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Battery Management System for EV's Using Microcontroller

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Abstract: ***The increasing adoption of Electric Vehicles (EVs) has created a demand for efficient and reliable Battery Management Systems (BMS) to ensure battery safety, performance, and lifespan. This paper presents a microcontroller-based BMS using PIC16F877A as the main controller and ESP32 for Wi-Fi communication. The system monitors battery voltage using a voltage divider circuit and temperature and humidity using a DHT11 sensor. It uses two external loads which is controlled by relay for battery discharge monitoring. The system estimates the State of Charge (SOC) and State of Health (SOH) and displays battery parameters on a 16×4 LCD. A buzzer provides alerts for low battery, full charge, and high temperature, while an automatic cooling fan helps prevent overheating. Wi-Fi communication enables wireless monitoring of battery information. The proposed system aims to provide an efficient and cost-effective solution for battery monitoring, charging management, and protection in electric vehicles.***

Keywords: Battery Management System (BMS), Electric Vehicle's (EV), PIC16F877A, ESP32, SOC, SOH, Voltage Protection, Temperature Monitoring, Wi-Fi Communication, DHT11, Li-ion Battery, IOT-based Monitoring.

I. INTRODUCTION

Electric vehicles are becoming increasingly popular due to their energy efficiency and reduced environmental impact. The battery is one of the most important components of an electric vehicle, and its performance directly affects vehicle efficiency and safety. Improper charging, over-discharging, and excessive temperature can reduce battery lifespan. Therefore, a reliable Battery Management System is required to monitor and control battery operations. The proposed system uses PIC16F877A microcontroller and ESP32 for wireless communication to provide real-time battery monitoring, charging control, and thermal protection.

II. RELATED WORK

Several research studies have been conducted to improve the performance and safety of Battery Management Systems for EVs. Microcontroller-based systems using Arduino and STM32 have been widely used for monitoring voltage, current, and temperature. Techniques such as Kalman Filter and Coulomb Counting are explored for accurate SOC and SOH estimation. Cell balancing methods, both passive and active, help maintain uniform charge across battery cells. With the advancement of IoT, wireless BMS using Wi-Fi enables remote monitoring and predictive maintenance. Thermal management is also considered crucial to prevent overheating and thermal runaway. Although existing systems address individual aspects, our work integrates monitoring, charging control, wireless communication, and thermal protection using PIC16F877A and ESP32 in a single embedded platform.

III. METHODOLOGY

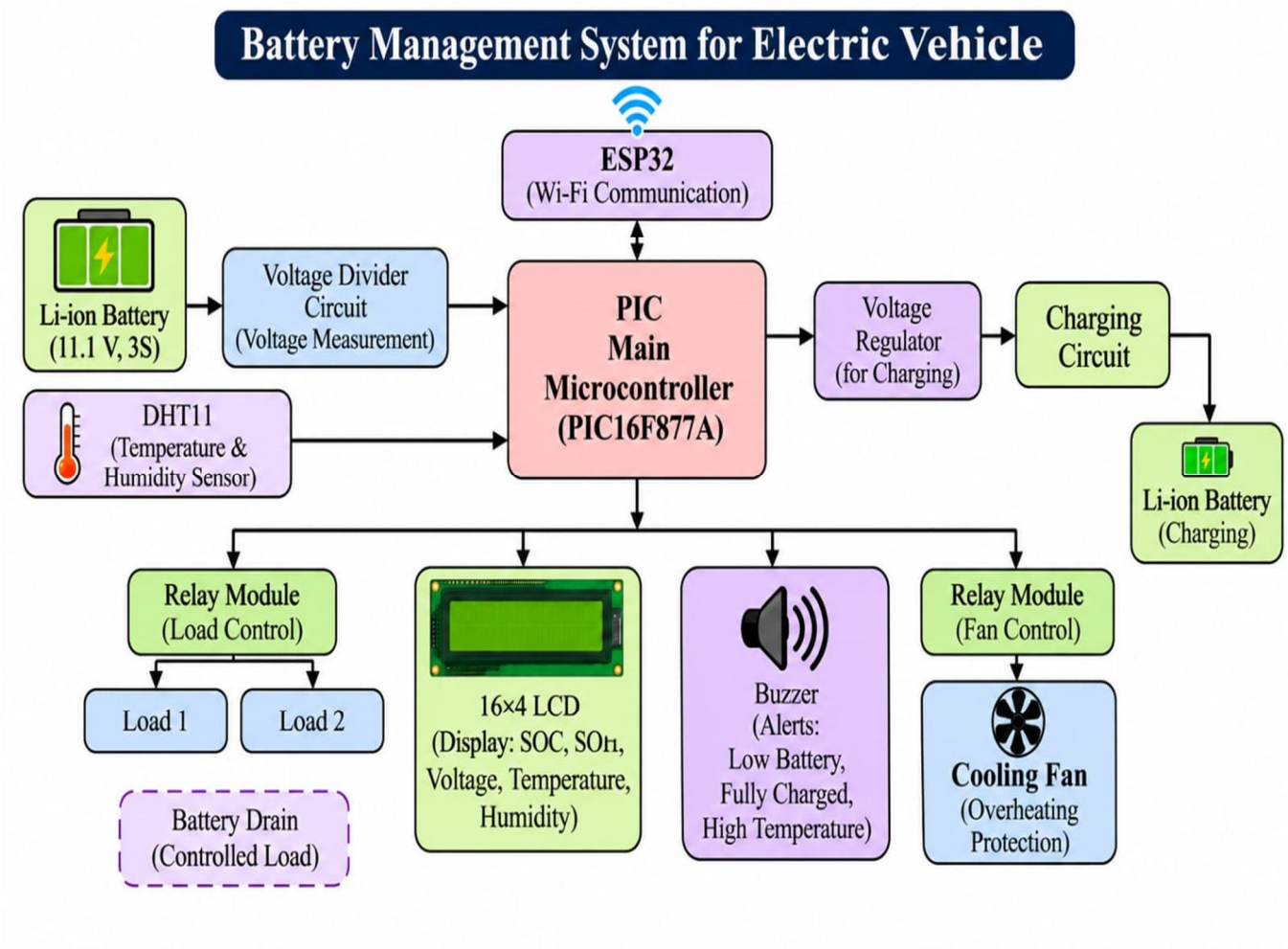
The methodology defines the functional workflow and interaction between hardware and software modules used for Battery Management System (BMS) for Electric Vehicles.

A. System Components

1. PIC16F877A Microcontroller
2. VD803 Development Board
3. ESP32(Wi-Fi Communication)
4. Lithium-ion Battery (12.7V)
5. DT11 (Temperature and Humidity Sensor)
7. Voltage Divider Circuit
8. Arduino IDE 2.3.10

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10. Buzzer
11. Cooling Fan
12. 16 × 4 LCD Display
13. External USB Cable and PICkit 3
14. MPLAB X IDE v6.20
15. MPLAB XC8 Compiler v4.00



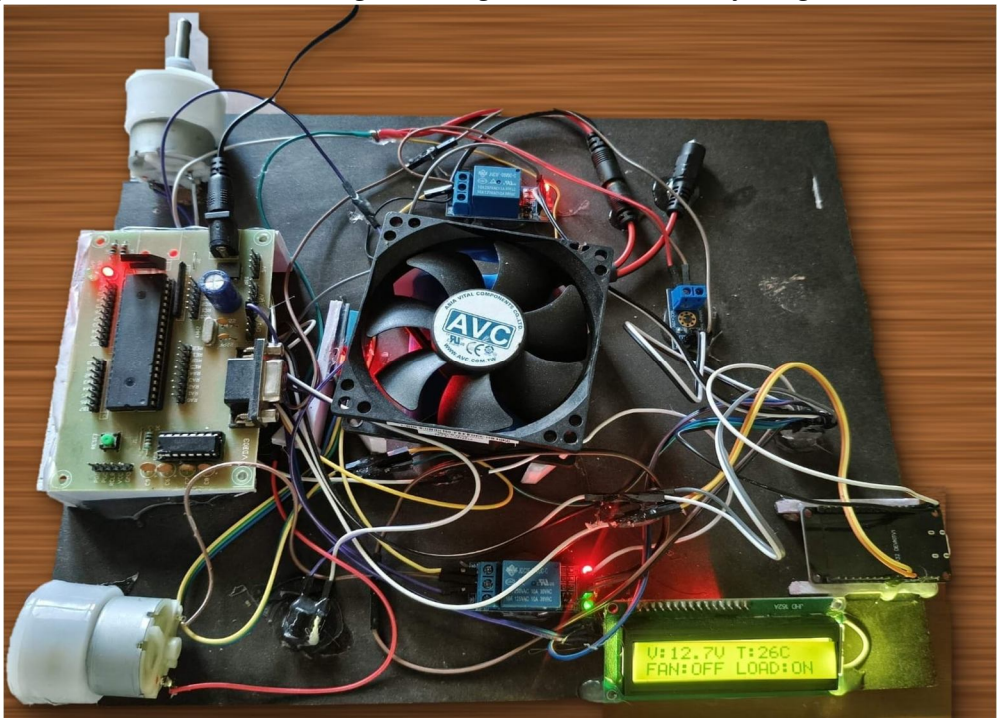
B. Process Workflow

1. The lithium-ion battery supplies power to the Battery Management System.
2. The voltage divider circuit measures battery voltage and provides a scaled signal to the PIC16F877A microcontroller.
3. The DHT11 sensor monitors the battery temperature and sends the measured data to the microcontroller.
5. If the battery voltage falls below the low-voltage threshold, the buzzer is activated, the load is disconnected through the relay, and charging is turned ON.
6. When the battery reaches the fully charged condition, the charging process is stopped and the buzzer is deactivated.
7. If the battery temperature exceeds the specified limit, the cooling fan is activated to reduce the temperature.
8. The relay modules control the cooling fan and load operations according to the monitored battery conditions.
9. The 16 × 4 LCD display shows battery voltage, temperature and system status.
10. The ESP32 provides Wi-Fi communication for remote monitoring of battery information.
11. The PIC16F877A controls the relays, buzzer and cooling fan based on the monitored battery parameters.
12. The system continuously monitors battery conditions to improve battery safety, reliability and operational efficiency.

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C. Model and Analysis

The implemented system ensures efficient monitoring and management of the EV battery using PIC16F877A and ESP32



the system displayed 12.7 V and 26 °C with the fan OFF and load ON, indicating normal operation. On low voltage, the buzzer sounds, the load is disconnected and charging starts. The fan switches ON and the load OFF when the temperature exceeds the limit, and the ESP32 enables remote monitoring over Wi-Fi.



(a) Normal condition



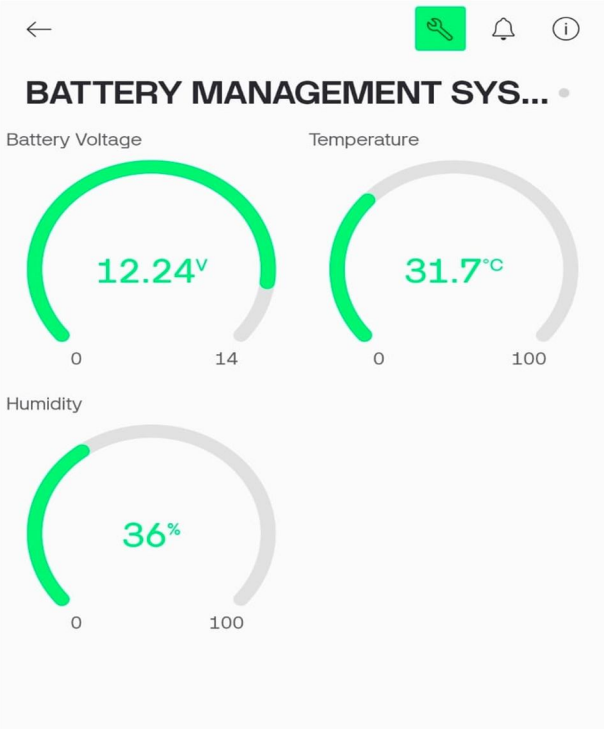
(b) Over-temperature condition

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IV. RESULTS

Performance Parameters	Observed Results
1. Battery Voltage	12.7V
2. Battery Temperature	26 °C
3. Cooling Fan (Normal)	OFF
4. Load Status	ON
5. Low-Voltage Protection	Activated at 7V
6. Fan Activation	Activated at 36-37°C

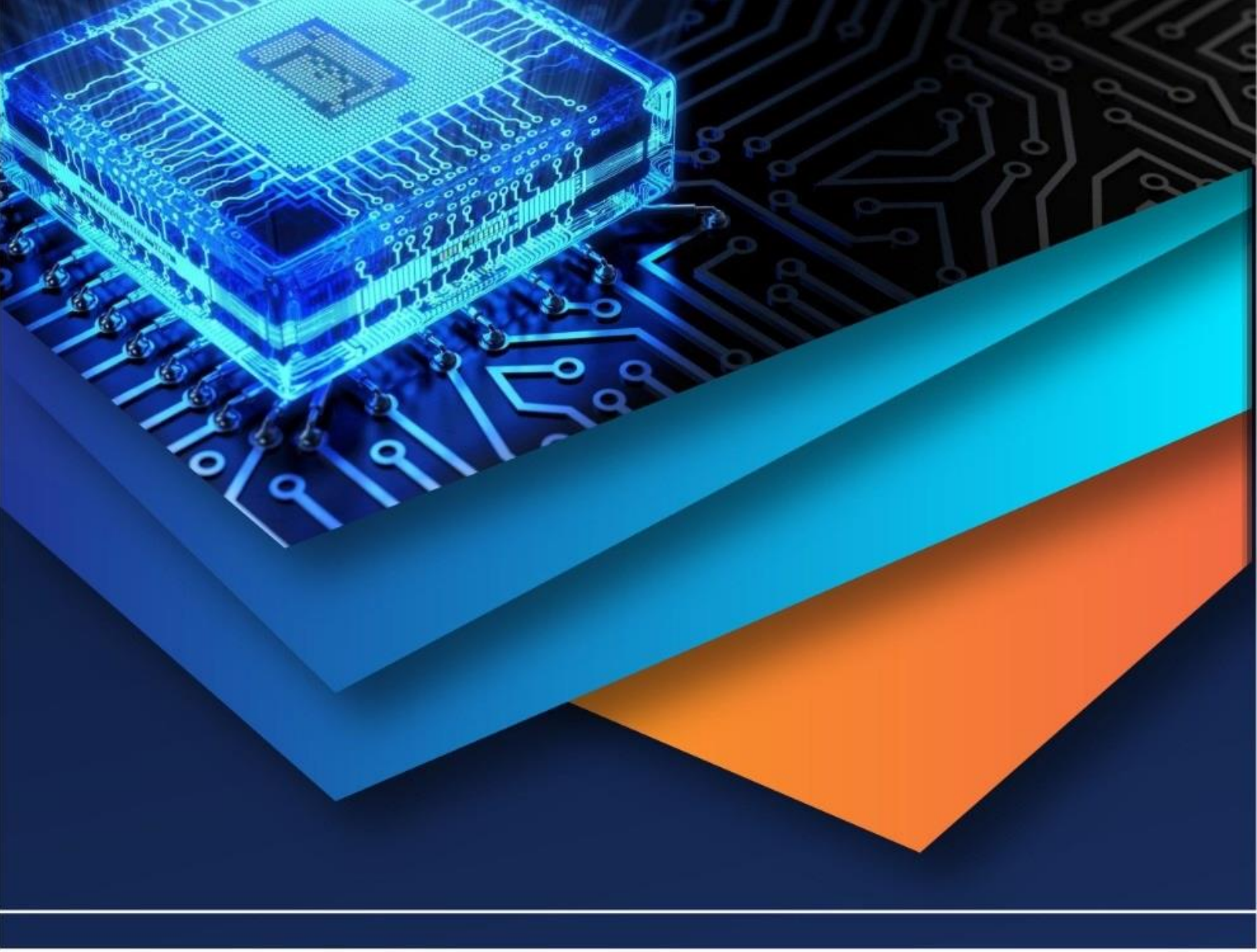
During testing, the voltage sensor circuit measured the battery voltage, while the DHT11 temperature sensor monitored the battery temperature. The microcontroller processed the sensor data and controlled the relay modules to manage the battery load and cooling fan according to the operating conditions. When the battery voltage dropped below the specified threshold, the system activated the buzzer, disconnected the load, and indicated that charging was required. When the battery reached its fully charged condition, the charging process was stopped. The ESP32 module enabled Wi-Fi-based communication and remote monitoring of battery parameters. The LCD displayed real-time battery voltage, temperature, and system status. The cooling fan helped maintain the battery temperature within the desired operating range, while the buzzer provided alerts during abnormal conditions. The developed system demonstrates an effective approach to battery monitoring, charging control, temperature management, and protection. It helps improve battery safety, reliability, and operational efficiency, making it suitable for electric vehicle battery management applications.



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