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Control and Measurement of Electrical Parameters of Electric Motors Using IOT And SCADA

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Abstract -The primary objective of the proposed system is to protect electrical equipment from potential faults. The system incorporates several sensors strategically placed on the equipment. These sensors collect data, which is then transmitted to a cloud platform via the Node MCU ESP8266. Simultaneously, the data is displayed on an LCD screen. The collected data is divided into training and testing datasets. A machine learning model is trained using various algorithms, and the most accurate one is selected based on its performance. In this case, the decision tree algorithm is used. The real-time data is processed and analyzed, and if the current or vibration values exceed the recorded thresholds, the relay is triggered to prevent damage to the equipment

Key Words: IOT, SCADA, ESP8266, LCD, Machine Learning algorithms

1. INTRODUCTION

Machines play a crucial role in various industries today, ranging from manufacturing to transportation. To maintain productivity and minimize downtime, these machines must operate efficiently. However, unexpected failures can still occur, leading to costly repairs, production delays, and potential safety hazards. This highlights the growing need for effective predictive maintenance techniques to identify and prevent equipment malfunctions before they happen.

The primary objective of this research is to develop a machine failure prediction system based on machine learning methods. The system aims to leverage real-time data generated by machines to detect anomalies in key electrical parameters such as overcurrent, overvoltage, overheating, excessive vibration, and other relevant factors. By using these abnormal values as benchmarks, the system can predict and avert potential failures in similar devices

2. HARDWARE IMPLEMENTATION

The proposed system is for all the electrical equipments which are continuously runs in the commercial regions and hence, these equipments need a prediction method. The proposed system involves the following hardware system:

3-PAHSE INDUCTION MOTOR:

3-phase induction motor is used to get the data of motor in both normal and abnormal condition with variable load. The rated voltage and current of the motor are 415v and 3.5 Amp respectively.

NodeMCU ESP8266 :

Node MCU is used to transmit the data from sensors to the cloud based platform and also to the LCD display. The board operates at 3.3V.

TEMPERATURE SENSOR:

The temperature sensor used here is DHT11 sensor to measure surface temperature and humidity. It measure temperature in the range of 0°C to 50°C (32°F to 122°F) with an accuracy of ±2°C (±3.6°F). It0operates at a voltage of 3.3V to 5V.

CURRENT SENSOR:

Generic ACS712030A Hall Current Sensor is used in our proposed system. It is used to measure the load current. It is designed to measure currents up to 30 Amperes. operates at 0A supply voltage between 4.5V and 5.5V.

VIBRATION SENSOR:

SW-420 vibration sensor is used in the system to measure the vibration of the motor .It gives the digital output when any vibration is detected. It operates at a supply voltage of 3.3V or 5V.

RELAY MODULE:

A 5V relay module is used in the system to cutoff the supply when the equipment reaches to the fault value. The relay module operates with a control voltage of 5V DC.

3. METHODOLOGY

SYSTEM DESIGN

The designed system includes setting up the necessary IoT devices, sensors, actuators, and communication network for the SCADA system. Establish connections between the SCADA system and the IoT devices. Collect data from electrical sensors integrated with the IoT devices, including parameters such as temperature, vibration, voltage, and current.

SPLTTING THE DATA

To eliminate noise, Handle missing values and normalize the data when necessary, then clean and preprocess the dataset. Extract relevant features from the preprocessed data, ensuring to identify key characteristics. These features can include statistical metrics, time-domain, or frequency-domain properties, depending on their relevance to the analysis. Based on the specific requirements of your electrical measurements and control, select the appropriate machine learning techniques (such as regression, classification, or clustering). Split the preprocessed data into training and testing sets, and use the training set to train the chosen models.

SELECTION OF ML ALGORITHM

Based on availability of multiple algorithms, the random forest, decision tree, K-nearest neighbor, and Naive Bayes, is employed in the study to train the data. Utilize the testing data to assess the trained models.

EVALUATION OF THE SELECTED ML MODEL

This process aids in evaluating the effectiveness and precision of the models in control and measurement of electrical parameters of electric motors.

PREDICT THE FAULT BASED ON VALUES

Upon reading the sensor data, when real-time vibration data exceeds the highest recorded data, the system is considered damaged, and the relay trips and real-time current data exceeds the highest recorded data, the supply is cut off, and the machine is shielded from the fault.

BLOCK DIAGRAM

Here, a 3-phase induction motor is used, with vibration, current, and temperature sensors installed on the motor. The power supply is provided through a 3-phase auto transformer. Once the IoT devices are connected to the cloud, sensor data is transmitted via a gateway (Node MCU ESP8266, in this case). The data is simultaneously recorded in the cloud and displayed on an LCD screen, with the analog current values shown directly on the display

The recorded data is then split into training and testing datasets. The training data is used to analyze and train the machine learning models using various algorithms, evaluating their accuracy. After testing, this process helps assess the effectiveness and precision of the models in predicting electrical measurements and controlling operations.

The trained models are then connected to the SCADA system, enabling real-time data processing and control. To make predictions or perform analyses, real-time data from the IoT devices is fed into the trained machine learning models. The models analyze this data and make predictions about electrical measurements and control actions. If the real-time vibration data exceeds the highest recorded threshold, the system is considered damaged, and the relay trips. Similarly, if the real-time current data surpasses the highest recorded value, the supply is automatically cut off to protect the machine from faults.

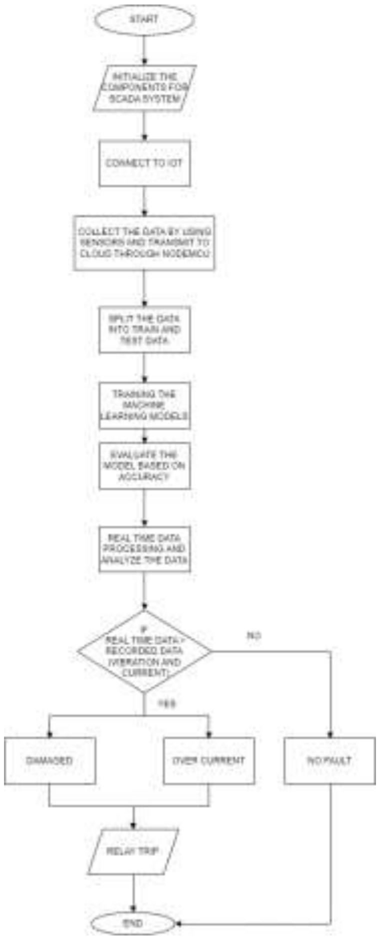

Figure no.1 Flow chart

Different Sensors are deployed strategically on the motor and connected to the node mcu esp8266.From Esp8266, it is connected to lcd display and relay module .Through the USB port of the node mcu it is connected to the serial port of the PC

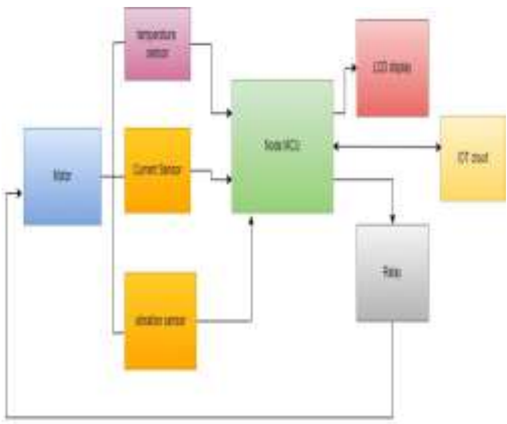

Figure No.2 Block diagram of the work

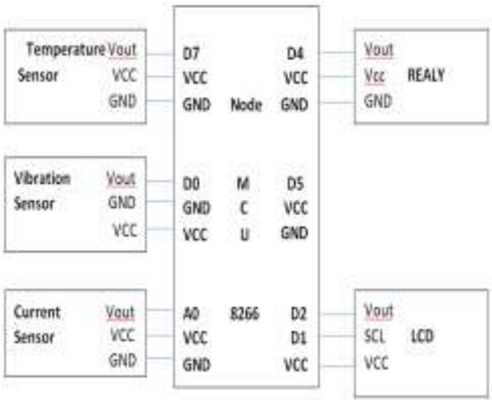

Figure No.3 Pin connection for NODE MCU

4. ANALYSIS AND RESULTS

Figure No. 4 displays the test results for recording the motor data under both normal and abnormal conditions. The results include four parameters: temperature, current, voltage, and vibration.

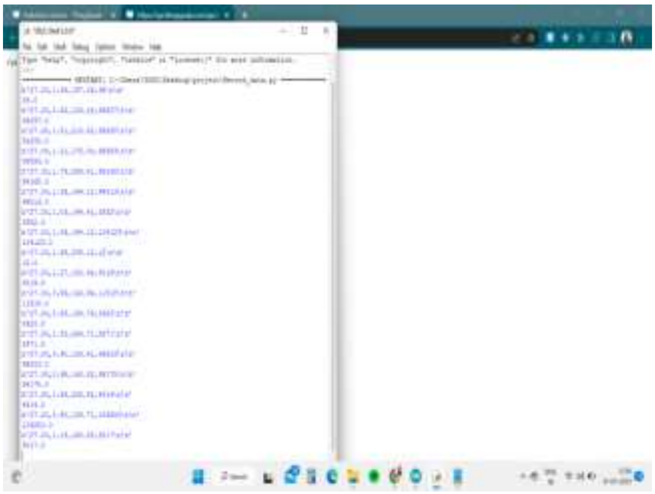

Figure No.4 Testing result

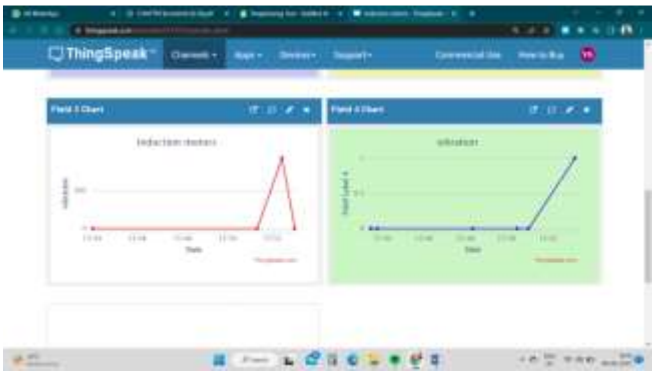

Figure No.5 Real time data plot in thingspeak platform

In Figure No. 5, the real-time data being recorded is simultaneously displayed in a graph format with timestamps on the IoT ThingSpeak platform.

Figure No. 6 shows the accuracy of four different algorithms, with the Decision Tree (DT) algorithm achieving an accuracy of 1.000, making it the selected choice.In Figure No. 7, the real-time vibration value exceeds the recorded threshold, indicating damage, and as a result, the relay trips.

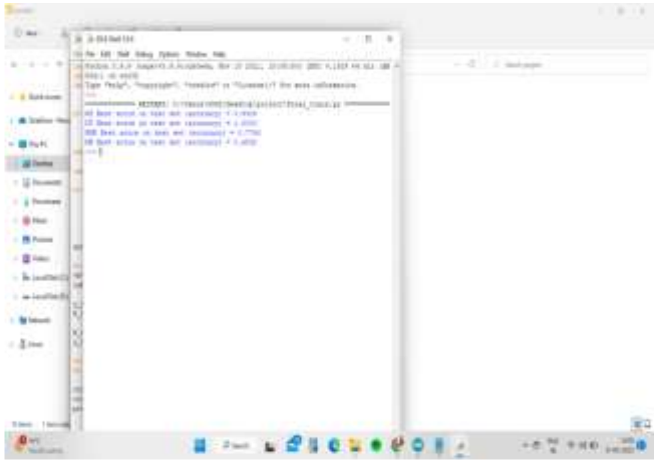

Figure No.6 accuracy of algorithms

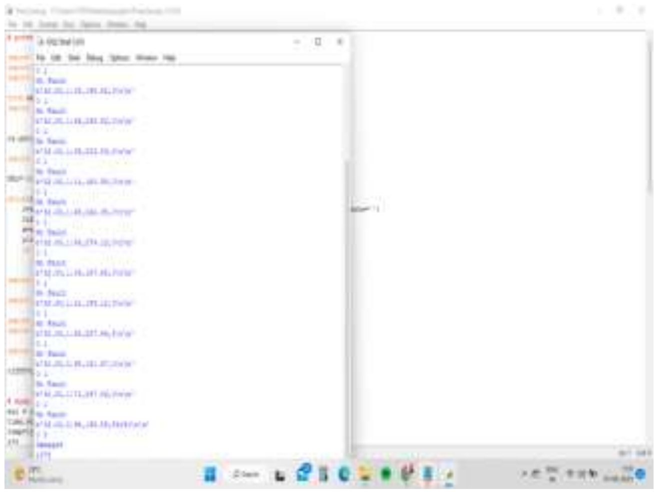

Figure No.7 Recording of real time value of vibration

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In this project, the electrical properties of an induction motor—such as current, voltage, vibration, and surface temperature—are continuously monitored and sent to the cloud. The collected data is then captured and stored in an Excel sheet using Python, after which it is processed and trained using machine learning techniques. The real-time data is analyzed with a high-precision algorithm, which can detect abnormal conditions. If any issues are detected, the algorithm predicts the problem in advance and triggers an automatic shutdown of the machine to prevent damage.

Through the integration of remote sensing (RS) and Internet of Things (IoT) technologies, this study successfully developed and implemented a modular motor status monitoring system. This system can help various industries and sectors reduce downtime and enhance operational efficiency.

VII CONCLUSION

The efficient method is developed to enable fault prediction models to detect issues before they actually occur, leading to the advancement of predictive maintenance. The hardware required to support these systems remains costly. A significant challenge in this area is making these solutions affordable and eliminating the need for specialized hardware setups. Furthermore, predictive maintenance algorithms can be enhanced by combining multiple techniques to improve accuracy and provide more precise results.

A concern in this field is the lack of sufficient data. Researchers often struggle to train and test models with high-quality data, as industrial environments typically generate limited data, especially when it comes to rare defects. To address this, many researchers focus on analyzing patterns in different types of failures and developing statistical models to generate synthetic signals, which can help alleviate the data scarcity. One of the primary challenges remains accurately identifying the range of amplitudes and frequency components associated with faults in electrical machines.

While substantial research is underway in this area, the complexity of the problem requires extensive data processing and robust testing, making it a challenging task.

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