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Six Phase Permanent Magnet Synchronous Motor Performance and Fault Prediction using AI & IIoT

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Abstract

An efficient algorithm is designed and implemented on an IIoT node for PMSM motor fault prediction and diagnosis. Temperature and vibration signals are acquired by temperature sensor and vibration detector. These two signals are processed and mixed on the IIoT and transmitted to a server. The received signal is separated, and the vibration signal is resampled for bearing fault identification. The proposed method is based on the edge computing reduces the power consumption and hence it is suitable to use on a battery supplied IIoT node for remote PMSM condition monitoring and fault diagnosis.

If in case of monitoring value is greater than the reference value it will notify to us using cloud and AI. Several measurement variables such as voltage, current, speed, and stator temperature are displayed in on-line monitoring interface through cloud.

Keywords—*Industrial Internet of Things, Artificial Intelligence, Permanent Magnet Synchronous Motor (PMSM).*

I. INTRODUCTION

With the potential of significant improvement in fuel economy, EV/HEVs have seen increasing market penetration in recent years. However, EV/HEVs are complex engineering systems, which have properties of high degree of nonlinearity, noise and uncertainties of model parameters, which can result in un- expected system malfunction [1]. As a key part of electrified vehicles, the electric traction system in an EV/HEV is typically composed of a DC battery source, a power converter that converts DC voltage to AC voltage, an electric machine as well as its controller. Among various types of electric machines, permanent magnet synchronous motors (PMSM) are widely used in automotive applications due to their high energy density, high efficiency, and wide speed range compared to other machines. For control purposes, a PMSM drive system in an EV/HEV is usually embedded with various types of sensors such as voltage, current, speed, and rotor position sensors, etc. Faults in any of these sensors that are crucial for speed and torque control may lead to performance degradation. Moreover, to prevent catastrophic failure of the entire drive system, and therefore to guarantee safe and reliable operation of EV/HEV, it is necessary to detect these faults at early stage.

Therefore, a suitable fault diagnosis and isolation (FDI) system that is capable of detecting incipient faults is extremely important to guarantee safe and reliable operation of electric drives as well as its fuel economy or electric range of electrified vehicles.

The integration of Artificial Intelligence (AI) and Industrial Internet of Things (IIoT) technologies has opened new possibilities for fault prediction and proactive maintenance strategies. AI techniques, such as machine learning and deep learning, can analyze large amounts of data collected from PMSMs and identify patterns associated with impending faults.

IIoT enables the seamless connection of PMSMs to the internet, allowing real-time monitoring of motor performance and the collection of sensor data for analysis.

The combination of AI and IIoT can provide early detection of faults in PMSMs, enabling timely interventions to prevent catastrophic failures and reduce downtime.

Fault prediction using AI and IIoT offers several advantages, including improved reliability, increased safety, enhanced energy efficiency, and cost savings. By continuously monitoring motor parameters such as current, voltage, temperature, and vibration, AI algorithms can detect subtle changes indicative of emerging faults.

The integration of IIoT devices, such as sensors and actuators, enables remote monitoring and control of PMSMs, facilitating predictive maintenance strategies.

II. SCOPE OF STUDY

Electric motors are components present in many industrial processes, owing to their strength, mechanical simplicity, and adaptability to a variety of applications in the industry. the paper. With the high productivity levels at industrial plants, any unscheduled shutdown due to failure (unplanned corrective maintenance) can be very disruptive to the production process. In industries like nuclear power and petrochemical, techniques able to detect the fault's early onset could avoid more serious problems.

III. OBJECTIVE

The main aim of the project work is to diagnose the common electrical and mechanical faults experimentally with suitable signal processing techniques. It is observed that most of the work available in literature is based on the MAT LAB programming which may be difficult at online monitoring. In the present project work, ESP32 is used to diagnose the faults with direct wireless online monitoring. The methods proposed in this research work allow continuous real time tracking of faults in permanent magnet synchronous motor operating under continuous stationary and non-stationary conditions. Therefore, second aim of this project work is to investing how the presence of common faults, such as rotor bar fault, short winding fault, air gap eccentricity, bearing fault, load fault, effect on different fault frequencies under different load conditions.

IV.PROPOSED METHODOLOGY

The project with the concept of getting the working temperature and vibration of the PMSM motor using temperature sensor and vibration sensor. The working temperature and vibration of the motor is measured and this measured signal is transmitted to the cloud using IIoT. We use the ESP 32 for transmitting the measured values to the cloud.

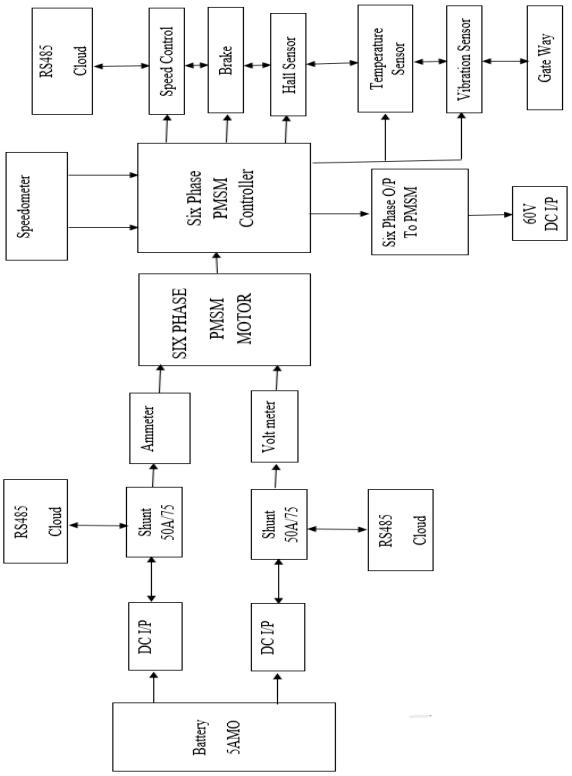

Figure 1: Block diagram

These signals from the cloud are received and displayed in our mobile or computer system. We can also view the working voltage and current of the motor. These parameters of the motor are always measured and transmitted to the cloud. Based on the values from the cloud we can know the condition of the motor. If any fault occurs in the motor we get notified. And we can modify the voltage and current of the motor drive. Sometimes it may fix the minor issues. We can use AI to analyse the received values from the cloud. We can program the AI to make decision and control the voltage and current values of the motor based on the received data from the cloud. In case of any mechanical fault the vibration of the motor is unusual. We should fix this mechanical fault manually.

V. WORKING PRINCIPLE

The working principle of an IIoT based PMSM fault prediction system involves several components and processes. Here is the general overview of how the system works:

- First the working voltage, current, temperature and vibration of the motor is measured using temperature sensor and vibration sensor
- And this measured data is sent to the cloud using ESP32 module.
- Now we can view the working voltage, current temperature values and vibration level through mobile or computer system.
- By using AI we can analyse the received data and control the input voltage and current value.

VII. ADVANTAGES

- Speed of operation is high.
- Less power consumption.
- Very less maintenance required.
- Improved efficiency: IIoT enables real-time monitoring and data collection from various devices, allowing for better optimization of processes, reducing downtime, and maximizing productivity.
- Enhanced safety: IIoT enables the implementation of advanced safety measures through real-time monitoring of equipment and environmental conditions. It can detect anomalies, issue alerts, and even automate emergency responses, ensuring a safer working environment for employees.
- Cost savings: By optimizing operations, reducing downtime, and improving maintenance practices, IIoT can lead to significant cost savings for industrial organizations.
- Remote monitoring and control: IIoT allow for remote monitoring and control of industrial processes and equipment. This enables real-time access to critical data, remote troubleshooting, and the ability to make adjustments or interventions from anywhere, enhancing operational flexibility.

VIII. CONCLUSION

An IIoT based PMSM motor fault prediction is a promising technology for sustainable working of PMSM motor. We can implement automatic control over input voltage and current of the PMSM motor to achieve better efficiency.

IX. RESULT AND DISCUSSION

The transmitted temperature and vibration values in the THINGSPEAK can be viewed in the website using mobile or laptop

REFERENCES

[1] Zheng, X., Zhao, D., & Jiang, Z. (2019). Online fault diagnosis of permanent magnet synchronous motors based on deep neural networks and cloud platform. Applied Sciences, 9(23), 5185

[2] Ahmed, N., Salam, Z., & Wahab, N. (2020). Fault diagnosis of permanent magnet synchronous motors using artificial intelligence techniques: A review. Energies, 13(12), 3160.

[3] Gao, X., Liu, X., Jiang, G., et al. (2020). Fault diagnosis of permanent magnet synchronous motors using machine learning-based feature selection and extreme learning machine. Energies, 13(5), 1117.

[4] Zhang, W., Xia, H., Huang, Y., et al. (2020). Deep neural network-based fault diagnosis for permanent magnet synchronous motors with denoised phase current signals. IEEE Access, 8, 78177-78185.

[5] Li, P., Wang, X., Li, J., et al. (2020). Fault diagnosis of permanent magnet synchronous motors based on a multi-scale convolutional neural network. Energies, 13(17), 4540.

Bonnet A.H. and Soukup G. C., 1992-July/August."Cause and analysis of stator and rotor failures in three-phase squiirel-cage induction motors, "IEEE Trans. Ind. Appl., vol. 28, no. 4, pp. 921-93

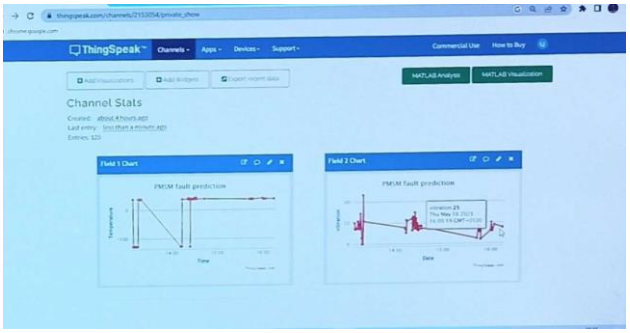

Figure 2: Simulation output