT DESIGNER 3

GX WORKS 3:MELSOFT GT Worksx3 advances screen design effectiveness and uses existing data. Specialized designs can be achieved with just a few clicks. Apply data: Reprocess previous projects. When generating a new project, search through the existing projects to find any already existing projects that may be reused. Keyword search helps slender down the search. Reuse earlier screens: Reuse individual screens from past or sample projects. The settings are also applied and reused such that you can make project data easily. Data browser: The data browser displays a list of objects that is used in the project. The settings can be corrected directly on the browser or by opening the setting dialog box. You can easily recognize any matching data and no longer have to open many screens. Label/Global label: Instead of using devices, we should use label names to generate easy-to-understand project data efficiently. Not only Mitsubishi Electric programmable controller devices, but also non-Mitsubishi Electric controller devices and GOT internal devices can be consigned to labels. Labels can also be used in GT Works3. Also, the labels can be imported from GX Works3, GX Works2, and MT Developer2.

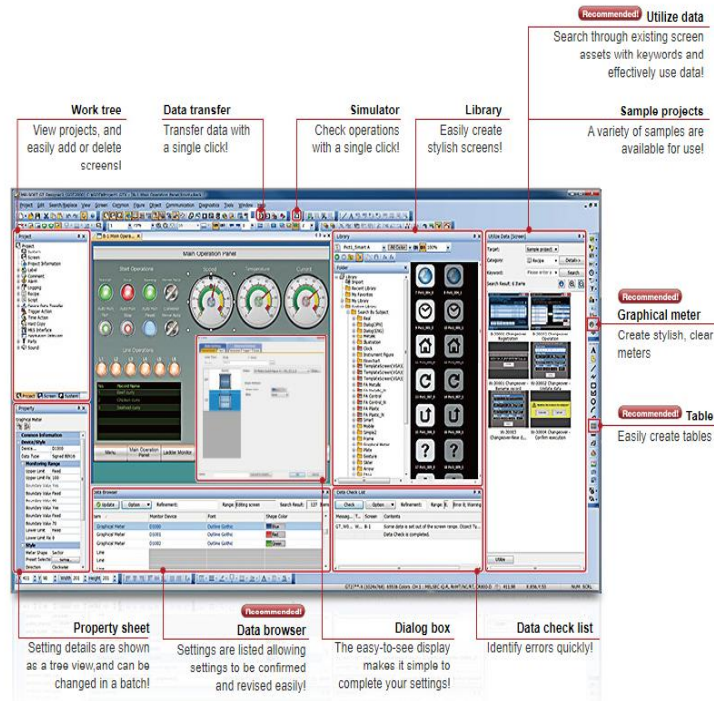


Fig 4:GT DESIGNER 3

GT Designer3:It is a software which create screens for GOT2000 series and GOT1000 series. This software enables you to create and simulate a project, and transfer data between the GOT and a personal computer.

GT Designer3 consists of the following drawing software.

GT Designer3 (GOT2000): Drawing software for GOT2000 series

GT Designer3(GOT1000): Drawing software for GOT1000 series for the project which cannot be edited or the operation in the drawing software in operation, the supported drawing software is started. The title bar of the window indicates which drawing software you are operating

1. Project creation:GT Designer3 manages the data used to operate the GOT for each project. Set screens to be displayed on the GOT and functions which operate with the GOT for the created project.

2. CREATING A PROJECT

2. Simulation:You can simulate the operations of the GOT set in the project being created with GT Designer3 on a personal computer using GT Simulator3. You can simulate the project created with GT Designer3 using only GT Simulator3. Projects for GOT2000 series, GOT1000 series, and GOT-A900 series GOTs can be simulated using only GT Simulator3.

3. Data transfer: Created projects and the data required for operating the GOT are written into the GOT from GT Designer3. The resource data stored in the GOT can be read from the GOT to GT Designer3. For the data transfer between GT Designer3 and the GOT, use a communication cable, network, or the data storage.

IV. CONCLUSION

In this domain of AC Motor Control, PLC will be used in automated systems with an A.C. motor. We will continuously monitor the state of input devices and make the decision based upon a custom program to control the state devices connected as output. The monitoring control system of the A.C. motor driven by VFD and controlled by PLC proves its high accuracy in speed regulation at constant-speed-variable-load operation. The PLC proved to be a versatile and efficient control tool in industrial electric drives applications.

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