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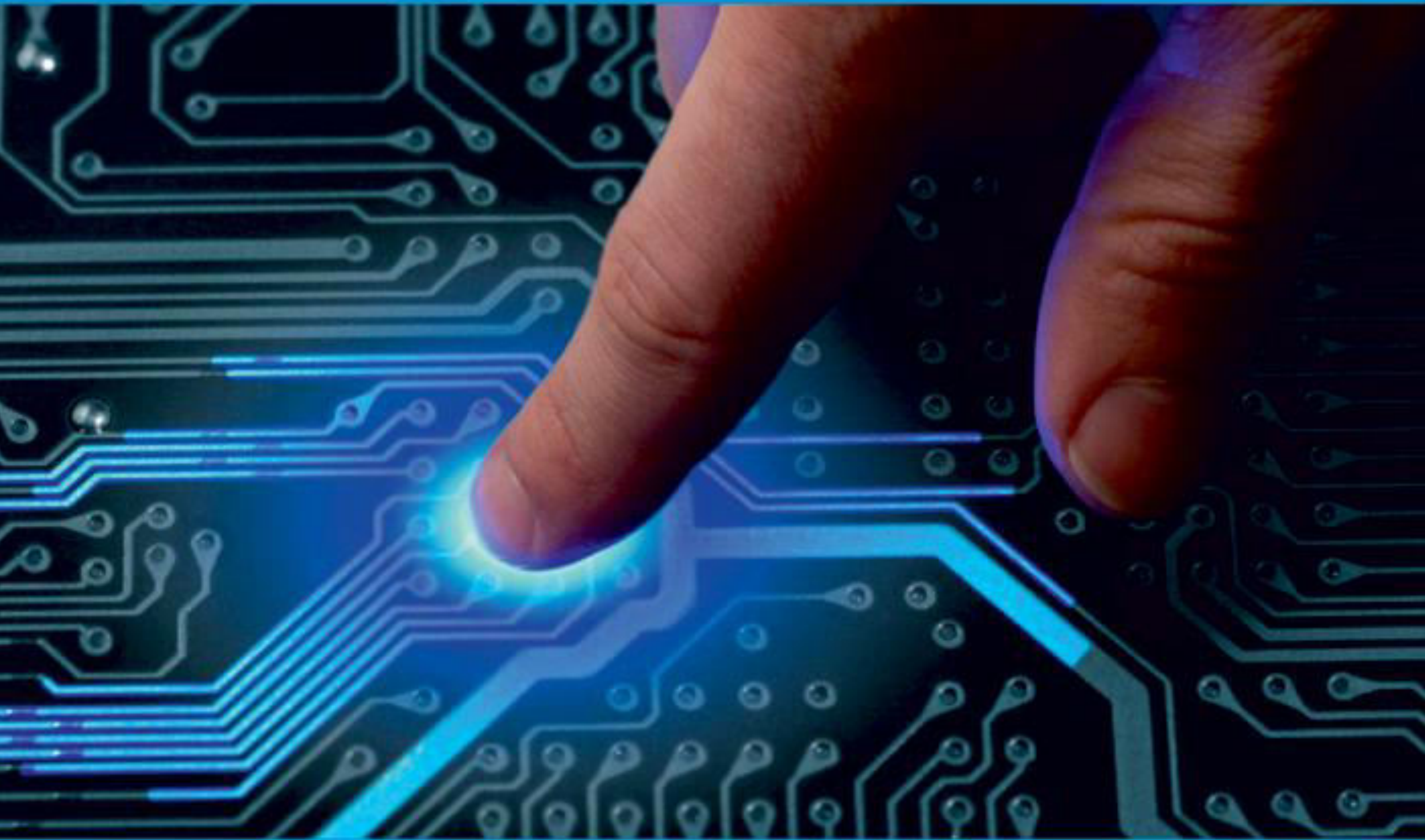

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Battery Status Monitoring System Using ESP8266 & Arduino IoT Cloud

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ABSTRACT: This paper proposes a low-cost battery monitoring system for IoT devices. It uses an ESP8266 Wi-Fi module to collect battery data and send it to the Arduino IoT Cloud for remote monitoring. The system includes sensors, an ESP8266, and a user-friendly dashboard. It can display real-time battery health and allow for historical data analysis and alerts. To save power, the system uses active/sleep cycles and the efficient MQTT protocol. The paper also explores using finite automata to model power consumption and demonstrates significant battery life extension through these techniques.

KEYWORDS : Battery Monitoring System (BSMS); Internet of Things (IoT); ESP8266 (low-cost Wi-Fi module); Arduino IoT Cloud; Sensor data (battery voltage); Real-time visualization; Energy efficiency; Active/Sleep Power Management; MQTT protocol (lightweight communication); Extended battery life; Reduced maintenance costs

I. INTRODUCTION

The rise of Internet of Things (IoT) devices has made efficient battery management a top priority across various industries. Traditional methods often lack real-time data, remote access, and proactive maintenance capabilities, leading to disruptions and unnecessary replacements. This paper proposes a novel Battery Status Monitoring System (BSMS) that leverages the power of ESP8266 and Arduino IoT Cloud to address these limitations.

The core of the BSMS is the ESP8266 module, a cost-effective and low-power microcontroller with built-in Wi-Fi. It handles wireless communication and data processing. This functionality is further enhanced by Arduino IoT Cloud, a robust cloud platform designed for managing IoT devices. The platform collects sensor data and presents it through user-friendly dashboards, allowing for remote monitoring of battery health from anywhere with an internet connection.

The BSMS goes beyond simple monitoring by offering real-time insights into battery health and performance. This enables proactive maintenance, allowing users to identify potential issues before they escalate and cause downtime. By seamlessly integrating hardware, software, and cloud infrastructure, the BSMS achieves scalability, reliability, and accessibility, making it suitable for a wide range of IoT applications. This innovative approach not only overcomes the limitations of existing methods but also sets a new standard for comprehensive battery monitoring solutions in the IoT ecosystem.

II. LITERATURE REVIEW

The explosion of Internet of Things (IoT) devices and the rise of renewable energy systems have placed a spotlight on efficient battery management. This review dives into key research to explore the cutting-edge advancements in battery management systems (BMS).

For IoT applications, researchers are pioneering the use of Wireless Sensor Networks (WSNs) for data collection and communication within BMS. Studies by Yadav et al. [1] and Banerjee et al. [2] delve into the nitty-gritty of WSN-based BMS design for IoT. They explore factors like communication protocols, energy-efficient algorithms, and specific considerations for integrating WSNs into BMS. Banerjee et al. [2] take it a step further, examining how IoT

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technologies can be harnessed for real-time monitoring, data analysis, and remote management of batteries used in diverse industries.

The realm of BMS extends beyond IoT. Several studies explore advancements in wireless BMS technologies. Liu et al. [3] offer a comprehensive review, analyzing various wireless communication methods, battery monitoring techniques, and energy management strategies employed in wireless BMS. This study also sheds light on the challenges and opportunities that lie ahead in this field, along with recent breakthroughs.

Moving towards application-specific designs, Amin and Hossain [4] present the design and implementation of a BMS specifically tailored for renewable energy applications. Their work details the seamless integration of sensors, microcontrollers, and communication modules to enable real-time monitoring and control of batteries within these systems.

The specific challenges of monitoring batteries in electric vehicles (EVs) are addressed in studies by Patil et al. [5] and Gao et al. [6]. These studies review BMS designed specifically for EVs, focusing on critical aspects like accuracy, reliability, and safety. They delve into various techniques and technologies employed in EV BMS design, including battery modeling, state estimation, thermal management, and fault diagnosis.

In conclusion, this review paints a vivid picture of the active research landscape surrounding battery management systems. From WSN-based communication for IoT devices to wireless technologies for broader applications, and further specialization for renewable energy and electric vehicles, advancements in BMS design are the key to optimizing battery performance and ensuring efficient operation across diverse fields. These innovations will continue to empower a future powered by reliable and sustainable battery management solutions.

III. RELATED WORK

The increasing popularity of Internet of Things (IoT) applications has driven research towards efficient battery monitoring systems. This review analyzes several key studies focusing on cost-effectiveness, ease of use, and practicality in various IoT fields like weather monitoring and agriculture. However, these studies also reveal limitations that need to be addressed.

Existing research offers valuable insights. One study presented a versatile control system design using the ESP8266 module, but limitations include cost and limited data transmission range. Another proposed a cost-effective IoT system for monitoring solar panel parameters, but weather heavily influences the output, and the circuit design is complex.

A study focusing on power consumption optimization in an IoT-based weather monitoring system highlights the importance of solar panel maintenance and deep sleep mode optimization. However, it acknowledges the need for higher-efficiency panels in cloudy conditions and potential limitations due to solar panel degradation over time.

Another research explored power consumption models for ESP8266-based monitoring nodes, demonstrating significant battery life extension through sleep mode optimization. However, the study acknowledges the increased complexity of the system compared to other approaches.

Finally, a study proposed a system for real-time remote object monitoring using the ESP8266 module. While exploring future advancements, the possibility of a more complex system design with additional modules arises.

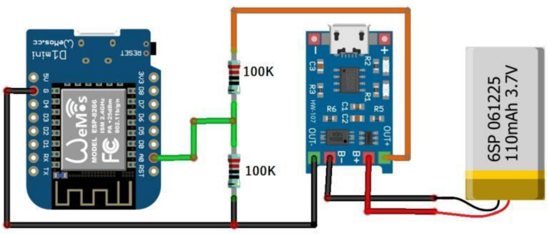

Fig. 1. Battery Status Monitoring System Circuit

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By examining these papers, we identify a critical need for a battery monitoring system that prioritizes low cost for widespread adoption, simplicity for ease of use, and reliability for consistent data collection. This review paves the way for further research aimed at developing a battery monitoring system that overcomes these limitations. The ideal system will be simple, cost-effective, and reliable, making it a valuable tool for optimizing battery performance across diverse IoT applications.

V. RESULT

Traditional battery management struggles to keep up with the demands of the growing Internet of Things (IoT) landscape. These methods often lack real-time data, remote access, and proactive maintenance capabilities, leading to unnecessary downtime and battery replacements. To address these limitations, a novel Battery Status Monitoring System (BSMS) is proposed. This system leverages the power of low-cost ESP8266 microcontrollers and the user-friendly Arduino IoT Cloud platform. By combining wireless communication, data processing, and cloud-based dashboards, BSMS offers real-time insights into battery health, enabling proactive maintenance and preventing disruptions before they occur. This innovative approach, seamlessly integrating hardware, software, and cloud infrastructure, sets a new standard for comprehensive battery monitoring solutions within the ever-expanding IoT ecosystem.

IV. CONCLUSION

As the Internet of Things (IoT) expands, efficient battery management becomes crucial for reliable device operation. This paper proposes a novel battery monitoring system that combines the power of ESP microcontrollers, Arduino, and cloud platforms like ThingSpeak. This system aims to overcome the shortcomings identified in existing research, focusing on simplicity, compactness, and reliable data collection.

Many existing IoT and ESP-based battery monitoring systems suffer from complexity, making them difficult to set up and maintain. Additionally, bulky designs limit their use in space-constrained environments. Furthermore, some systems struggle with inaccurate outputs under harsh conditions or due to unnecessary features that can affect predictions.

By utilizing these readily available components, the proposed system aims to achieve a simplified design for easy setup and maintenance. Additionally, the system will be compact, making it suitable for deployment in space-constrained locations. Finally, the system will focus on core functionalities to ensure reliable data collection. Users can access real-time battery life data (percentage remaining) on the cloud platform, enabling proactive maintenance and resource management.

This streamlined approach not only addresses the limitations identified in existing research but also paves the way for a more user-friendly and cost-effective solution for battery monitoring in diverse IoT applications.

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