International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Monitoring of Three Phase Induction Motor by using PLC and HMI

Prof. Shruti Gour [*1], Vaishnavi Biradar[*2], Rajnandini Gaikwad[*3], Sanika Khopde[*4] , Sakshi Bhise [*5], Nisha Bhise [*6]

*1

Prof, Department of Electrical Engineering, Trinity College Of Engineering And Research, Pune-411048

*23456

Students Department of Electrical Engineering, Trinity College Of Engineering And Research, Pune-411048.

***Abstract* -** Three-phase induction motors are widely used in industry because they are strong, cheap, and work well. But these motors are prone to electrical and thermal problems when they run continuously under different load and environmental conditions. This can cause unexpected downtime and maintenance costs. This review paper provides an extensive analysis of health monitoring and safeguarding methodologies for three-phase induction motors, utilizing Programmable Logic Controller (PLC) and Human Machine Interface (HMI) systems integrated with a Variable Frequency Drive (VFD). The systems that were looked at focus on keeping an eye on important motor parameters like phase current, phase voltage, temperature, speed, acceleration and deceleration (ramp-up and ramp-down), and operational status in both normal and abnormal situations. We also look at how VFDs help with soft starting, speed control, energy efficiency, and lowering mechanical stress. We talk about fault conditions like overcurrent and overtemperature in depth. We also talk about how to use PLC-based logic to find faults, set off alarms, and trip protections. We look at HMI-based visualization, data logging, and remote monitoring features as important tools for predictive maintenance and condition-based monitoring. The study shows that PLC–HMI integrated systems are more reliable, respond to faults faster, make operations safer, and cost less to maintain than traditional protection methods. This review is meant to be a technical guide for engineers and researchers who work with intelligent condition monitoring systems and industrial motor automation.

***Keywords* -** Three-phase induction motor, PLC, HMI, Variable Frequency Drive (VFD), condition monitoring, fault detection, overcurrent protection, overtemperature protection, industrial automation.

I. INTRODUCTION

Known as the "backbone of industrial drives," three-phase induction motors are essential in today's industrial settings. Because of their durable design, excellent dependability, and comparatively low operating costs, they are widely utilized in applications like pumps, compressors, conveyors, elevators, machine tools, and manufacturing systems. However, motor health and performance can be severely impacted by continuous operation under variable load conditions, frequent starting and stopping, voltage fluctuations, and unfavorable environmental factors. Electromechanical relays, contactors, timers, and thermal overload relays are typically used in traditional industrial setups to protect and monitor induction motors. These techniques offer rudimentary protection, but they have drawbacks like slow response times, poor accuracy, no real-time monitoring, and no historical data analysis. Because of this, problems like overcurrent and overtemperature may go unnoticed until they cause a lot of damage, which means more downtime and expensive repairs.As industrial automation has progressed, Programmable Logic Controllers (PLCs) have become a dependable and adaptable option for controlling, monitoring, and protecting motors. With the right sensors and signal conditioning circuits, PLCs can get real-time data on motor parameters like current, voltage, temperature, and speed. PLCs can find unusual operating conditions and take protective measures like turning off the motor or sounding an alarm based on pre-set logic. PLC-based solutions are more accurate, respond faster, are easier to change, and work better with modern control architectures than traditional protection systems. Human Machine Interface systems make monitoring even better by giving users a graphical user interface that lets them see motor parameters, alarms, fault history logging, and remote supervision in real time. HMI systems let operators keep an eye on motor health

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

all the time, look at trends, and do predictive maintenance, which makes the whole system more reliable and available. Also, combining Variable Frequency Drives (VFDs) with PLC–HMI systems has made induction motors work better and last longer.

By changing the supply frequency and voltage, VFDs make it possible to control speed very precisely, start softly, and ramp up and down in a controlled way. They also work more efficiently. VFDs help reduce thermal stress and extend the life of motors by lowering inrush current and mechanical stress when starting and stopping. This review paper is about using PLC and HMI systems with VFD integration to keep an eye on the health of three-phase induction motors. The study examines diverse methodologies documented in the literature for the monitoring of electrical and thermal parameters, including current, voltage, temperature, speed, acceleration, deceleration characteristics, and fault conditions such as overcurrent and overtemperature. The focus is on PLC-based fault detection logic, HMI-based data logging and visualization, and the overall benefits of integrated automation systems compared to traditional protection methods.

II. LITERATURE SURVEY.

(Paper1): Ioannides, M. G., (2004). "Development of a Monitoring and Control System for Induction Motors Using PLC", IEEE Transactions on Energy Conversion. The major aim of the study was to improve performance, efficiency, and safety of the induction motors by combining programmable logic controllers with the inverter drive system. In this way, the proposed system constantly monitors motor speed, load current, and voltage status while providing automatic control and protection from the overloading. It should be noted that both hardware and software implementations were used in order to develop the control system based on the ladder programming and closed loop motor speed control using PI technique.

(Paper 2): Debasmita Basak, Arvind Tiwari, and S. P. Das (2006) presented a review on fault diagnosis and condition monitoring of electrical machines in the IEEE International Conference on Industrial Technology. The study focused on improving the reliability and performance of electrical machines, particularly induction motors, through advanced condition monitoring and diagnostic techniques. The paper discussed various fault detection methods using machine parameters such as current, voltage, vibration, torque, flux, speed, and power signals.

Different monitoring approaches including online/offline monitoring, model-based diagnosis, signal-based analysis, and sensor-based techniques were analyzed. The authors emphasized the importance of stator current signature analysis for detecting faults such as stator winding faults, broken rotor bars, air-gap eccentricity, and bearing failures. The study also highlighted the use of signal processing and intelligent diagnostic techniques for identifying machine abnormalities and improving system reliability.

(Paper 3): Piyush Ahuja, Rajiv Kumar, and Kumar Dhiraj (2016) devised a PLC based system for monitoring and controlling a three phase induction motor. The research work, which appeared in the International Journal of Innovative Research in Science, Engineering and Technology, emphasized on improvement in safety, reliability and operational efficiency of induction motors by continuous monitoring of variables such as speed, voltage, current, and temperature. The system used sensors like thermocouples, encoders, and energy meters to collect and analyze the data through PLC. PLC was used in the process to control and monitor the parameters and in case any abnormal operating conditions, for example, overvoltage, under voltage, overheating, overcurrent and overspeed were encountered, the PLC would automatically turn off the motor to prevent damage and increase reliability. The paper highlighted the strengths of PLC such as real time monitoring, flexibility, automation and easy implementation. The experiments proved the functionality of the monitoring and protective system.

(Paper 4): SCADA-Based Health Monitoring of Electrical Drives Dr. S. Sujatha, S. Srinivasan, S. Tamil Selvan, and S. Venkatesh (2017) created a health monitoring scheme through SCADA for electrical drives that sought to minimize maintenance cost and improve operation. The research centered on health monitoring of the drive based on temperature, current, torque, and speed of both induction and servo

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

motors using sensors combined with PLC and SCADA systems. It was possible to detect faults and monitor machines remotely with higher safety levels under Industry 4.0 .

(Paper 5): Tushar Patil, Paras Jain, Sonu Vishwakarma, Pranshu Katiyar, Kundan Kumar, and Swapnil Namekar (2020) introduced a monitoring and control system for induction motors and stepper motors through a PLC-SCADA approach in the International Journal of Research in Engineering, Science and Management. The study aimed at automating industries through Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) systems. It focused on enhancing industries using PLC and SCADA technology for efficient speed control and monitoring of motors. The speed control was performed using Variable Frequency Drives (VFD), where the motors were controlled using variation in supply frequency to achieve accurate speed regulation. This was facilitated by the real-time monitoring and operation features provided by SCADA. The study further examined the advantages associated with automation, such as reduced human errors, high productivity, efficient operations, and effective speed control of motors. Various speed control methods were outlined for induction motors, and an experimental analysis conducted using PLC ladder logic and SCADA interfaces demonstrated that automation led to efficient speed control of induction motors and stepper motor.

(Paper 6)Real-Time Monitoring System for Machine Health Using Machine Learning and IoT Technology: The authors Tzen Ket Wong, Hou Kit Mun, Swee King Phang, Kai Lok Lum, and Wei Qiang Tan (2021) have developed a real-time monitoring system for machine health using machine learning and IoT technology. They monitored the electrical variables like voltage, current, and power factor from the industrial machines and wirelessly sent the readings to the server for further processing. This study was able to implement real-time monitoring, detection of supply imbalance, and identification of machine operating stages through neural network technology.

(Paper 7): Prasetyo et al. (2024) developed and discussed three-phase motor protection system employing PLC and HMI in the International Journal of Multidisciplinary Approach Research and Science. In this research, the focus was on protecting three-phase induction motors against various electrical phenomena including high-starting currents, overcurrents, undervoltage, overvoltage, under frequency and short circuits. The three-phase motor protection system was designed utilizing the Programmable Logic Controller (PLC) and the Human Machine Interface (HMI) in order to monitor and control the running condition of the three phase induction motor. The developed motor protection system was used to continuously monitor the operating conditions of the motor such as current, voltage, temperature, frequency, and speed in order to determine any abnormal situation. The protection system automatically switched off the running motor when the measured current level exceeded the predetermined safe value. Experiments were carried out under both no load and full load conditions and the obtained results showed that the PLC-HMI based three-phase motor protection system successfully detected overcurrent condition in the three phase induction motor.

(Paper 8)- M. G. Ioannides, (2004). “Development of a Monitoring and Control System for Induction Motors Using PLC” IEEE Transactions on Energy Conversion. The main goal of this study was to make induction motors work better be more efficient and safer. This is done by using logic controllers with systems that control the motor. The system always checks the motor speed how much current is being used and the voltage. It also automatically. Protects the motor from being overloaded. The researchers used both hardware and software to make this control system. They used a kind of programming called ladder programming and a way to control the motor speed called PI control technique. This technique helps the motor run, at the speed. The induction motors are a part of this study. The researchers wanted to improve the induction motors by using a control system.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

III. PROBLEM STATEMENT

Three phase induction motors are used a lot in industries because they work well and are reliable.. Problems like too much load, getting too hot changes, in voltage and single phasing can hurt the motor and make it work badly. The old ways of checking the motors need someone to watch them all the time. May not find problems quickly.

To fix these problems we need a system that uses a Programmable Logic Controller and a Human Machine Interface. This system helps us watch the three phase induction motor in time finds problems automatically protects the motor and makes it easy to control. This makes the three phase induction motor safer more reliable and helps get work done in industries. The three phase induction motor works better with this system.

IV. OBJECTIVE

The main goal of this review paper is to systematically look at and summarize all the research that has been done on using PLC and HMI systems with Variable Frequency Drives (VFDs) to keep an eye on and protect three phase induction motors. This study seeks to evaluate diverse methodologies employed for the real-time measurement and monitoring of essential motor parameters, including current, voltage, temperature, speed, and ramp-up and ramp down characteristics. Another important goal is to look at PLC-based control and protection methods used to find and fix fault conditions, especially overcurrent and overtemperature faults, to make sure the motor works safely and reliably. The paper also wants to look at how HMI systems help with condition-based and predictive maintenance by providing good visualization, alarm management, data logging, and remote monitoring. This review also aims to compare PLC– HMI-based monitoring methods with traditional protection methods. It will do this by showing how they are better in terms of accuracy, response time, operational safety, and maintenance efficiency, while also pointing out current problems and future research directions in intelligent induction motor health monitoring systems. The goal of this project is to control a three phase induction motor using Programmable Logic Controller (PLC) and Human Machine Interface (HMI) with an aim towards enhancing safety, efficiency, reliability, and fault detection automation.

SCOPE

This project is about using a Programmable Logic Controller and a Human Machine Interface to keep an eye on and control a three phase induction motor. The system always checks things like voltage, current, temperature, speed and if something is going wrong. It does this in time. The system helps find problems like the motor getting too hot or working hard and it stops the motor automatically if something goes wrong. The Human Machine Interface shows what is happening with the motor, any problems and what the operator needs to do. This makes things safer and more reliable, at work. It means people do not have to work as hard to check and control the motor. The three phase induction motor is. Monitored all the time.

V. LIMITATIONS

The three phase induction motor monitoring system that uses a PLC and HMI has some problems. This three phase induction motor monitoring system needs to be programmed and it needs to be used by someone who knows what they are doing for it to work properly. When you first set up the three phase induction motor monitoring system and later when you need to maintain it the cost is higher than ways of monitoring. The three phase induction motor monitoring system relies on sensors and communication devices so if any of these parts stop working it can affect how accurate the monitoring is. The three phase induction motor monitoring system is mostly useful, for applications where the power supply is good and the environment is controlled. The three phase induction motor monitoring system also needs hardware and software to do advanced analysis of problems and to monitor things from a distance.

VI. BLOCK DIAGRAM

The block diagram shows how a three phase induction motor is monitored and controlled using a Programmable Logic Controller (PLC) and a Human Machine Interface (HMI). The AC supply goes to the Variable Frequency Drive (VFD). The VFD controls the speed and operation of the induction motor by changing the frequency and voltage supplied to the motor. The induction motor is the device that operates in this system. Sensors connected to the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

motor measure parameters like current, voltage, temperature, speed and ramp up & ramp down conditions. These sensors send analog signals to the Analog to Digital (A to D) converter. The A to D converter changes the analog signals into signals so that the PLC can process them. The PLC is the controller of the system. It receives data monitors the motor conditions detects faults and performs control operations automatically. The HMI is connected to the PLC for user interaction. It displays motor parameters, alarms, fault conditions and operating status, on the screen. Through the HMI the operator can start, stop, monitor and control the motor easily. This system improves automation, safety, reliability and efficiency of the three phase induction motor system.

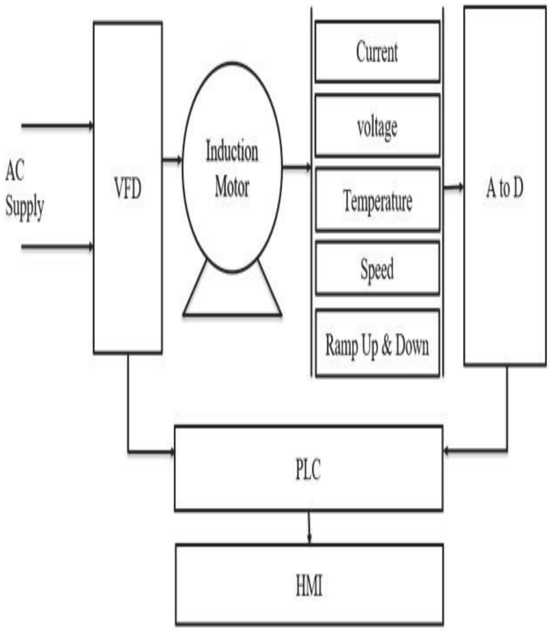


Fig. 7.1 Block diagram

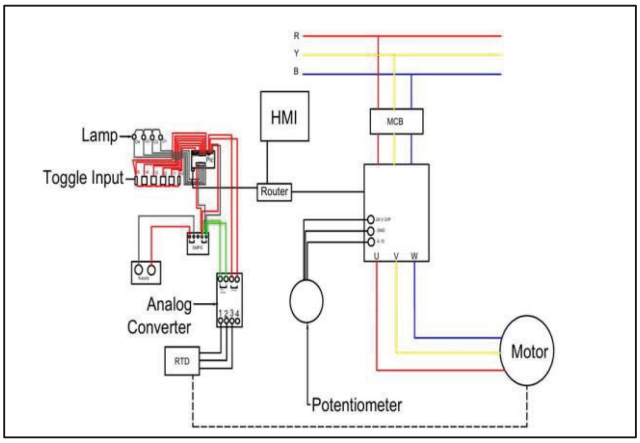
VII. WORKING PRINCIPLE

The circuit diagram shows how a three phase induction is controlled and monitored using a Programmable Logic Controller and a Human Machine Interface. We have three phase supply lines these are R, Y and B. They are connected to the Miniature Circuit Breaker. This Miniature Circuit Breaker protects the motor from getting much power and from short circuits. From the Miniature Circuit Breaker the power goes to the Variable Frequency Drive. The Variable Frequency Drive controls how fast the motor runs by changing the power it gets. The motor is connected to some devices that check how it is doing. We use a Resistance Temperature Detector to check the motor temperature. This detector sends a signal to an analog converter, which changes the signal into something the Programmable Logic Controller can understand. We also have a potentiometer connected to the Variable Frequency Drive so we can change the motor speed by hand. The analog converter sends the information it gets from the detectors to the Programmable Logic Controller. The Programmable Logic Controller is like the brain of the system. It gets signals, from the detectors looks at the information and tells the motor what to do based on what it has been programmed to do. We have some toggle switches that we can use to turn the motor on and off and to tell it what to do. There are also some lamps that show us what the motor is doing if it has a problem or if it is running. We use a Switched Mode Power Supply to give the Programmable Logic Controller and other parts the power they need. The Human Machine Interface is connected to the Programmable Logic Controller so we can talk to it. Get information from it. The Human Machine Interface shows us what is going on with the motor. It tells us if there are any problems. We can use the Human Machine Interface to control the motor and to see what it is doing. So the whole system helps us control the motor keep it safe and make it run well in factories and other places where it is used.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Component Name	Specification	Function
Three-Phase Induction Motor	0.5 HP to 1 HP, 415V, 50Hz, squirrel cage type	Converts three-phase electrical energy into mechanical rotational motion.
Programmable Logic Controller (PLC)	Siemens S71200 CPU-1214C DC/DC/DC c	Controls and automates industrial processes and machines.
HMI Software	Wonderware InTouch / Siemens WinCC / Factory I/O (for simulation)	Used for monitoring and controlling industrial processes visually.
VFD (Variable frequen cy Drive)	G120CPN power module type: IP20,1.5 kW,UF	Controls motor speed and torque by varying supply frequency and voltage.
Temperatur e Sensor	RTD PT100, range: -50°C to +300°C	Measures temperature by change in resistance.
Power Supply	24V DC, 2A SMPS	Converts AC supply into regulated 24V DC power.
Alarm Indicator	24V DC buzzer and LED indicators	Provides visual and audible indication during fault or warning conditions.

VII. CIRCUIT DIAGRAM

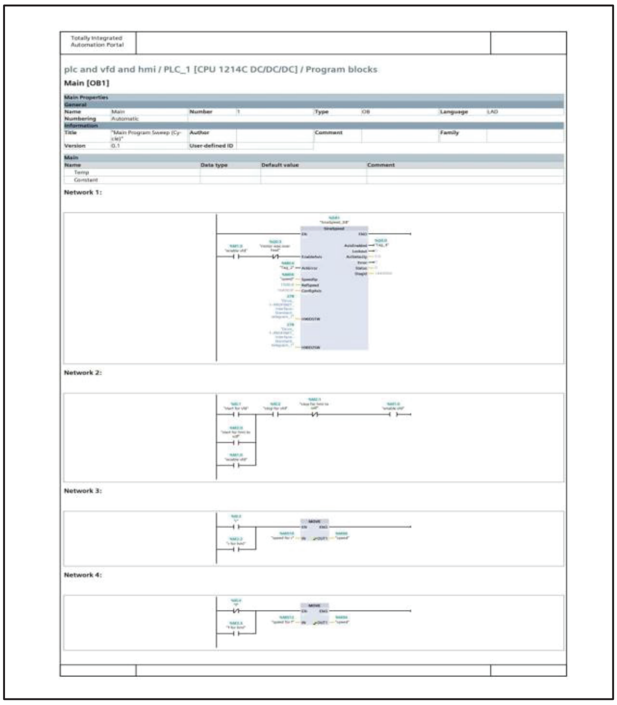


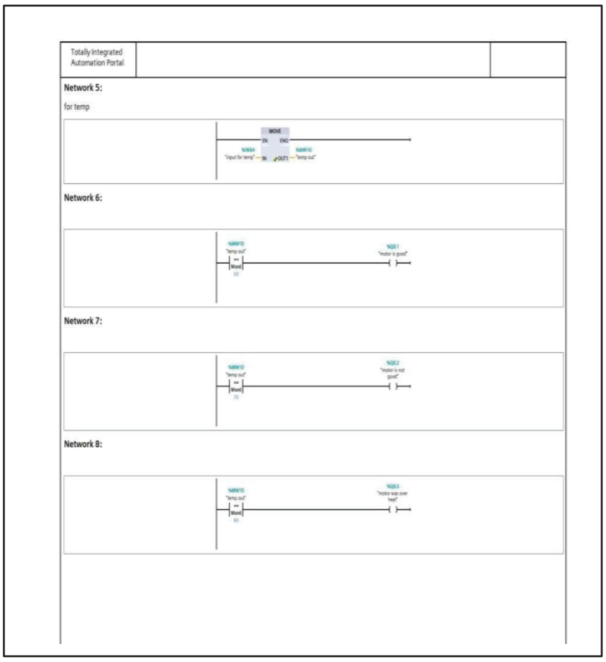
The circuit diagram shows how a three phase induction motor is controlled and monitored using a Programmable Logic Controller and a Human Machine Interface. We have three phase supply lines these are R, Y and B. They are connected to the Miniature Circuit Breaker. This Miniature Circuit Breaker protects the motor from getting much power and from short circuits. From the Miniature Circuit Breaker the power goes to the Variable Frequency Drive. The Variable Frequency Drive controls how fast the motor runs by changing the power it gets. The motor is connected to some devices that check how it is doing. We use a Resistance Temperature Detector to check the motor temperature. This detector sends a signal to an analog converter, which changes the signal into something the Programmable Logic Controller can understand. We also have a potentiometer connected to the Variable Frequency Drive so we can change the motor speed by hand. The analog converter sends the information it gets from the detectors to the Programmable Logic Controller. The Programmable Logic Controller is like the brain of the system. It gets signals, from the detectors looks at the information and tells the motor what to do based on what it has been programmed to do. We have some toggle switches that we can use to turn the motor on and off and to tell it what to do. There are also some lamps that show us what the motor is doing if it has a problem or if it is running. We use a Switched Mode Power Supply to give the Programmable Logic Controller and other parts the power they need. The Human Machine Interface is connected to the Programmable Logic Controller so

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

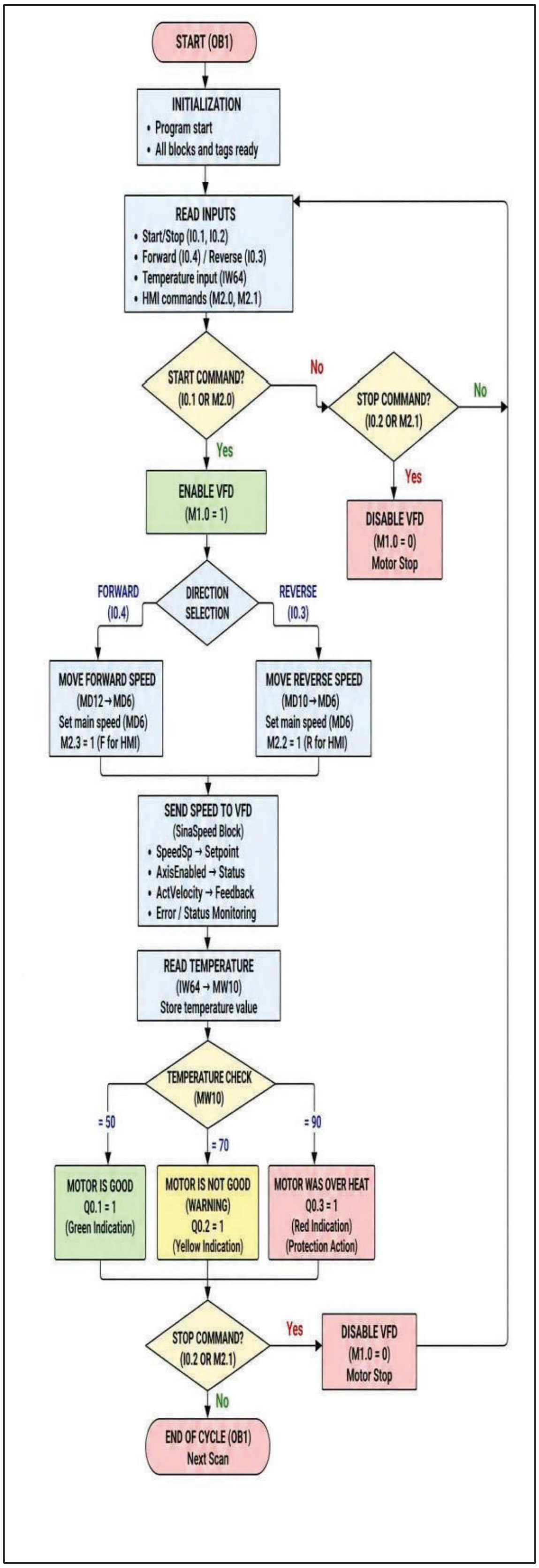
we can talk to it. Get information from it. The Human Machine Interface shows us what is going on with the motor. It tells us if there are any problems. We can use the Human Machine Interface to control the motor and to see what it is doing. So the whole system helps us control the motor keep it safe and make it run well in factories and other places where it is used.

LADDER PROGRAMMING





VIII. FLOW CHART



International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

IX. FINAL RESULTS

The system we made to monitor the three phase induction motor using a PLC and HMI worked well. It kept an eye on things like voltage and current and temperature and speed and how the motor was running in real time. The VFD did a job of controlling the motor speed based on what we told it to do. The PLC was very good at finding problems like when the motor was getting too hot or was overloaded. It helped keep the motor safe. The HMI showed us everything that was going on with the motor like alarms and what was happening with it. This made it easy to keep an eye on things and control the system. Using this system made things easier for people and safer and more reliable. It helped the three phase induction motor run more efficiently. So this project showed that using a PLC and HMI to automate things is a good idea, for monitoring and controlling motors in industry. The three phase induction motor and the PLC and HMI system worked together well.

CONCLUSION

The project on "Health Monitoring of Three-Phase Induction Motor using PLC and HMI" is now complete. We have successfully. Implemented the Health Monitoring of Three-Phase Induction Motor using PLC and HMI system. The Health Monitoring of Three-Phase Induction Motor using PLC and HMI system keeps an eye on important things like how much current and voltage the motor is using, its temperature and how fast it is going all in real time. The PLC is like the brain of the Health Monitoring of Three-Phase Induction Motor using PLC and HMI system. It looks at the information that comes from the sensors all the time and finds problems, like much current getting too hot and voltage going up and down. If something goes wrong the PLC acts fast by making an alarm sound and stopping the motor so it does not get damaged. The HMI part of the Health Monitoring of Three-Phase Induction Motor using PLC and HMI system is easy to use and understand. It shows what is happening in time and people can see how well the system is working. They can also see if there are any patterns and fix problems quickly. This makes the whole Health Monitoring of Three-Phase Induction Motor using PLC and HMI system work better and last longer. Using a Variable Frequency Drive or VFD for short helps control the speed of the motor and reduces the stress on it. So the Health Monitoring of Three-Phase Induction Motor using PLC and HMI system protects the motor better. It does not have to stop working as often. This also helps plan maintenance. In the end the Health Monitoring of Three-Phase Induction Motor using PLC and HMI system we made is a way to keep an eye on and protect three-phase induction motors. It can be used in factories and other places to make things automated, safer and work better.

X. REFERENCES

[1] M. Benbouzid, M. Vieira, and C. Theys, "Induction motor's fault detection and localization using stator current advanced signal processing techniques," IEEE Trans. Power Electron., vol. 14, no. 1, pp. 14-22, Jan. 1999

[2] M. G. loannides, "Design and implementation of PLC-based monitoring control system for induction motor," IEEE Trans. Energy Convers.,vol. 19, no. 3, pp. 469W76, Sep. 2004.

[3] Okoli F.I, Onubogu J.O, Okezie C.C, Okorogu V.N, "The Simulation of the Control of ar Industrial Mixer using PLC' International Journal of Inventive Engineering and Sciences (IJIES) ISSN: 2319-9598, Volume-1, Issue-2, January 2013,25.

[4] 'I. Colak, H. Celik, 'I. Sefa, and S. Demirbas, "On line protection system for induction motors," Energy Convers. Manage., vol. 46, no. 17, pp. 2773-2786,
2005.

[5] W. T. Thomson and M. Fenger, "Current signature analysis to detect induction motor faults," IEEE Ind. Appl. Mag., vol. 7, no. 4, pp. 26-34,
Jul./Aug. 2001

[6] R. Ramesh, P. Suresh, "Condition Monitoring of Induction Motor Using PLC and SCADA", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE),
Vol. 4, Issue 5, 2015.

[7] M. Saravanan, P. Thangavel, "Health Monitoring and Fault Diagnosis of Three Phase Induction Motor Using PLC and SCADA", International Journal of Engineering Research 4 Technology (IJERT), Vol. 9, Issue 7, 2020.

[8] R. Arulmozhiyal, K. Baskaran, "Implementationof PLC Based Motor Fault Detection and Protection System", IEEE International Conference on Communication Control and Computing Technologies (ICCCCT), 2010.

[9] V. Sharma, A. Kumar, "Condition Monitoring and Fault Diagnosis of Induction Motor Using Vibration Analysis", International Journal of Engineering Science and Computing (IJESC), Vol. 7, Issue 3, 2017.

[10] S. Das, S. Paul, "IoT Based Induction Motor Monitoring and Fault Detection System", International Research Journal of Engineering and Technology (IRJET), Vol. 6, Issue 5, 2019.

[11] P. Gupta, R. Patel, 'TLC and SCADA Based Automated System for Motor Protection and Monitoring", International Journal of Emerging Technologies and Innovative Research (JETIR), Vol. 8, Issue 6, 2021.

[12] IEEE Std 1159-2019, "IEEE
Recommended Practice for Monitoring Electric Power Quality", IEEE Standards Association, 2019.

[13] Frank D. Petruzella, "Programmable Logic Controllers", McGraw-Hill Education, 5th Edition, 2016.