

IOT-Based Motor Fault Diagnosis System

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Abstract:- Industrial motors are important components in many systems, and unexpected failures can lead to production loss and high maintenance costs. This project presents an IoT-based Motor fault diagnosis system for real-time monitoring and predictive maintenance of motors. The system collects motor parameters such as vibration, temperature, current, and speed using sensors connected to an IoT controller like ESP32. The collected data is transmitted to a cloud platform for continuous monitoring and analysis. The system uses data analysis and machine learning techniques to identify abnormal motor conditions and predict possible faults before failure occurs. The proposed method helps in reducing downtime, improving motor performance, and increasing the lifespan of industrial machines. This IoT-based approach provides a cost-effective and efficient solution for smart industrial maintenance.

Keywords:. IoT, ESP32, LSTM, Predictive Maintenance, Condition Monitoring, Remaining Useful Life (RUL)

1. INTRODUCTION

Electric motors are essential components in industrial systems, and unexpected motor failures can lead to production downtime, increased maintenance costs, and reduced operational efficiency. IoT-based Motor fault diagnosis is an effective predictive maintenance approach that continuously monitors motor health using sensor data. In this work, temperature, humidity, and vibration data are collected through sensors and processed using an ESP32 microcontroller with built-in IoT connectivity. The collected data is analyzed using the Long Short-Term Memory (LSTM) algorithm to detect abnormal operating conditions and predict potential faults before failure occurs. This intelligent monitoring system improves equipment reliability, supports real-time fault detection, and contributes to Industry 4.0 by enabling smart and data-driven maintenance.

[1] The paper presents an IoT-based machine signature analysis system for continuous machine health monitoring. It uses sensor data to detect faults at an early stage, enabling predictive maintenance and reducing unexpected equipment failures.

[2] This paper discusses Motor Current Signature Analysis

(MCSA) as an effective technique for induction motor fault diagnosis. It explains how variations in motor current harmonics can be used to identify motor faults and improve system reliability.

[3] The paper proposes an IoT-based motor health condition monitoring system using an ESP32 and multiple sensors to monitor current, voltage, vibration, temperature, and speed. It integrates TinyML for edge-based fault detection and supports real-time remote monitoring through IoT platforms.

[4] This paper presents an IoT-enabled real-time condition monitoring framework that combines edge computing, predictive analytics, and deep learning to detect electrical machine faults and predict Remaining Useful Life (RUL), improving maintenance efficiency and reducing downtime.

[5] The paper presents an IoT-based fault detection and identification system for Brushless DC (BLDC) motors. It uses real-time sensor data to identify motor faults at an early stage, enhancing operational reliability while reducing maintenance costs and unexpected failures.

[6] This paper presents an IoT-based health monitoring and fault detection system for industrial AC induction motors. It continuously monitors motor parameters to enable predictive maintenance, improve operational efficiency, and reduce unexpected equipment failures.

[7] This paper investigates the use of machine learning algorithms for condition monitoring and fault detection in small induction motors. It demonstrates that machine learning techniques can accurately identify motor faults, improving diagnostic performance and supporting predictive maintenance.

2. PROPOSED SYSTEM

The proposed system introduces an IoT-Based Motor Signature Analysis System designed for real-time condition monitoring, anomaly detection, and predictive maintenance of industrial electric motors. The hardware architecture integrates a multi-sensor array managed by a central edge computing unit, minimizing raw data transmission overhead.

The input layer consists of an MPU6050 Accelerometer / Gyroscope for vibration and structural movement tracking, a Hall Effect/Shunt Current Sensor for electrical signature analysis, and an Analog Temperature Sensor for thermal profiling, all powered via a dedicated 5V 1A Power Supply. These sensor modalities interface directly with an ESP32 NodeMCU-32 microcontroller using localized communication protocols (I²C for motion data, direct analog routing for thermal tracking, and digital lines for current telemetry). A localized 1.3" OLED display provides immediate, on-site diagnostics of critical metrics such as motor speed and baseline wave forms

3. BLOCK DIAGRAM

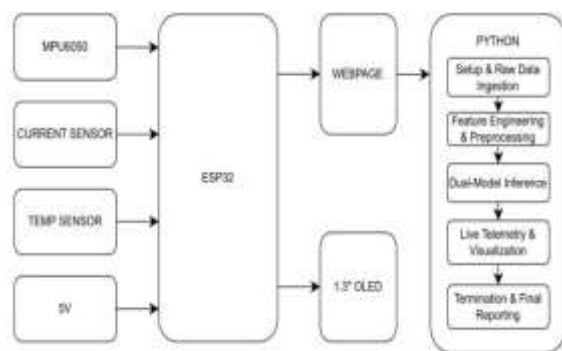


Fig-1: Block diagram

The provided block diagram illustrates an end-to-end hardware and software architecture for a real-time IoT monitoring system. On the hardware frontend, an ESP32 microcontroller acts as the central data acquisition hub, collecting raw telemetry from an array of physical inputs—including an MPU6050 accelerometer/gyroscope, a Current Sensor, and a Temperature Sensor—all sustained by a dedicated 5V power supply. The microcontroller distributes this acquired data simultaneously to a local 1.3" OLED display for instant, on-site telemetry readings and to an external Webpage via Wi-Fi/Bluetooth. This webpage serves as the bridge to a comprehensive backend Python pipeline, which sequentially executes data ingestion, feature engineering/preprocessing (such as

filtering or wavelet transforms), dual-model ML inference for anomaly detection, live telemetry visualization, and final reporting/alerts.

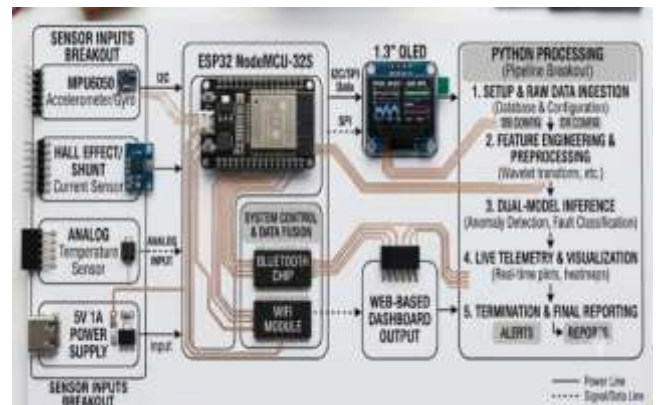


Fig-1: Pictorial Representation Of Block Diagram

4. CONTENTS

The existing motor fault diagnosis systems mainly depend on periodic manual inspections and basic monitoring techniques. These systems do not provide continuous real-time monitoring, AI-based fault prediction, or IoT-enabled remote access. As a result, faults are often detected only after they become severe, leading to unexpected motor failures, increased maintenance costs, and production downtime.

ESP32 Microcontroller:

The ESP32 is the main controller of the COPD monitoring system. It collects data from sensors, processes health information, controls the oxygen valve, connects to Wi-Fi, and uploads real-time data to the cloud for remote monitoring.

MPU6050 Sensor

The MPU6050 is a combined accelerometer and gyroscope sensor. It measures the motor's vibration, acceleration, and angular velocity. These measurements help detect mechanical faults such as bearing wear, shaft misalignment, and imbalance.

DS18B20 Temperature Sensor

The DS18B20 is a digital temperature sensor used to monitor the motor's temperature. It provides accurate temperature readings and helps identify overheating, preventing damage to the motor.

MAX471 Current Sensor

The MAX471 is a current sensing module used to measure the current consumed by the motor. Changes in current indicate abnormal operating conditions such as overload, electrical faults,

or excessive mechanical load.

OLED Display (I2C):

The OLED display shows real-time patient information such as SpO₂ level, heart rate, ECG status, GPS status, and system alerts, allowing easy local monitoring.

5. CIRCUIT DIAGRAM

The circuit consists of an ESP32, MPU6050, DS18B20 temperature sensor, MAX471 current sensor, and an OLED display. The ESP32 collects vibration, temperature, and current data from the sensors, displays the values on the OLED, and transmits the data through Wi-Fi to a webpage. The collected data is analyzed using the LSTM AI algorithm to monitor motor health and detect faults at an early stage.

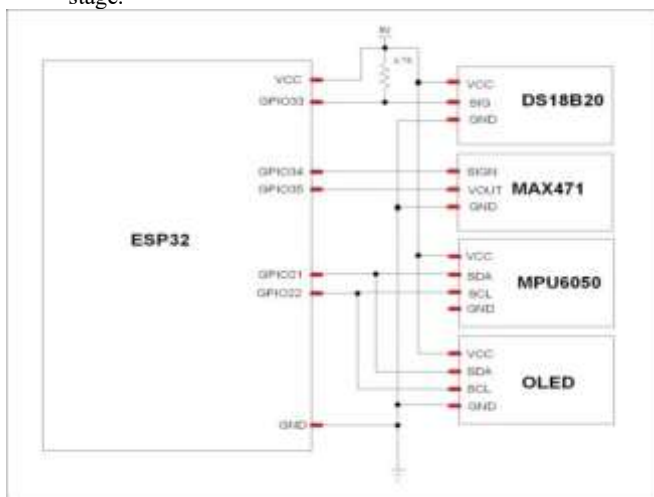


Fig-5.1: Circuit diagram

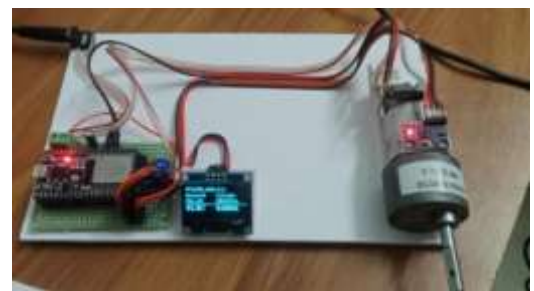
6. WORKING

This circuit consists of an ESP32 microcontroller connected with different sensors and a display module. The ESP32 acts as the main processing unit that collects data from all connected devices and processes the information. The DS18B20 temperature sensor is connected to the ESP32 through the GPIO33 pin. It measures the temperature of the motor or system and sends digital temperature data to the ESP32. A 4.7KΩ pull-up resistor is connected between VCC and the signal line to provide proper communication between the sensor and the microcontroller. The MAX471 current sensor is connected to the ESP32 using GPIO34. It measures the current consumed by the motor and provides an analog voltage output through the VOUT pin. The ESP32 reads this voltage signal and calculates the motor current condition. The MPU6050 accelerometer and gyroscope sensor is connected using the I²C

communication protocol. The SDA and SCL pins of MPU6050 are connected to GPIO21 and GPIO22 of ESP32. It detects motor vibration, acceleration, and rotational changes, which helps in identifying mechanical faults. The OLED display is also connected through the I²C interface using the same SDA and SCL pins. It displays real-time sensor values such as temperature, current, and vibration data. All sensors share a common 5V power supply and GND connection with the ESP32. The ESP32 collects data from the sensors, processes it, and sends the information for monitoring and analysis. This setup is used for real-time motor condition monitoring and fault detection.

7. IMPLEMENTATION AND TEST RESULT

The proposed IoT-Based Motor fault diagnosis System is implemented using an ESP32 microcontroller, MPU6050 vibration sensor, temperature sensor, current sensor, OLED display, and a DC motor. The sensors continuously monitor the motor's vibration, temperature, and current during operation. The ESP32 collects and processes these sensor values, displays the real-time parameters on the OLED screen, and transmits the data via Wi-Fi to a computer for monitoring and analysis. The collected data is analyzed using a Long Short-Term Memory (LSTM) machine learning model to evaluate the motor's health condition and predict its Remaining Useful Life (RUL). This implementation enables real-time condition monitoring, early fault detection, and predictive maintenance, helping to reduce unexpected motor failures.





The implementation results demonstrate that the proposed IoT-Based Motor fault diagnosis System successfully monitors the motor condition in real time. Sensor data, including vibration (X, Y, Z axes), temperature, and current, are collected by the ESP32 and displayed on the IMS Telemetry dashboard. The system also allows the collected data to be downloaded for further analysis and machine learning model training.

The final test report shows the effectiveness of the fault prediction model. During testing, the system analyzed 990 operating cycles and predicted a Remaining Useful Life (RUL) of 0.03, indicating that the motor had almost reached the end of its operational life. The model classified the motor status as critical failure, providing an early warning before complete failure. The health score and RUL prediction graphs clearly show the degradation of the motor over time, proving that the proposed system can accurately detect faults and support predictive maintenance. This implementation helps reduce unexpected breakdowns, maintenance costs, and downtime while improving motor reliability.

8. ADVANTAGES

1. **Early Fault Detection** – Detects motor faults before they become serious.
2. **Reduced Maintenance Cost** – Lowers repair and maintenance expenses.
3. **Prevents Unexpected Breakdowns** – Minimizes unplanned machine failures.
4. **Increases Motor Lifespan** – Extends the operating life of the motor.
5. **Improves Reliability** – Ensures smooth and reliable motor operation.
6. **Supports Predictive Maintenance** – Enables maintenance based on the motor's actual condition.
7. **Reduces Downtime** – Decreases production

interruptions and improves productivity.

8. **Real-Time Monitoring** – Continuously monitors motor health using IoT.
9. **Improves Energy Efficiency** – Detects inefficient motor operation and reduces energy wastage.
10. **Remote Monitoring** – Allows users to monitor motor performance from anywhere through IoT platforms.
11. **Enhances Safety** – Reduces the risk of accidents caused by motor failures.
12. **Accurate Fault Diagnosis** – AI/ML algorithms (such as LSTM) improve fault detection accuracy.

9. APPLICATIONS

1. **Industrial Manufacturing** – Monitors motors used in conveyors, pumps, compressors, and production machines to prevent unexpected failures.
2. **Power Generation Plants** – Detects faults in generators and auxiliary motors, ensuring reliable electricity production.
3. **Oil and Gas Industry** – Monitors motors driving pumps, compressors, and drilling equipment in harsh operating environments.
4. **Water Treatment and Distribution** – Diagnoses faults in water pumps and treatment plant motors to ensure uninterrupted water supply.
5. **HVAC Systems** – Monitors motors in heating, ventilation, and air conditioning systems to improve energy efficiency and reliability.
6. **Electric Vehicles (EVs)** – Tracks the health of traction motors and predicts maintenance requirements.
7. **Railway and Metro Systems** – Detects faults in traction motors to improve safety and reduce downtime.
8. **Mining Industry** – Monitors heavy-duty motors used in crushers, conveyors, and drilling equipment.
9. **Wind Turbines** – Diagnoses generator and motor faults to improve renewable energy system reliability.
10. **Smart Factories (Industry 4.0)** – Integrates with IoT platforms for real-time monitoring, predictive maintenance, and remote fault diagnosis.
11. **Agricultural Equipment** – Monitors motors in irrigation pumps, grain processing machines, and farm automation systems.
12. **Marine and Ship Applications** – Detects faults in

propulsion and auxiliary motors, improving operational safety and reducing maintenance costs.\

10. FUTURE SCOPE

IoT based Motor fault diagnosis system has a wide future scope in industrial automation and smart manufacturing. Integration with IoT, Artificial Intelligence (AI), and Machine Learning (ML) can improve real-time fault detection and accurate prediction of motor failures. Advanced sensors and edge computing can enable continuous monitoring with faster decision-making. AI models such as LSTM can be used for predicting remaining useful life (RUL) of motors. Cloud-based monitoring can help industries access motor health data remotely. In the future, MSA can support fully automated predictive maintenance systems, reducing downtime, improving energy efficiency, and increasing equipment reliability.

11. CONCLUSION

IoT based motor fault diagnosis system is an effective condition monitoring technique used to detect faults in motors by analyzing electrical and mechanical signatures such as current, voltage, vibration, temperature, and other parameters. It helps identify problems like bearing faults, insulation failures, rotor defects, and abnormal operating conditions at an early stage. By using IoT sensors and AI algorithms such as LSTM, real-time monitoring and predictive maintenance can be achieved. This reduces downtime, improves motor efficiency, increases equipment life, and lowers maintenance costs. Therefore, MSA is an important technology for reliable and smart industrial motor management.

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