IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⵣ Peer-reviewed & Refereed journal ⵣ Vol. 14, Issue 3, March 2026

DOI: 10.17148/IJIREEICE.2026.14356

IOT BASED SMART MOTOR PROTECTION AND CONTROL SYSTEM

L. Karunakar[1], V. Lokesh Sai[2]

Assistant Professor, Dept. of EEE Andhra Loyola Institute of Engineering and Technology,

Vijayawada, Andhra Pradesh, India[1]

UG Student, Dept. of EEE Andhra Loyola Institute of Engineering and Technology,

Vijayawada, Andhra Pradesh, India[2]

Abstract: The increasing use of electric motors in industrial and domestic applications has made motor monitoring and protection an important requirement for ensuring safe and efficient operation. Motors often operate under varying loads and environmental conditions, which may lead to faults such as overheating, excessive vibration, and overcurrent. If these conditions are not detected early, they can result in severe motor damage, reduced efficiency, unexpected downtime, and increased maintenance costs. Therefore, continuous monitoring of motor operating parameters is essential for preventing failures and improving system reliability.

This project presents the design and implementation of an **IoT-based Motor Safety Monitoring System** that continuously monitors important motor parameters and provides automatic protection against abnormal operating conditions. The system is built using the **ESP32** microcontroller, which serves as the central processing unit for collecting sensor data and controlling system operations.

The proposed system utilizes multiple sensors to monitor critical parameters of the motor. A current sensor is used to measure the electrical current drawn by the motor, which helps detect overload conditions. A vibration sensor is used to identify mechanical abnormalities such as imbalance or loose components. A temperature sensor (DS18B20) is used to monitor the thermal condition of the motor to prevent overheating. These sensors continuously send data to the ESP32 microcontroller, where the values are processed and compared with predefined threshold limits.

If any parameter exceeds its safe threshold value, the system identifies it as a fault condition and automatically shuts down the motor using a relay module. This immediate response helps protect the motor from severe damage and ensures safe operation. In addition to local protection, the system also provides remote monitoring capabilities through the **Blynk IoT** platform.

The ESP32 connects to a WiFi network and transmits real-time sensor data to the Blynk cloud server. A mobile dashboard displays parameters such as current, vibration level, temperature, and motor status. The user can monitor the system remotely and receive alerts whenever abnormal conditions occur.

For demonstration purposes, a **DC Johnson motor** is used as a prototype to simulate the behavior of an industrial motor. Experimental testing shows that the system successfully detects abnormal conditions such as overcurrent, excessive vibration, and overheating, and automatically stops the motor to prevent damage.

I. INTRODUCTION

Electric motors are widely used in industries, manufacturing plants, water pumping systems, transportation systems, and many household appliances. They play a crucial role in converting electrical energy into mechanical energy. Because motors operate continuously under varying loads and environmental conditions, they are prone to faults such as overheating, excessive vibration, and abnormal current consumption.

These faults can lead to severe consequences such as motor damage, reduced efficiency, unexpected downtime, and safety hazards. Traditional motor monitoring methods rely on manual inspection or periodic maintenance, which may fail to detect problems in real time.

With the advancement of **Embedded Systems and Internet of Things (IoT)** technologies, it has become possible to continuously monitor the health of motors and detect abnormal conditions instantly. This project implements a **Motor**

DOI: 10.17148/IJIREEICE.2026.14356

Safety Monitoring System using ESP32 and IoT, which measures key parameters such as current, vibration, and temperature to ensure safe motor operation.

The system uses sensors connected to an ESP32 microcontroller to collect real-time data. The collected data is transmitted through WiFi to the **Blynk IoT platform**, where it can be monitored remotely through a mobile dashboard. If abnormal conditions are detected, the system automatically stops the motor using a relay to prevent damage.

This approach enables real-time monitoring, remote control, and predictive maintenance of motors.
Motors in industrial and domestic applications are subjected to several stresses during operation. These stresses may arise due to electrical faults, mechanical problems, or environmental conditions. Without proper protection mechanisms, these issues can lead to permanent motor failure.

overheating of the motor windings and insulation failure.
Monitoring the current allows early detection of overload conditions and enables automatic shutdown to prevent damage. Mechanical problems such as shaft misalignment, bearing wear, or rotor imbalance often cause abnormal vibration in motors. Excessive vibration can reduce the lifespan of mechanical components and lead to catastrophic failure if left unchecked.

By using a vibration sensor, the system can detect abnormal mechanical behavior and take preventive action.
Motor temperature increases due to electrical losses and mechanical friction. If the temperature exceeds safe limits, it may cause insulation breakdown and motor burnout.

Monitoring the temperature using a temperature probe helps ensure the motor operates within safe thermal limits.
In many industrial environments, motors are installed in remote or hazardous locations where continuous manual monitoring is difficult. An IoT-based monitoring system allows engineers to monitor motor parameters remotely using a mobile application.

The Internet of Things (IoT) refers to the network of interconnected devices capable of collecting and exchanging data over the internet. IoT technologies are increasingly used in industrial environments to improve automation, monitoring, and maintenance.

In this project, IoT enables the following capabilities:

- Real-time monitoring of motor parameters
- Remote access to sensor data
- Instant alerts during fault conditions
- Data visualization through a mobile dashboard

The ESP32 microcontroller includes built-in WiFi capabilities, making it ideal for IoT applications. The sensor data collected by ESP32 is transmitted to the Blynk cloud platform, where it can be visualized and monitored.

Using IoT for motor monitoring offers several advantages such as improved efficiency, reduced maintenance costs, and increased equipment lifespan.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.414 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 3, March 2026
DOI: 10.17148/IJIREEICE.2026.14356

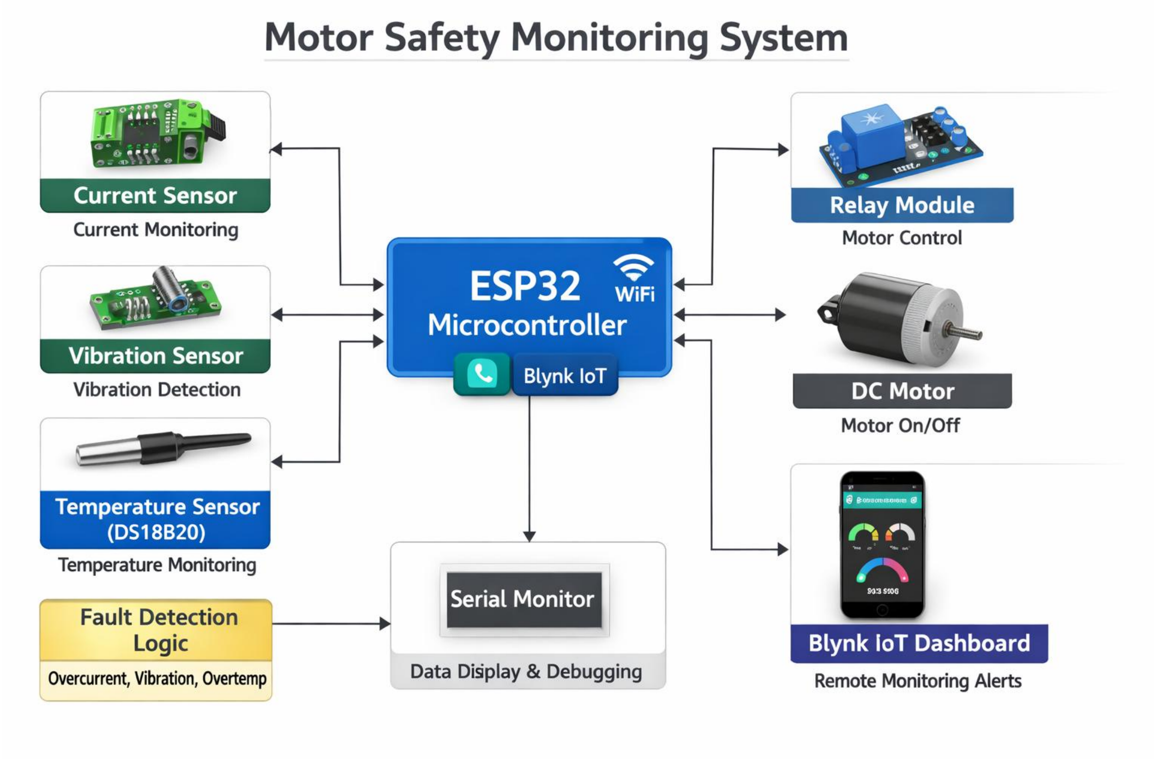

Fig 1: Cricuit Diagram

II. HAREDWARE ASSEMBLING

Mount the ESP32 microcontroller on a stable base to act as the central controlling unit. nstall the Johnson DC motor as the primary mechanical load. Position the relay module to act as an interface switch between the ESP32 and motor. Connect the HW-872 current sensor in series with the motor's power supply circuit. Affix the vibration sensor module directly to the motor casing to detect mechanical faults. Attach the DS18B20 temperature sensor to the motor surface for thermal monitoring.

Solder a 4.7k pull-up resistor between the VCC and DATA pins of the DS18B20 sensor. Wire the relay control signal to ESP32 pin GPIO26. Wire the current sensor output to ESP32 analog pin GPIO34. Wire the vibration sensor output to ESP32 analog pin GPIO27. Wire the temperature sensor data pin to ESP32 pin GPIO25. Establish a common ground (GND) for the ESP32, all sensors, and the relay module.

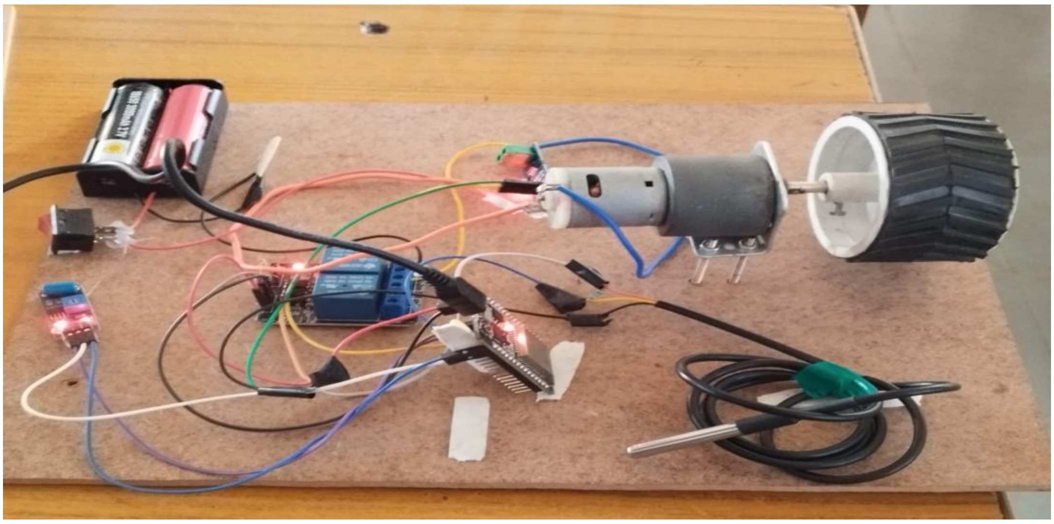

Fig2: Hardware Arrangement

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.414 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 3, March 2026
DOI: 10.17148/IJIREEICE.2026.14356

III. SOFTWARE ASSEMBLING

Install Arduino IDE on your PC or Laptop to begin the programming process. Add the ESP32 board URL in the Arduino IDE Preferences to enable ESP32 support. Install the ESP32 board package through the Board Manager in the Arduino IDE. Install necessary libraries for Blynk and the DS18B20 temperature sensor. Create a new project on the Blynk Cloud to obtain your unique Authentication Token. Connect the ESP32 microcontroller to your PC using a micro-USB cable.

Select the correct ESP32 Board and COM Port within the Arduino IDE menu. Copy and paste the code into the IDE, ensuring your WiFi and Blynk credentials are correct. Click the Upload button to flash the code onto the ESP32 microcontroller. Install the Blynk App on your smartphone from the Google Play Store or Apple App Store. Design the mobile dashboard using gauges, graphs, and notification widgets. Connect the app to the Blynk Cloud to begin receiving real-time motor health data.

IV. ADVANTAGES OF THE PROPOSED DESIGN

The developed motor safety monitoring system offers several advantages compared to traditional monitoring methods.

- **Real-Time Monitoring**

One of the major advantages of the system is the ability to monitor motor parameters in real time. The sensors continuously measure current, vibration, and temperature, allowing the system to detect abnormal conditions immediately.
This helps prevent equipment damage and ensures safer motor operation.

- **Automatic Fault Detection**

The system automatically detects fault conditions such as:
• Overcurrent
• Excessive vibration
• Overtemperature
Once a fault is detected, the ESP32 microcontroller immediately stops the motor using a relay. This automatic protection prevents further damage to the motor and surrounding equipment.

- **Remote Monitoring Using IoT**

The integration with the Blynk IoT platform allows users to monitor motor conditions remotely through a mobile application.
The user can view:
• Current sensor values
• Vibration levels
• Motor temperature
• Motor status alerts
This remote monitoring capability is very useful in industrial environments where motors may be located in inaccessible areas.

- **Low Cost Implementation**

The system uses inexpensive and widely available components such as ESP32, sensors, and relay modules.
Because of this, the system can be implemented at low cost while still providing reliable monitoring functionality.

- **Easy Installation and Expansion**

The hardware design is simple and modular. Additional sensors can easily be integrated into the system if required.
For example, sensors for:
• Voltage monitoring
• Humidity monitoring
• Speed measurement
• Gas detection
can be added to extend system capabilities.

- **Improved Equipment Lifespan**

By detecting abnormal conditions early, the system helps prevent severe damage to motors.
This increases the lifespan of the equipment and reduces maintenance costs.

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 3, March 2026
DOI: 10.17148/IJIREEICE.2026.14356

V. APPLICATIONS

The developed system can be applied in several industrial and domestic environments where motor safety is important. Some common applications include:

- Industrial motor monitoring systems
- Water pumping stations
- Manufacturing equipment
- HVAC systems
- Agricultural motor pumps `

VI. FUTURE SCOPE AND IMPROVEMENTS

Modern industrial systems require reliable monitoring solutions to ensure continuous and safe operation of equipment. Motors are essential components in many machines and industrial processes, and any unexpected failure can lead to production loss, increased maintenance costs, and safety risks.

The Motor Safety Monitoring System developed in this project provides an intelligent solution for monitoring motor conditions in real time. By integrating sensors, embedded processing, and IoT technology, the system can detect abnormal motor behavior and automatically shut down the motor before severe damage occurs.

The system uses the **ESP32** to collect sensor data and transmit it to the **Blynk IoT**, enabling remote monitoring and control.

This chapter discusses the advantages of the proposed system, the limitations observed during implementation, and the future improvements that can enhance the system.

VII. DISCUSSION

Integrating IoT into motor protection and control represents a significant shift from traditional "reactive" maintenance to "proactive" smart management. Below is a detailed discussion covering the architecture, operational benefits, and future potential of these systems.

1. System Overview and Architecture

An IoT-based smart motor system functions by creating a digital twin of the physical motor. It continuously harvests data, processes it locally or in the cloud, and executes protective actions in milliseconds.

Core Components

- **Sensors:** The "nervous system" of the unit. Common sensors include the **ACS712** for current, **ZMPT101B** for voltage, and **DS18B20** or **DHT11** for temperature and humidity.
- **Microcontroller (The Brain):** Usually an **ESP32** or **NodeMCU (ESP8266)** due to their built-in Wi-Fi capabilities. They handle the logic: "If current > threshold, then trip relay."
- **Actuators/Relays:** Mechanical or solid-state switches that physically disconnect the motor during a fault.
- **IoT Platform:** Services like **Blynk, ThingSpeak, or AWS IoT** that provide the dashboard for remote monitoring and data logging.

2. Key Discussion Points: Why IoT?

A. Real-Time Fault Detection vs. Thermal Relays

Traditional thermal relays rely on heat buildup to trip, which can sometimes be too slow to prevent winding damage. IoT systems offer **instantaneous tripping** based on digital thresholds for:

- **Overload/Overcurrent:** Detecting spikes before they cause permanent insulation failure.
- **Phase Imbalance/Loss:** Critical for 3-phase motors where losing one phase can quickly burn out the motor.
- **Undervoltage/Overvoltage:** Protecting the motor from "dirty" power supply

VIII. CONCLUSION

Electric motors are essential components in many industrial and domestic systems. They are used in manufacturing plants, pumping stations, automation systems, transportation equipment, and household appliances. Because motors operate continuously under varying loads and environmental conditions, they are susceptible to faults such as overheating, excessive vibration, and electrical overload.Failure of motors can lead to equipment damage, production losses, and

DOI: 10.17148/IJIREEICE.2026.14356

increased maintenance costs. Therefore, it is important to monitor motor operating conditions continuously and detect abnormal behavior at an early stage.This project presented the design and implementation of an IoT-based Motor Safety Monitoring System that monitors key parameters of a motor and provides automatic protection against unsafe operating conditions.

The system was developed using the **ESP32**, which collects data from sensors and transmits it to the **Blynk IoT** for real-time monitoring.The primary objective of this project was to design a smart motor monitoring system capable of detecting abnormal conditions and preventing motor damage.The system uses multiple sensors to measure important motor parameters such as current, vibration, and temperature. These parameters provide valuable information about the health and operating condition of the motor.The ESP32 microcontroller continuously reads sensor values and compares them with predefined threshold limits. If any parameter exceeds the safe limit, the system immediately stops the motor using a relay module.At the same time, sensor data is transmitted through WiFi to the Blynk IoT platform. The mobile dashboard displays real-time motor parameters, allowing users to monitor the system remotely.The system was successfully implemented using a DC Johnson motor as a prototype to simulate an industrial motor. The sensors were able to detect abnormal conditions, and the relay mechanism successfully stopped the motor during fault situations.

REFERENCES

1. **“IoT Based Single Phase Induction Motor Protection System”**
    - Authors: Shubham Khurse et al.
    - Journal: IJRASET (2022)
    - Focus: Real-time monitoring and protection of motors using IoT
    - Key idea: Improves reliability by continuous monitoring and control

2. **“Induction Motor Condition Monitoring and Controlling Based on IoT”**
    - Authors: G. Mamatha, A. H. Thejaswi
    - Journal: IJRESM (2021)
    - Focus: Monitoring parameters like temperature, current, voltage, vibration
    - Key idea: Detects faults early and prevents motor damage

3. **“IoT-Based Control, Monitoring, and Protection System for 3-Phase Induction Motors”**
    - Journal: Journal of Power, Energy and Control (2024)
    - Focus: Wireless monitoring using ESP8266 and Blynk
    - Key idea: Motor protection using temperature, current, and voltage sensors

4. **“Design and Implementation of an IoT-Based Induction Motor Protection and Control System Using Arduino and ESP32”**
    - Journal: Journal of Electrical Systems (2025)
    - Focus: Multi-parameter monitoring (temperature, RPM, vibration, voltage)
    - Key idea: Automatic shutdown using relay during fault conditions

BIOGRAPHY

[1]. **L Karunakar,** Assistant Professor, Dept. of EEE Andhra Loyola Institute of Engineering and Technology, Since Working 13 Years.

[2]. **V. Lokesh Sai,** Dept. of EEE Andhra Loyola Institute of Engineering and Technology, UG Program

