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Resilient Model Predictive Control (RMPC) Technique Based Induction Motor Monitoring and Control using Labview

K. R. Kavitha, S. Vijayalakshmi, M. Senthilvadivu, Benita C. Evangelin

Abstract:** Nowadays induction motor is the most popular type of motor for industrial applications. The main advantage of the induction motor is its straightforward rotor construction leading to low cost, hard work, and low maintenance requirements. This work presents a remote control and monitoring the electrical and mechanical faults of an induction motor based on Labview for safe and economic data communication in industrial fields. In this work, the utilization of the Resilient Model Predictive Control (RMPC) to tackle the electrical and mechanical issue in an induction motor is proposed. This strategy allows for synchronization and active fault detection for the important and exclusion of a particular setting. Different importance levels of different control models of performance are evaluated. We continuously monitor technical motor parameters such as the sensor's peak timing, increment duration, peak overflow, and the load current and voltage relaxation error in an induction motor. The measured values are then sent to the processing unit, which displays the processing and displaying parameters that the Gateway module communicates with the Gateway module to send information to the remote monitoring cloud. The system also presents automatic and manual control methods to stop or start the induction motor using Lab view to avoid system failure. The applicability of the proposed framework is to use MATLAB in the creation of simulation results and experiments to approve MATLAB2017a programming and its execution evaluation results show that under actual operating conditions.

***Keywords:** Lab view, Resilient Model Predictive Control, Wireless Sensor Network, Matlab*

I. INTRODUCTION:

Before the creation of AC induction motors, DC motors were broadly utilized for mechanical purposes. Because of the innovation of AC induction motors as their elite traits over DC motors, mechanical robotization can frequently be ascribed to this. An induction motor accompanies (I) a stationary piece of the rotor called the rotor (b). Power comprises of an attractive circuit interlinking two electrical circuits placed in two fundamental parts, changed over to some degree by electromagnetic induction.

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* Correspondence Author
Dr. K. R. Kavitha, Professor, Department of ECE, Sona College of Technology, Salem, Tamil Nadu, India.
Dr. S. Vijayalakshmi, Assistant Professor, Department of ECE, SonaCollege of Technology, Salem, Tamil Nadu, India.
M. Senthilvadivu, Assistant Professor, Department of ECE, Sona College of Technology, Salem, Tamil Nadu, India.
Benita C Evangelin, PG Student, Sona College of Technology, Salem, Tamil Nadu, India.

From an investigation of the structure and capacity of an induction motor, it uncovers that the primary issues of induction motors can be delegated follows:

Electrical-related faults: under-current, unbalanced supply voltage or current, faults caused by single phase, or, overload, etc., of voltages falling into this section.

(B) Mechanical Mistakes: Mistakes cause broken rotor bars, unbalanced mass, damaged air space, eccentric bearings, rotor failure, and static failure. Due to ambient temperature and outdoor humidity and mechanical vibration all of the failures under this classification are: (c) environmental related failures.

The performance of the high-performance AC motor is understood by the motor parameters and so the performance of the AC induction motor depends on the electrical, mechanical and environmental factors mentioned above. The parameters of an induction motor can be measured by testing of the rotor test and any load test. Current, voltage, speed, vibrations, temperatures, and external humidity of induction motors are all important factors such as electro-mechanical and environmental factors.The performance of an induction motor is directly influenced by the parameters mentioned above. The induction motor is a dangerous operation in some specific industrial applications, so even if the product is crossed by its cut across the quality levels of the object, the product is still in operation.

Recent advances in processing technology have made industrial automation particularly noticeable as fast processing, sustainable and critical materials availability. Future generations of businesses have made automated and advanced systems look more advanced and automated than traditional ones. "Smart Industries" gives a new word in this new era of monitoring as well as controlling various industry uses. LabVIEW has received a lot of attention as an emerging technology for modern distances and is expected to bring benefits for many applications. "LabVIEW 's concept of industrial automation provides the best way to access remote access. Each device or system can be connected to other devices on the device. So it helps businesses to have better productivity, manage, and increase their output, data related to statistics, records, and various other parameters among various devices for this purpose. The work proposed here is used for controlling the AC induction motor for monitoring and avoiding system failures.This work is depicted out as takes after: First, the exhibiting of research background is depicted in segment 2. By then, the exhibiting of proposed induction motor control is analyzed in section3. Zone 4 speaks to the outcome and exchange. Finally, and the work ends are abridged in segment 5

II. PREVIOUS RESEARCH WORKS

Research New machine learning techniques are being used to solve the problems of many contemporary types of artificial intelligence.

One of the most important of these methods has been the use of Artificial Neural Network (ANN) technology, which has been used to generate real image spectra and improve optimal conditions, leading to strong and accurate results.

Three-phase asynchronous motors are used in most industries because of the simple and secure configuration. Immediately, however, they cause certain disorders to cause errors, including some unpleasant stresses. Therefore some control methods [1–5] have been achieved to achieve better control systems. Induction motor current, voltage, temperature and speed are used as data driver systems and are very important in the performance of induction motors, directly affecting this fundamental level. However, to control the machine for continuous action in production become dangerous and dangerous steps. In this case, remote control and surveillance technology becomes a comparable solution to eliminate these risks [6]. Therefore, wireless data communication has been used in various industries.

Many researchers and critics have been actively monitoring some aspects of IM [7-10] because monitoring of induction motors is a fast-growing technology for detecting early failures. It avoids accidental failure of business processes. Tracking technologies Traditional and digital technologies can be classified as follows. If compared to traditional monitoring systems described by computer-based ones, traditional systems reduce the efficiency and sensitivity of the system because it significantly increases the time it can detect the shortcomings of the content of many mechanical and electrical equipment. Another disadvantage of traditional methods is their cost; Although digital systems reduce it, [11] it is clear that traditional systems increase the cost of organization.

The communication technology has traditionally been used for communication needs in many industrial and automation applications. These correspondence frameworks are explicitly intended to meet stringent continuous and development unwavering quality necessities in numerous mechanical applications [12, 13]. Obviously, remote innovation ought to give a similar kind and nature of administration to industry clients, as customary, wired innovation [14, 15]. Be that as it may, remote innovation contrasts from multiple points of view from wire. These distinctions present huge system models, convention configuration difficulties, and devices for mechanical and computerization applications [16-18]. Numerous gadgets and machines can be controlled and information isn't gotten and can be transmitted by remote innovation simultaneously. Hence, the usefulness of the framework can be acknowledged with no issues.

Because of the rapid growth of modern wireless communications, LabVIEW has attracted a lot of attention for emerging technologies that can greatly benefit from many applications. "LabVIEW" is a newly introduced concept but .From thread review control technique is not sufficient for systems that provide a helping hand to track and control the induction motor through remote access [19-21]. Advanced Strategy ie this work proposed by the Resilient model Predictive Control Technique. This technique reveals how to improve the efficiency of the induction motor control system.

III. MATERIALS AND METHOD

The proposed system is enabled by a microcontroller, temperature sensor, humidity sensor, leakage detector, speed control sensor, torque control sensor, current and voltage measurement circuit and AC induction motor. Here we monitor and use motors controlled via web pages or Android apps. A block diagram of the proposed system is shown in Figure 1 as shown.

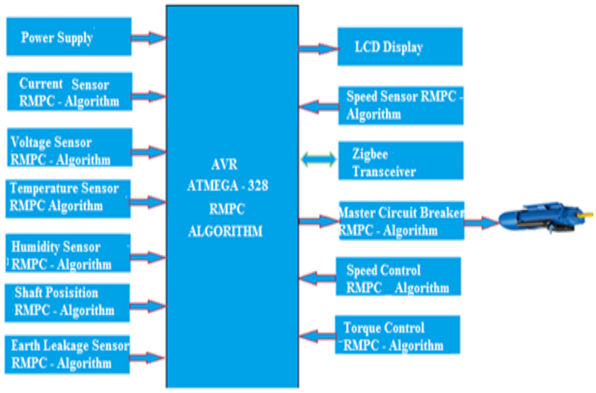

Fig 1: Block Diagram

For induction motor parameter monitoring we are using light weighted and easily configurable sensors like shaft, Torque, Speed, a DH11 sensor for temperature and humidity, ACS712 for current measurement and the voltage divider for voltage measurement. Excellent for obtaining microcontroller application data. The Atmega328 board has been used in this research to communicate with other devices where sensor data can be obtained, and on local, cloud server information and when an error is detected. Fig. 1 shows block diagram of hardware connections. Analysis of cloud storage data received from sensors local and converted to cloud server wireless. It is planned that after the data has begun, the organization is looking into the source material. On the other hand, it also stores raw data on a personal computer. The program comes packaged to process real-time data and store it in the cloud on the Thing Speak cloud computing platform. This stored data can be accessed from anywhere via the Internet.

3.1 VOLTAGE PROTECTION

The voltage protection system of the induction motor below and above protects the motor from voltage problems, where exceeding the rated voltage is an overvoltage and less than the rated voltage is a voltage based on the voltage. The schematic diagram of the overvoltage protection circuit includes its comparison of one of the two voltages is the power supply and the other across the variable resistor shown in Figure 2. The voltage drop across the variable resistor is higher or lower than a certain The limit is reduced and the comparator generates a signal comparison. This signal is fed to the microcontroller and the microcontroller takes appropriate action.

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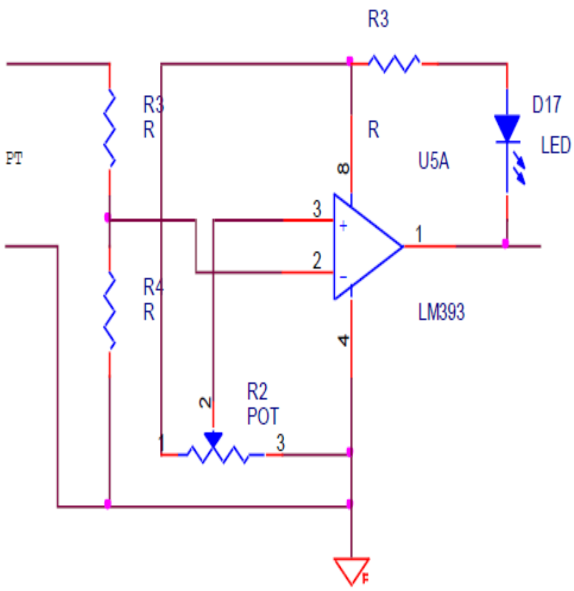

Fig 2: Voltage Protection

3.2 EARTH LEAKAGE CONTROL

Induction motor ground current should not be supplied by the resistor of any motor insulator with varying frequency from current to voltage source. Therefore various experimental voltage sources are provided with induction motor in order to find the variable frequency square wave, variable frequency sine wave and the DC source included in the resistor of the motor insulator. Device Traveling The current state of leakage defines this type of sensitivity. There are three distinct pieces of differential insurance: a differential sensors and differential hand-off and a power electrical switch. Figure 3 shows these accessories and their connection in a straightforward genuine application.

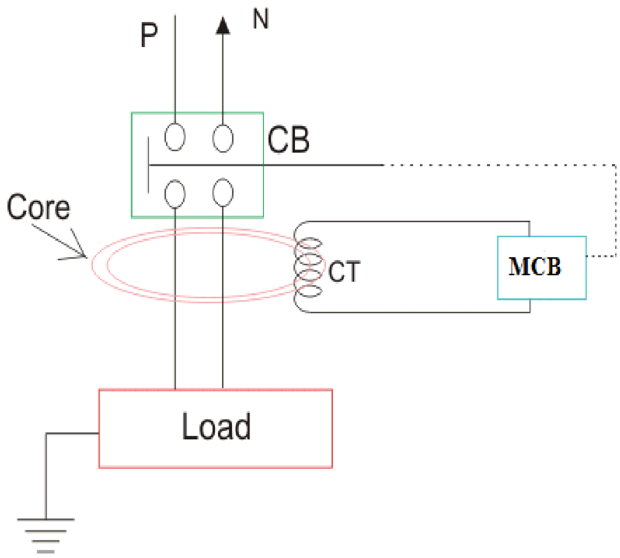

Fig 3: Earth Leakage Detection

The sensor is a transformer that includes motor flows. In view of the hypothesis that if the flows don't add to zero, a voltage of leftover current is instigated in the relative subspace. The transfer despite everything decides if this voltage will bumble contingent upon the security affectability. This affectability can be remedied by an interior limit which continues the base current thought about a flaw. The power electrical switch is adequate if the predefined load has a sufficient breaking facility and can be an electromagnetic switch or a strong state gadget

3.3SPEED AND TEMPERATURE CONTROL

The automatic speed control of a single-phase induction motor is controlled to vary with ambient temperature. The control circuit is embedded with a comparator, an amplifier, and a relay. The following steps describe the overall working principle of the device.
Step 1: From the point of making the speed range is assigned by the manufacturer. A range of the number of speeds for "n" requires a total of (N-1) window detectors and a single comparator.
Step 2: Initially, the operating temperature range is set (by the user or by default settings). Window detectors for this problem are provided, which compare the sensor's output to its reference voltage. Each window detector has a maximum and minimum reference temperature range in which it works.
Step 3: Now only one window detector will give it a positive output for a specific ambient temperature that will be within the range of that window detector.
Step 4: The output of the window detector is then amplified and fed to a corresponding contact relay which is based on a TRIAC-based voltage control circuit that corresponds to a resistor whose opposite window detector completes the circuit.
Step 5: Here the voltage is applied to the motor for control, so the speed is controlled

3.4 MOISTURE CONTROL

Moisture control is one of the most testing coordinated ecological issue examines. Such anxieties can happen if nature acts as a threatening to the motor being excessively cold or excessively wet. The nearness of outside material doesn't debase the persevering conduction and can diminish the pace of motor warmth misfortune. The wind current must be liberated from where the motor is found, generally the dampness will increment as the rotor and the warmth created by the stabilizer will diminish any protection life.

3.5 TORQUE CONTROL OF INDUCTION MOTOR

One of the methods used in a variable frequency drive to control torque (and finally speed) on AC electric motors using direct torque control (DTC). This involves calculating the motor's magnetic field and torque rating based on the measured voltage and motor current. There are many useful features to realize, such as simple operation of motor parameters and fast torque response. However, the use of hysteretic controllers for both the value of sustained flow coupling has significant problems that result from the conventional DTC technique because of the considerable torque and the nature of the patch connection. Therefore, the controller that predicts the flexibility model based on the language rules does the job of solving this nonlinear problem.

3.6RESILIENT MODEL PREDICTIVE CONTROL ALGORITHM

The network contains an input layer, a hidden layer, an output layer and the proposed scheme to be used. The outputs of their consonant voltages are taken as sources of pulse learning. Switching to the Flexible Directed Neural Network Used to control the pulse-facing and triggering mechanism. The benefits of an RMPC approach are its ability to automate the application without the need for any specific control functionality involved. The RMPC-based neural system has developed highly controlled features methods. The three input units feature the imaginary RMPC design, N hidden units and a yield unit appeared in figure.4

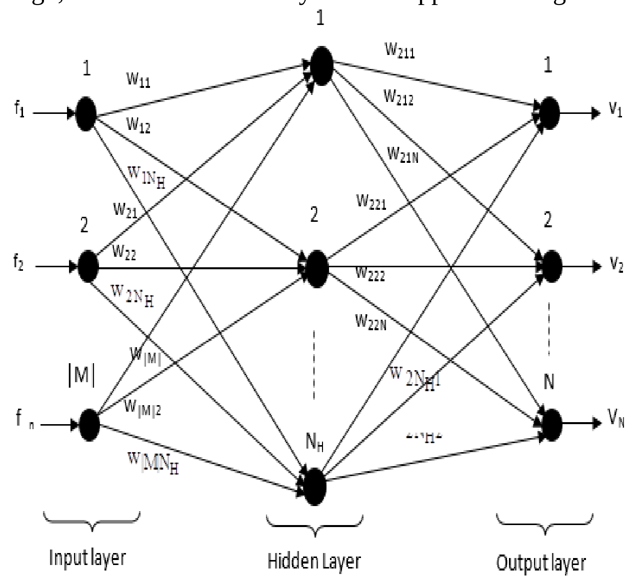

Figure 4. Training Structure of Resilient Directed Neural Network

The training procedure is described below.

Step1: Generate random weights in the interval wmin, wmax and share it to neurons of the hidden layer and the outer layer. Allocate unity weight to the neurons of the input layer.

Step 2: Give the training data set D as the contribution to the system and decide the RBP error as takes after $e = V_r - V_{out}$, (1)

Where V_r and V_{out} are the objective function and the network outputs, respectively.

Step 3: From every output neuron of the network, the elements of $V_{out} = (V_h)$ can be determined as follows $V_h = \sum_{n=1}^{N_{Hid}} w_{nh} y_n$ (2)

Where, $y_n = \sum_{j=1}^{N_l} \frac{w_{jn}}{1+e^{-ikl}}$

where N_{Hid} is the number of hidden neurons, w_{nh} is the assigned weight of the *n*-*h* link of the network and V_h is the output of the h[th] output neuron and y_n is the output of the n^{th} hidden neuron.

Step 4: By the attained RBP error, control the adjustment in weights as follows

$$\Delta w = \gamma . Vout . e (3)$$

Where, the knowledge function γ, usually varies from 0.1 to 0.45.

Step 5: Regulate original weights as follows,

$$w = w + \Delta w \quad (4)$$

3.9EFFICIENCY ESTIMATION ON RMPC ALGORITHM

The RMPC-based induction motor ability is assessed by the coupling between the electric power motor and the mechanical power given to the post by the motor as showed by the accompanying conditions.

$$\beta = \frac{P_{out}}{P_{in}} \text{ .... } (5)$$

P_{in} Of the induction motor can be figured by the immediate streams and voltages, as indicated by the accompanying condition.

$$P_{in} = iV \text{ ... } (6)$$

P_{out} Can be controlled by the deliberate shaft torque and the rotor speed as takes after

$$P_{out} = T_{shaft} * w_r \text{ .... } (7)$$

The efficiency of β can be estimated by the following equation.

$$\beta = \frac{T_{shaft} * w_r}{iV} \text{ ... } (8)$$

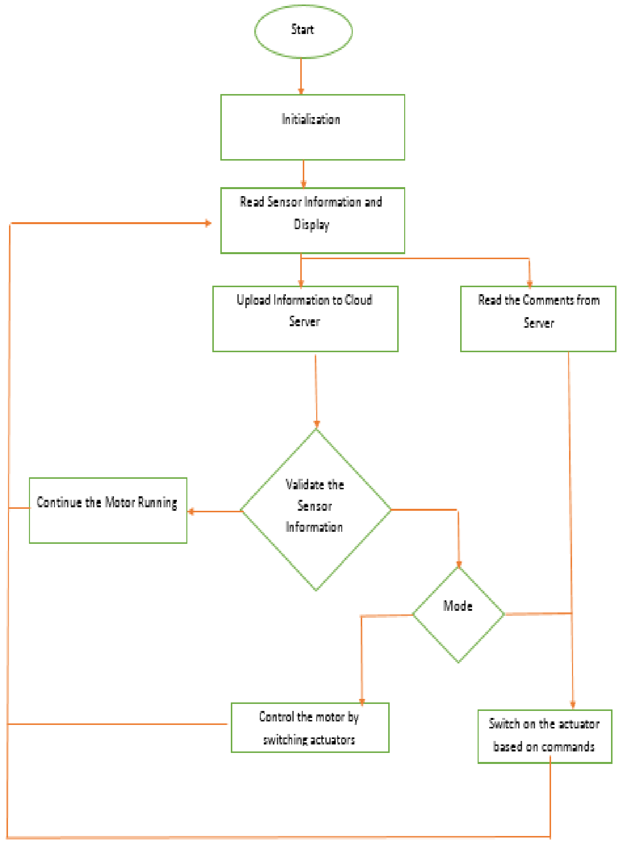

Fig 5: Flow Chart

The above figure shows the flow diagram of RMPC controlling technique. The underlying error is determined by adding an accumulator error and the derivative error is calculated by subtracting the error to correct the previous error. Each time the control circle finishes, each addition of these flaws has a consistent adequacy that doesn't influence the reaction time and accuracy. On the off chance that these blunders are duplicated by their benefit constants, at that point the control esteem is added to figure the new control esteem. Along these lines the control parameter is continually refreshed dependent on the reaction of the motors. This guaranteed the motor was moving at the ideal speed regardless of traction, obstacles, or other surprising path conditions.

IV. RESULTS AND DISCUSSIONS

In this section discuss the simulation results and performance evaluation of proposed induction motor control system. The details of the test motor appear in Table 1

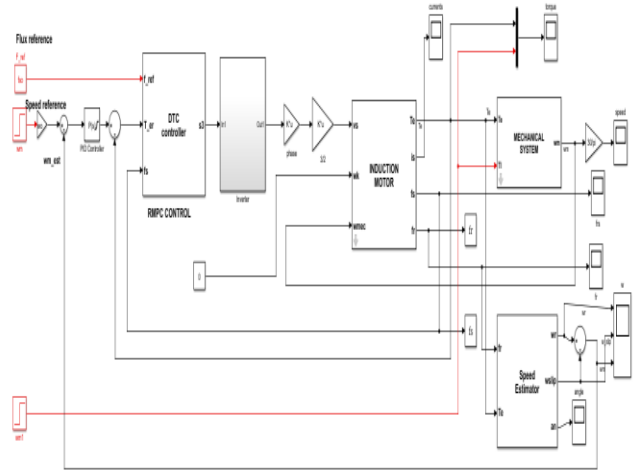

Fig 6: Simulink Model of RMPC fed induction motor

The Simulink model of RMPC based induction motor fed system is shown in Figure.6

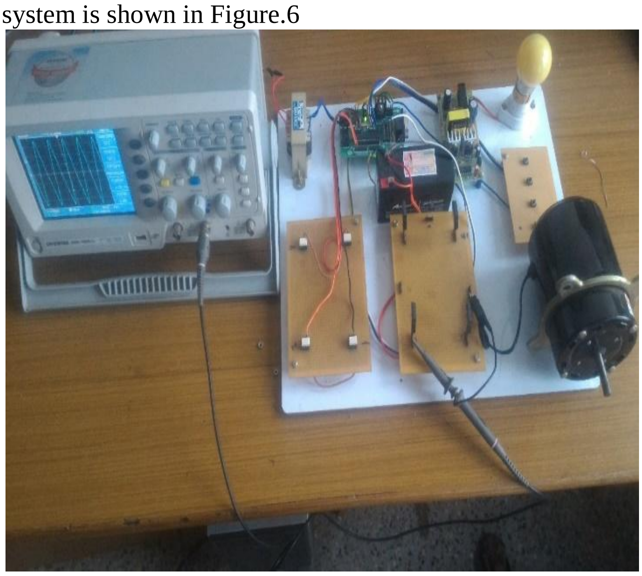

Figure 7: Hardware setup

The test diagram of the RMPC-based probe for the induction motor appears in Figure. 7. The microcontroller board picks up the Hall effect signals directly from the inbuilt sensors of the induction motor. The motor relies mainly on the correct reading of compensation Hall effect signals. The test induction motor driver was attempted under full load (3300 rpm) and 1000 rpm at no load conditions to analyze the implementation of the proposed RMPC-based control. The specification of experimental data is listed in Table 1.

Table. 1 Specifications of test Motor drive

Induction motor type	Single Phase Induction Motor
Rated voltage	230
Rated current	5 Amps
Frequency	50HZ
Rpm	1500
Winding insulation	Class B
Phase	Single phase
HP	2HP
Bearing type	Roller thrust bearing
Temperature	90°C
Fault	Under voltage/over voltage, over current, high temperature, overload, earth leakage and over a speed

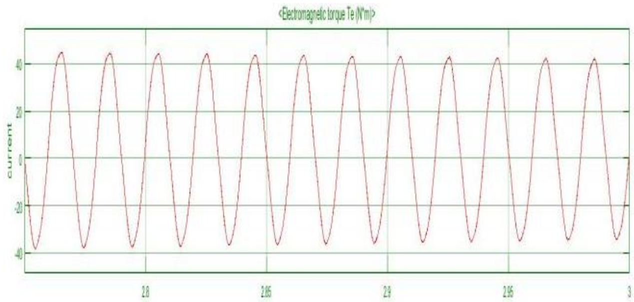

Fig 8: Electromagnetic torque

The output response of proposed RMPC based electromagnetic torque response is shown in Figure 8. The Torque mainly depends on the variation of duty cycle.

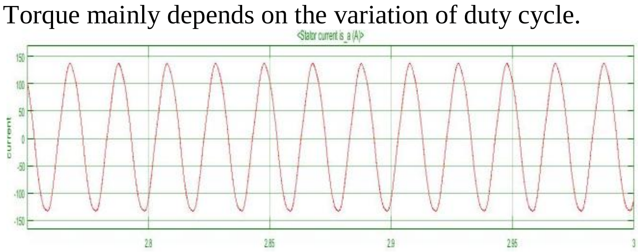

Fig 9: Stator current

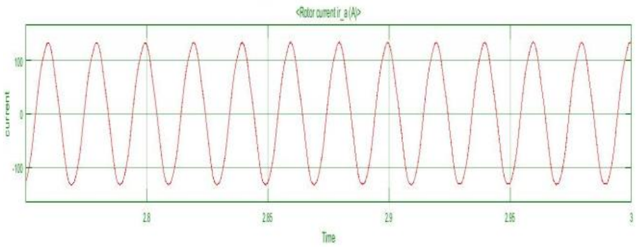

Fig 10: Rotor Current

The output response of proposed RMPC based stator and rotor current response is shown in Figure 9. The current response mainly depends on the variation of duty cycle.

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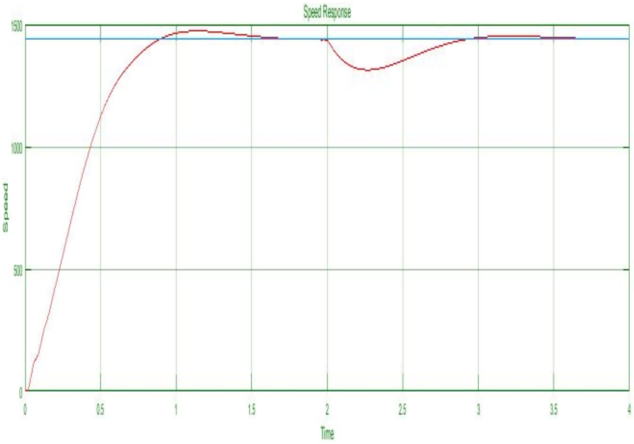

Fig 11: Speed Response

The output response of proposed RMPC based speed response is shown in Figure 9. The speed response mainly depends on the variation of load torque and the false data classification ratio is shown in Figure 12.

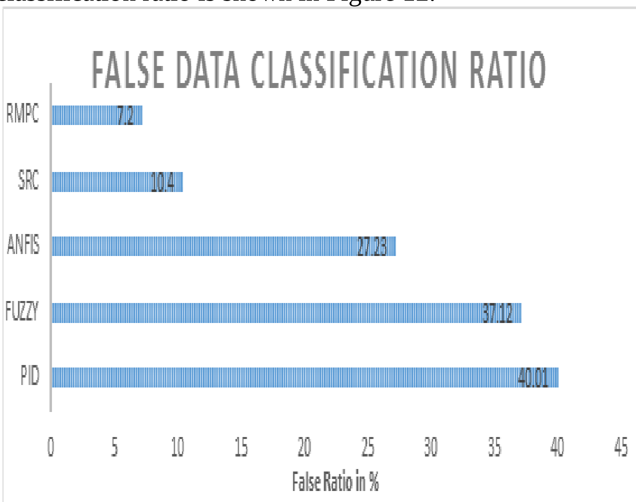

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Fig 12: Comparison Of Various Methodsin False Ratio

Table 2: Control System Parameters for Varying Load Condition

Methods	Peak time(sec)	Reference value(rpm)	Peak Overshoot (%)	Recovery time(sec)	Steady state error value (rpm)	Steady state error (%)
PID	0.6417	1500	1.5225	0.66	10	0.89
FUZZY	0.6010	1500	1.4151	0.60	9.25	0.82
ANFIS	0.6002	1500	0.9814	0.56	8.1	0.66
Proposed RMPC	0.9412	1500	0.5421	0.29	5.02	0.26

Control System Parameters for Varying Load Condition of proposed RMPC based induction motor control system is discussed in Table 2

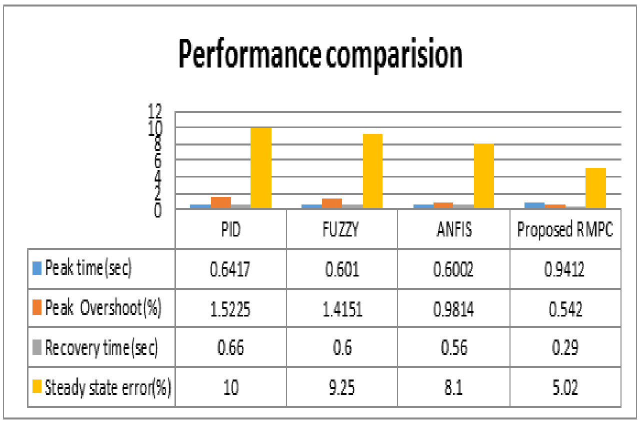

Fig 13: Performance Comparison

Control System Parameters for Varying Load Condition of proposed RMPC based induction motor control system is discussed in Figure 13. As compared with existing methods the proposed RMPC method gives the best response.

V. CONCLUSION

This work examines early issue recognition and the checking of motor framework disappointments utilizing the remotely utilizing RMPC technique. The framework is intended to join distinctive parameter estimations continuously to improve the lusciousness of various offenses. The control of the motor framework presents various parameters to be specific current, voltage, temperature, stickiness, shaft, speed and torque for examination. Subsequently, this plan has various wellsprings of data, which can make cautions, contrasted with customary strategies that depend just on vibration or temperature. The idea of remote observing and motor control is presented here. The information got from the organizer hub is put away and introduced utilizing ongoing designs in visual base improvement applications. The proposed framework can without much of a stretch be moved up to incorporate different sensors for detecting hubs and different sensors if necessary. The association got a high level of self-governance, simple establishment and low upkeep cost. Test outcomes affirm the practicality of executing the framework

REFERENCES

1. Bayindir, R & Sefa, Ibrahim & Colak, Ilhami & Bektas, Askin. (2008). Fault Detection and Protection of Induction Motors Using Sensors. Energy Conversion, IEEE Transactions on. 23. 734 - 741. 10.1109/TEC.2008.921558.
2. Waswani, Ravi & Pawar, Aakanksha & Deore, Mangesh & Patel, Rajankumar. (2017). Induction motor fault detection, protection and speed control using arduino. 1-5. 10.1109/ICIIECS.2017.8276071.
3. A Pugachev "Investigation of induction motor temperature distribution in traction applications" IOP Conf. Series: Earth and Environmental Science 87 (2017) 032033 DOI: :10.1088/1755-1315/87/3/032033
4. R.Pari "DSPIC Based Fault Detection and Protection of Induction Motor" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified Organization) Vol. 6, Issue 2, February 2017.

5. S.Sneha "Controlling and Protection of Three Phase Induction Motor Using PLC", International Journal for Research in Applied Science & Engineering Technology (IJRASET) , Volume 4 Issue XI, November 2016
6. Gomes R.D., Adissi M.O., da Silva T.A.B., Filho A.C.L., Spohn M.A., Belo F.A. (2015) Application of Wireless Sensor Networks Technology for Induction Motor Monitoring in Industrial Environments. In: Leung H., Chandra Mukhopadhyay S. (eds) Intelligent Environmental Sensing. Smart Sensors, Measurement and Instrumentation, vol 13. Springer, Cham
7. Abdülkadir Çakır "Remote Controlling and Monitoring of Induction Motors through Internet" TELKOMNIKA Indonesian Journal of Electrical Engineering Vol. 12, No. 12, December 2014, pp. 8051 ~ 8059 DOI: 10.11591/telkomnika.v12i12.6719
8. Eduardo Cabal-Yepez "Real-time condition monitoring on VSD-fed induction motors through statistical analysis and synchronous speed observation" International Transactions on Electrical Energy Systems Int. Trans. Electr. Energ. Syst. 2015; 25:1657–1672
9. R. Kirubashankar "Design and Implementation of Web Based Remote Supervisory Control and Information System" International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-1, Issue-4, September 2011
10. Tae-june Kang; Chanseung Yang; Yonghyun Park; Doosoo Hyun; Sang Bin Lee; Mike Teska "Electrical Monitoring of Mechanical Defects in Induction Motor Driven V-Belt-Pulley Speed Reduction Couplings" IEEE Transactions on Industry Applications,Year: 2018,
11. P. S. Joshi , "Wireless Speed Control Of An Induction Motor Using PWM Technique With GSM" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 5, May - 2013 ISSN: 2278-0181
12. Andreas Frotzscher; Ulf Wetzker; Matthias Bauer; Markus Rentschler; Matthias Beyer; Stefan Elspass; Henrik Klessig "Requirements and current solutions of wireless communication in in dustrial automation"2014 IEEE International Conference on Communications Workshops (ICC), Year: 2014, Pages: 67 – 72
13. E. Sisinni "9 – Isochronous wireless communication system for industrial automation" Industrial Wireless Sensor NetworksMonitoring, Control and Automation, 2016, Pages 167–188
14. Flammini, Alessandra & Ferrari, P & Marioli, Daniele & Sisinni, Emiliano & Taroni, Andrea. (2009). Wired and wireless sensor networks for industrial applications. Microelectronics Journal. 40. 1322-1336. 10.1016/j.mejo.2008.08.012.
15. Bayindir, R & Şen, Merve. (2011). A parameter monitoring system for induction motors based on Zigbee protocol. Gazi University Journal of Science. 24. 763-771.
16. Abel C. Lima-Filho; Ruan D. Gomes; Marcéu O. Adissi; Tássio Alessandro Borges da Silva; Francisco A. Belo; Marco A. Spohn "Embedded System Integrated Into a Wireless Sensor Network for On lineDynamic Torque and Efficiency Monitoring in Induction Motors" IEEE/ASME Transactions on Mechatronics, Year: 2012, Volume: 17, Issue: 3,Pages: 404 - 414
17. Yan Zhuoa "Design and Implement of Welding Motor Control System Based on Wireless sensor network" Power Electronics and Engineering Application , procedia Engineering 23 (2011) 367 – 373
18. Jonathan Medina-García "A Wireless Sensor System for Real-Time Monitoring and Fault Detection of Motor Arrays" Sensors 2017, 17, 469; doi:10.3390/s17030469
19. O. Touhami; R. Sadoun; A. Belouchrani; S. Hamdani; A. Boukoucha; S. Ouaged "Remote monitoring system of electrical machines via INTERNET" Diagnostics for Electric Machines, Power Electronics and Drives (SDEMPED), Year: 2013, Pages: 23 – 27
20. Zafer Aydogmus; Omur Aydogmus "A Web-Based Remote Access Laboratory Using SCADA IEEE Transactions on Education" Year: 2009, Volume: 52, Issue: 1,Pages: 126 – 132
21. Geetha Stochastic Rule Control Algorithm Based Enlistment of Induction Motor Parameters Monitoring in Applications,Wireless Personal Communications

AUTHORS PROFILE

Dr. K. R. Kavitha, Professor/ECE, Sona College of Technology, Salem. Her area of interest is Nano Electronics. She has published more than 25 international and National Journals/Conferences.

Dr. S. Vijayalakshmi, AP/ECE, SonaCollege of Technology, Salem. Her area of interest is Digital Image Processing. She has published more than 20 international and National journals/Conferences.

M. Senthilvadivu, AP/ECE, SonaCollege of Technology, Salem. Her area of interest is Digital Signal Processing. She has published more than 00 international and National journals/Conferences.

Benita C Evangelin, PG Student, Sona College of Technology, Salem. Her area of interest is Neural Network and VLSI Design.