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Cloud Enabled Predictive Maintenance Tool for Induction Motor

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Abstract— **Predictive maintenance is to foresee the failures and to take the preemptive actions. The recent advancements in cloud storage have provided an incredible opening to store the data coming from different sources such as factories, buildings, machines and sensors. The stored data are not only used to monitor the devices connected with the cloud but used to predict the failure of the devices in advance. The proposed system is to predict the failure of an induction motor and to schedule the preventive maintenance. Usually, induction motors are widely used in conveyer belts, elevators, compressors and pumps etc. The productivity of an induction motor can be increased by decreasing the fault occurrence. The various parameters which affect the performance are voltage, current, vibration, speed, power factor and frequency. Accelerometer is used for finding the vibration of the motor. Current sensor, voltage sensor and speed sensor are used to measure current, voltage and speed of the induction motor. The values from the sensors are digitized and stored in the cloud for further processing. Machine Learning (ML) based predictive model is developed based on the historical data from the sensors during normal and abnormal conditions of the induction motor. The induction motor's behavior is continuously monitored with respect to current operating characteristics. This can be monitored remotely in a dashboard using PC, Tablets or Mobile. The ML prediction algorithm generates the maintenance call automatically and thus eliminates the breakdown.**

Keywords— Predictive Maintenance, Induction Motor, Machine Learning, Cloud

I. INTRODUCTION

The main objective is to ensure predictive maintenance of an induction motor when there is an failure. The preventative maintenance system will plan repair in advance while keeping an eye out for potential faults. The current innovation in the cloud storage provides an efficient way of storing data which comes from the diverse sources. Induction motors have many power application and various advantages like simplicity, robustness and low cost, are being extensively used in industries and other application. Various types of Sensors are used to receive different characteristics data from the machine and signal conditioning is performed to remove fluctuation in analogue signals from the sensor. The data acquisition process is performed and the data are processed by a microprocessor and transmitted to IoT platform using wireless networks. The recent advancements in cloud storage has provided an incredible opening to store the data coming from different sources such as factories, buildings, machines and sensors. The processed data from the microprocessor is sent as packets to cloud through TCP protocol (light weight data transfer protocol). The stored data are not only used to monitor the device connected with the cloud but used to predict the failure of the device in advance [1] [2] [3].

In real scenarios, the data from these sources have hundreds or even thousands of failures. The information should be gathered from all pertinent sources and should depict the full picture or timeline of events leading up to the failure. For instance, if we wanted to forecast when a car's brakes would malfunction, we would need to gather information over an extended period of time from not only the brake pads but also the wheels, the entire maintenance history of the vehicle, the date the wheels and brake pads were replaced, the make and model of the vehicle, the date it was purchased, the history of how and where the vehicle was driven, and more. A model that learns from such abundant data will be able to spot patterns, possibly spot dependencies that would not be as clear, and accurately forecast when a brake failure will happen. Businesses will begin gathering data more purposefully as the subject develops and machine learning as a field is better understood. Using Models for Predictive When just a portion of the data is available, maintenance of falls under the standard challenge of modelling with imbalanced data. [1].

The parameters such as voltage, current, vibration, speed, power factor and frequency are collected from the induction motor using respective sensors [2] [3]. The values from the sensors are stored periodically to the cloud for prediction of the induction motor failure. Algorithms for machine learning are used to anticipate failure, accordingly the preventive maintenance can be scheduled. The historical data and the past failure data in the database are used to train the model. Maintenance call is generated in well advance immediately after identifying the problems by AI/ML [4]. The maintenance call will be generated at a proper time which could prevent the machine failure and breakdown can be eliminated. Figure 1 illustrates the percentage of machine failure with business impact for machines.

Fig. 1. Machine Failure Vs Business Impact

II. LITERATURE SURVEY

This section presents the failure prediction of induction motor discussed in the literature. Markiewicz et al. have introduced Induction Motors failure prediction using RNN [5]. The failure data is fetched and transferred to the cloud. The edge computing is used in order to reduce the computational power. The sensors outperform in terms of energy and the prediction accuracy is also better in [5]. Chang et al. have proposed a method for anomaly detection in microprocessor-based systems [6]. Fourier transform is used to analyse the input signal from the sensors and is used to detect the pattern of fault. Cortex-M4 microcontroller is used for prototype implementation and is compared with the commercial and is less than 10 % vibration. Pravin Renold and Venkatalakshmi have presented IoT based health monitoring of induction motor [7]. Planned maintenance should be replaced with predictive maintenance, which relies on tracking the motor's operational state. The IoT based monitoring device monitors the induction motor vibration and based on that the fault is predicted. Naïve Bayes classifier is used for prediction.

Lande et al. have presented induction motor parameters monitoring using ATMEGA-16 and GSM is used for communication [8]. The developed device is cost effective with high accuracy. [9] have discussed various fault diagnosis systems for induction motor. Hayouni et al. have presented to efficiently estimate DC motor upkeep, a platform enabling remote control of revolving machinery was created [10]. Wong et al. have used IoT technology to introduce a real-time system for equipment health monitoring [11]. The prediction is done based on machine learning. Nandi et al. have discussed fault diagnosis of various electrical motors [12]. [13] describes the predictive maintenance of the induction motor. Vinothkanna [14] have developed a induction motor for wireless automation and [15] discussed the fault detection in induction motor. Table 1 describes the comparison on different techniques for prediction of fault on induction motor in the literature.

TABLE 1. COMPARISON ON LITERATURE

Sl. No.	Technique Used	Parameters Considered	Efficiency
1.	IoT with RNN [5]	Accuracy, F1-Score	91.97% of accuracy
2.	Fast Fourier Transform [6]	vibration signals	Promising capability and viability for using online
3.	IoT with Naïve Bayes classifier [7]	Vibration	93.2% of accuracy – Load 100 of accuracy - Noload
4.	ATMEGA-16 with GSM [8]	Waiting Time	Reduced waiting time
5.	IoT with Allan's variance technique [10]	Acceleration Signal	Accuracy is high

III. PROPOSED WORK

The proposed system is used to identify the health condition of the induction motor and to predict the breakdown of the machine before it happens using the art of cloud storage [16]. The induction motor is a motor that operates on the basis of electromagnetic induction. Electromagnetic induction is the phenomena that occurs when an electrical conductor is put in a rotating magnetic field. Two crucial components of the motor are the stator and rotor. While the rotor carries the primary or field winding, the stator, which is fixed, carries the overlapping windings. The stator's windings are evenly separated from one another by a 120° angle. The process of generating a magnetic field everywhere around a motor's constituent parts is referred to as excitation. A revolving magnetic field is created on the stator when a three-phase supply is applied.

Various types of sensors are used to receive different characteristics data from the machine and signal conditioning is performed to remove fluctuation in analogue signals from the sensor. The data acquisition process is performed. Data are processed by a microprocessor and transmitted to IoT platform cloud using wireless networks. The recent advancements in cloud storage have provided an incredible opening to store the data coming from different sources such as factories, buildings, machines and sensors. The processed data from the microprocessor is sent as packets to cloud through MQTT [17] protocol (light weight data transfer protocol). The stored data are not only used to monitor the device connected with the cloud but used to predict the failure of the device in advance. Supervised machine learning is used to build predictive model.

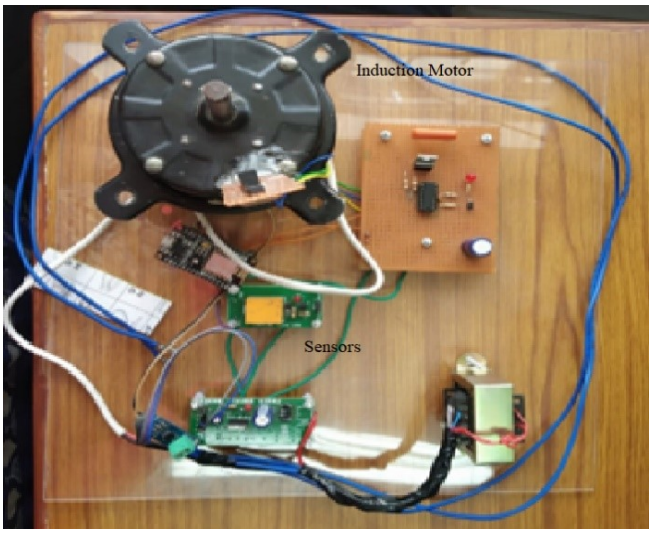

Fig. 2 Prototype of the proposed method

The historical data and the past failure data in the database are used to train the model. Maintenance call is generated in well advance immediately after identifying the problems by AI/ML. The maintenance call generated well in advance at a proper time could prevent the machine failure and breakdown can be eliminated predict machine failure and generate maintenance call in advance. The prototype of the induction motor is shown in figure 2. The

Architecture of the Predictive Maintenance of Induction Motor is shown in figure 3.

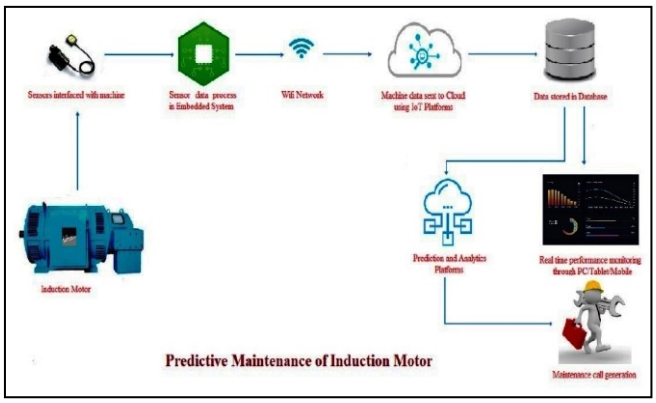

Fig 3. Architecture of the Predictive Maintenance of Induction Motor

IV. RESULT

The proposed system for predicting the failure of the induction motor is implemented using microprocessor Arduino and sensors. The vibration of the motor, voltage, current and speed of the induction motor is sensed using accelerometer, voltage sensor, current sensor and proximity sensor. ADAFRUIT IO and BLYNK are the cloud services used for storing the sensor value to the cloud.

The advantages of the proposed system are listed below,

- Predict 90% of machine failure using cloud storage.
- Human intervention is reduced.
- Optimize the periodic maintenance operation.
- Damage in machine part can be identified in advance using cloud.
- Service of the machine is made easy.
- Reduced Diagnostic time.

The voltage output characteristics screen is shown in figure 4. Figure 5 shows current output characteristics and figure 6 shows speed output characteristics. Figure 7 shows the screen of the dashboard.

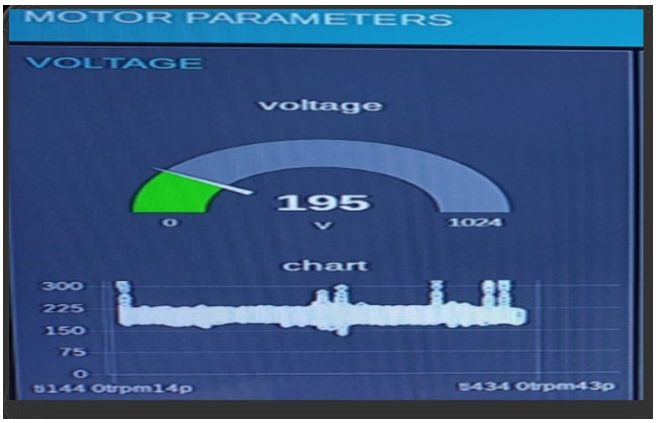

Fig 4. Voltage Output Characteristics

Fig 5. Current Output Characteristics

Fig 6. Speed Output Characteristics

Fig 7. Dashboard

V. CONCLUTION

A test bench of this kind will be able to determine the machine's state of health through the steady state parameter analysis because induction motors have several industrial applications. Additionally resolves a variety of issues throughout the machine's maintenance plan. Numerous more similar applications of process control could be based on the computer's performance in terms of control, acquisition, and calculation. The proposed system might decrease the need for manual machine intervention. lowers the cost of maintenance as well. The suggested system could foresee a machine's failure. in order to prevent the machine's complete shutdown. It is possible to analyze machine performance in real time and detect errors. Deep learning algorithms could be used in future to improve the prediction.

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