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Electric vehicle battery management IoT-WIFI based system

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Abstract : This study explores the use of WIFI technology in the Internet of Things (IoT) to monitor the battery performance of an electric car. The battery is one of the most important and expensive components in electric vehicles.

The objective of this study is to precisely monitor and evaluation of State of Charge (SOC), State of Health (SOH), and detection of in-flight failures of rechargeable batteries in electric cars continue to be a problem for researchers to assure vehicle and user safety. Battery monitoring entails keeping track of key operational parameters such as voltage, current, battery internal resistance, and ambient temperature while charging and discharging. This WIFI-based technology, with its long range and low power consumption, can be useful in the design and execution of IOT-based battery management system.

Index Terms **- IoT, Battery management system, electric vehicles, WIFI, cloud computing.**

I. Introduction

Due to steep rise in fuel prices, vehicle maintenance cost, and cost of ownership electric vehicles popularity is increasing day by day [1]. All the vehicle manufacturers are searching and researching on the alternate energy source to internal combustion engine (ICE) [2]. Usage of electrical vehicle will definitely reduce/produce zero emissions and subsequently improve the environmental conditions. Lithium-ion battery is the primary source of power in electric vehicles [3,4].

A Battery Management System (BMS) is very important system, which is required to monitor the operational system, performance, and battery life, including the charge and discharge process. It is made up of measuring devices that are used to determine parameters such as voltage, current, and temperature [5-7]. These parameters can be used to calculate the battery's state of charge (SOC) as well as battery state of health (SOH) [8]. Live monitoring and health approximation of lithium-ion batteries in electric vehicles is required for safe and reliable battery operation. With effective battery monitoring system, customers and OEM can get the live status of their vehicles' batteries at any time and from any location, and a faulty battery can be immediately diagnosed and changed before it depletes the capacity to functioning the strings of rest of good batteries [9,10]

II. METHODOLOGY

A. System Overview

In electric vehicles specifically cars 96 battery cell are used across 8 modules. Due to usage of multiple batteries we need to have a master and slave controller structure. Refer fig. 1 for the same. For the electric car's battery, we need 8 slave controllers and 1 master controller. Slave controllers will measure the voltage, current and temperature and send the data to the master controller by using WIFI technology. Based on the information and data received from the slave controllers master controller will control the battery output, charging and also transfer the information along with data to the user on mobile app as well as on the web page/server.

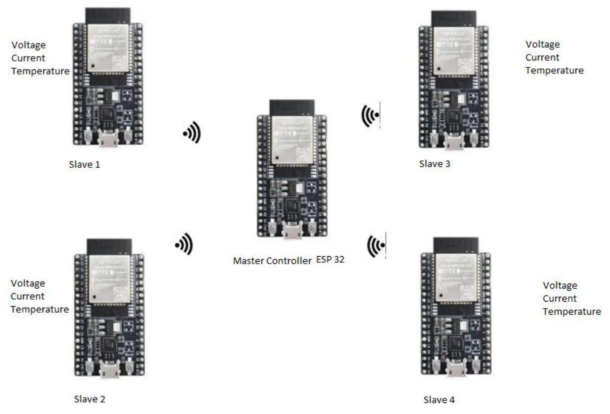

Fig. 1: Battery Management system Structure (Master and Slave)

B. System Flow chart

Controller process flowchart is explained in fig. 2. Processes are described as below:

1. Start battery supply and battery charging module
2. Battery fuel gauge and temperature sensor reads the SOC, Voltage level and battery temperature and forward it to the controller (esp32 - over I2C communication) to analyse further.
3. If the measured battery SOC value is less than minimum threshold value then output load turns OFF and the charging module turns ON automatically.
4. If the measured battery SOC value is greater than minimum threshold value but less than maximum threshold then output load turns ON automatically and charging module remains ON.
5. If the measured battery SOC value is greater than the maximum threshold then output load remains ON and the Charging module turns OFF automatically.
6. In any of the above conditions, if temperature reading goes above temperature threshold, load and charging module turns off automatically

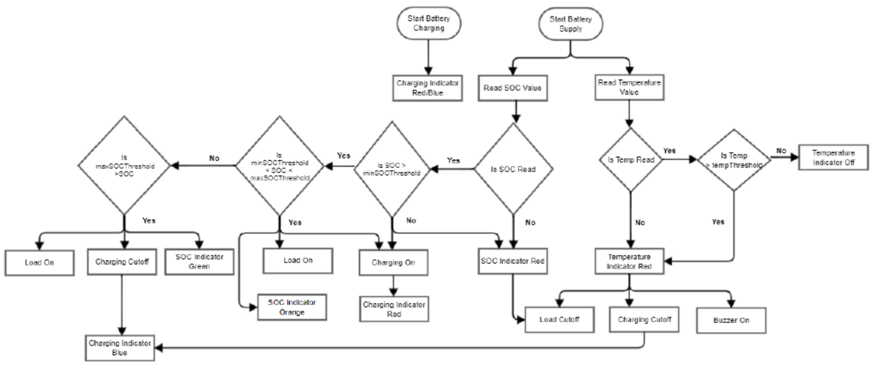

Fig.2: System flowchart

C. Hardware Selection & Design

This system consists of ESP 32, Lipo fuel gauge sensor, Lithium-ion battery charging board, Lithium-Ion battery & display units. Fig2 shows the actual designed prototype model of battery management system.

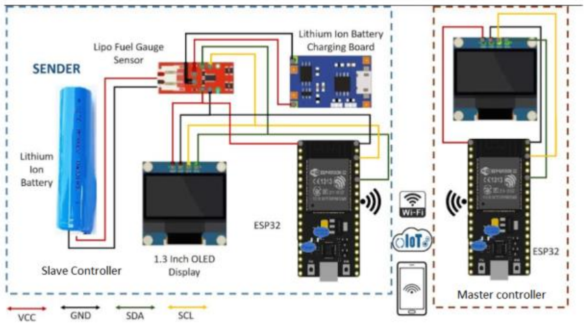

Fig. 3: Actual designed representational hardware model of the Battery Management System IOT (using WIFI technology)

D. Voltage Testing, Analysis & Discussion

Voltage measurement experiment was conducted with 10 batteries, the output of lipo fuel gauge sensor were cross checked by multimeter for all 10 batteries. Fig. 4 shows data of voltage measured with multimeter instrument as well as lipo fuel gauge sensor.

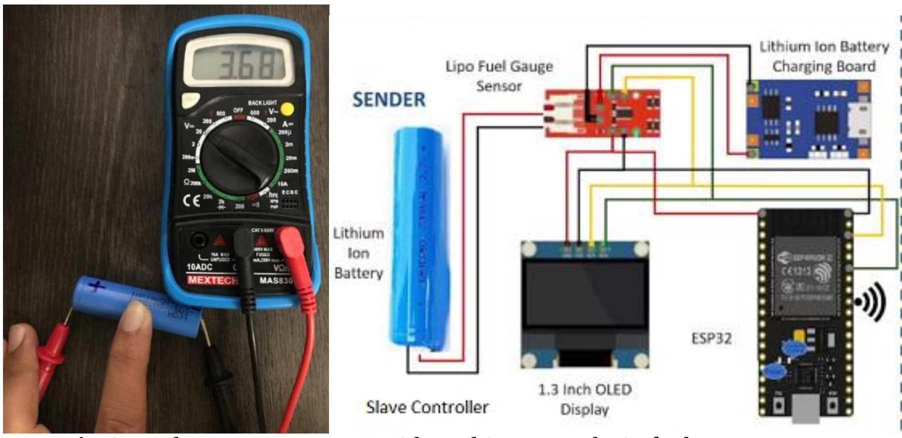

Fig.4 - Voltage measurement with Multimeter and Lip fuel gauge sensor.

III. OBSERVATIONS

Voltage measurement done by the lipo fuel gauge sensor is 99 % accurate, so we can use this sensor for our model.

Battery sr. no.	Voltage measurement results		Accuracy in %
	Multimeter	Lipo fuel gauge sensor	
1	9.56	9.51	99.48
2	3.84	3.79	98.70
3	8.78	8.71	99.20
4	1.24	1.22	98.39
5	3.52	3.47	98.58
6	8.35	8.28	99.16
7	3.28	3.24	98.78
8	1.25	1.24	99.20
9	3.62	3.59	99.17
10	8.7	8.64	99.31

Table 1: shows the measured voltage of 10 batteries

A. Battery management system testing and discussions – **Test Condition 1**

Verify that load cut off and charging turns on automatically when battery level is below minimum threshold and temperature are below threshold value

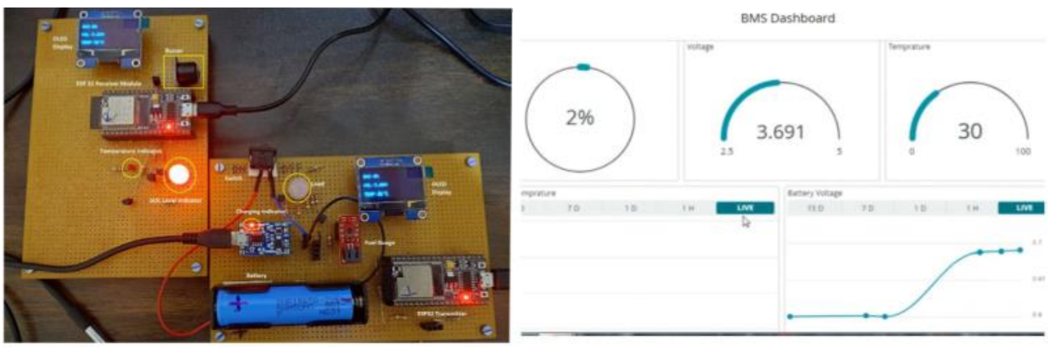

Fig. 5: Hardware model showing load cutoff and charging started automatically

Precondition:

1. Battery charging module is on
2. Battery SOC level is below critical threshold (e.g., 2%)
3. Battery Transmitter and Receiver modules are on
4. Temperature level is below threshold (e.g., 30 ºc)

Test Results:

SOC was measured at 2% and temperature was measured at 30ºc at the slave/transmitter module, and the identical signal was sent to the master/receiver module, as shown in Fig.5. When the detected signal drops below the threshold limits, the load and charging are turned off instantly

B. Battery management system testing and discussions – **Test Condition 2**

Verify that battery load and charging turn off automatically when battery level is below minimum threshold and temperature are above threshold value

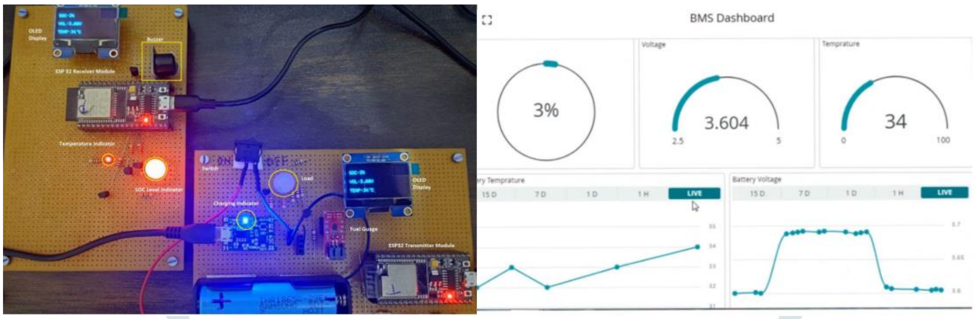

Fig 6: Hardware model showing load cutoff and charging cutoff automatically

Precondition:

1. Battery charging module is on
2. Battery SOC level is below minimum threshold (e.g., 3%)
3. Battery Transmitter and Receiver modules are on
4. Temperature level is above threshold (e.g., 34 ºc)

Test Results:

Figure 6 depicts On the Transmitter module; the SOC level was 3% and the temperature was 34ºc. The receiver module successfully receives SOC level 3% and temperature level 34ºc. Load and Charging were switched off automatically on the transmitter module. The Charging Indicator on the transmitter module (Blue). On the receiver module, the SOC indication (Red), the Temperature indicator (Red), and the Buzzer were all switched on (Beep)

C. Battery management system testing and discussions **– Test Condition 3**

Verify that battery load and charging turn on automatically when battery level is within minimum and maximum battery threshold value range and temperature is below threshold value.

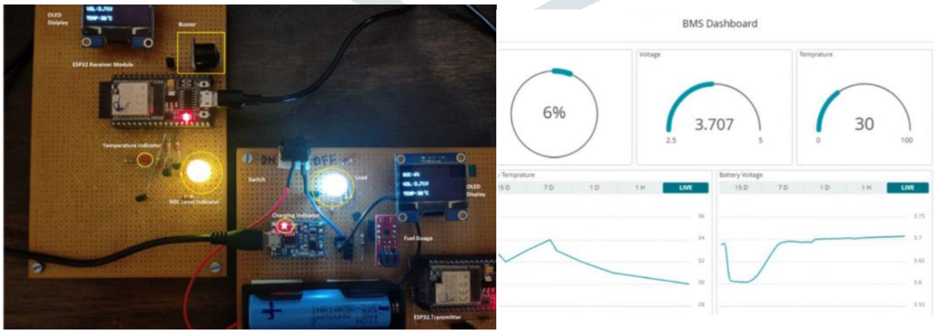

Fig 7: Hardware model showing load and charging turn ON automatically

Precondition:

1. Battery charging module is on
2. Battery SOC level is within minimum and maximum battery threshold value range (e.g., 6%)
3. Battery Transmitter and Receiver modules are on
4. Temperature level is below threshold (e.g., 30 ºc)

Test Results:

As seen in Figure 7, The SOC level on the Transmitter module was 6%, and the temperature was 30ºc. The receiver module successfully receives SOC Level 6% and Temperature Level 30ºc. Load and Charging were switched on automatically on the transmitter module. Charging Indicator on the transmitter module (Red). On the receiver module, the SOC indication (orange) was switched on, the temperature indicator was turned off, and the buzzer was turned off.

D. Battery management system testing and discussions – **Test Condition 4**

Verify that battery load and charging turn off automatically when battery level is within minimum and maximum battery threshold value range but temperature is above threshold value

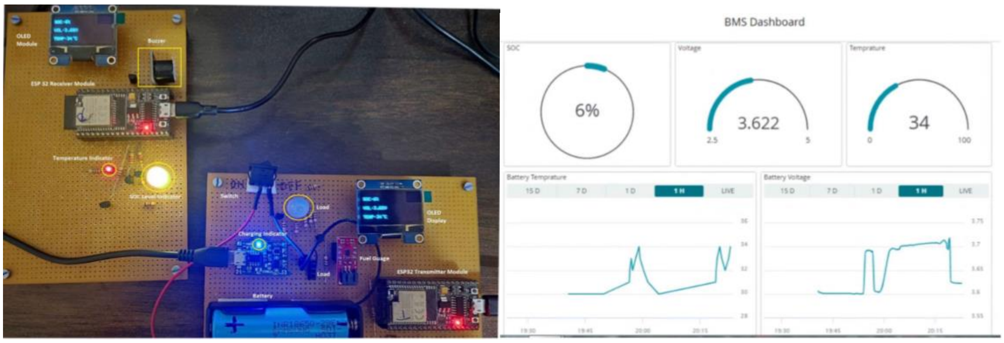

Fig 8: Hardware model showing load and charging turn OFF automatically

Precondition:

1. Battery charging module is on
2. Battery SOC level is is within minimum and maximum battery threshold value range (e.g. 6%)
3. Battery Transmitter and Receiver modules are on
4. Temperature level is below threshold (e.g. 34 ºc)

Test Results

Figure 8 depicts, On the Transmitter module, the SOC level was 6% and the temperature was 34ºc. The receiver module successfully receives SOC level 6% and temperature level 34ºc. Load and Charging were switched off automatically on the transmitter module. The Charging Indicator on the transmitter module (Blue). On the receiver module, the SOC indication (Orange), the temperature indicator (Red), and the buzzer were all switched on (Beep)

E. Battery management system testing and discussions – **Test Condition 5**

Verify that battery load turns on and charging turns off automatically when battery level above maximum battery threshold value and temperature is below threshold value

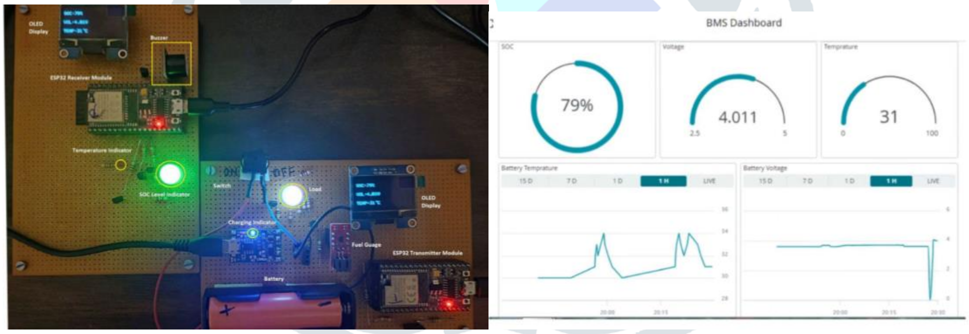

Fig 9: Hardware model showing load turn ON and charging turn OFF automatically

Precondition:

1. Battery charging module is on
2. Battery SOC level is within minimum and maximum battery threshold value range (e.g., 79%)
3. Battery Transmitter and Receiver modules are on
4. Temperature level is below threshold (e.g., 31 ºc)

Test Results

Figure 9 shows that the SOC level on the Transmitter module was 79% and the temperature was 31ºc. The receiver module successfully receives SOC level 79% and temperature level 31ºc. Load switched on and Charging turned off automatically on the transmitter module. The Charging Indicator on the transmitter module (Blue). On the receiver module, the SOC indication (Green) is switched on, the temperature indicator is turned off, and the buzzer is turned off

F. Battery management system testing and discussions – **Test Condition 6**

Verify that battery load and charging turn off automatically when battery level is above maximum battery threshold value but temperature is above threshold value

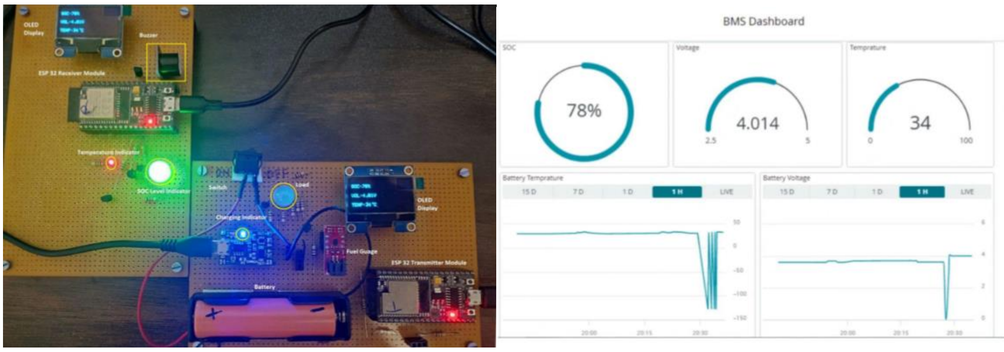

Fig 10: Hardware model showing load and charging turn OFF automatically

Precondition:
1. Battery charging module is on
2. Battery SOC level is above maximum battery threshold value range (e.g., 78%)
3. Battery Transmitter and Receiver modules are on
4. Temperature level is below threshold (e.g., 34 ºc)

Test Results

As seen in Figure 10, The SOC level on the Transmitter module was 78%, and the temperature level was 34ºc. SOC Level 78% and Temperature Level 34ºc are successfully received by the receiver module. Load and Charging on the transmitter module were automatically switched off. The Charging Indicator is located on the transmitter module (Blue). On the receiver module, the SOC indication (Green), the temperature indicator (Red), and the buzzer were all switched on (Beep)

IV. CONCLUSIONS

The study discussed the design and development of an IoT-based battery management system for electric cars that uses WIFI technology to monitor battery performance and degradation online. The purpose is to show that the concept of the idea can be realized. The system is being created by developing hardware for the battery monitoring device as well as a cloud-based battery monitoring user interface. The system can now show information such as battery status and time through the internet thanks to the addition of WIFI technology. The solution, which can be utilized in smartphones by installing an IOT app, can help users check their batteries and serve as a battery deterioration warning. More functionalities may be added to the system to improve the system even more

REFERENCES

[1] chickrama,b, Michael Sinninga , Markus Lienkampa,b, An Overview of Costs for Vehicle Components, Fuels, Greenhouse Gas Emissions and Total Cost of Ownership Update 2017.

[2] Utsav Patel, Dhruv Patel, Janmay Shah and Yashanjay Shinde; ALTERNATE ENERGY SOURCED VEHICLE-REVIEW STUDY; nternational Journal of Modern Trends in Engineering and Research (IJMTER), Volume 04, Issue 1, [January–2017]

[3] Sarah Scott and Robert Ireland; Lithium-Ion Battery Materials for Electric Vehicles and their Global Value Chains, Office of Industries Working Paper ID-068 June 2020.

[4] Marcy Lowe, Saori Tokuoka, Tali Trigg and Gary Gereffi; Lithium-ion Batteries for Electric Vehicles: THE U.S. VALUE CHAIN, Technical Report · October 2010.

[5] Hossam A. Gabbar, Ahmed M. Othman and Muhammad R. Abdussami; Review of Battery Management Systems (BMS) Development and Industrial Standards, Technologies 2021, 9, 28.

[6] Pop, V. (Ed.) Battery Management Systems: Accurate State-of-Charge Indication for Battery Powered Applications; Springer: Dordrecht, The Netherlands, 2008.

[7] Jiang, J.; Zhang, C. Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles; Wiley Online Library: Hoboken, NJ, USA, 2015

[8] Koko Friansa, Irsyad Nashirul Haq, Bening Maria Santi, Deddy Kurniadi, Edi Leksono, Brian Yuliarto, Development of Battery Monitoring System in Smart Microgrid Based on Internet of Things (IoT), Procedia Engineering,Volume 170, Pages 482-487(2017).

[9] Mohd Helmy Abd Wahab, Nur Imanina Mohamad Anuar, Radzi Ambar, Aslina Baharum, Shanoor Shanta, Mohd Suffian Sulaiman, Shukor Sanim Mohd Fauzi, Hafizul Fahri Hanafi; IoT-Based Battery Monitoring System for Electric Vehicle, International Journal of Engineering & Technology, 7 (4.31) (2018) 505-510

[10] Ataur Rahman, Mizanur Rahman, Mahbubur Rashid; Wireless Battery Management System of Electric Transport, IOP Conf. Series: Materials Science and Engineering 260 (2017) 012029