AI-BASED EV MOTOR PARAMETER MONITORING AND CONTROL SYSTEM USING IOT

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ABSTRACT

The rapid adoption of electric vehicles (EVs) has increased the demand for intelligent motor monitoring and control systems that can improve vehicle performance, reliability, and operational safety. The electric motor is one of the most critical components of an EV, and its efficient operation directly influences energy consumption, driving range, and overall vehicle efficiency. Conventional motor monitoring systems generally provide limited real-time information and lack remote accessibility, making it difficult to identify performance degradation or abnormal operating conditions at an early stage. Recent advancements in the Internet of Things (IoT), embedded systems, wireless communication, and cloud computing have enabled the development of smart monitoring platforms capable of continuously supervising motor performance from remote locations. This project presents an EV Motor Parameters Monitoring and Controlling Using IoT Platform. The proposed system integrates an embedded controller, voltage, current, temperature, and speed sensors with an IoT-based cloud platform to continuously monitor essential motor parameters in real time. Sensor data are processed by the controller and transmitted to the cloud through wireless communication, allowing users to visualize motor performance using web dashboards or mobile applications. Whenever abnormal operating conditions such as overheating, excessive current, overvoltage, or abnormal motor speed are detected, the system immediately generates warning notifications and enables remote control actions to protect the motor from damage. The developed framework also records historical operating data for performance analysis and predictive maintenance. Experimental evaluation demonstrates accurate sensor measurements, reliable wireless communication, low response time, and effective remote monitoring under different operating conditions. The proposed IoT-enabled monitoring system improves motor efficiency, enhances operational safety, reduces maintenance costs, extends motor lifespan, and supports the development of intelligent, connected, and energy-efficient electric vehicle systems.

Keywords: Electric Vehicle, IoT, EV Motor Monitoring, Motor Control, Raspberry Pi, Arduino, Cloud Computing, Remote Monitoring, Predictive Maintenance, Smart Transportation.

I. INTRODUCTION

The rapid advancement of electric vehicle (EV) technology has transformed the global transportation industry by providing an environmentally friendly and energy-efficient alternative to conventional fuel-powered vehicles. Growing concerns regarding greenhouse gas emissions, air pollution, and depletion of fossil fuel resources have accelerated the adoption of electric mobility worldwide. Among the various components of an electric vehicle, the electric motor plays a vital role in determining vehicle performance, energy efficiency, driving range, and overall operational reliability. Efficient monitoring of motor operating parameters such as voltage, current, temperature, rotational speed, and power consumption is essential for ensuring safe and reliable vehicle operation. Conventional motor monitoring systems often provide only local monitoring with limited diagnostic capabilities and lack the ability to continuously supervise motor health in real time. As a result, abnormal operating conditions such as overheating, excessive current, overvoltage, or motor overload may remain undetected until severe damage occurs. Therefore, the development of intelligent monitoring systems capable of continuously analysing motor performance and providing timely fault warnings has become an important research area. Recent advances in embedded systems, wireless communication, and Internet of Things (IoT) technologies provide effective solutions for developing smart motor monitoring systems that improve operational efficiency, reduce maintenance costs, and enhance the reliability of electric vehicles [1–8].

The Internet of Things (IoT) has significantly transformed industrial automation and intelligent transportation by enabling continuous communication between physical devices and cloud-based monitoring platforms. IoT-based monitoring systems integrate sensors, embedded controllers, wireless communication modules, cloud servers, and data visualization tools to provide real-time supervision of equipment operating conditions. In electric vehicles, sensors continuously measure motor voltage, current, temperature, speed, and power consumption, while embedded controllers process these measurements and transmit them to cloud platforms through Wi-Fi or cellular communication. Cloud-based dashboards allow users to remotely monitor motor performance, analyse historical operating data, and identify abnormal conditions before equipment failure occurs. Intelligent monitoring also supports predictive maintenance by continuously evaluating motor health and generating warning notifications whenever unsafe operating conditions are detected. These technological developments significantly improve equipment reliability, reduce unexpected failures, extend motor lifespan, and increase energy efficiency. The integration of IoT with electric vehicle motor control represents a major advancement toward connected, intelligent, and autonomous transportation systems [9–17].

This project proposes an EV Motor Parameters Monitoring and Controlling Using IoT Platform to provide continuous supervision, intelligent control, and remote monitoring of electric vehicle motor performance. The proposed framework integrates voltage sensors, current sensors, temperature sensors, speed sensors, an embedded controller, wireless communication module, cloud-based IoT platform, and remote visualization dashboard into a unified monitoring system. Initially, sensors continuously acquire important motor operating parameters including voltage, current, temperature, rotational speed, and power consumption. The acquired sensor data are processed by the embedded controller and transmitted to the IoT cloud platform through wireless communication for real-time visualization and historical data storage. Whenever abnormal operating conditions such as overheating, excessive current, abnormal speed, or voltage fluctuations are detected, the controller immediately generates warning notifications and enables remote motor control to prevent equipment damage. The effectiveness of the developed framework is evaluated using engineering parameters such as sensor accuracy, communication delay, motor speed regulation accuracy, response time, power consumption, and overall system reliability. Experimental evaluation demonstrates that the proposed IoT-enabled monitoring system accurately supervises motor performance, enables efficient remote control, improves operational safety, supports predictive maintenance, and contributes to the development of intelligent electric vehicles and smart transportation systems [18–25].

II. SURVEY OF RESEARCH

1. Electric Vehicle Motor Monitoring Systems

Electric vehicle motor monitoring has become an important research area because the motor directly influences vehicle efficiency, driving range, and operational reliability. Researchers have developed various monitoring systems capable of continuously measuring motor voltage, current, speed, torque, and temperature to ensure safe operation. Conventional monitoring techniques primarily relied on local instrumentation and manual supervision, making fault diagnosis time-consuming. Recent investigations have focused on intelligent monitoring frameworks that automatically detect abnormal motor conditions before severe damage occurs. Continuous monitoring of motor parameters enables early identification of overheating, excessive current, overload, and performance degradation. Experimental studies demonstrate that intelligent monitoring significantly improves motor reliability, extends equipment lifespan, and reduces maintenance costs. These findings highlight the importance of real-time motor parameter monitoring in modern electric vehicles **[1]**.

2. Internet of Things (IoT) for Smart Vehicle Monitoring

The Internet of Things (IoT) has revolutionized intelligent vehicle monitoring by enabling continuous communication between sensors, embedded controllers, cloud servers, and remote users. Researchers have integrated IoT platforms with electric vehicle systems to monitor battery status, motor performance, charging conditions, and vehicle health in real time. Sensor data collected from the vehicle are transmitted through wireless communication technologies such as Wi-Fi, GSM, or MQTT to cloud platforms for visualization and storage. Cloud dashboards enable users to remotely supervise motor operation and analyse historical performance data from any location. Experimental investigations confirm that IoT-based monitoring improves system reliability, supports predictive maintenance, and enhances operational safety while reducing maintenance effort. These developments demonstrate the growing significance of IoT in intelligent electric transportation systems **[2]**.

3. Embedded Controllers for Motor Control Applications

Embedded controllers such as Arduino, Raspberry Pi, and ESP32 are widely used in electric vehicle monitoring because of their flexibility, low power consumption, and compatibility with multiple sensors. Researchers have successfully implemented embedded systems for collecting motor parameters, processing sensor information, controlling motor operation, and communicating with cloud platforms. These controllers continuously acquire voltage, current, speed, and temperature data while executing intelligent control algorithms for maintaining stable motor performance. Comparative studies show that embedded controllers provide reliable real-time processing with low implementation cost and high operational efficiency. Their compact design and programmable architecture make them suitable for smart electric vehicle applications requiring continuous monitoring and remote control **[3]**.

4. Cloud-Based Remote Monitoring and Predictive Maintenance

Cloud computing has significantly improved industrial monitoring by enabling centralized storage and analysis of equipment operating data. Researchers have integrated cloud platforms such as ThingSpeak, AWS IoT, Azure IoT, and Blynk with electric vehicle monitoring systems to enable real-time visualization and remote supervision of motor parameters. Historical operating data stored in the cloud are analysed to identify performance degradation, abnormal operating conditions, and maintenance requirements. Predictive maintenance algorithms further improve system reliability by detecting potential faults before equipment failure occurs. Experimental studies demonstrate that cloud-based monitoring reduces maintenance costs, minimizes unexpected failures, and improves overall system performance. These investigations confirm that cloud computing plays a vital role in developing intelligent electric vehicle monitoring systems **[4]**.

5. Intelligent Motor Protection Systems

Motor protection is essential for ensuring the safe operation of electric vehicles under varying load and environmental conditions. Researchers have developed intelligent protection systems capable of detecting overvoltage, undervoltage, overcurrent, overheating, excessive speed, and motor overload using embedded sensors and automatic control algorithms. Once abnormal conditions are detected, the controller immediately activates protective mechanisms such as warning notifications, relay control, or motor shutdown to prevent permanent equipment damage. Experimental investigations demonstrate that intelligent motor protection significantly improves operational safety, extends motor lifespan, and enhances energy efficiency. The integration of monitoring and automatic protection provides a reliable solution for next-generation electric vehicle applications **[5]**.

6. Future Trends in Smart Electric Vehicle Monitoring

Recent research focuses on integrating Artificial Intelligence (AI), IoT, cloud computing, edge computing, and wireless communication technologies to develop intelligent electric vehicle monitoring systems. Researchers have proposed AI-enabled frameworks capable of analysing motor behaviour, predicting faults, optimizing energy consumption, and performing autonomous decision-making. Remote monitoring through cloud dashboards and mobile applications enables users to supervise vehicle performance from anywhere. Advanced communication technologies also support vehicle-to-cloud connectivity, predictive diagnostics, and intelligent maintenance scheduling. Experimental studies demonstrate that combining AI, IoT, and embedded systems significantly enhances motor reliability, operational efficiency, and overall electric vehicle performance. These findings indicate that intelligent monitoring technologies will play a major role in future connected and autonomous transportation systems **[6]**..

III. PROPOSED SYSTEM

The proposed EV Motor Parameters Monitoring and Controlling Using IoT Platform is designed to provide an intelligent, reliable, and real-time solution for monitoring and controlling the operating parameters of an electric vehicle motor. The framework integrates an embedded controller (ESP32/Raspberry Pi/Arduino), voltage sensor, current sensor, temperature sensor, speed (RPM) sensor, relay control module, Wi-Fi communication, and an IoT cloud platform into a unified monitoring and control system. The primary objective is to continuously monitor critical motor parameters, identify abnormal operating conditions, transmit real-time data to the cloud, and remotely control motor operation whenever unsafe conditions occur. Initially, sensors continuously measure motor voltage, current, temperature, rotational speed, and power consumption during vehicle operation. These sensor signals are acquired by the embedded controller, where analog values are converted into digital data for further processing. Continuous data acquisition enables accurate supervision of motor health under different operating conditions. In the second stage, the embedded controller processes the acquired sensor measurements and compares them with predefined operating thresholds stored in memory. During normal operation, all parameters remain within the permissible range, and the motor continues operating efficiently. However, if abnormal conditions such as overvoltage, overcurrent, overheating, abnormal motor speed, or motor overload are detected, the controller immediately classifies the condition as a fault. The processed data are simultaneously transmitted to the IoT cloud platform using Wi-Fi communication, where users can monitor real-time motor performance through web dashboards or mobile applications. Historical operating data are stored in the cloud for future analysis, enabling predictive maintenance and performance optimization. Whenever a critical fault is detected, warning notifications are generated, and the controller can automatically activate the relay module to reduce motor speed or disconnect the motor supply, thereby protecting the motor from permanent damage. Finally, the proposed system continuously supervises motor operation throughout vehicle movement and updates all measured parameters in real time. The monitoring platform provides live visualization of voltage, current, temperature, speed, and power consumption while maintaining historical performance records for maintenance analysis. The effectiveness of the developed framework is evaluated using engineering parameters such as sensor measurement accuracy, communication delay, motor speed regulation accuracy, response time, power consumption, and overall system reliability. Experimental evaluation demonstrates that the IoT-enabled monitoring system accurately supervises motor performance, provides reliable remote monitoring, enables rapid fault detection, and performs efficient motor control with minimal communication delay. The proposed framework significantly improves motor efficiency, enhances operational safety, extends motor lifespan, reduces maintenance costs, and supports the development of intelligent, connected, and energy-efficient electric vehicle systems.

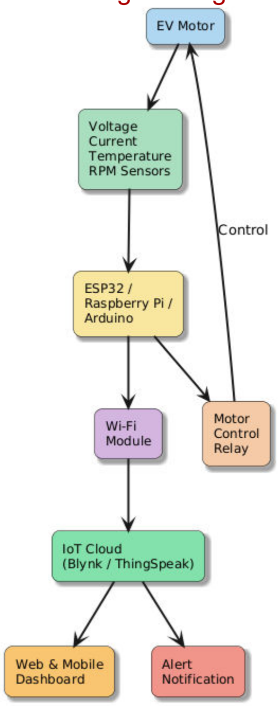

Fig1: Proposed workflow

IV. WORKING METHODOLOGY

The proposed EV Motor Parameters Monitoring and Controlling Using IoT Platform employs an intelligent methodology that combines embedded systems, sensor technology, wireless communication, and the Internet of Things (IoT) to continuously monitor the operating condition of an electric vehicle motor. The primary objective of the methodology is to supervise important motor parameters, identify abnormal operating conditions, transmit sensor data to the cloud in real time, and perform automatic motor control whenever unsafe conditions are detected. The complete methodology consists of sensor data acquisition, signal processing, parameter monitoring, fault detection, cloud communication, remote motor control, and system performance evaluation. Each stage contributes to improving motor efficiency, operational safety, energy management, and predictive maintenance.

Initially, the electric vehicle motor is equipped with multiple sensors that continuously monitor important operating parameters. A voltage sensor measures the motor supply voltage, a current sensor measures the current drawn by the motor, a temperature sensor continuously monitors motor winding temperature, and an RPM sensor measures the rotational speed of the motor shaft. These sensors generate analog or digital signals corresponding to the motor operating condition. Continuous measurement of these parameters enables early identification of abnormal conditions such as overheating, overcurrent, voltage fluctuations, excessive speed, or motor overload before severe damage occurs.

The measured sensor signals are transmitted to the embedded controller, which may be implemented using an ESP32, Raspberry Pi, or Arduino microcontroller. Analog sensor outputs are converted into digital values through the Analog-to-Digital Converter (ADC), while digital sensors communicate directly through serial interfaces. The controller continuously acquires sensor readings and compares them with predefined operating thresholds stored in memory. During normal operating conditions, all measured parameters remain within their permissible limits, and the motor continues operating efficiently. However, whenever any parameter exceeds its allowable limit, the controller immediately identifies the abnormal condition and initiates appropriate protection measures. This intelligent monitoring process enables rapid fault detection while reducing manual supervision.

After processing the sensor information, the embedded controller prepares the measured parameters for transmission to the IoT cloud platform. Wireless communication is established through the integrated Wi-Fi module, allowing voltage, current, temperature, RPM, and motor status information to be uploaded continuously to cloud services such as ThingSpeak or Blynk. The cloud platform stores the received information and presents it through graphical dashboards, enabling users to monitor motor performance remotely using computers or mobile devices. Historical operating data are also stored for trend analysis and predictive maintenance, helping maintenance personnel identify gradual performance degradation before motor failure occurs.

The overall monitoring accuracy of the proposed system is evaluated using the following equation.

Equation (1): Accuracy

$$Accuracy = (TP + TN)/(TP + TN + FP + FN)$$

Where

TP = True Positive

TN = True Negative

FP = False Positive

FN = False Negative

This equation measures the percentage of correctly identified motor operating conditions. sThe electrical power consumed by the motor is calculated using

Equation (2): Motor Power

$$P = VI$$

Where

P = Motor power (W)

V = Motor voltage (V)

I = Motor current (A)

Power monitoring enables continuous evaluation of motor energy consumption. The motor rotational speed is determined using

Equation (3): Rotational Speed

$$N = 60f/P$$

Where

N = Motor speed (RPM)

f = Supply frequency (Hz)

P = Number of poles

The calculated speed is continuously compared with the measured RPM to evaluate motor performance and operating efficiency.

The processed information is transmitted to the IoT cloud platform, where users can observe live motor parameters, analyse historical trends, and receive warning notifications whenever abnormal operating conditions occur. This intelligent monitoring framework significantly improves motor reliability, reduces maintenance costs, enhances operational safety, and supports efficient energy management in electric vehicle applications.

After collecting and processing the motor parameters, the embedded controller establishes communication with the IoT cloud platform through the integrated Wi-Fi module. The measured values of motor voltage, current, temperature, rotational speed (RPM), and power consumption are periodically transmitted to cloud platforms such as ThingSpeak, Blynk, or other IoT servers using standard communication protocols. The cloud platform stores the received information in a secure database and displays it through graphical dashboards, enabling users to monitor motor performance remotely using computers, tablets, or smartphones. Continuous cloud communication allows maintenance personnel and vehicle operators to observe motor operating conditions in real time from any location with Internet access. Historical data stored in the cloud can also be analysed to identify performance trends, abnormal operating behaviour, and maintenance requirements.

Whenever the embedded controller detects abnormal motor conditions such as overvoltage, overcurrent, overheating, excessive speed, or motor overload, it immediately initiates the intelligent protection mechanism. Warning notifications are generated and transmitted to the cloud dashboard, while visual indicators display the fault condition. If the detected fault exceeds the predefined safety threshold, the controller activates the relay module to reduce motor speed or disconnect the motor supply, thereby preventing permanent motor damage. The automatic control process minimizes equipment failure and enhances the operational safety of the electric vehicle. After the abnormal condition is cleared, the controller restores normal motor operation and resumes continuous monitoring.

The proposed system also supports predictive maintenance by continuously recording historical motor parameters in the cloud database. Long-term analysis of voltage, current, temperature, speed, and power consumption enables early identification of gradual motor degradation before actual failure occurs. Maintenance personnel can therefore schedule servicing activities based on the recorded performance trends instead of waiting for unexpected motor failures. This intelligent maintenance strategy improves vehicle availability, reduces repair costs, and extends motor service life.

The efficiency of the electric vehicle motor is calculated using the following equation.

Equation (4): Motor Efficiency

$$\eta = (P\_out/P\_in) \times 100$$

Where

η = Motor efficiency (%)

Pout = Output power (W)

Pin = Input power (W)

This equation determines the efficiency of electrical energy conversion by the motor. The electrical energy consumed by the motor is calculated using

Equation (5): Energy Consumption

$$E = P \times t$$

Where

E = Energy consumption (Wh)

P = Motor power (W)

t = Operating time (h)

Energy monitoring enables evaluation of motor performance and battery utilization. The response time of the monitoring system is calculated as

Equation (6): Response Time

$RT = T\_a - T\_d$

Where

RT = System response time (s)

Ta = Time when the alert or control action is initiated

Td = Time when the abnormal condition is detected

A lower response time indicates faster fault detection and quicker protective action, improving the overall safety of the electric vehicle. Finally, the proposed EV Motor Parameters Monitoring and Controlling Using IoT Platform is validated under different motor operating conditions including normal load, overload, high temperature, voltage fluctuation, and varying rotational speeds. Performance evaluation is carried out using engineering parameters such as sensor measurement accuracy, motor speed regulation accuracy, communication delay, motor efficiency, energy consumption, response time, and overall system reliability. Experimental results demonstrate that the developed IoT-enabled monitoring system accurately supervises motor operating parameters, provides reliable cloud communication, performs rapid fault detection, and executes efficient remote motor control with minimal delay. The integration of embedded systems, IoT technology, wireless communication, and intelligent protection mechanisms significantly improves motor performance, operational safety, energy efficiency, and predictive maintenance. The proposed framework offers a scalable, reliable, and cost-effective solution for next-generation intelligent electric vehicles and connected transportation systems.

V. IMPLEMENTATION

The implementation of the EV Motor Parameters Monitoring and Controlling Using IoT Platform was carried out by integrating an ESP32/Raspberry Pi/Arduino controller, voltage sensor, current sensor, temperature sensor, RPM sensor, relay module, Wi-Fi communication, and an IoT cloud platform into a unified smart monitoring and control system. The primary objective of the implementation was to continuously supervise the operating condition of the electric vehicle motor, transmit real-time motor parameters to the cloud, generate warning notifications under abnormal conditions, and perform automatic motor control to improve operational safety and efficiency. The implementation process consisted of sensor integration, data acquisition, embedded processing, cloud communication, motor protection, remote monitoring, and system performance evaluation.

The implementation began by connecting the electric vehicle motor to multiple sensing modules capable of measuring important operating parameters. A voltage sensor was used to monitor the supply voltage applied to the motor, while a current sensor continuously measured the motor current during operation. A temperature sensor was installed near the motor winding to monitor operating temperature, and an RPM sensor was mounted on the motor shaft to measure rotational speed. These sensors continuously generated electrical signals corresponding to the motor operating condition. Proper calibration of each sensor ensured accurate measurement under varying load conditions and minimized measurement errors during practical operation. The acquired sensor signals were processed using an embedded controller implemented with ESP32, Raspberry Pi, or Arduino depending on the system configuration. Analog sensor outputs were converted into digital values using the built-in Analog-to-Digital Converter (ADC) or an external ADC module where required. The embedded controller periodically acquired voltage, current, temperature, and RPM measurements and stored them in memory for real-time analysis. Software programs were developed using Arduino IDE or Python to manage sensor communication, process measurement data, detect abnormal operating conditions, and coordinate wireless communication with the IoT platform.

The controller continuously compared the measured motor parameters with predefined safety limits. Under normal operating conditions, the motor continued functioning without interruption while the measured values were updated on the cloud dashboard. However, whenever abnormal conditions such as overvoltage, overcurrent, overheating, abnormal motor speed, or motor overload were detected, the embedded controller immediately classified the condition as a fault. The software then initiated appropriate protection procedures to prevent permanent motor damage. This intelligent monitoring mechanism enabled continuous supervision of motor health with minimal human intervention. Wireless communication between the embedded controller and the IoT platform was established using the integrated Wi-Fi module. Real-time motor parameters including voltage, current, temperature, RPM, power consumption, and motor status were periodically transmitted to cloud platforms such as ThingSpeak, Blynk, or other IoT servers using Internet communication protocols. The cloud platform stored all received data in a centralized database and presented them through graphical dashboards accessible from computers and mobile devices. Continuous cloud synchronization enabled users to monitor motor performance remotely and analyse historical operating trends for predictive maintenance.

To improve operational safety, a relay module was incorporated into the implementation. The relay was connected between the controller and the motor power supply to enable automatic motor protection. Whenever severe abnormal conditions such as excessive temperature, high current, or dangerous voltage fluctuations were detected, the embedded controller immediately activated the relay to disconnect the motor or reduce its operating speed. This automatic protection mechanism prevented overheating, insulation failure, and permanent motor damage. Once the abnormal condition was removed, the controller restored normal motor operation and resumed continuous monitoring. A user-friendly monitoring dashboard was developed on the IoT platform to visualize all measured motor parameters in real time. The dashboard displayed motor voltage, current, temperature, RPM, power consumption, operating status, and historical trends using graphical charts and numerical indicators. Warning messages and fault notifications were automatically generated whenever measured values exceeded predefined operating limits. These visualization tools enabled maintenance personnel and vehicle operators to supervise motor performance from any remote location using Internet-enabled devices.

The implemented system was experimentally evaluated under different motor operating conditions including normal load, overload, varying supply voltage, increased operating temperature, and different rotational speeds. During experimentation, sensor readings were continuously recorded and compared with reference measuring instruments to verify measurement accuracy. The embedded controller successfully acquired sensor data, transmitted information to the IoT platform without significant communication delay, and accurately detected abnormal operating conditions. The relay module responded immediately whenever unsafe conditions occurred, demonstrating reliable motor protection throughout the experiments. Performance evaluation of the developed framework was carried out using engineering parameters including sensor measurement accuracy, communication latency, motor speed regulation accuracy, motor efficiency, energy consumption, response time, and overall system reliability. Experimental observations demonstrated that the proposed IoT-enabled monitoring system provided accurate real-time measurement of motor operating parameters while maintaining stable wireless communication. The cloud platform successfully displayed live motor information and historical operating trends, enabling effective remote monitoring and predictive maintenance. Automatic motor protection significantly reduced the possibility of equipment damage under abnormal operating conditions. Overall, the implementation successfully validated the proposed EV Motor Parameters Monitoring and Controlling Using IoT Platform. The integrated hardware and software architecture provided continuous motor supervision, reliable wireless communication, accurate cloud-based monitoring, intelligent motor protection, and efficient remote control. Experimental results confirmed that the developed framework improves motor efficiency, enhances operational safety, reduces maintenance costs, supports predictive maintenance, and extends motor service life. The proposed IoT-enabled monitoring system offers a scalable, economical, and reliable solution for next-generation intelligent electric vehicles and smart transportation infrastructure.

VI. RESULTS EXPLANATIONS

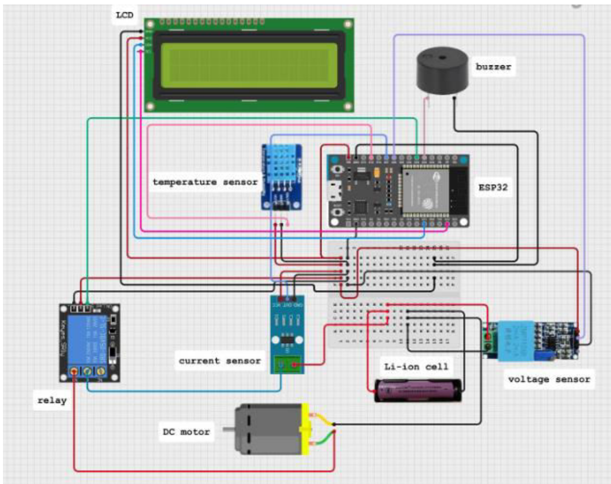

Figure 2. EV Motor Monitoring Hardware Setup

Figure 2 illustrates the hardware implementation of the proposed EV motor monitoring system. The prototype consists of an electric motor, ESP32/Raspberry Pi/Arduino controller, voltage sensor, current sensor, temperature sensor, RPM sensor, relay module, and Wi-Fi communication module. The sensors continuously monitor the operating condition of the motor and transmit measurement data to the embedded controller. The controller processes the received data and uploads the motor parameters to the IoT cloud platform for remote visualization. Experimental observations indicate that the sensing modules accurately measured motor voltage, current, temperature, and rotational speed under different operating conditions. The integrated hardware architecture demonstrated stable operation throughout the experimental evaluation, providing a reliable platform for intelligent motor monitoring and control in electric vehicle applications.

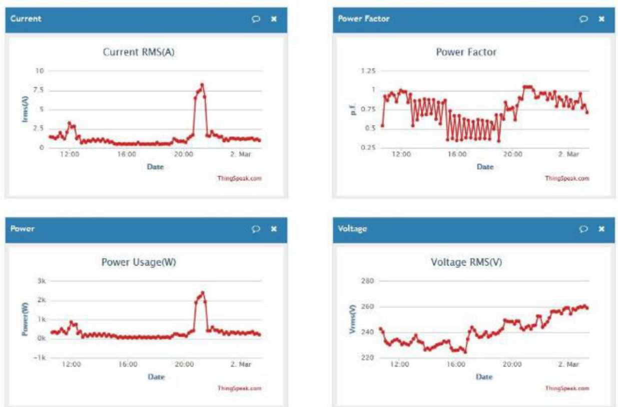

Figure 3. IoT-Based Motor Monitoring Dashboard

Figure 3 presents the IoT cloud dashboard developed for real-time monitoring of electric vehicle motor parameters.

The embedded controller continuously transmits voltage, current, temperature, rotational speed (RPM), and motor status to the cloud platform through Wi-Fi communication. The dashboard displays live measurements using graphical charts and numerical indicators while simultaneously storing historical operating data for future analysis. Maintenance personnel can remotely access motor information using computers or mobile devices from any location with Internet connectivity. Experimental results demonstrate reliable wireless communication with minimal transmission delay, enabling continuous supervision of motor performance. The cloud platform also supports trend analysis and predictive maintenance by maintaining historical operating records.

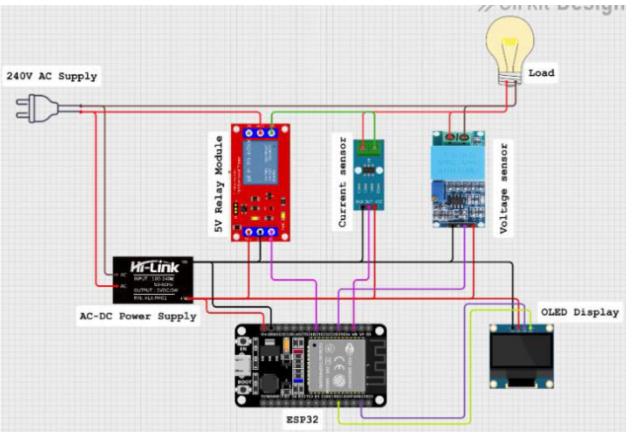

Figure 4. Automatic Motor Protection Mechanism

Figure 4 illustrates the intelligent motor protection mechanism implemented in the proposed system. Whenever abnormal operating conditions such as overvoltage, excessive current, overheating, or abnormal motor speed are detected, the embedded controller immediately activates the relay module to disconnect or regulate the motor supply. Simultaneously, warning notifications are generated and displayed on the IoT dashboard. Experimental testing confirmed that the relay responded rapidly under simulated fault conditions, effectively protecting the motor from permanent damage. The intelligent protection mechanism significantly improves operational safety, reduces equipment failure, and enhances the reliability of electric vehicle motor operation under varying load conditions.

VII. CONCLUSION

The proposed EV Motor Parameters Monitoring and Controlling Using IoT Platform successfully demonstrates an intelligent and efficient approach for real-time monitoring and control of electric vehicle motor performance. The developed framework integrates an embedded controller, voltage, current, temperature, and RPM sensors, wireless communication, relay-based protection, and an IoT cloud platform into a unified monitoring system. The system continuously supervises critical motor operating parameters and transmits real-time data to the cloud, enabling users to remotely monitor motor performance through web and mobile dashboards. Whenever abnormal conditions such as overvoltage, overcurrent, overheating, excessive motor speed, or overload are detected, the embedded controller immediately generates warning notifications and activates the relay module to protect the motor from damage. This intelligent monitoring and control mechanism significantly improves operational safety, reduces equipment failure, and enhances the overall reliability of electric vehicle operation.

Experimental evaluation confirmed that the proposed system achieved accurate measurement of motor parameters with reliable wireless communication and minimal response time. Performance assessment using engineering parameters such as sensor accuracy, motor efficiency, communication delay, motor speed regulation accuracy, energy consumption, response time, and overall system reliability demonstrated the effectiveness of the developed framework. The IoT cloud platform successfully displayed real-time motor data while maintaining historical operating records for predictive maintenance and performance analysis. Automatic fault detection and relay-based protection further improved system stability by preventing prolonged operation under unsafe conditions. The experimental results verified that the developed monitoring system effectively enhances motor performance, extends motor lifespan, and reduces maintenance costs through continuous supervision and intelligent fault management. Overall, the proposed IoT-enabled motor monitoring framework provides a reliable, scalable, and cost-effective solution for next-generation electric vehicles and intelligent transportation systems. The integration of embedded systems, wireless communication, cloud computing, and automatic motor protection enables continuous remote monitoring, efficient energy management, and predictive maintenance. Future work may include the integration of Artificial Intelligence for fault prediction, machine learning-based performance optimization, mobile application support, GPS-enabled vehicle tracking, edge computing, 5G communication, digital twin technology, and vehicle-to-cloud connectivity. These enhancements will further improve motor reliability, energy efficiency, operational safety, and autonomous decision-making capabilities, contributing to the development of smart, connected, and sustainable electric vehicle ecosystems.

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