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# IoT-Based Wireless Battery Surveillance and Management System

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## Abstract

This research offers an Internet-of-Things (IoT) based battery surveillance machine for electric powered motors (EVs). The machine, is built using ESP32 microcontroller and Blynk IoT Cloud, to monitor the battery health in real-time. . The is equipped with sensors, to collects important facts along with voltage and charging styles. In case of faults, alerts are sent for prompt action. The ESP32 wirelessly transmits facts to the Blynk IoT Cloud platform, enabling the system to track and manage. Through a consumer-friendly interface, key parameters are visualized, facilitating proactive battery control. Additionally, the device offers Wi-Fi charging abilities through inductive coils, enhancing comfort. This included the capability to optimize EV battery overall performance and strengthen electric automobile technology.

**Keywords:** IoT, EV, Wireless Charging, Battery Surveillance.

## 1. Introduction

The integration of Internet-of-Things (IoT) era with electric powered car (EV) battery tracking addresses a vital challenge within the car enterprise: the gradual degradation of battery overall performance through the years and electric cars closely depend upon battery strength, making any decline in strength deliver a significant issue impacting vehicle overall


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performance and leads to degradation. To deal with this challenge, we propose a singular IoT-primarily based battery surveillance gadget designed to evaluate and monitor the performance of electric car batteries in reall-time.

Our proposed system incorporates two key additives: a monitoring device and a user interface. The wireless battery surveillance system makes use of superior technology along with the ESP32 microcontroller and Blynk IoT Cloud to offer green and reall-time tracking of battery fitness. With the sensors, the machine gathers data along with voltage, percent, charging, and discharging, making sure complete insight into the battery's universal overall performance. In the event of a fault detection, the machine at once sends indicators to the client, notifying them of capability problems and allowing timely intervention.The ESP32 microcontroller serves as the exchange hub, wirelessly transmitting records to the Blynk IoT Cloud platform. The Blynk IoT Cloud allows seamless far off tracking and control, allowing customers to get admission to the battery fame from anywhere with a web connection. Through a consumer-pleasant interface, the Cloud platform visualizes the records, showing key parameters and producing signals for extraordinary conditions. Additionally, our machine gives wireless charging station competencies through inductive coils, further improving convenience and usefulness for user. Inductive charging, is increasingly used in number of electric powered and hybrid cars, that operates at the precept of electromagnetic induction. Within a Wi-Fi charging gadget, a charging pad is geared up with a coil of cord that generates an electromagnetic wave when an electric power passes through it. Simultaneously, the car is positioned with a corresponding receiver coil, usually positioned below it. When the automobile is placed over the charging pad, the receiver coil aligns with the electromagnetic waves produced by means of the pad. This alignment enables the transfer of energy between the 2 coils. As the electromagnetic region interacts with the receiver coil, it induces an alternating current(AC) inside it. Efficient alignment between the charging pad and receiver coil is essential for the most efficient charging performance. Safety issues and compliance with standards remain paramount in the development and application of inductive charging technologies for automotive systems

Wi-Fi battery monitoring tools are designed for packages ranging from renewable energy storage to portable electronic devices, ensuring their active control optimizes battery life and overall performance by combining ESP32 and Blynk IoT Cloud.

The system provides a reliable and scalable solution for battery status monitoring. Through experimental verification, our results demonstrate the efficiency of the device to efficiently detect defective batteries in all operations, thus contributing to the development of electric vehicle generation.

## 2. Literature Review

Recent wireless battery surveillence have garnered significant attention in recent years due to their potential to revolutionize manufacturing, prototyping, and various other industries. A comprehensive review of existing literature reveals a plethora of studies focusing on the design, functionality, and applications of the project.

This research holds significant promise for the advancement of electric vehicle technology, as effective battery management is crucial for enhancing EV performance, range, and longevity. By employing IoT solutions, the proposed BMS (battery management system) offers a more proactive and data-driven approach to battery management, which could lead to improved overall efficiency and sustainability in the electric vehicle industry[1].

This approach not only enhances the reliability and safety of electric vehicles but also contributes to the development of smarter and more interconnected transportation systems. As the demand for electric vehicles continues to grow, innovations like this IoT-based BMS play a crucial role in addressing the challenges associated with battery performance and management in the electrified transportation sector[2].

The review delves into the various aspects of wireless charging technology, exploring its potential applications, technical specifications, and advancements in the field. Wireless charging stations offer the convenience of charging EVs without the need for physical cables, paving the way for seamless integration into urban environments and enabling effortless charging experiences for EV owners.The review covers key topics such as the underlying principles of wireless charging, including inductive and resonant charging techniques, as well as the efficiency and safety considerations associated with wireless charging systems. [3].

The review delves into the various wireless charging technologies, such as inductive and resonant charging, highlighting their respective advantages and limitations. Additionally, it addresses key considerations such as charging efficiency, interoperability, and standardization efforts aimed at ensuring compatibility across different wireless charging systems. By synthesizing insights from existing research and developments, The author's review serves as a valuable resource for researchers, practitioners, and policymakers seeking to understand the current landscape and future prospects of wireless charging technology for electric vehicles. [4].

The study explores various aspects of wireless charging station design, including power transfer efficiency, alignment optimization, and compatibility with different EV models. Additionally, it investigates implementation challenges such as cost considerations, regulatory compliance, and the integration of wireless charging infrastructure into existing urban environments. By identifying and analyzing these challenges, contributing to the ongoing dialogue surrounding the development and adoption of wireless charging technology for electric vehicles. [5].

The research addresses the growing demand for effective battery management solutions in the electric vehicle industry, where maximizing battery efficiency and lifespan is crucial for widespread adoption. Through the implementation of IoT-based wireless technology, aim to revolutionize battery management practices, enabling remote monitoring and diagnostics for proactive maintenance and timely interventions. This approach not only improves the reliability and safety of electric vehicles but also contributes to the development of smarter and interconnected transportation systems.[6].

The research addresses the growing demand for innovative battery management solutions in the electric vehicle industry, where effective management of battery health and performance is critical for optimizing vehicle range and longevity. The authors in [7]focuses on designing a system that not only ensures accurate monitoring of battery parameters but also enables efficient data transmission and analysis. By utilizing wireless communication protocols, the wireless BMS facilitates real-time monitoring of battery status, enabling proactive maintenance and timely interventions to prevent potential issues or failures..

The research addresses the growing demand for smart charging solutions in the electric vehicle industry, where seamless integration of charging infrastructure with IoT technology is crucial for optimizing charging efficiency and user experience. The authors focus on designing a system that not only wirelessly charges EVs but also enables remote monitoring and control through IoT-enabled sensors and communication modules. This approach not only simplifies the charging process for EV owners but also facilitates intelligent management of charging stations, leading to improved operational efficiency and sustainability.[8]

The authors likely explore how IoT sensors and connectivity can enhance the functionality and efficiency of wireless charging stations. They may delve into how IoT enables real-time monitoring of charging status, energy consumption, and remote management of charging infrastructure, contributing to a more seamless and convenient user experience for EV owners.[9]

The authors likely discuss the significance of wireless charging in the context of EV infrastructure, highlighting its potential to simplify the charging process and improve user experience. They might delve into the technical aspects of the system, such as the underlying charging mechanism, communication protocols used for IoT integration, and the feasibility of deployment in real-world scenarios. Overall, the paper likely contributes to the growing body of research aimed at advancing sustainable transportation solutions through innovative technologies like wireless charging and IoT.[10]

The authors likely discusses how IoT enables wireless communication between the battery cells and the central control unit, allowing real-time monitoring of individual cell health, temperature, and voltage. This wireless approach improves efficiency and reduces maintenance costs compared to traditional wired systems. Moreover, they might explore how IoT connectivity facilitates remote diagnostics, firmware updates, and predictive maintenance, enhancing the overall reliability and longevity of EV batteries. This research contributes to the advancement of EV technology, addressing key challenges in battery management through innovative IoT integration.[11]

Wireless charging eliminates the need for physical cables, providing a more convenient and user-friendly solution for EV owners. The authors likely detail aspects such as power transfer efficiency, safety protocols, and the integration of this system with existing EV infrastructure.[12]

The paper addresses the growing need for efficient battery monitoring and management in the EV industry. By leveraging IoT, the proposed system enables real-time monitoring of battery health, performance, and charging status wirelessly. This enhances the overall efficiency and reliability of EV battery management, contributing to the advancement of sustainable transportation solutions.[13].

The smart battery management system described in the paper offers a range of advanced features, including predictive maintenance based on data analytics, remote monitoring and control via IoT-enabled devices, and adaptive charging algorithms to maximize battery longevity. By harnessing the power of IoT, the authors demonstrate how EV manufacturers and users can benefit from improved safety, reduced operational costs, and enhanced user experience. The paper highlights the potential of IoT-driven solutions in revolutionizing the automotive industry, particularly in the context of electric mobility [14].

The authors, Roy, Koustav, and their collaborators, propose a system that integrates IoT sensors with advanced communication systems to gather data on various parameters such as battery temperature, voltage, and current. This data is then analyzed to assess the health and status of the batteries, enabling proactive maintenance and management strategies. By employing IoT, the system enables remote monitoring and control, allowing for timely interventions to prevent battery degradation and maximize vehicle range and lifespan. [15].

## 3. Proposed System

The project aims to explore recent developments in electric vehicle (EV) battery management and wireless transmission technologies. It aims to evaluate the integration of Internet of Things (IoT) technologies in battery monitoring systems and consider the development of wireless charging solutions, especially inductive charging systems Through advanced research the project increases battery performance , extends battery life of user. It also seeks to identify opportunities to improve the experience and ultimately the project aims to contribute to the development of EV technology and promote sustainable.

The methodology is said to be described as that, Firstly the system is configured, including all necessary hardware components. The ESP32 microcontroller acts as a central component, along with sensors to monitor battery parameters and inductive charging coils.

Hardware configuration follows, where the ESP32 microcontroller is configured and connected to selected sensors, including voltage, current,and temperature sensors. The system also integrates inductive charging coils. Then, software development begins, focusing on data collection, transmission, and processing. The ESP32 microcontroller is planned to collect sensor data and transmit it wirelessly to the Blynk IoT Cloud platform. User interfaces have been developed for remote monitoring and control.

The accuracy of the sensor measurement, the performance of the wireless data transmission, and the efficiency of the charging system are checked in different conditions. Optimization and fine-tuning are then performed to increase system performance and performance. Implementation of the system for real-world applications follows, with seamless integration into user interfaces such as mobile applications or web-based platforms. Users have access to intuitive interfaces to check battery status, receive alerts and manage charge remotely.

Data management and cloud integration have been used to store and manage sensor readings, data creation and user interactions. Cloud platforms facilitate centralized data storage, analysis and access. Emergency and reports are combined to identify unusual events or emergencies, such as battery faults or battery-related problems. Automated notifications are sent to users or emergency personnel for timely intervention.

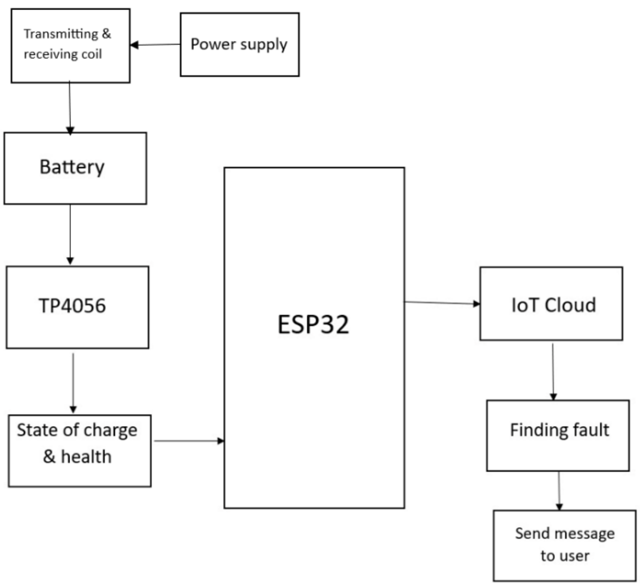


**Figure 1.** Proposed System Architecture

Following this approach, IoT-based battery monitoring systems and wireless charging technology can be optimized, tested and deployed to address the challenges of electric vehicle battery management and charging as described above.

These are the hardware components are needed given below.

**Table 1.** Hardware Components

| S.No | Components | Units |
|---|---|---|
| 1 | Arduino UNO | 1 |
| 2 | IR SENSOR | 2 |
| 3 | Lithium Ion Battery | 1 |
| 4 | LCD | 1 |
| 5 | RELAY | 2 |
| 6 | Inductive coil | 1 |
| 7 | TP4056 Module | 1 |
| 8 | Charging module | 1 |
| 9 | ESP8266 | 1 |
| 10 | LED | 1 |
| 11 | Resistors | 2 |
| 12 | Connecting wires | few |

## 4. Results and Discussion

Experimentation and implementation of the proposed battery monitoring and wireless charging system begins with thorough planning and component selection. The battery monitoring and wireless charging system integrates two critical functionalities: battery monitoring utilizing the TP4056 charging module and a wireless charging station comprising various hardware components. The TP4056 module serves as the cornerstone for monitoring the battery's charge health and state, capturing essential metrics such as voltage, current, and charging status. This data offers valuable insights into the battery's performance and overall health. This chapter deals with the results and discussion of the proposed portable 3D printer with adjustable platform for versatile application... The setup for the proposed system is shown in Figure given below.

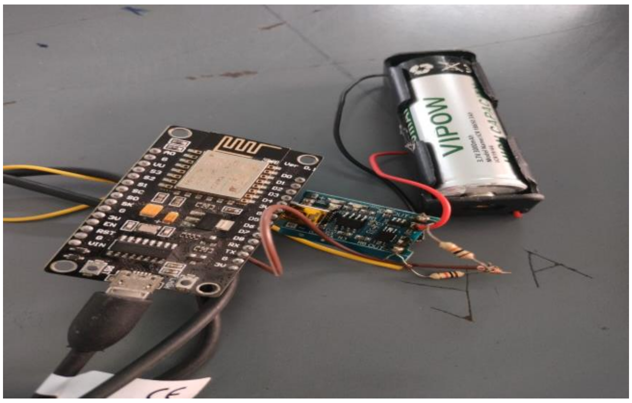

**Figure 2.** Hardware Setup with ESP8266

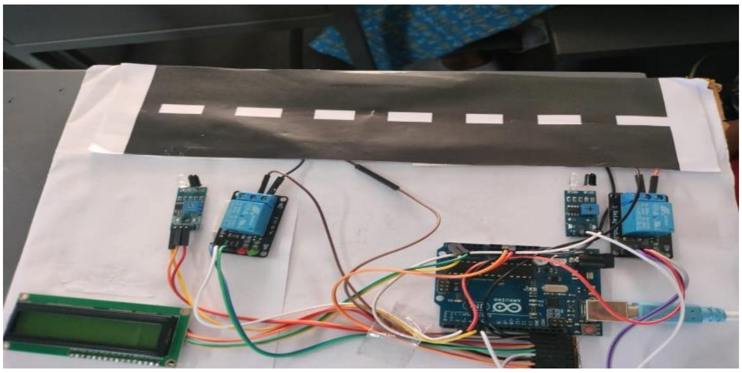

**Figure 3.** Hardware Setup with Arduino UNO

Conversely, the wireless charging station encompasses a range of hardware elements, including a voltage regulator, Arduino Nano microcontroller, IR sensor, LCD display, and inductive coil. Each component plays a crucial role in facilitating efficient wireless charging and providing a seamless user experience which makes it easier for user.The voltage regulator ensures a stable power supply, while the Arduino Nano manages the charging process, orchestrating the flow of current to the inductive coil through it.

The IR sensor serves as a detection mechanism, identifying the presence of a battery placed on the charging pad and initiating the charging process accordingly. The LCD display offers visual feedback, indicating available charging slots and the charging status of connected devices, enhancing user convenience and control over the charging process.

Data gathered from both the battery monitoring module and the wireless charging station are aggregated and processed by an ESP32 microcontroller. This centralized processing unit ensures efficient data management and facilitates seamless communication between the various system components. The processed data is then transmitted to the Blynk IoT Cloud for storage and visualization purposes. In the event of any anomalies or faults detected during operation, the system triggers notifications to users via the Cloud platform, ensuring prompt intervention and maintenance.bDuring the experimentation phase, the system undergoes comprehensive testing to validate its functionality, reliability, and user-friendliness. User feedback is solicited and incorporated into iterative improvements, driving enhancements in performance and usability. Upon successful testing, the system is deemed ready for real-world deployment, where it continuously monitors battery health and provides reliable wireless charging services Routine maintenance procedures are established to uphold the system's operational integrity and ensure ongoing performance optimization. By aligning with the project's objectives of effective battery management and user convenience, the system strives to deliver a seamless and reliable charging experience for users.

The sensors along with the microcontroller are all integrated with the IoT-based system's circuit design along with it.The output of battery voltage will be displayed from the module and this output is shown in the Blynk IoT Cloud.Here the voltage from the battery along with the state of charging will be displayed so that the user will know their status in the Cloud. The output of battery percentage will be displayed from the module and this output is shown in the Blynk IoT Cloud.Here the percentage from the battery along with the state of discharging will be displayed so that the user will know their status in the Cloud.And it shown below of them. The system's sensor data collection and analysis reliability is highly important. It must give reliable and exact readings to accurately monitor. The system's accuracy and dependability must be protected throughout time. sensors, and the main of the operation should be able to communicate reliably no matter the weather or other external factors.

The reliability of sensor data collection and analysis is paramount in the wireless battery monitoring system. Accurate and precise readings are essential for effectively monitoring battery health and performance over time. The system must ensure consistent communication between sensors and the central processing unit, irrespective of external factors or environmental conditions.

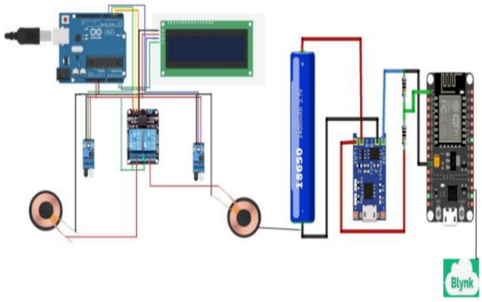


**Figure 4.** Circuit Diagram

Timely alerts and notifications are critical components of the system's functionality, enabling users to respond promptly to any abnormalities detected in the battery's behavior. Rapid detection of faults or deteriorating performance can prevent potential hazards and ensure optimal battery functionality. The system's capacity to support multiple sensors and wearables simultaneously is essential for scalability and accommodating varying user needs. Overall, the wireless battery monitoring system aims to deliver enhanced safety, remote accessibility, and real-time monitoring capabilities through continuous data collection, accurate analysis, and seamless integration with Cloud-based platforms. By addressing the limitations of conventional battery monitoring systems, such as limited real-time monitoring and communication capabilities, the proposed system offers a comprehensive solution for proactive battery management and optimization.

The output displayed in the cloud app is displayed below

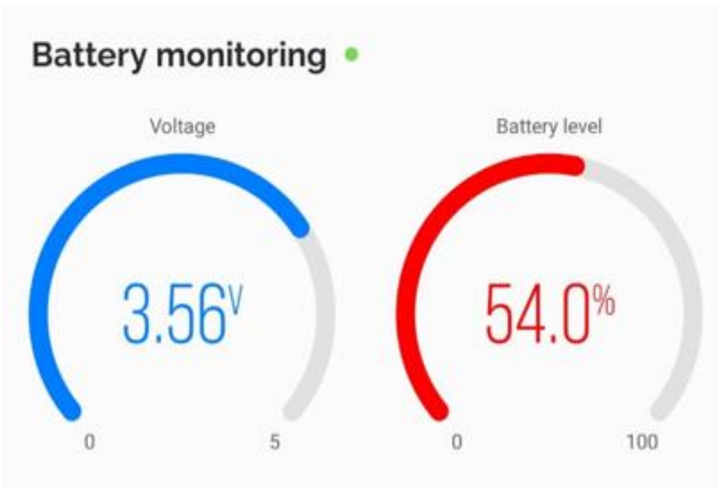


**Figure 5.** Data in the Cloud

## 5. Conclusion

The proposed IoT-based wireless battery monitoring system offers a solution for managing battery health and performance. Through the integration of components including the ESP32 microcontroller, TP4056 charging module, voltage regulator, Arduino Nano, and inductive coil, the system facilitates real-time monitoring and fault detection. With features such as remote monitoring via the Blynk IoT Cloud platform and wireless charging capability, user convenience is significantly enhanced while ensuring optimal battery lifespan. This system represents a substantial advancement in battery management technology, promising heightened reliability and performance across a spectrum of applications. Its implementation with efficient battery monitoring and underscores its potential to revolutionize various applications.

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