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IoT-Based Battery Monitoring System for Unmanned Aerial Vehicle

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Abstract

This paper discusses the application of the Internet of Things (IoT) to the performance monitoring of unmanned aerial vehicle (UAV) batteries. The paper proposes the use of IoT technologies to directly control the performance of the UAV when the amount of energy supplied to the UAV gradually decreases, resulting in performance degradation. The proposed IoT-based battery monitoring system consists of a monitoring device that monitors the voltage and sends the data to a microcontroller device that sends the data to the cloud for display. Based on the test results, the system can detect impaired battery performance and send notification messages to the user for further action.

1. Introduction

In the ever-changing world of unmanned aerial vehicles (UAVs), where advanced technology meets endless possibilities, finding innovative solutions to improve efficiency and reliability is critical. One of the biggest challenges for UAVs is the efficient management and optimization of their energy sources. The rise of the Internet of Things (IoT) has ushered in an era of change where real-time data monitoring and analysis are central. This change led to the development of an innovative system known as the IoTbased UAV Battery Monitoring System.

Previous battery monitoring systems for unmanned aerial vehicles (UAVs) only monitored and detected the condition of the battery and alarmed the user via battery indicator inside the vehicle. Due to the advancement of the design of notification systems, internet of things (IoT) technology can be used to notify the manufacturer and users regarding the battery status. This can be considered as one of the maintenance support procedures that can be done by the manufacturer. IoT utilizes internet connectivity beyond traditional applications, where diverse range of devices and everyday things can be connected via the internet, making the world at the user's fingertips.

This paper introduces an innovative IoT-based battery monitoring system designed specifically for Unmanned Aerial Vehicles (UAVs). The primary objective of this system is to furnish realtime information regarding the battery's voltage through wireless communication channels.

In the following sections of this paper, we will discuss the technical aspects of an IoT-based battery monitoring system by exploring its architecture, methodology, implementation, and hardware design. With this research, we aim to shed light on the transformative impact of this system on UAV technology and usher in a new era of real-time, wireless and intelligent battery monitoring.

2. Related work

2.1. Technology Based on Wireless Communication Wireless communication is a type of communication that is carried out and transmitted wirelessly. It is a broad term that includes all procedures and forms of connecting and communicating with two or more devices using wireless communication technologies and devices. From previous work, several different technologies such as GSM, ZigBee, GPRS, Android and Bluetooth communication have been used for wireless battery monitoring.

Wi-Fi is a wireless technology used to connect computers, tablets, smartphones and other devices to the Internet. Wi-Fi is a radio signal sent from a wireless router to a nearby device, which converts the signal into data that you can see and use. The device sends the radio signal back to the router, which connects to the Internet via a wire or cable.

A Wi-Fi network is simply an internet connection shared by multiple devices in a home or business via a wireless router. The router is connected directly to the Internet modem and acts as a hub that sends the Internet signal to all Wi-Fi compatible devices. This gives you the flexibility to stay connected to the Internet when you are in network coverage. The term was coined by a marketing company because the wireless industry was looking for a userfriendly name to refer to some of the not-so-user-friendly IEEE 802.11 technology, and the name stuck. Wi-Fi, often referred to as Wi-Fi, wifi, wi-fi or wifi, is often thought to be short for Wireless Fidelity, and the organization that paid for the marketing efforts is sometimes referred to as Wireless Fidelity Alliance Inc.

Wi-Fi uses radio waves to transmit data from your wireless router to your Wi-Fi enabled devices like your TV, smartphone, tablet and computer. Because they communicate with each other over airwaves, your devices and personal information can become vulnerable to hackers, cyber-attacks and other threats. This is especially true when you connect to a public Wi-Fi network at places like a coffee shop or airport. When possible, it's best to connect to a wireless network that is password-protected or a personal hotspot.

2.2. Technology Based on Wireless Battery Monitoring System

Reliable battery management is essential for safety. There are several reasons for battery failure, such as battery degradation and design flaws. A manual battery monitoring system is like a regular battery monitoring system, which means it does not store data in a
database. However, the collected data is displayed only in real time. Therefore, remote monitoring of battery systems using wireless technology is essential. Several battery monitoring systems using wireless communication have been developed for the industry, such as UPS (Uninterruptible Power Supply), which is important to ensure continuity of power supply to households and businesses during power outages. Suresh et al. proposed a PLC-based battery monitoring system for UPS using GSM modules and SCADA, warning when batteries are in critical condition and room temperature.[1]. Sardar et al. also developed a UPS battery monitoring system using GSM [2]. The system can monitor battery voltage, current and temperature. Hommalai et al. developed a battery monitoring system that uses wireless communication to detect dead UPS battery cells. [3]. In addition, there are several studies related to the development of an electric car battery monitoring system using wireless data transmission. Dhotre et al. developed an automatic battery charging and engine control system for electric vehicles using a GSM module [4]. When the battery level drops below the threshold, a text message is sent to the user. The user can then respond with a text message to automatically start the engine to charge the battery. Mathew et al. proposed a wireless battery monitoring system using a 2.4 GHz radio transmission system for electric vehicles. [5]. The modular design consists of a transmission module (monitors the batteries) and a control module (reports the status of the batteries). Bacquet et al. also developed a battery management system using 2.4 GHz radio transmission for EV [6]. They showed that radio transmission is possible for electric vehicle battery monitoring in harsh conditions. Luo et al. developed a battery monitoring system for electric vehicles based on GPRS communication, which consists of an online monitoring terminal to measure battery parameters (voltage and temperature) via a GPRS data transmission device and a user interface for battery monitoring. [7]. Rahman et al. proposed a battery management system for electric vehicles using ZigBee communication and point-to-point wireless topology [8]. ZigBee was used due to its low power consumption, low cost, high reliability and low data rate. They concluded that the wireless battery management system is important for electric vehicles mainly to balance the charge to extend the battery life, but it is not effective in controlling the battery temperature. Recently, Menghua et al. introduced a lithium-ion battery monitoring system for electric vehicles using WIFI communication, which collects and displays battery voltage, current, temperature and other parameters on a smartphone.[9].
According to the aforementioned research, it is evident that there is currently a lack of automated monitoring systems that can alert users about the battery's performance. Consequently, the integration of IoT technology into the monitoring system can greatly enhance preventive maintenance practices, ensuring optimal battery quality and enhancing user safety.

3. Methodology

3.1. System Overview

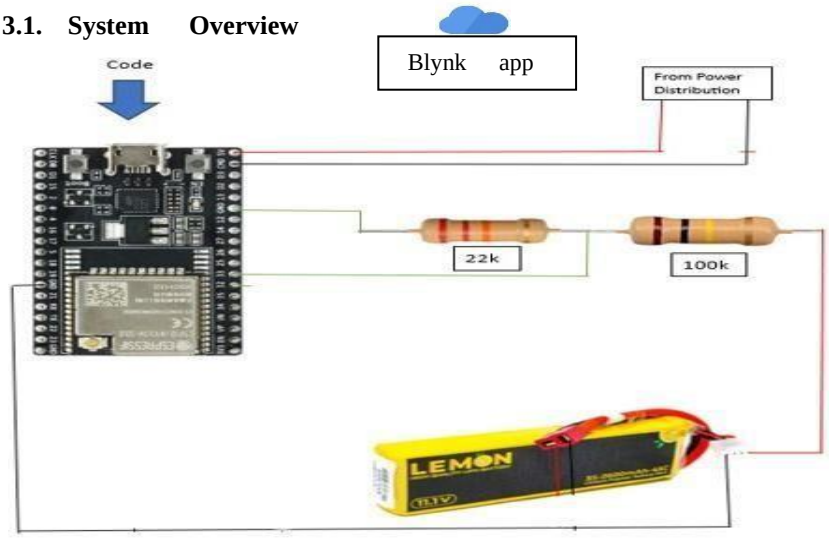

Fig. 1: Overview of the proposed system

Figure 1 depicts the overview of the proposed system. In order for the system to work, initially, the voltage Divider Circuit measures the lithium-ion battery's voltage level. The voltage divider ensures that the voltage level is within the ESP32's analog input range. Utilizing the Blynk cloud platform, the ESP32 establishes a connection to enable remote monitoring. The Blynk app, installed on a user's smartphone, serves as the interface for visualizing battery voltage data. A specific Blynk dashboard is created, displaying real-time information about the battery voltage.

3.2. System Architecture

Figure 2 illustrates the source code flow of the system. System will utilize the ESP32 microcontroller to allow users to monitor the voltage level of a battery. The ESP32 will act as the central controller and will be connected to a voltage divider circuit that is responsible for measuring the battery voltage. The voltage divider circuit will ensure that the voltage level falls within the analog input range of the ESP32. By using the Blynk cloud platform, the ESP32 will establish a connection that enables remote monitoring.

The ESP32 program will be developed using the Arduino IDE or a suitable platform and will incorporate the Blynk library to facilitate seamless communication with the cloud. The Blynk authentication token will be integrated into the ESP32 code to ensure secure and authenticated data transmission. With this system, users will have the ability to remotely check the status of their device's battery and receive timely updates on their smartphones or computer dashboards.

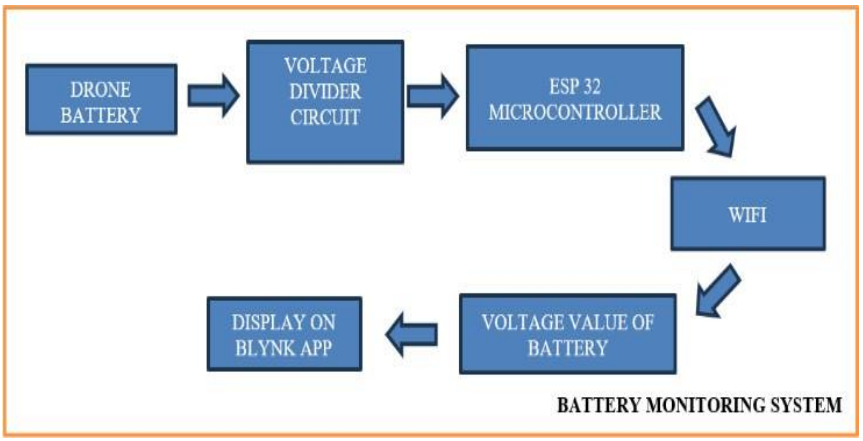

Fig. 2: System Architecture

3.3. Hardware Design

Initially, in order to verify the suitability of the hardware parts, the design of the system was developed using Breadboard Prototype Figure 3 illustrates the circuit design of the system. The figure shows the system is consists of a ESP32, Battery, LCD potentiometer, LCD. Figure 4 shows the actual hardware design of the proposed IoT-based battery monitoring system. As shown in the figure, the design of the system is similar to the circuit prepared using Breadboard.

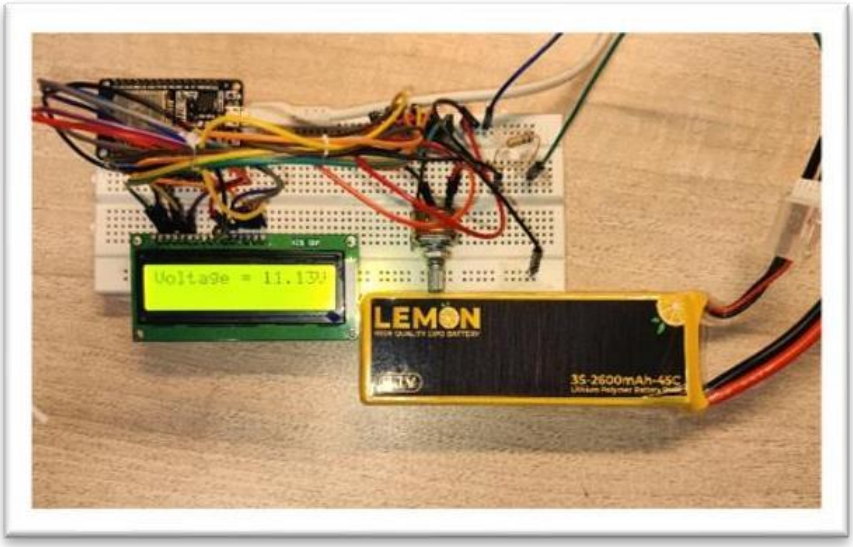

Fig. 3: The design of the circuit using Breadboard Prototype

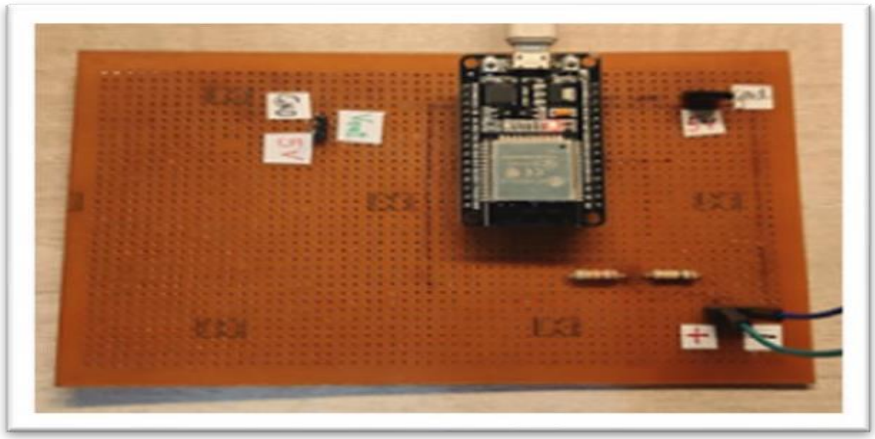

Fig. 4: The actual design of the hardware for the proposed battery monitoring system

4. Experiments and Analysis

This section reports the experiments and analysis of the system. First, experiment steps and results on the characteristics of voltage divider circuit, ESP32 module will be described. This is to make sure the circuits are in good condition. Then, experiments and results to verify degradation of battery will be explained.

4.1. Result

In this experiment, the values of battery were measured using a multimeter as shown in Figure 5. Then, the values were compared with the value of the same battery that were connected to the voltage divider circuit as shown in Figure 6. The purpose is to show the differences and accuracy percentage between both values.

Fig. 5: Battery voltage measurement using multimeter

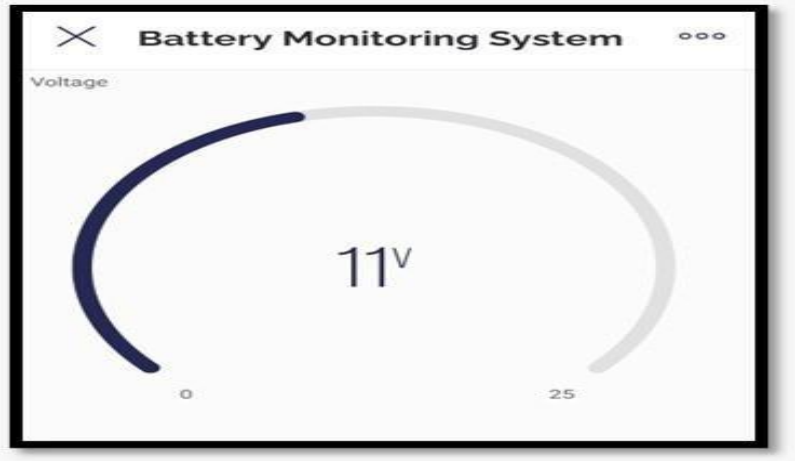

Fig. 6: Battery voltage measurement using voltage Divider circuit

5. Conclusion

The paper described the design and development of an IoT-based battery monitoring system for a UAV to monitor battery performance degradation online. The goal is to show that the idea of an idea is feasible. The development of the system consists in the development of the hardware of the battery monitoring device.
The system can display battery voltage information.
More changes can be made to improve the system by adding more features to the system. The system can be used on smartphones by developing a smartphone application to help the user monitor the battery and remind them when the battery is running low. To improve your internet connection.

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