IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8431

Speed Control of Electric Motors Using New Automation Techniques

Prof. Ravindra Mukund Malkar[1], Prof. Vaibhav Baburao Magdum[2]

Assistant Professor, Department of Electrical Engineering,

DKTE Society's Textile & Engineering Institute, Ichalkaranji, (MS), India[1,2]

Abstract: Automation and control is used of various control systems to operate devices such as machines, industrial processes, boilers and electrostatic precipitators, to switch on communication networks, to navigate and stabilize ships, aircraft and other applications and vehicles with minimal human intervention. Some processes have been fully automated. The engine speed is controlled by the pilot as a control system. The control algorithm is implemented using a programmable logic controller. The complex motor system consists of a DC motor, a driver and a tachometer generator. The main goal is to get a satisfactory time response of the system's performance under the action of the external load. The PI controller is designed in the programming environment on a previously identified non-linear motor system. The PI controller is then integrated into the programmable controller. We will measure the speed of the motor with an incremental rotary encoder by adjusting the parameters (PLC, driver) and also reduce the overall cost of the system. Our control system is kept with the available Siemens PLC. In addition, we will monitor the motor parameters via the SCADA system.

Keywords: VFD, PLC, SCADA, Controller.

I. INTRODUCTION

The induction motor plays an important role in every sector thanks to its simple and robust construction. The advantage of induction motors is that they are robust and can be used in all environmental conditions. Induction motors are cheaper due to the lack of brushes, switches and slip rings. Unlike DC motors and synchronous motors, they are maintenance-free motors as there are no brushes, switches and slip rings. Induction motors can be used in polluted and potentially explosive environments because they do not have brushes that can cause sparks. Unlike synchronous motors, three-phase induction motors have an automatic starting torque. Therefore, unlike the synchronous motor, no starting method is used. By implementing a system to monitor and control the motor speed, the induction motor can be used in high performance variable speed applications.

To control the speed of these motors, a motor drive and control system can be used in several ways. The speed of an induction motor makes it possible, depending on the supply frequency, to change the number of motor stators and to adjust the absorbed power. In an induction motor, there is no electrical connection to the rotor, but currents are induced in the rotor circuit. The rotor conductors carry current into the magnetic field of the stator and therefore a force is applied to them that tends to move them perpendicular to the field. Most of the site control is actually done automatically by a remote terminal unit (RTU) or programmable logic controller (PLC). [1, 2] A PLC-SCADA based monitoring and control system for a frequency converter system has been developed to drive a three phase induction motor.

The integration of PLC and SCADA for industrial automation includes: a human-machine interface in which the processed data is presented to a human operator who monitors and controls the process; A remote terminal collects information by connecting to sensors, converting sensor signals into digital data and sending digital data to the monitoring system. This information is then displayed on a series of screens. APIs used as field devices due to their economical, versatile, flexible and configurable properties. PI and PID controllers are the most common types of controllers used in the industry.

This is evidenced by the fact that the PI controller represents more than 97% of the dimming controller. This is because the PI controller helps stabilize the system by reducing the steady state error and maximum overshoot. DC motors can be easily controlled via AC motors and are therefore generally preferred. In addition, since the motors have high power density, high torque / inertia ratio and high efficiency, they do not generate any system behavior. Second, any change in load torque produces the corresponding change in rotor speed. The purpose of this article is to control the motor speed independently of the system parameter using a programmable logic controller based on a PI controller.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8431

II. METHODOLOGY

A] For A.C. Motor

1. PROGRAMMABLE LOGIC CONTROLLER (PLC):
Richard E. Morley, founder of Modicum Corporation, invented the first PLC in 1969. A PLC is a solid state device that performs logic functions previously performed by components such as electromechanical relays, drum switches, mechanical timers / counters, and so on. for controlling and operating devices and machines in the production process. While electromechanical relays (control relays, pneumatic timing relays, etc.) have worked well for many generations, often under adverse conditions, the ever-increasing sophistication and complexity of modern processing equipment requires more reliable control functions and is more active. Speed that timing devices cannot. Relays must be wired to perform a specific function. If the system requirements change, the relay wiring must be changed or adapted. The methods and analyzes that were carried out as part of your research should be described in this section. One simple strategy to follow is to use the keywords in your title in the first few sentences.

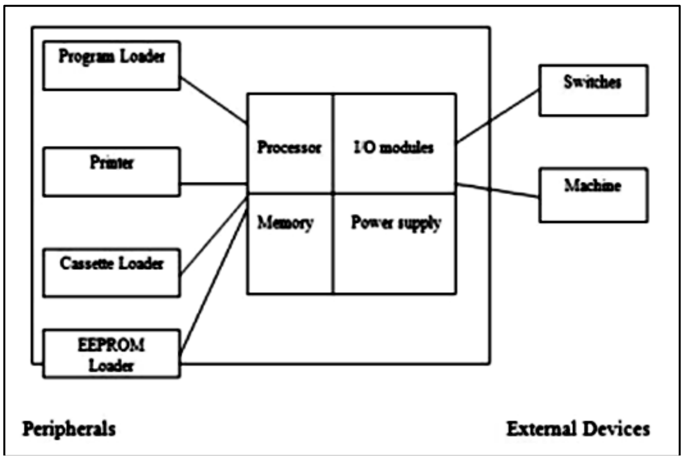

Fig.1 Block diagram of PLC

2. SUPERVISORY CONTROL AND DATA ACQUISITION:
SCADA stands for supervisory control and data collection. SCADA refers to a system that collects data from various sensors in a factory, facility or other remote location and then sends that data to a central computer, which then manages and controls the data. SCADA is a term often used to describe control and management solutions in a wide variety of industries. One of the most important processes of SCADA is the ability to monitor an entire system in real time. The main purposes of using a SCADA system are to collect the required data from remote locations and also from the local location, display it on the master computer monitor in the control room, store and enable data on the hard drive of the control master computer from control equipment. field (remote or local) from the control room. SCADA systems are designed so that immediate corrections can be made to the operating system to extend the life of the equipment and avoid costly repairs. It also translates into savings in working hours and the ability of employees to focus on activities that require human involvement.

BLOCK DIAGRAM:

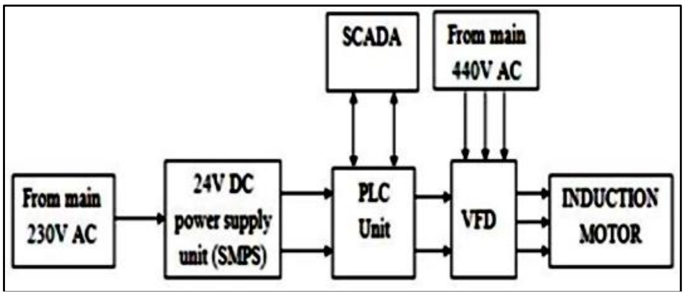

Fig.2 Block diagram of Proposed System (A.C. Motor)

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8431

Schematic diagram of the proposed system shown in Fig. 2 and consists of two power supply units, one with 230 V and the other with 440 V. The 230 V power supply from the mains is converted to 24 V direct current and sent to the PLC unit. The second supply from the 440 V main network is supplied directly to the frequency converter. The PLC (Programmable Logic Controller) unit in the block diagram is used to control the frequency converter and the motor is controlled through the frequency converter. The PLC has memory for storing user program or logic and memory for controlling the operation of a processing machine or driven equipment. The PLC is programmed in LADDER LOGIC (a true high-level graphic language easily understood by engineers). The motor speed is controlled by varying the frequency via the pulse width modulation controller. The variable frequency is set with VFD. The frequency converter is connected to the motor. By changing the output frequency, it is possible to vary the speed of the motor.

3. VARIABLE FREQUENCY DRIVE (VFD):

A frequency converter is used for applications where speed control is essential due to load variations that require corresponding increasing or decreasing speed. The use of frequency converters with inverters offers a number of advantages over direct operation from the grid: it prevents inrush currents, as the inverter increases the frequency from 0 Hz instead of providing a peak current of 50 Hz at start-up of the engine. Any desired degree of smooth starting and braking can be achieved by specifying the acceleration and deceleration times. If a different flow rate is required for the transport of liquids or gases, the motor must not run at full power, resulting in energy savings.

B] For D.C. Motor:

The system supplied consists of a Simatic S7-1200 PLC, a DC motor, a rectifier circuit and a tachometer generator.
The PLC consists of 2 input modules, namely the main power supply and the motor feedback, and an output module, the PWM output, which goes to the gate connection of the IGBT to control the duty cycle.

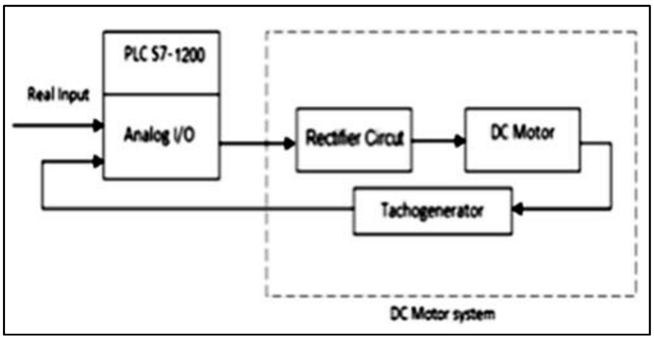

Fig.3 Block diagram of Proposed System (D.C. Motor)

III.MODELLING AND ANALYSIS

A] For A.C. Motor
The motor speed can be controlled by varying the power frequency. The voltage induced in the stator is directly proportional to the product of the supply frequency and the flux of the air gap. If the stator drop is neglected, the voltage at the terminals can be considered proportional to the product of frequency and flux. V1 α f.Φ Effect of a variation of the supply frequency without changing the terminal voltage: 1. Lowering the supply frequency without changing the terminal voltage leads to an increase in the air gap current and therefore to the saturation of the motor. This leads to an increase in magnetizing current, core loss and stator copper loss, distorting the line current and voltage and producing high step noise. 2. Increasing the supply frequency without changing the voltage on the terminals will reduce the flux, which will reduce the torque power of the motor. One driver used in the control is Siemens (Micro Master 440). [3].

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8431

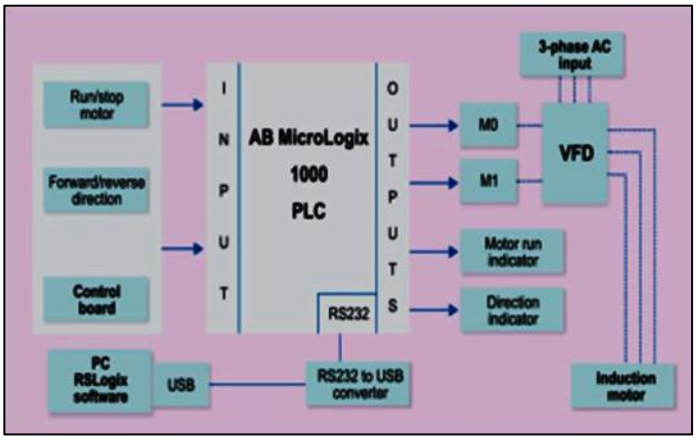

Fig.4 Structure of PLC System with A.C. Motor control.

B] For D.C. Motor:

A Simatic S7-1200 has an extraordinarily consistent range of technological features with the additional advantage of a compact design. It consists of the following modules:

a) 13 analog and digital signal modules.
b) 2 communication modules for point-to-point communication.
c) Ethernet switch with 4 ports.
d) Stabilized power supply units PS 1207 with a nominal voltage of 24 V DC.

Power supply circuit: The rectifier circuit is used to convert the AC signal into DC power. The output of this circuit is approximately 220V DC. The components used are 470 µF heat sinks, diodes and capacitors that act as filters to remove ripples.

IV. RESULT AND DISCUSSION

The DC motor of specification 0.37kW, 230V, 1.8A, 1500 rpm is considered here for the experiment.

A) Calculating transfer function of the motor:

1. Calculating field resistance Rf

TABLE-1: Field Resistance and Calculations.

I_f	V_f	Speed (rpm)	Speed (w)	Rf	T=P/w
0.35	110x2	990	103.67	628.57	0.5196
0.30	96x2	1040	109.00	640.00	0.4943
0.25	83x2	1130	118.30	664.00	0.4554
0.22	75x2	1168	122.30	681.8	0.4405

From experimental calculations, we have: Back EMF, Eb=215.5, Power, Eb*Ia= 53.875.

2. Speed Test:

TABLE-2: Speed Test calculations

Speed (rpm)	Speed (w)	Time (sec)
1515	158.65	0
0	0	3.35

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8431

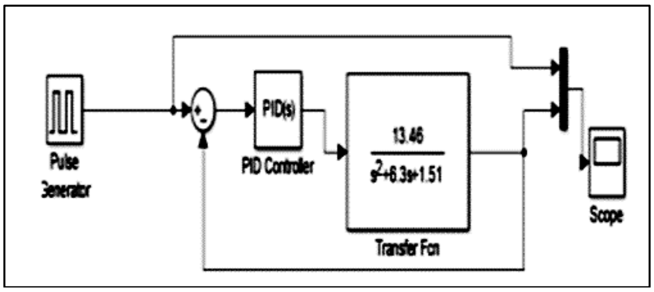

Fig.5 Simulation model in programming environment

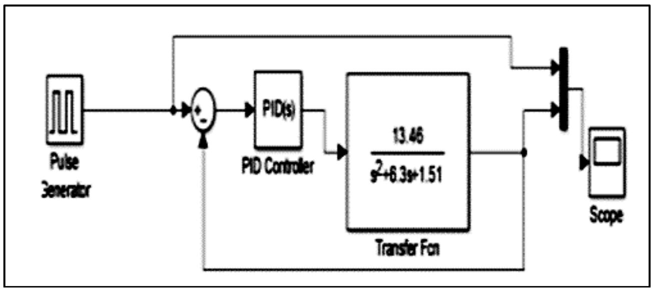

Fig.6 Time response to pulse signal simulation mode.

The PI controller tuning parameters calculated by the direct synthesis process serve as input to the PLC, which in turn supplies a PWM signal to the gate connection of the IGBT. From the experimental results we know that the tachometer generator indicates 11V when the engine is running at 1200 rpm. So if a setpoint of 11V is entered into the PLC (which acts as motor feedback), the tachometer will read 1200 RPM, indicating our results.

V. CONCLUSION

The aim of this project was to control the motor speed with PLC (Siemens) S7-300, micro-master converter 440, incremental rotary encoder instead of encoder (Siemens), since the incremental encoder is cheaper than the encoder (Siemens) and the same Action As an encoder (Siemens), we then adjust the counting parameters in the hardware configuration for the frequency measurement control and adjust the PI control parameters to determine the speed in the PLC programming, as shown in the results of the figures above. In this project, too, we were motivated to monitor the speed of a three-phase induction motor using a SCADA system. The control system is based on the latest technology, which offers a high degree of flexibility and efficiency. The monitoring system offers the possibility to analyze the operation of the induction motor in online / offline mode and to protect the system from errors and error states. In this article, a programmable logic controller was also developed that is based on a classic PI controller to control the speed of the DC motor. The system consists of a DC motor, a tachometer generator and a power amplifier circuit. The performance of the PI controller is monitored in simulation mode. In the experiments, the PLC-based PI controller is used, which demonstrates the efficiency of the speed control of the DC motor.

REFERENCES

[1]. Vaibhav Gupta, “Induction Motor Speed Control Using PLC AND SCADA” International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 03 | Mar-2018.

[2]. Masood Nazir, "Design of PLC based speed control of DC motor using PI controller,” International Journal of Scientific and Technical Advancements, Volume 4 , Issue 1, pp. 5-8, 2018.

[3]. Senad Huseinbegovi, Nedim Osmi, Jasmin Velagi, Kerim Obaranin, Design of PLC- based PI Controller for a DC Motor under Real Constraints, IEEE Conference on Systems and Control(MSC 2009), Saint Petesburg, Russia.

[4]. J.Velagi, A. Galijaevi, Design of Fuzzy Logic Control of Permanent magnet DC motor under real constraints and disturbance, 3. IEEE Multi conference on Systems and Control (MSC 2009), Saint Petesburg, Russia (in press), July 8-10, 2009.

[5]. M. A. Rahman and P. Zhou, Field circuit analysis of brushless permanent magnet synchronous motors, IEEE Transactions on Industrial Electronics, vol. 43, no. 2, Apr. 1996, pp 256-267.

[6]. Yasar Birbir, H.Selcuk Nogay, "Design and Implementation of PLC-Based Monitoring Control System for Three-Phase Induction Motors Fed by PWM Inverter", international journal of systems applications, engineering &development, 2(3), 2008

[7]. Rinchen Geongmit Dorjee, "Monitoring and Control of a Variable Frequency Drive Using PLC and SCADA", International Journal on Recent and Innovation Trends in Computing and Communication, 2 (10), October 2014D.

[8]. Ali Gulabi," Development of an Embedded SCADA System with PLC and Java Application for Synchronous Operation of Standard Servo Drives", Master thesis, Faculty of Engineering and Computer Science of the University of Applied Sciences Hamburg, May 2007.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8431

BIOGRAPHY

Mr. Ravindra Mukund Malkar is M.E. in Electrical Power System from Walchand COE, Sangli (MS). He is B.E. Electrical from MSBCOE, Latur, (MS). Presently he is working as Assistant Professor in DKTE Society's Textile & Engineering Institute, Ichalkaranji, An Autonomous Institute affiliated under Shivaji University, Kolhapur (MS). His research areas include Harmonics, Transmission Lines and Power system. He has published and presented the papers in International Journals and International/National conferences. He is a Life member of Indian Society of Technical Education, New Delhi**.**

Mr. Vaibhav Baburao Magdum is M.E. in Electrical Power system from PVGCOET, Pune (MS). He is B.E. Electrical from AISSMS, COE, Pune, (MS). Presently he is working as Assistant Professor in DKTE Society's Textile & Engineering Institute, Ichalkaranji, An Autonomous Institute affiliated under Shivaji University, Kolhapur (MS). His research areas include Electrical Machines, Drives, Power System, Switchgear & Protection. He has published and presented the papers in International Journals and International/National conferences. He is a Life member of Indian Society of Technical Education, New Delhi.