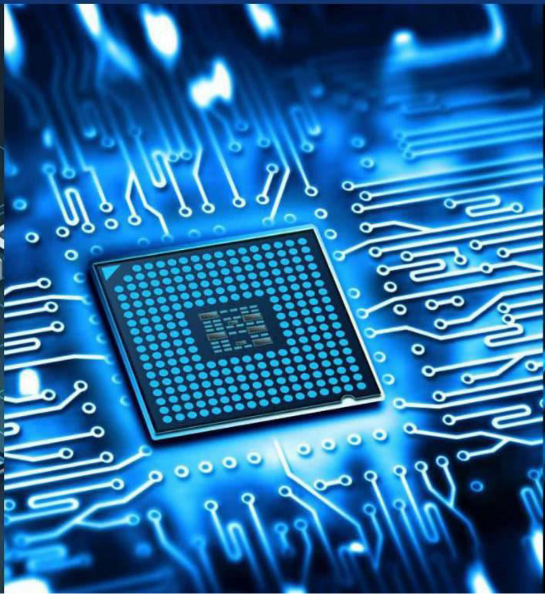
ISSN(O): 2320-9801
ISSN(P): 2320-9798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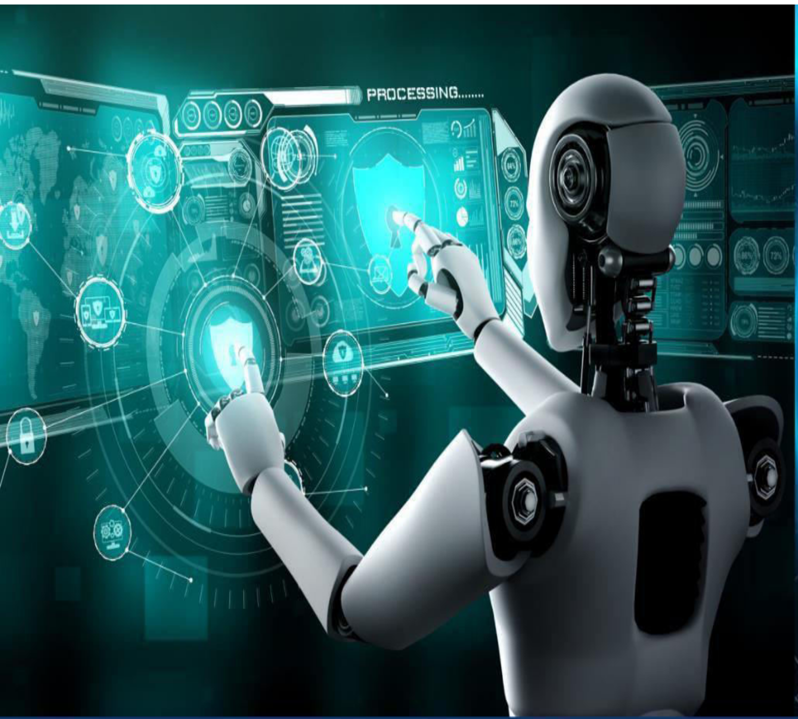

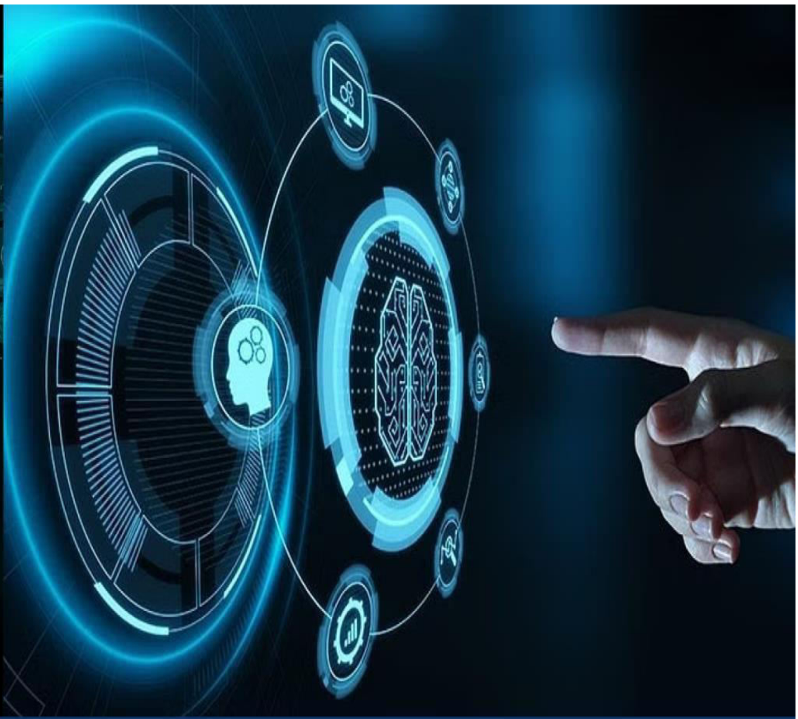

Impact Factor: 8.771

Volume 14, Issue 1, January 2026

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International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IOT Based Electric Vehicle Energy Consumption Predicting Device

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ABSTRACT: The rapid adoption of electric vehicles (EVs) has increased the need for efficient energy management and accurate prediction of power consumption. This project presents an IoT-based Electric Vehicle Energy Consumption Predicting Device that monitors real-time vehicle parameters and predicts energy usage during operation. Sensors are used to collect data such as battery voltage, current, speed, distance traveled, and temperature. The collected data is processed by a microcontroller and transmitted to a cloud platform through IoT communication modules.

KEYWORDS: IoT, Electric Vehicle, Energy Consumption Prediction, Battery Monitoring, Sensors, Real-Time. Data, Cloud Platform, Smart Mobility

I. INTRODUCTION

Electric vehicles (EVs) are becoming an important part of modern transportation due to their low emissions and high energy efficiency. However, one of the major challenges faced by EV users is uncertainty about energy consumption and remaining driving range. Accurate prediction of energy usage is essential for effective trip planning, battery management, and reducing range anxiety.

The **IoT-based Electric Vehicle Energy Consumption Predicting Device** addresses this challenge by continuously monitoring key vehicle and battery parameters using sensors. These parameters are processed in real time by a microcontroller and transmitted to a cloud platform through IoT technology. By analysing this data, the system predicts energy consumption and estimates the remaining range of the vehicle.

Energy consumption in electric vehicles is influenced by several factors such as driving speed, road conditions, load, battery health, and environmental temperature. Without proper monitoring and prediction, drivers may face unexpected battery depletion, leading to inconvenience and reduced confidence in EV technology. Therefore, a smart system capable of predicting energy consumption in advance is highly necessary.

This project helps drivers make informed decisions improves battery utilization supports development of smart and sustainable transport-tation systems.

II. METHODOLOGY

1. System. Initialization
The system starts by initializing the microcontroller, sensors, and IoT communication module. Calibration is performed to ensure accurate measurement of voltage, current, speed, and temperature.

2. Real-Time Data Collection
Sensors continuously monitor critical EV parameters such as battery voltage, current flow, battery temperature, vehicle speed, and distance traveled. This data reflects the real-time operating condition of the vehicle.

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3. Signal Conditioning and Data Processing
The raw sensor signals are filtered and converted into digital values by the microcontroller. Electrical parameters like power ($P = V \times I$) and total energy consumption are calculated using embedded algorithms.

4. Local Decision Making
The microcontroller performs preliminary analysis, such as detecting abnormal battery conditions or sudden energy drops, to ensure system reliability and safety.

5. IoT Data Transmission
The processed data is sent to a cloud server through an IoT module using wireless communication protocols such as Wi-Fi or GSM. Secure data transmission methods are applied.

6. Cloud Data Storage
The received data is stored in cloud databases, enabling long-term data logging and access from remote locations.

7. Energy Consumption Prediction Algorithm
Historical and real-time data are analyzed using predictive models to estimate future energy consumption and remaining driving range based on current driving patterns and battery status.

8. Visualization and monitoring
A web or mobile application displays real-time values, predicted energy consumption, battery status, and estimated range in an easy-to-understand format.

9. User Alerts and Recommendations
The system generates alerts for low battery levels and provides recommendations for efficient driving or timely charging.

10. Performance Evaluation
The predicted results are compared with actual energy usage to improve model accuracy and system performance over time.

III. REQUIREMENTS

Functional requirements:
Real-Time parameter Monitoring
The system shall continuously monitor key electric vehicle parameters such as battery voltage, current, temperature, vehicle speed, and distance traveled using appropriate sensors.

Accurate power calculation
The system shall calculate instantaneous power by multiplying measured voltage and current values and update this information in real time.
Energy Consumption Estimation

The system shall compute total energy consumption over time by integrating power data, providing energy usage per tip.

Battery Status Evaluation
The system shall assess battery health indicators Such as state of charge(SOC),temperature limits, and abnormal voltage or current conditions.

Energy Consumption Prediction
The system shall analyze historical and real-time data using predictive algorithms to estimate futureenergy consumption under current driving condition

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Data Accuracy and Reliability
The system shall ensure reliable operation with minimal data loss and maintain accuracy through sensor calibration and validation.

Non-functional requirements:
Performance: The system shall process sensor Data and update energy consumption and predicti -on results in near real time with minimal delay.
Accuracy: The system shall provide accurate measurement and prediction of energy consumpt-ion within acceptable error limits through proper sensor calibration and data processing.
Reliability: The system shall operate continuously without failure during vehicle operation and ensure consistent data collection and transmission.
Scalability: System shall support expansion to
multiple vehicles and handle increased data volume without performance degradation.
Security: The system shall ensure secure data transmission and storage using authentication and basic encryption techniques.
Usability: User interface should be simple, intuitive, and easy to understand.
Maintainability: The system should be east to maintain and update.Firmware,software and could components must allow straightforward debugging,updates and feature enhancements without major system changes.

Use Case
This use case, an electric vehicle (EV) driver uses the IoT-based energy consumption predicting device to monitor and manage the vehicle's energy usage during operation. When the vehicle is powered on, the system automatically collects real-time data from various sensors measuring battery voltage, current, temperature, speed, and distance traveled. This data is processed by the microcontroller to calculate power and total energy consumption, and then transmitted to a cloud platform through IoT communication.

IV. SYSTEM ARCHITECTURE

The system architecture consists of sensing,processing, communication and application layers working together to predict electric vehicle energy consumption.
Sensing layer: This layer includes sensors such as voltage sensors,current sensors and speed/distance sensors.These sensors continuously collect real-time related to the battery and vehicle operation.
Processing layer: A microcontroller(Arduino/ESP32) acts as the central processing unit.It receives raw data from the sensors, performs signal conditioning, calculates power and energy consumption and prepares data for transmission.
Communication layer: An Iot communication module is integrated with the microcontroller to transmit process data wirelessly to the cloud platform in real time.
Application layer: A web or mobile application displays real-time sensor values,energy consumption trends, pred-icted range and alerts.This layer provides user interaction and remote monitoring.
Cloud layer: The cloud platform receives data from the Vehicle, stores it in a database and performs data analysis. Prediction algorithm use both real-time and historical data.

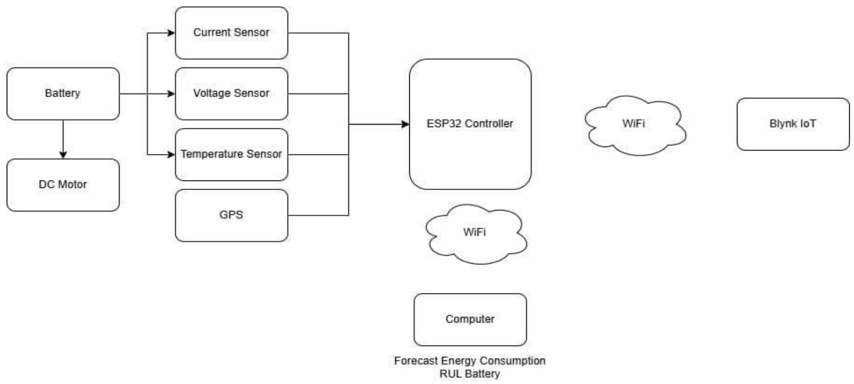

Fig 1: System Architecture

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V. WORK FLOW

1. Data Acquisition (Sensing Layer)

Sensors installed in the electric vehicle collect real-time operational data:

- Battery parameters: Voltage, Current, State of Charge (SoC), State of Health (SoH)
- Vehicle parameters: Speed, acceleration, motor RPM, load
- Environmental parameters: Temperature, road gradient, traffic conditions
- Driving behaviour: Braking pattern, throttle usage

2. Data Processing (Embedded System Layer)

- A microcontroller / embedded board (ESP32, Arduino, Raspberry Pi, etc.) reads sensor data.
- Raw data is:
  - Filtered (noise removal)
  - Normalized
  - Converted into usable digital values

3. Data Transmission (Communication Layer)

Processed data is transmitted using IoT communication technologies:

- Wi-Fi
- GSM / LTE
- Bluetooth (short range)
- MQTT / HTTP protocols

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Processed data is transmitted using IoT communication technologies:

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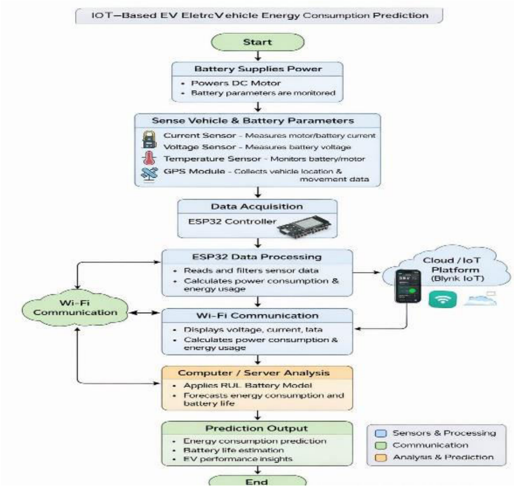
- MQTT / HTTP protocols

5. User Interface (Application Layer)

- Information displayed on:
  - Mobile App
  - Web Dashboard
  - Vehicle display unit
- Shows:
  - Predicted range
  - Energy consumption graph
  - Battery health
  - Charging station suggestions

6. Feedback & Continuous Learning

- User driving behaviour and actual consumption are fed back to the system.
- Prediction models are updated periodically.



Flowchart

VI. FUTURE SCOPE

The future scope of the IoT-based electric vehicle energy consumption predicting device is highly promising with advancements in intelligent technologies. The system can be further improved by incorporating advanced machine learning and artificial intelligence algorithms to enhance prediction accuracy under varying driving and environmental conditions. Integration of GPS and real-time traffic data can enable route-based energy consumption prediction, helping drivers select the most energy-efficient paths.

system can also be extended for fleet management applications, allowing monitoring and optimization of multiple electric vehicles simultaneously. Additionally, battery health analysis and remaining useful life prediction can be included to support preventive maintenance and prolong battery lifespan. Integration with smart charging infrastructure and smart city systems can further enhance energy planning and sustainability. These future enhancements will make the system more robust, scalable, and suitable for widespread real-world adoption.

VII. CONCLUSION

In conclusion, the IoT-based electric vehicle energy consumption predicting device provides an effective solution for monitoring and managing energy usage in electric vehicles. By integrating sensors, embedded systems, IoT communication, and predictive analytics, the system enables real-time monitoring of vehicle parameters and accurate estimation of energy Consumption and remaining driving range. This helps reduce range anxiety, improve trip planning, and promote efficient battery utilization. The proposed system demonstrates how IoT technology can enhance the performance, reliability, and user experience of electric vehicles. Overall, this project contributes to the development of smart, sustainable transportation systems and supports the growing adoption of electric mobility.

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