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Effective Power Management System for E-Vehicle

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Abstract: Battery management systems (BMS) are used in electric vehicles to monitor and control the charging and discharging of rechargeable batteries, making operation more economical. The battery management system ensures that the battery remains safe and reliable and its performance is increased without it entering a harmful state. Various monitoring techniques are used to monitor the battery's condition, voltage, current, and ambient temperature. Various analogue/digital sensors with microcontrollers are used for monitoring.

This paper deals with the state of charge, state of health, state of life and maximum capacity of a battery. By reviewing all these methods, future challenges and possible solutions can be identified. With the rapidly developing technology of smart grid and electric vehicles, battery has emerged as the most important energy storage device that attracts much attention. It is equally important to improve the performance of the battery management system (BMS) to make the battery a safe, reliable and cost-effective solution. The special features and requirements of the smart grid and electric vehicles, such as deep charge/discharge protection and accurate state of charge (SOC) and state of health (SOH) estimation, increase the need for a more efficient BMS. The BMS should include accurate algorithms for measuring and estimating the functional state of the battery while being equipped with advanced mechanisms to protect the battery from hazardous and inefficient operating conditions.

Keywords: BMS, SOC, SOH, Temperature.

I. INTRODUCTION

Nowadays, Li-ion batteries with an energy density of up to 265 Wh/kg have the upper hand. However, they have a reputation for occasionally bursting under excessive load and consuming all the energy. For this reason, battery management systems (BMS) are often required to keep them under control.

A battery management system (BMS) is an electronic system that manages a rechargeable battery (cell or battery pack) by, for example, protecting it from operating outside its safe operating range, monitoring its condition, calculating secondary data, reporting that data, controlling its environment, authenticating it, and/or balancing it.

II. LITERATURE REWIEW

[1] Power-efficient acquisition front end for the Li-ion battery management systems. In this paper they talked about Li-ion battery its high energy density, lack of memory effect, and other advantages, because of this it has become the secondary battery of choice in portable electronic devices. To assure the safety and usable time of the battery, calculating the state of charge (SOC) of the Li-ion battery is the key to achieving a battery management system (BMS). Based on the Coulomb sensing method, the SOC is estimated by accurately monitoring analog signals.

[2] A journal on Battery Management System in Electric Vehicle talked about how EVs are future transport system and importance of battery in them. Battery storage forms the most important part of any electric vehicle (EV) as it stores the necessary energy for the operation of EV. So, in order to extract the maximum output of a battery and to ensure its safe operation it is necessary that an efficient battery management system exist in the same.

[3] An article on key technologies in the battery management system of electric vehicles. In this paper, they have talked about the importance of battery management system and its use in ev (electric vehicle) where a suitable battery management system (BMS) is vital in ensuring safe and reliable operation of batteries.

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[4] In a paper Working principle of Arduino and using it as a tool for study and research explored the working principle and applications of an Arduino board. This also explores on how it can be used as a tool for study and research works. Arduino board can provide a quick tool in development of VLSI test bench especially of sensors. Main advantages are fast processing and easy interface. Today, with increasing number of people using open-source software and hardware devices day after day, technology is forming a new dimension by making complicated things look easier and interesting.

[5] A detailed paper on battery management system for electric vehicle and its applications. talked about why Li-ion batteries are widely used in Ev's and how they can be dangerous if they are not operated within their Safety Operation Area (SOA). Therefore, a battery management system (BMS) must be used in every lithium-ion battery, especially for those used in electric vehicles.

[6] A paper Management System in Electric Vehicle talked about how a BMS acts as an electronic regulator that monitors and controls the charging and discharging of rechargeable batteries. It is simply battery monitoring, keeping a check on the key operational parameters during charging and discharging such as voltages, currents and the battery internal and ambient temperature. The monitoring circuits would normally provide inputs to protection devices which would generate alarms or disconnect the battery from the load or charger should any of the parameters become out of limits.

[7] There are many technologies of batteries to improve the power quality and reliability of the power system. this paper carried out to discuss about four batteries technologies: lithium-ion, lead-acid, nickel-cadmium and nickel-metal hydride. in fact, it gives a digest description of these batteries and proposes an easy mathematical model of every one of these dynamic batteries. finally, a comparison between the different types of batteries and a suggestion of the most suitable photovoltaics battery technology are presented.

[8] Cells, cell configuration inside a battery pack and also how battery life is affected due to improper cell configuration is important while designing a battery. Battery life, under a normal operating cycle, tends to degrade almost exponentially as the battery string length is increased. series connected battery strings are prone to dramatic reduction in life and potential damage if high-rate charging is continued after the onset of gassing. In order to improve battery life, individual cells need to be maintained at an equalized charge level.

[9] A paper on Designing a New Generalized Battery Management System talked about battery management systems (BMSs) and how they are used in many battery-operated industrial and commercial systems to make the battery operation more efficient and the estimation of battery state non-destructive.

[10] Thinger.io is anew open-source platform with capabilities for the collection, management and analysis of a huge amount of heterogeneous sensor data. In addition, this platform allows the use of hardware-agnostic in a highly scalable and cost-effective manner. This platform is called Thinger.io. One of the main characteristics of Thinger.io is the ability to model sensorized environments through a high-level language that allows a simple and easy implementation of data fusion applications, as we will show in this paper.

[11] BQ76925 is a AFE semiconductor ic which is combined with a microcontroller to build a complete battery management system. Key aspects of the system include the microcontroller, filtering and protection, communications, measurement, and power management. Important considerations are discussed that aid in the design of the hardware and firmware of the battery management system.

[12] IoT microcontroller unit (MCU) or development board contain low-power processors which support various programming environments and may collect data from the sensor by using the firmware and transfer raw or processed data to an local or cloud-based server. Node MCU is an open source and LUA programming language-based firmware developed for ESP8266 Wi-Fi chip. Espruino , Mongoose OS, software development kit (SDK) provided by Espressif, ESP8266 add-on for Arduino are a few of development platforms that may program the ESP8266.ESP8266 may be used to either host the application or to offload all Wi-Fi networking functions from another application processor through its self contained Wi-Fi networking solution. ESP8266 has powerful on-board processing capabilities and sufficient storage that allow it to be integrated with minimal development up-front and minimal loading during runtime through its GPIOs(General Purpose input/output) with the sensors specific devices. ESP8266 has very low cost and high features which makes it an ideal module for Internet Of Things (IoT). It can be used in any application that require it to connect a device to local network or internet.

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[13] A secondary loop cooling battery thermal management system is designed, and then, a phased control strategy for adjusting the compressor speed according to the battery temperature interval is proposed. On this basis, the compressor speed as the decision variable, and the energy consumption of the compressor and the aging losses of the battery are as the optimization goals, which constitute a multi-objective optimization model, and a genetic algorithm is adopted to solve it

[14] A variety of rechargeable batteries are now available in world markets for powering electric vehicles (EVs). The lithium-ion (Li-ion) battery is considered the best among all battery types and cells because of its superior characteristics and performance. The positive environmental impacts and recycling potential of lithium batteries have influenced the development of new research for improving Li-ion battery technologies. However, the cost reduction, safe operation, and mitigation of negative ecological impacts are now a common concern for advancement.

This paper provides a comprehensive study on the state of the art of Li-ion batteries including the fundamentals, structures, and overall performance evaluations of different types of lithium batteries. A study on a battery management system for Li-ion battery storage in EV applications is demonstrated, which includes a cell condition monitoring, charge, and discharge control, states estimation, protection and equalization, temperature control and heat management, battery fault diagnosis, and assessment aimed at enhancing the overall performance of the system.

III. SUMMARY AND OBSERVATION

An effective power management system for e-vehicles is essential to ensure optimal performance, range, and battery life. This system needs to manage the power flows between the battery, the motor, and the other vehicle systems, while also considering driving conditions, user preferences, and environmental factors. Some key components of a power management system for e-vehicles include a battery management system (BMS) to monitor and control the state of charge and temperature of the battery, a motor controller to regulate the power output to the motor, and an energy management system (EMS) to optimize the power flows and minimize energy losses.

Observations suggest that effective power management systems require a balance between maximizing performance and minimizing energy consumption. E-vehicle manufacturers are constantly striving to improve the efficiency and effectiveness of these systems through advancements in technology and software. Additionally, as the market for e-vehicles continues to grow, there is a need for standardization and interoperability among different power management systems to facilitate charging and compatibility with various infrastructures.

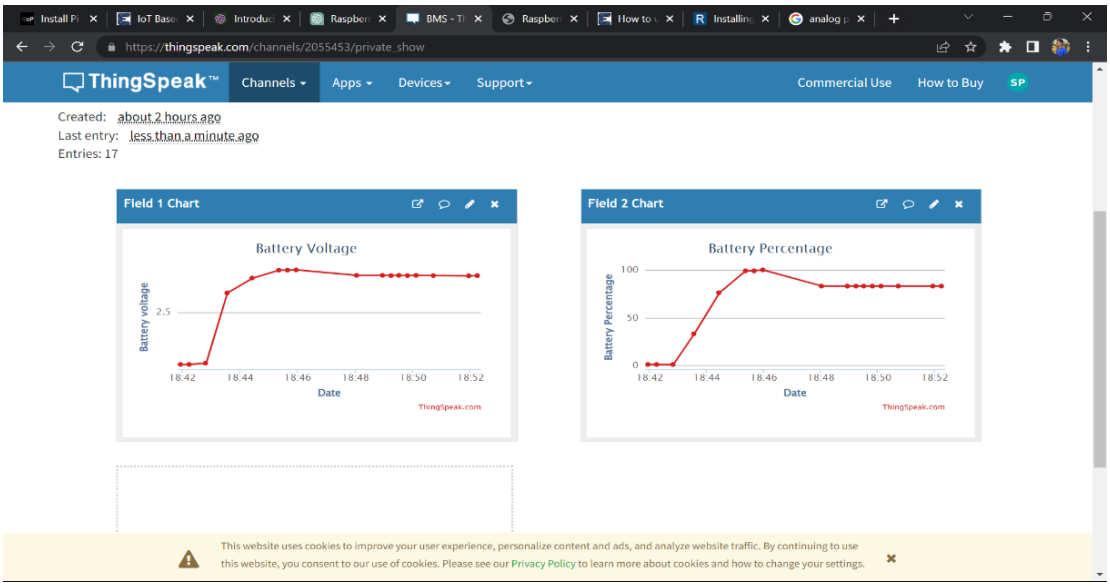

Fig. 1 ThingSpeak Output

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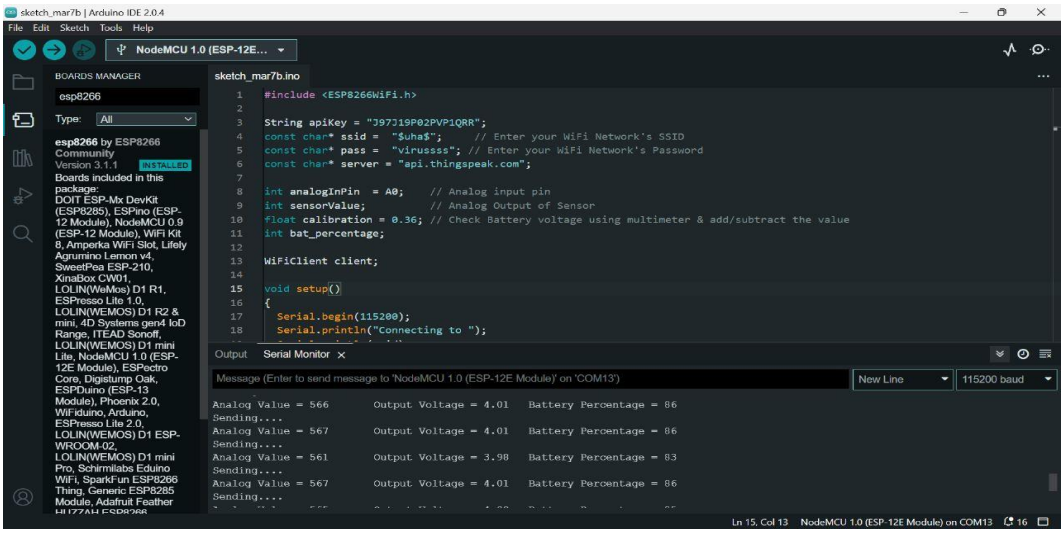

Fig. 2

IV. CONCLUSION

An effective power management system is critical for the optimal performance and efficiency of e-vehicles. Such a system should ensure that the vehicle's battery is charged efficiently and that power is distributed optimally to the various electrical components of the vehicle. To achieve this, e-vehicles require sophisticated power electronics and control systems that can accurately measure and monitor the vehicle's power consumption and adjust the power flow accordingly. Additionally, advanced algorithms and predictive modelling can be used to optimize power management and minimize energy waste, by implementing an effective power management system, e-vehicle manufacturers can improve the overall driving range, reduce charging times, and extend the battery life of their vehicles. This, in turn, can increase the attractiveness and adoption of e-vehicles, leading to a more sustainable future for transportation.

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