EV BATTERY MANAGEMENT SYSTEM – CHARGE MONITORING AND FIRE PROTECTION

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Abstract: Electric vehicles surely are the future of transportation, but EV technology has not been fully developed with respect to efficiency and safety as of 2022. We come across electric vehicle battery fire and similar incidents as the EV market expands. Most electric vehicle fire incidents occur due to battery blast or fire. So here we attempt to solve the problem by using some sensors and battery pack based system powered by an STM32 controller. The system is designed to protect batteries from various parameters that may incite a fire. The system is designed to constantly monitor battery voltage current temperature and instantly cut off the input or output from battery as soon as any unusual behavior is detected. This System provides the following advantages: Battery Status Monitoring and Display, Charging of Battery as per required input parameters ,Temperature monitoring with auto cutoff. The system makes use of a li ion Battery, Battery charging and monitor system, Push Buttons, LCD Display, current sensor, voltage sensor, temperature sensor to develop this system. The system monitors as well as protects an EV battery at all times. We here develop the system as per a 3S li ion battery. The system we design will not only monitor the battery and charge it safely but also protect it to avoid accidents from occurring. The system when turned on uses its charging and monitoring circuitry that allows user to safety charge the 3S battery. While charging the voltage sensor is used to check voltage and limit the flow of current too to the battery using charging circuitry. The LCD display also displays the current voltage level of battery. As soon as the battery is fully charged, the system cuts off the supply and displays Battery fully charged on LCD Display. When connected to a load the current sensor keeps track of current drawn from battery and displays the parameter on LCD Display. The temperature sensor is used to monitor temperature of battery while charging as well as discharging. If the battery temperature is observed to deviate from standard values, the system automatically cuts off input as well as output supply and displays the temperature as well as a buzzer alert on the LCD display. Thus the system allows for a smart and efficient battery charging as well as protection system.

Keywords – Arduino NANO, Relay, Current and Voltage Sensor, DC Motor, Temperature Sensor, Buck Converter, Monitoring, Fire Protection.

I. INTRODUCTION

In the current trend, internal combustion engine-powered vehicles are increasingly giving way to battery-powered electric vehicles as the primary form of transportation. The transition from conventional gasoline-powered cars to electric vehicles (EVs) was sparked by the necessity for electric automobiles. Electric traction motors are used in electric vehicles to move them forward. It could also be self-contained with a battery, solar panels, or an electrical generator to turn gasoline into electricity, or it might be fueled by electricity from sources outside the vehicle using a collector system.

The automobile sector might make the security of lithium-ion batteries in vehicles a top concern. The event's activities are primarily focused on lowering risks and enhancing safety concepts and procedures. Constant monitoring of battery parameters, such as temperature, gas level, voltage, and current, can warn the system of any anomalous or worse emergency conditions. Early detection of such activity is crucial because these situations could result in battery fire or explosion. If a fire or any other unintentional impact on the battery were to occur, the interior of the battery might get exposed, which would make it to warm up excessively, which would result in an explosion and fire. Our reliable sensor-based network can continuously monitor batteries. This technique will be very beneficial for preserving the valuable life of the engine and the investment in the car.

The Main objective of this project is to detect the any abnormal fault in the lithium-ion battery. The purpose of our research is to use micro-controllers and sensors like current sensor, temperature sensor to monitor the parameters like temperature and monitoring the Lithium-ion battery of Electric vehicle. And protect it from unwanted situations occur during charging and discharging also with the help of solenoid valve, the condition of hazardous fire can be stopped.

II. LITERATURE SURVEY

The idea of dedicated planned model of Battery protection system of work unit came from the incident once we watch countless news on catching fireplace in EVs. As transport is a elementary demand of contemporary life, however the normal combustion engine is quickly changing into outdated. hydrocarbon or diesel vehicles are extremely polluting and are being quickly replaced by totally electric vehicles. totally electric vehicles (EV) have zero pipe emissions and are far better for the environment. the electrical vehicle revolution is here. Therefore, EV safety is of utmost importance. Consequently, the fusion of electrical and electronic information will accomplish this dreadfully efficiently. Everyone needs safe travel because of the expanding population. Since India is a developing nation and experiences hot weather most of the time, we all tend to recognize this. These elements cause an issue for EVs.

Battery Thermal Management in EVs and HEVs: Issues and Solutions January 2001 Research gate. Thermal management of batteries in electric vehicles (EVs) and hybrid electric vehicles (HEVs) is essential for effective operation in all climates. This has been recognized in the design of battery modules and packs for pre-production prototype or production EVs and HEVs. Designs are evolving and various issues are being addressed. There are trade-offs between performance, functionality, volume, mass, cost, maintenance, and safety. In this paper, we will review some of the issues and associated solutions for battery thermal management and what information is needed for proper design of battery management systems.

Internal battery temperature estimation using series battery resistance measurements during cold temperatures 25 August 2006 journal of power source. A technique has been developed to estimate the internal battery temperature (Tbat) of secondary batteries by measuring the series battery resistance (RB) at cold ambient temperatures. Tests were performed on both lead-acid and nickel metal hydride batteries at different cold temperatures to obtain useful plots of RB versus Tbat. RB was measured by using a pulse discharge circuit to apply a short-duration current pulse (IB) directly to the battery. The test results indicated that RB not only varies with temperature but also varies with the amplitude of IB. The RB versus Tbat plots were later utilized to predict Tbat from RB during alternating current (AC) battery heating at cold ambient temperatures.

Precision Battery Management System Instrumentation and Measurement Technology Conference, 2005 Research gate. The paper presents a new battery management system for a lithium ion battery pack for more efficient operation and sturdy. The new system contains an embedded microcontroller to track the energy content of cell battery, optimize the output current, and to provide extensive feedback of all the measurements taken. This system sends all data to a telemetry system so that the data can be relayed to a laptop via wireless signal. Two unique advance features of the BMS are its ability to optimize the battery pack energy and also to provide cell equalization.

21st century cars and ICs 7 February 2000 IEEE International Solid-State Circuits Conference. Digest of Technical Papers. This paper describes where cars are headed for the next five to ten years, focusing on three movements: environmental stewardship, integration of intelligence, information-oriented technology, and the perspective of electronics and semiconductor technologies leading these movements.

III. METHODOLOGY

The system was developed using a lithium-ion battery, a battery charging and monitoring system, push buttons, an LCD display, current and voltage sensors, and a temperature sensor. The technology constantly monitors and safeguards an EV battery. Here, we design the system to work with a 3S lithium-ion battery. In addition to monitoring the battery and charging it securely, the system we develop will also keep it secure to prevent accidents. The system's charging and monitoring circuitry is activated when it is turned on, enabling the user to safely charge the 3S battery. Utilizing charging circuitry, the voltage sensor is used to monitor voltage and limit the amount of current that may be delivered to the battery. Additionally, the LCD display shows the battery's current voltage level. The mechanism switches off the supply as soon as the battery is fully charged and displays Battery fully charged on the LCD Display. The current sensor monitors battery current when it is connected to a load and displays the parameter on the LCD Display. The temperature sensor is used to keep track of the battery's temperature both while charging and discharging. The system automatically shuts off input and output supply and shows the battery temperature along with a buzzer alarm on the LCD display if the battery temperature is seen to stray from typical values. Consequently, the technology enables an intelligent and effective battery charging and protection system.

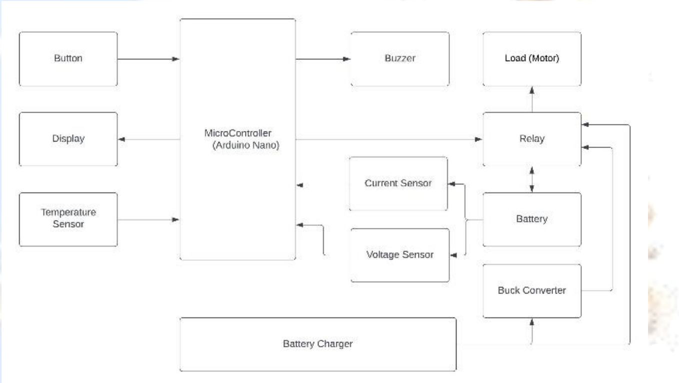


Fig.1: Block Diagram

A. *Technical Background*

Electric vehicles surely are the future of transportation, but EV technology has not been fully developed with respect to efficiency and safety. We come across electric vehicle battery fire and similar incidents as the EV market expands.

Empathy towards EV owners means understanding their concerns about safety and convenience during the charging process. Design user-friendly charging interfaces that provide clear instructions and visual indicators for safe charging.

It towards the professionals responsible for maintaining and monitoring EV BMS involves providing them with comprehensive training and resources to effectively carry out their tasks.

B. *Proposed Solution*

The objective of an Electric Vehicle Battery Management System (BMS) charge monitoring and fire protection is to ensure the safe and efficient operation of the electric vehicle's battery pack during charging and to mitigate the risk of fire or other safety hazards.

Charge Monitoring: The BMS monitors the charging process to ensure that the battery pack is charged within safe operating limits. It continuously measures parameters such as voltage, current, and temperature to prevent overcharging, which can lead to thermal runaway and fire hazards.

State of Charge (SOC) Management: The BMS accurately tracks the State of Charge of the battery pack to prevent over-discharging, which can reduce battery life and compromise safety.

C. Hardware Components (Required for prototype)

1. Arduino Nano
2. Current Sensor
3. Voltage Sensor
4. Relay
5. 12V Geared DC Motor
6. Temperature Sensor
7. Buck Converter
8. Buzzer
9. OLED Display

D. Software Requirements

1. Arduino IDE

E. Implementation

The Main objective of this project is to detect the any abnormal fault in the lithium-ion battery. The purpose of our research is to use micro-controllers and sensors like current sensor, temperature sensor to monitor the parameters like temperature and monitoring the Lithium-ion battery of Electric vehicle. And protect it from unwanted situations occur during charging and discharging also with the help of solenoid valve, the condition of hazardous fire can be stopped.

F. Working principle

The working principle of an Electric Vehicle Battery Management System (BMS) involves several key functions and components that work together to monitor and protect the battery pack. the EV BMS's working principle involves monitoring critical battery parameters, estimating the SoC, managing cell balancing, and implementing safety measures to ensure the battery's optimal performance, longevity, and safety.

G. Circuit Diagram

Battery Management System (BMS) that includes charge monitoring and fire protection involves a complex interconnection of various components. an overview of the main components and their functions within the BMS circuit like sensors, lithium ion battery, DC motor, buck converters, buzzers, and display.

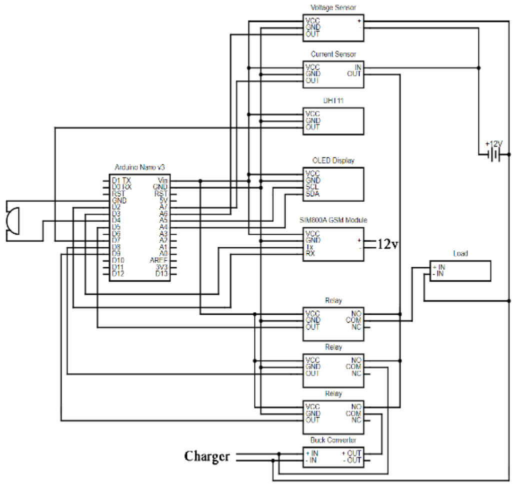


Fig.2: Circuit Diagram

IV. SIMULATION

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++.It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.

V. CONCLUSION

In conclusion, the future of Electric Vehicle Battery Management System (BMS) charge monitoring and fire protection holds great potential for advancements in ensuring the safety and efficiency of electric vehicle batteries. The following key points summarize the future scope in this field:

• Enhanced monitoring systems will employ advanced sensors, data analytics, and machine learning algorithms to accurately monitor battery charge levels, detect potential issues, and prevent overcharging or undercharging.

• Intelligent charging algorithms will optimize the charging process based on factors such as battery health, temperature, and energy source availability, improving efficiency and reducing fire hazards.

• Effective thermal management systems, such as liquid cooling or solid-state cooling technologies, will be integrated into BMSs to maintain optimal battery temperature and prevent overheating and thermal runaway.

- Predictive analytics will play a crucial role in identifying potential battery faults or fire risks, enabling proactive measures and early warnings to prevent incidents.
- Integration of advanced fire suppression systems, including fire detection sensors, flame retardants, and localized extinguishing agents, will be implemented to rapidly suppress fires in the battery compartment.
- Vehicle-to-grid (V2G) integration may enable bidirectional energy flow, allowing EV batteries to not only receive energy but also contribute power back to the grid, creating a more dynamic and efficient energy ecosystem.

Overall, these advancements in BMS charge monitoring and fire protection will contribute to safer and more reliable electric vehicle technology, instilling confidence in the widespread adoption of EVs and accelerating the transition to a sustainable and electrified transportation future.

VI. FUTURE SCOPE

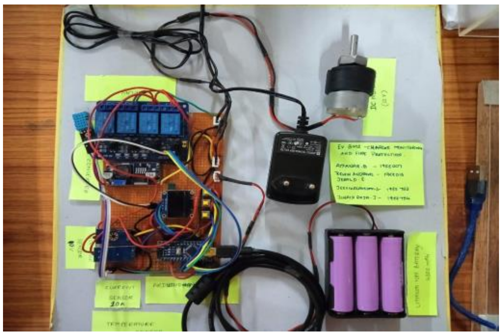
The future scope for Electric Vehicle Battery Management System (BMS) charge monitoring and fire protection is promising, as the development and advancement of electric vehicle technology continues to progress. Here are some potential areas of focus and advancements in this field:

- Enhanced Monitoring Systems: Future BMS designs may incorporate more advanced monitoring capabilities to ensure accurate and precise monitoring of battery charge levels. This could involve the integration of improved sensors, data analytics, and machine learning algorithms to detect and prevent potential battery issues, such as overcharging or undercharging.

- Intelligent Charging Algorithms: BMSs can be further enhanced with intelligent charging algorithms that optimize the charging process based on various factors such as battery health, temperature, and energy source availability. These algorithms can help extend battery life, improve charging efficiency, and mitigate the risk of fire hazards during the charging process.

- Thermal Management: Effective thermal management is crucial for EV batteries to prevent overheating, which can lead to fire hazards. Future BMSs may incorporate advanced thermal management systems, such as liquid cooling or solid-state cooling technologies, to maintain optimal battery temperature and prevent thermal runaway.

VII. RESULT



VII. REFERENCE

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