



e-ISSN: 2278-8875  
p-ISSN: 2320-3765

# International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 15, Issue 4, April 2026

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 8.807**

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# AI and IoT Based Electric Vehicle Monitoring System

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**ABSTRACT:** The usage of electric vehicles is increasing due to their ability to reduce air pollution and fuel consumption. But tracking the health of electric vehicles and their performance is critical to ensure they are operating safely and efficiently. In this project, an IoT and Artificial Intelligence based smart monitoring system is designed. The system continuously monitors critical parameters of the electric vehicle to do list like battery voltage, current, temperature and location. IoT technology collects and transmits the data through microcontroller connected to almost all sensors. The collected data can be viewed using a mobile application for real-time monitoring. Artificial Intelligence is used to analyse the battery condition and identify possible faults or abnormal conditions. If any unusual situation such as overheating or battery fault occurs, the system provides an alert to the user immediately. This helps in improving the safety, performance, and lifetime of the electric vehicle battery. The proposed system provides a smart and efficient solution for monitoring electric vehicle remotely ensuring better battery management.

**KEYWORDS:** Artificial Intelligence, Internet of Things, Electric Vehicle Monitoring, Battery Management System, Real -Time Monitoring, fault Detection

## I. INTRODUCTION

The rapid growth of transportation systems has significantly increased fuel consumption and environmental pollution due to emissions from conventional internal combustion engine vehicles. Electric vehicles (EVs) have emerged as a sustainable alternative, offering reduced emissions and improved energy efficiency. However, the performance, safety, and reliability of EVs are highly dependent on the condition of their battery systems. Continuous monitoring of key parameters such as voltage, current, and temperature is essential to prevent battery degradation and potential safety risks. Recent advancements in Internet of Things (IoT) technology enable real-time monitoring and remote access to vehicle data through connected sensors and communication modules. In addition, Artificial Intelligence (AI) techniques facilitate intelligent analysis of large datasets, allowing early detection of anomalies and predictive maintenance. This paper proposes an integrated AI- and IoT-based electric vehicle monitoring system designed to track battery parameters and vehicle location in real time. The system utilizes sensors, microcontrollers, and communication technologies to ensure efficient data acquisition and transmission, while AI algorithms enhance system intelligence and reliability. The proposed approach aims to improve battery safety, optimize performance, and support the development of smart and sustainable transportation systems.

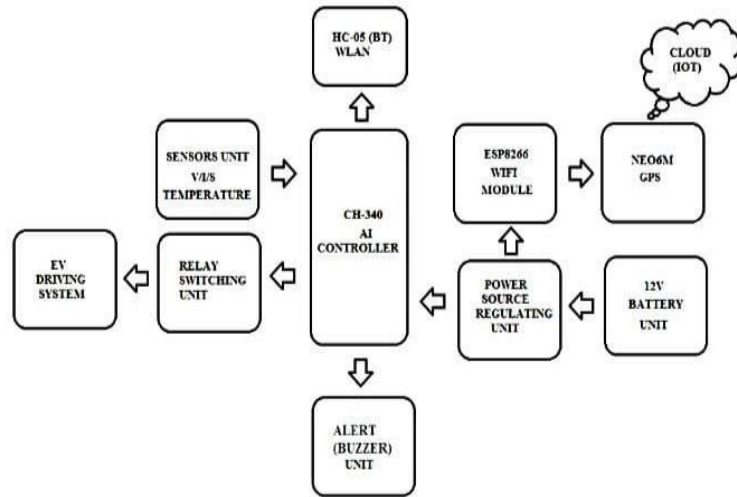
## II. LITERATURE SURVEY

Numerous research efforts have been carried out to develop advanced monitoring systems for electric vehicles (EVs) and to improve wireless power transfer technologies. Wireless power transfer has emerged as a promising solution to eliminate the dependency on physical charging cables. Researchers have extensively explored techniques such as resonant inductive coupling and capacitive coupling to achieve efficient energy transmission. These methods focus on improving power transfer efficiency, reducing energy loss, and enhancing the convenience of EV charging systems. In addition to power transfer technologies, significant attention has been given to the development of intelligent vehicle monitoring systems. Many studies have proposed Internet of Things (IoT)-based frameworks that integrate sensors and embedded systems to continuously monitor key vehicle parameters, including battery voltage, current, temperature, and overall system performance. The collected data is transmitted to cloud platforms using wireless communication technologies such as Wi-Fi, GPS, Bluetooth. This enables users to access real-time information about the vehicle through mobile applications or web-based interfaces. Furthermore, these IoT-based systems support remote monitoring and data analysis, which helps in early detection of faults and preventive maintenance. Some research work also emphasizes the integration of advanced data analytics techniques to improve system reliability and efficiency. Overall,

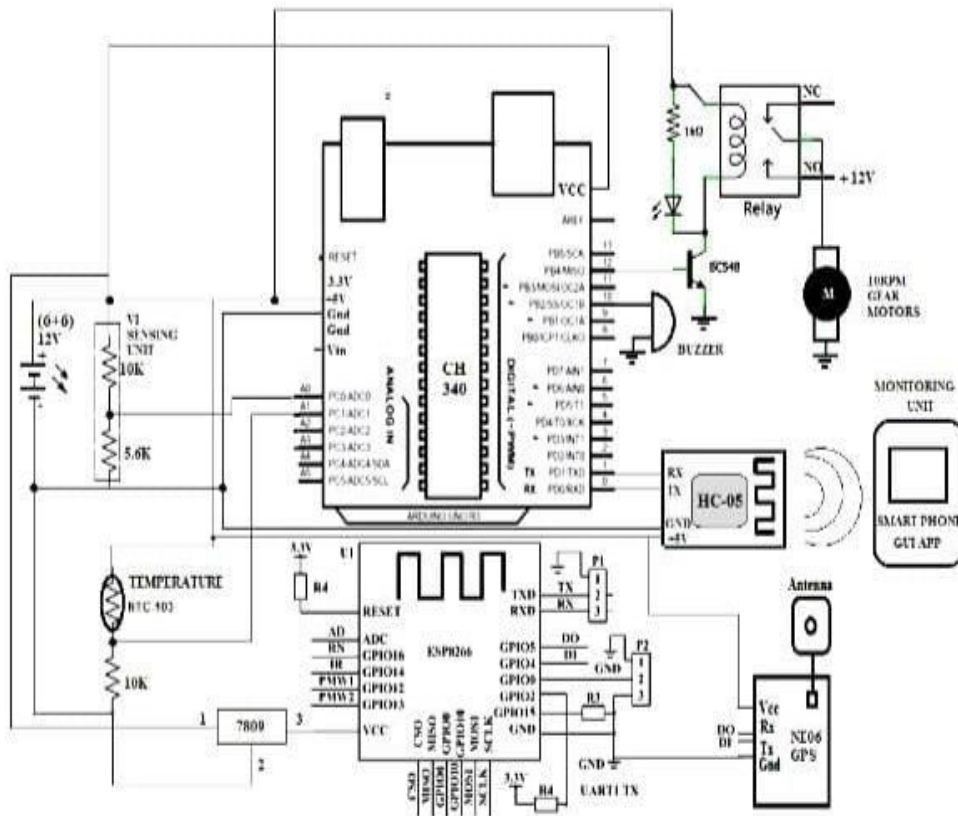


existing literature highlights the importance of combining wireless power transfer and IoT-based monitoring systems to enhance the performance, safety, and user convenience of electric vehicles

III. BLOCK DIAGRAM



IV. CIRCUIT DIAGRAM





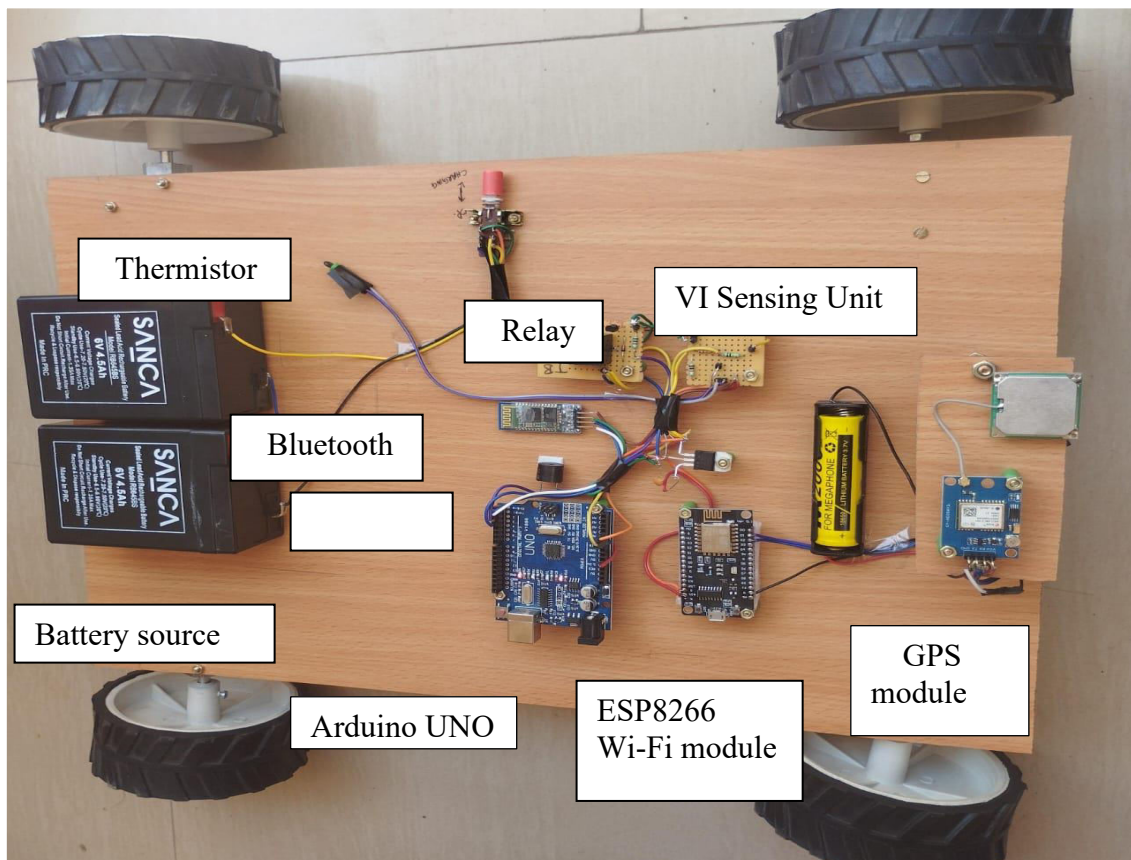
### V. HARDWARE IMPLEMENTATION

The hardware implementation of the proposed AI and IoT-based Electric Vehicle Monitoring System includes a microcontroller, sensors, communication modules, and a battery unit. The system is designed to monitor important battery parameters such as voltage, current, temperature, and the location of the vehicle.

The Arduino Uno microcontroller functions as the central controller of the system. It gathers data from various sensors and processes the information for monitoring. The battery voltage and current are measured using a resistive network based on Ohm’s Law, while the battery temperature is monitored using a thermistor sensor. A GPS module is integrated into the system to determine the real-time location of the vehicle. This module receives signals from satellites and provides location details such as latitude and longitude. The obtained location data is transmitted through the ESP8266 Wi-Fi module. ESP8266 sends the GPS information to a web server, and the generated IP address can be accessed through a web browser to track the vehicle’s location.

A Bluetooth module is used to enable communication between the hardware system and a mobile device. The module is paired with a terminal application installed on a smartphone. Using this application, users can monitor battery parameters such as discharge voltage, current, and temperature in real time.

The system also includes a buzzer, which serves as an alert mechanism. Whenever abnormal conditions such as high temperature or voltage fluctuations are detected, the buzzer produces a warning sound to notify the user. Additionally, the terminal application enables users to control certain system functions. Through Bluetooth communication, users can send commands from the terminal app to switch the system ON or OFF. Overall, the developed system allows real-time monitoring of battery parameters through the terminal application and enables vehicle location tracking through the web server.





## VI. HARDWARE COMPONENTS

### 6.1. Arduino Uno:

The Arduino Uno serves as the system's primary controller. It is built around the ATmega328 microcontroller and features multiple digital and analog input/output pins. This microcontroller processes data from sensors and manages communication modules.

### 6.2. ESP8266 Wi-Fi Module:

The ESP8266 module provides internet access for the system. It enables the microcontroller to send vehicle data to an IoT cloud platform via Wi-Fi, facilitating remote monitoring of vehicle parameters.

### 6.3. GPS Module:

The GPS module determines the vehicle's real-time location by receiving signals from GPS satellites. It supplies location details such as latitude and longitude, allowing users to track the vehicle remotely.

### 6.4. Temperature Sensor:

A thermistor temperature sensor is employed to measure the battery's temperature. The thermistor's resistance varies with temperature, enabling the system to detect changes in battery temperature.

### 6.5. Bluetooth Module:

The Bluetooth module allows communication between the monitoring system and mobile devices. Through Bluetooth connectivity, users can access vehicle data using a smartphone application.

### 6.6. Relay Module:

A relay module is used to control the power supply of the system. It acts as an electrically operated switch that can turn the battery connection ON or OFF based on system conditions. The relay can also be used to protect the battery by disconnecting the circuit if abnormal parameters such as high temperature or overvoltage are detected.

### 6.7. Battery Power Supply:

In the proposed system, the electric vehicle battery acts as the primary power source for the monitoring system. The battery provides the required electrical energy for operating the microcontroller, sensors, communication modules, and other electronic components. The battery voltage is supplied to the system through appropriate regulation circuits to ensure safe operation of the components. Since electronic components such as the Arduino microcontroller and communication modules require lower voltage levels, voltage regulation is used to convert the battery voltage into suitable levels.

The battery not only powers the monitoring system but also serves as the main parameter being monitored. Parameters such as battery voltage, current, and temperature are continuously measured to evaluate the battery condition and performance. Monitoring the battery power supply is essential to ensure safe operation of the electric vehicle and to prevent issues such as overcharging, overheating, and battery degradation.

### 6.8. Buzzer:

A buzzer is used as an alert system in case of abnormal conditions such as high temperature or battery faults. When the system detects unsafe parameters, the buzzer generates an audible warning to alert the user immediately. The system can be programmed to log fault events for diagnostic purposes, thereby enhancing reliability and user awareness. This alert mechanism not only prevents potential damage to the electric vehicle's components but also safeguards the user by prompting timely corrective action. By integrating the buzzer with the microcontroller, the system achieves real-time monitoring and rapid response, making it an essential part of the overall EV safety architecture.

### 6.9. Voltage Measurement using Ohm's Law:

In the proposed system, the battery voltage is measured using a resistive voltage divider circuit based on Ohm's Law. Since the battery voltage is higher than the safe input voltage of the microcontroller, a voltage divider network is used to reduce the voltage to a measurable range. The voltage divider consists of two resistors connected in series across the battery. According to Ohm's Law and the voltage division principle, the output voltage across the resistor is proportional to the input voltage.



The output voltage of the divider is given by:

$$V_{out} = V_{in} * (R_2 / (R_1 + R_2))$$

were

$V_{in}$  – Battery input voltage

$R_1, R_2$  – Resistor value

The reduced voltage is then fed into the analog input pin of the Arduino microcontroller, which converts the analog signal into digital values for monitoring.

#### 6.10. Current Measurement using Ohm's Law:

Current measurements in the system is performed using a shunt resistor method based on Ohm's Law. A small resistor with known resistance is connected in series with the battery circuit. When current flows through the shunt resistor, a small voltage drop occurs across it. According to Ohm's Law:

$$I = V/R$$

were

$I$  – Current flowing through the circuit

$V$  – Voltage drops across the shunt resistor

$R$  – Resistance of the shunt resistor

The voltage drop across the resistor is measured by the microcontroller using its analog input pin. By knowing the resistance value, the current flowing through the circuit can be calculated. This method provides a simple and cost-effective way to monitor battery current in electric vehicles

#### 6.11. Algorithm

Step 1: Start

Step 2: Initialize sensors (Voltage, Current, Temperature, GPS)

Step 3: Initialize microcontroller and communication module (Wi-Fi/GSM)

Step 4: Establish connection with IoT cloud platform

Step 5: Read sensor values (Voltage, Current, Temperature, Location)

Step 6: If sensor value < minimum threshold → set to safe value

Step 7: If sensor value > maximum threshold → generate alert condition

Step 8: Preprocess data (filter noise and normalize values)

Step 9: Transmit data to cloud using IoT protocol (MQTT/HTTP)

Step 10: Apply AI algorithm for data analysis and fault prediction

Step 11: If abnormal condition detected → send alert to user

Step 12: Update real-time data on mobile/web application

Step 13: Wait for a short delay

Step 14: Repeat from Step 5



VII. RESULT AND ANALYSIS

7.1 SOFTWARE OUTPUT (MOBILE APP)

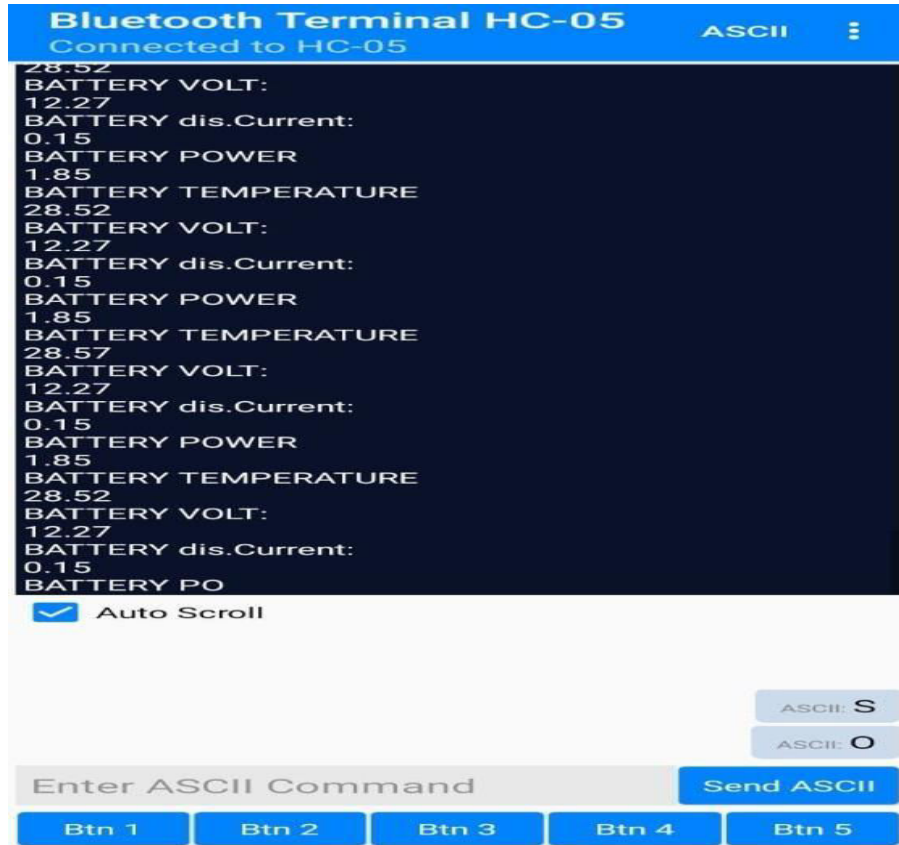


Fig.7.1 Smartphone App Displaying Real Time Battery Parameters

7.2 GPS TRACKING RESULT

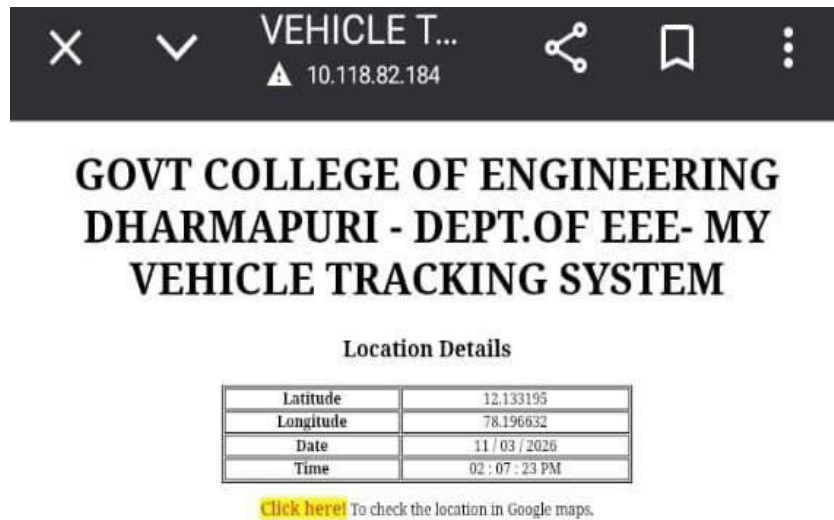


Fig.7.2 GPS Tracking Interface Showing Vehicle Location



### 7.3 PERFORMANCE GRAPH

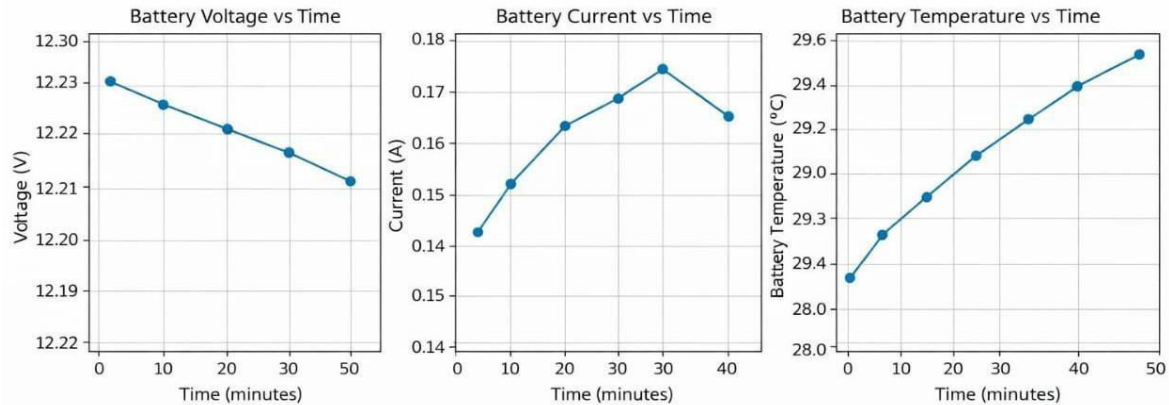


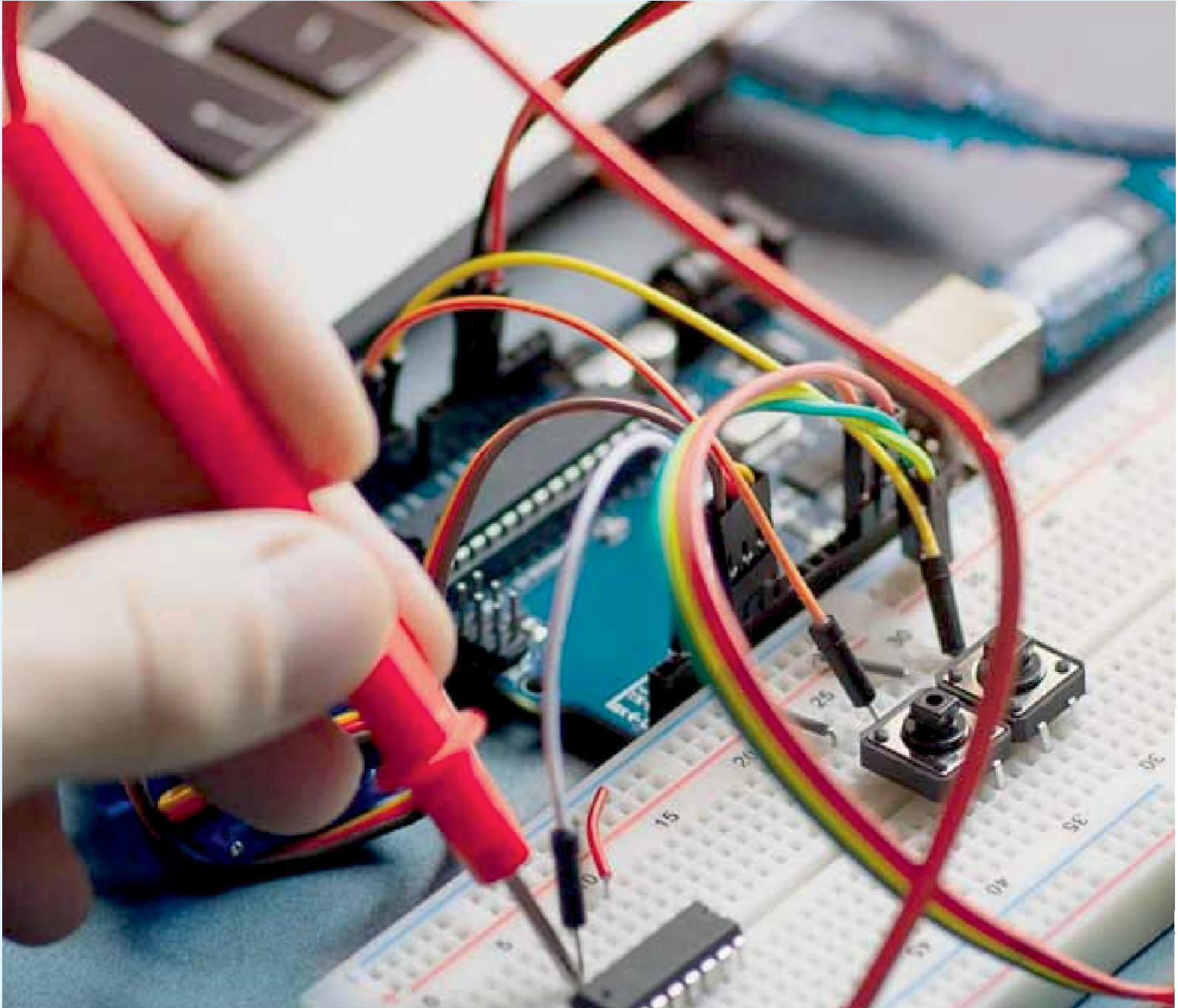
Fig.7.3 Performance analysis of EV battery showing voltage, current and temperature variation with respect to time

### VIII. CONCLUSION

This paper presents the design and implementation of an AI and IoT-based electric vehicle (EV) monitoring system for continuous battery performance analysis and real-time data communication. The proposed system effectively monitors critical battery parameters such as voltage, current, and temperature, enabling accurate assessment of battery condition and operational efficiency. The integration of IoT technology facilitates seamless data transmission through wireless communication networks, allowing users to remotely access vehicle status via mobile or web-based platforms. Additionally, the incorporation of AI techniques enhances the system's capability to analyse data, detect abnormalities, and predict potential faults at an early stage. The developed system ensures improved reliability, reduced manual intervention, and enhanced user convenience. Furthermore, the real-time monitoring and alert mechanism contribute to increased safety and extended battery lifespan. Overall, the proposed approach demonstrates a cost-effective and efficient solution for smart electric vehicle management.

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