International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 OPEN ACCESS
Available Online at : www.ijsrcseit.com
doi : https://doi.org/10.32628/IJSRCSEIT

PLC-Based Induction Motor Speed Control and Monitoring System

Nitin D. Sonawane[1], Jayesh Dhavan[2], Rupali Raskar[3]
[1,2,3]Department of Electrical Engineering, MSBTE, MET BKC Institute of Technology – Polytechnic, Nashik, Maharashtra, India

ARTICLEINFO

Article History:

Accepted: 15 Nov 2023

Published: 30 Nov 2023

Publication Issue

Volume 9, Issue 6

November-December-2023

Page Number

202-206

ABSTRACT

Because of their excellent self-starting ability, low cost, high efficiency, and great robustness and reliability, induction motors are the most widely used motor type in industry. The majority of these apps require a quick and intelligent speed control mechanism. Numerous speed control techniques can be used to give the single-phase induction motor the necessary speed control. This paper describes a PLC-based speed control and monitoring system. The PWM inverter, driver circuit, and PLC controller are all part of this system. This method uses a constant V/Hz ratio to determine the supply voltage to the induction motor based on the frequency output needed. The motor's speed, voltage, and current are among the many parameters that are tracked and displayed on the LCD panel. It lowers expenses, increases accuracy, and offers secure and visual context in contrast to other traditional techniques. Furthermore, at high speeds, PLC-based speed control becomes more efficient.

Keywords : automation, PWM Inverter, induction motor (IM), programmable logic Controller (PLC).

I. INTRODUCTION

Numerous utility, commercial, industrial, and residential applications employ induction motors. This is as a result of the motor's ruggedness, high efficiency, wide speed range, and cheap manufacturing costs [1]. Nevertheless, compared to DC and permanent magnet machines, they require far more sophisticated management strategies and more costly, higher-rated power converters due to the involved model nonlinearities [2]. An induction motor's speed control needs to be managed by a controller that maximises torque while minimising loss. IMs are dependable, but they are also vulnerable to unfavourable forces that can lead to malfunctions and failure. One rapidly developing method for early fault identification is instant message monitoring. It helps to prevent an industrial process's unplanned breakdown. Techniques for monitoring can be categorised as conventional or digital. [3].

Traditional induction monitoring methods Typically, a mix of mechanical and electrical components, including contactors, timers, electromagnetic switches, thermal relays, over-current relays, and over-voltage or lower-voltage relays, are used to provide motors [3]. When compared to electronic equipment, the mechanical portions of these devices respond quite slowly. The equipment's mechanical components can shorten the system's lifespan, decrease its efficiency, and compromise its dependability when operating. Economically speaking, digital hardware has been less expensive while classical relays have become more expensive lately [4]. Numerous researchers have looked into the monitoring of induction motors regarding different faults and their causes, as well as detection techniques, current trends, and diagnosis methods aided by computer, microprocessor, artificial intelligence, and other monitoring and protection technologies. Additionally for various problems including damaged bearings, unbalanced voltage, inter-turn faults, ball bearing failures, speed ripple effect, air gap eccentricity, broken rotor bars, shaft speed oscillation, and microcontroller-based digital protectors, among others. The other motor factors in these studies were not taken into account in their whole because one or two variables were taken into consideration jointly to safeguard the IMs. This could make protection challenging.

Additionally, voltages, currents, temperatures, and speed are measured using a computer-based monitoring and protection system. After that, it is moved to the computer so that the ultimate protection choice can be made. Here, every motor variable was taken into account; nevertheless, the cost and system size are increased by using an analogue-to-digital conversion (ADC) card [5]. The combination of programmable logic controllers (PLCs) with power electronics in electric machine applications has been introduced in production automation since the technology for motion control of electric drives became accessible.

Benefits from this use include practically equal power factor control over motors and other equipment and less voltage drop when turned on. PLCs are widely used in companies to automate processes, reduce production costs, and improve quality and dependability [6]. Additional uses for PLCs include machine machines that have better precision CNC (computerized numerical control). PLCs interfaced with power converters, PCs, and other electric equipment are required to obtain precise industrial electric drive systems. However, this increases the equipment's sophistication, complexity, and cost [3].

Induction motors using PLCs is a field where very few articles have been published. A PLC is utilized as a power factor controller for a three-phase induction motor in order to increase power factor and maintain a steady voltage-to-frequency ratio throughout the control cycle [5]. In a different instance, PLC fuzzy control is used to develop a variable-frequency speed-regulating system for mine hoists [7]. The vector control integrated circuit regulates the voltage or current of three-phase pulse-width modulation (PWM) inverters using a complex programmable logic device (CPLD) and integer arithmetic [6]. A single-phase induction motor's (SPIM) speed can be managed using a variety of speed control techniques, including supply frequency management, rotor resistance control, pole changing, and stator voltage control.

II. PROGRAMMABLE LOGIC CONTROLLER

A programmable controller, sometimes known as a PLC, is a type of small computer designed to automate practical tasks. Industrial equipment can be configured to sense, activate, and control PLCs. As a result, a PLC has several I/O terminals to interface various electrical signals. The control programme is loaded into the PLC memory, and the input and output components of the processes are connected to the PLC. Fig. 1 [8] depicts the PLC's fundamental construction.

PLC is made up of the following primary components:

Central Processing Unit power supply
Module for input (digital or analogue)
Module for output (digital or analogue)
Operator interface (PC) for programming devices [9]

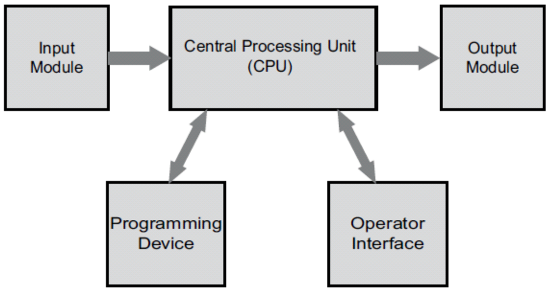

Fig 1: Basic structure of the PLC [6]

As per IEC 61131-3, there are five types of programming languages used for programming of PLC as follow:-

1. FBD (Function block diagram),
2. LD (Ladder diagram),
3. ST (Structured text, similar to the Pascal programming language),
4. IL (Instruction list, similar to assembly language) and
5. SFC (Sequential function chart) [8].

These techniques emphasize logical organization of operations. In our case, we have used ladder diagram technique for programming.

III. SYSTEM DESCRIPTION

In this study, an induction motor's current, voltage, and speed are measured using analogue inputs and sensors in a PLC-based system. Furthermore, it keeps an eye on the inputs and activates the outputs in accordance with the programme..

A. Hardware

The hardware system used in this study consists of a 0.75 kW/1440 r/min single-phase IM, PWM inverter consisting of microcontroller PIC16F777 which has three no. of PWM modules, IGBT driver circuit, max 485 Transceiver, RS 232 Dual driver and receiver, Linear optocoupler (LOC111), 2 wire serial EEPROM, and a Delta PLC of series DVPSS2 is used. A PLC has 8 no. of high speed digital input terminals and 5 no. of high speed digital output terminals. It works on 24 VDC supply.

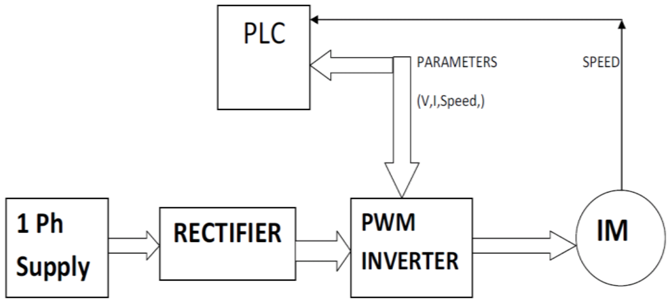

Fig 2 : Block diagram of experimental set up

An induction motor that runs on a single phase is controlled and tested. With the use of an optocoupler and high-speed input to the PLC, the speed of the induction motor may be determined. The rectifier, which receives the single-phase voltage from the power supply and rectifies it, provides a dc input to the insulated gate bipolar transistor (IGBT) inverter. The induction motor receives a single-phase voltage output from the IGBT inverter, which transforms the DC voltage input. Conversely, RS 485 is used to interface the inverter with the PLC. In order to maintain a constant V/f ratio, the PLC transmits signals based on the actual speed and sets speed to the inverter, which then modifies supply to the motor..

B. Software Developed

It uses a Delta PLC DVPSS2 with a PIC16F777 microprocessor. There are 4096 words in the PLC programming memory that is being used. The software is Delta_WPLSoft_V2.30. One programming language that is utilised is the ladder diagram (LAD). PLC software was loaded into the device via an RS232-RS485 PC/plan-position indicator (PPI) cable after being prepared on the computer. The most crucial factor is the baud rate between the PLC and the computer while the prepared software is being loaded onto the PLC from the computer. According to the handbook, the baud rate needs to match the switch configuration on the bound cable. A microcontroller processes analogue signals using an analogous module.

Typically, analogue modules function with 8- or 12-bit systems. The analogue module may be linked to one or more analogue sensors. Digital data is created by processing analogue data. The analogue module is used to measure the motor's phase currents, voltages, and speed. The flowchart needed for the system is displayed in Fig. 2 [2].

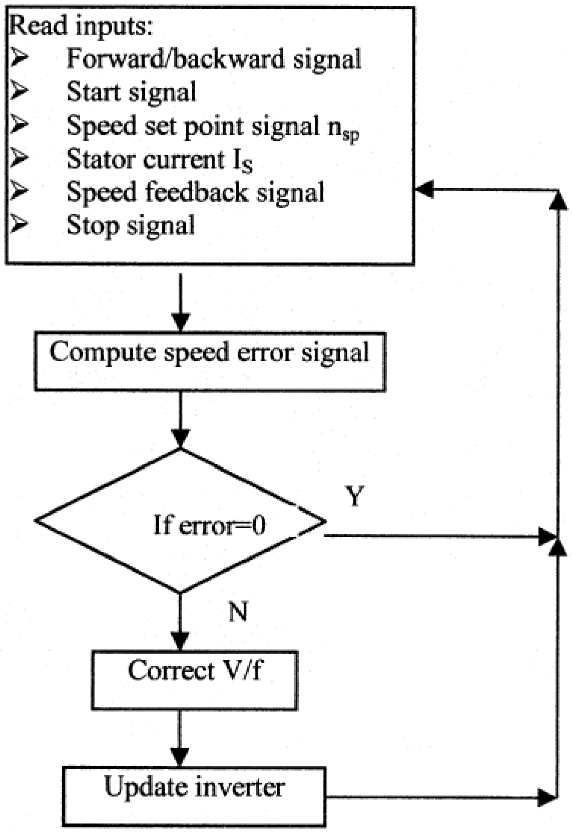

Fig 3 : Flowchart of speed control software used

Advantages of use of PLCs are as follows:

- Smaller physical size than hard-wire solutions.
- Easier and faster to make changes.
- PLCs have integrated diagnostics and override functions.
- Diagnostics are centrally available.
- Applications can be immediately documented.
- Applications can be duplicated faster and less expensively.

Table I : Measured Parameters

Variable	Symbol	Unit
Voltage	V	Volts
Current	A	Ampere
Speed	n.	Rpm

IV. Conclusion

PLC can therefore be applied to speed control applications in automated systems using an induction motor. When operating at constant speed with varying load, the PWM inverter-driven induction motor's monitoring and speed control system, which is managed by a PLC, has a high degree of accuracy in speed regulation.Compared to an inverter-fed induction motor operating in an open-loop arrangement, an induction motor operating under PLC control has a higher efficiency.In particular, the PLC-controlled system's efficiency has significantly improved at high loads and speeds. Consequently, the PLC has shown itself to be a flexible and effective control instrument for industrial electric drive applications.

REFERENCES

[1]. M., Y. Zhongming and W. Bin, "A review on induction motor online fault diagnosis," in 3rd Int. Power Electron. Motion Control Conf. (PIEMC 2000), vol. 3, pp. 1353–1358.

[2]. Ramazan Bayindir, ˙Ibrahim Sefa, ˙Ilhami Colak, and Askin Bektas Member, IEEE, "Fault Detection and Protection of Induction Motors Using Sensors" IEEE Transactions On Energy Conversion, Vol. 23, No. 3, September 2008

[3]. M. G. Ioannides, "Design and implementation of PLC-based monitoring control system for induction motor," IEEE Trans. Energy Convers., vol. 19, no. 3, pp. 469–476, Sep. 2004.

[4]. Colak, R. Bayindir, A. Bekta,, Member, "Protection of Induction Motor Using PLC" IEEE POWERENG 2007, April 12-14, 2007, Setubal, Portugal.
[5]. A. R. Al-Ali, M. M. Negm, and M. Kassas, "A PLC based power factor controller for a 3-phase induction motor," in Proc. Conf. Rec. IEEE Ind. Appl., vol. 2, 2000, pp. 1065–1072.
[6]. W.I.Ibrahim, R.M.T.Raja Ismail,M.R.Ghazali. "Development of Variable Speed Drive for Single Phase Induction Motor Based on Frequency Control" EnCon2011, 4th Engineering Conference Kuching, Sarawak, Malaysia
[7]. Divya Asija "Speed Control of Induction Motor Using Fuzzy-PI Controller" 2010 2nd International Conference on Mechanical and Electronics Engineering (ICMEE 2010)
[8]. "Programmable logic controller" Wikipedia, the free encyclopedia, March 2009
[9]. "Basics of PLC" Manual – 2010
[10]. Hugh jack "Automating Manufacturing Systems with PLC" Version 5.0, May 2007
[11]. "Programmable logic controller Basic level" Texbook TP301 – Manual Festo didactic W. Bolten "Programmable Logic Controller" third edition.

Cite this article as :

Nitin D. Sonawane, Jayesh Dhavan, Rupali Raskar, "PLC-Based Induction Motor Speed Control and Monitoring System", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 9, Issue 6, pp.202-206, November-December-2023.