BMS OF ELECTRIC TWO WHEELER

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Abstract: Nowadays due to increasing emissions from the vehicles; global warming, greenhouse gases level increases, and the mass use of fossil fuels, the electric vehicles came into existence as they deliver good results in performances and efficiencies in recent years. Electric vehicles are in used in the automotive world as it is the most reliable option to overcome Environmental issues like global warming and greenhouse effect. In batteries, lithium ion has good features like lightweight, fast charging, low self-discharge and long lifespan so it is used widely. The performances of the Electric Vehicles are affected by the performance of battery packs. whereas in motors Brushless DC motors have better specifications over conventional brushed DC motor, which have advantages better speed versus torque characteristics, high efficiency, high dynamic response, long operating life, noiseless operation higher speed ranges, low maintenance. To control and operate the motor and battery smoothly for the long run efficient drive controller and battery management system is used. Thus the above components makes the complete electric vehicle which is better option to conventional vehicle in order to reduce environment issues. This paper compromises with design and fabrication of Electric Bike which makes use of Electric energy and The electrical power generated which is used to run the bike can give better fuel economy compared to conventional vehicle, better performance and also causes no pollution.

Keywords: Lithium-Ion battery,BLDC motor,Power, Controller, safety, Battery thermal management(BTMS), Air cooling system, Liquid cooling system.

I.INTRODUCTION

Electric vehicle batteries account for over 90% of battery use in the energy sector. They are typically lithium-ion batteries that are designed for high power-to-weight ratio and energy density. Compared to liquid fuels, most current battery technologies have much lower specific energy. This increases the weight of vehicles or reduces their range. The battery is the heart of an electric scooter, typically lithium-ion for better energy density and longevity. It provides the necessary power to the motor. The range of the scooter depends on the battery capacity, usually measured in watt-hours (Wh). The primary function of a BMS is to monitor and manage the lithium-ion battery pack, which serves as the energy storage unit in electric two-wheelers. It performs various tasks such as cell balancing, state-of-charge (SOC) estimation, temperature management, and fault detection. By continuously monitoring individual battery cells, the BMS ensures that they operate within safe voltage and temperature limits, thereby prolonging the lifespan of the battery pack and maintaining its health.

Battery usage in the power sector is mainly about electric vehicle batteries. These are usually lithium-ion batteries that have been optimized for high energy density and power-to-weight ratio. Majority of current battery technologies have much lower specific energy compared to liquid fuels. As a result, they increase the weight of vehicles or decrease their range. Typically, an electric scooter has a lithium-ion battery because it has better energy density than other types such as lead-acid. An electric scooter’s motor requires power which comes from the battery. The scooter’s distance covered depends on how long its battery can last and this is measured in watt-hours (Wh). Its major function is monitoring and controlling lithium-ion battery packs used as storage devices for two-wheeler EVs (electric vehicles). Some of these functions are cell balancing, temperature control, SOC estimation, and fault detection among others. This way, by continuously observing individual cells within batteries to ensure safe voltage levels or temperatures at all times; the BMS can extend the life span of the entire pack as well as maintain its health in general.

The Battery Management System (BMS) serves as the central nervous system of an electric scooter’s battery pack. Its primary function is to oversee and regulate the charging and discharging processes of the battery cells, ensuring efficiency and safety. Essentially, the BMS acts as a safeguard, monitoring vital parameters to prevent potential damage and maximise battery life.

II. FUNCTIONAL OVERVIEW

A Battery Management System (BMS), which manages the electronics of a rechargeable battery, whether a **cell** or a **battery pack**, thus becomes a crucial factor in ensuring electric vehicle safety. It safeguards both the user and the battery by ensuring that the cell operates within its safe operating parameters. BMS monitors the State of Health (SOH) of the battery, collects data, controls environmental factors that affect the cell, and balances them to ensure the same voltage across cells.

A battery pack with a BMS connected to an external communication data transfer system or a data bus is referred to as a smart battery pack. It may include additional features and functions such as fuel gauge integration, smart bus communication protocols, General Purpose Input Output (GPIO) options, cell balancing, wireless charging, embedded battery chargers, and protection circuitry, all aimed at providing information about the battery's power status. This information can help the device conserve power intelligently.

BMS (Battery Monitoring System) is an electronic board that is installed between the actual battery and the power wires in order to control the process of its charge / discharge, monitor the status of the battery and its elements, control the temperature, the number of charge / discharge cycles and protect the components of the battery.

BMS are responsible for the monitoring of the battery state, ensuring operation within safe limits. BMS offer multiple functionalities with the state of charge (SoC) estimation being the most challenging hence the most studied by engineers. All estimation methodologies and algorithms have pros and cons, which best suits the application that is developed for. This research concludes that according to designers, the optimum BMS provides battery packs with the needed protection, good functioning conditions and accurate prediction for the battery's state including charge and life. Finally, this research presents and validates an SoC algorithm based on the reformulated Peukert's equation which is also valid for variable load and multi-pulsing scenarios with an accuracy exceeding 95%.

Key Functions of BMS:

1. **Battery Monitoring:**

    - **Voltage Monitoring:** Continuously measures the voltage of each cell in the battery pack to ensure they operate within safe limits.
    - **Current Monitoring:** Tracks the charging and discharging currents to prevent overcurrent conditions.
    - **Temperature Monitoring:** Uses sensors to monitor the temperature of the battery cells to avoid overheating.

2. **Battery Protection:**

    - **Overcharge Protection:** Prevents the battery cells from being charged beyond their maximum voltage.
    - **Overdischarge Protection:** Stops the discharge process when cells reach their minimum safe voltage.
    - **Short-Circuit Protection:** Detects and disconnects the battery in case of a short circuit to prevent damage and hazards.
    - **Overcurrent Protection:** Limits the current to prevent damage to cells and circuitry.

3. **Balancing:**

    - **Passive Balancing:** Dissipates excess energy from higher charged cells as heat to balance the state of charge among all cells.
    - **Active Balancing:** Transfers energy from higher charged cells to lower charged ones to ensure uniform charge distribution.

4. **State Estimation:**

    - **State of Charge (SOC):** Estimates the remaining charge in the battery.
    - **State of Health (SOH):** Assesses the overall condition and remaining useful life of the battery.
    - **State of Power (SOP):** Predicts the power capability of the battery under current conditions.

5. **Communication:**

- **Internal Communication:** Manages data exchange between the BMS controller and individual cell monitoring units.
- **External Communication:** Interfaces with the vehicle's main control unit (MCU) and user interface to provide status updates, alerts, and diagnostic information.

6. **Data Logging:**

- **Operational Data:** Records data on voltage, current, temperature, and other parameters for performance monitoring and diagnostics.
- **Event Logging:** Keeps track of significant events such as overvoltage, undervoltage, overcurrent, and temperature excursions.

III. DESIGN

The BMS design is to be implemented on a battery pack consisting of 52 Li-Ion Batteries in a 13-series,4-parallel arrangement with a nominal voltage of 48.1 volts, a maximum voltage of 54.6 volts, and a total capacity of 10 Ah.

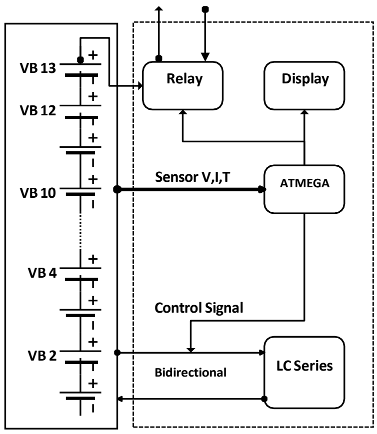

Fig:1 Device block diagram

Designing a Battery Management System (BMS) for an electric two-wheeler involves several key steps and considerations to ensure the system is safe, efficient, and reliable. Here's a detailed look at the design process:

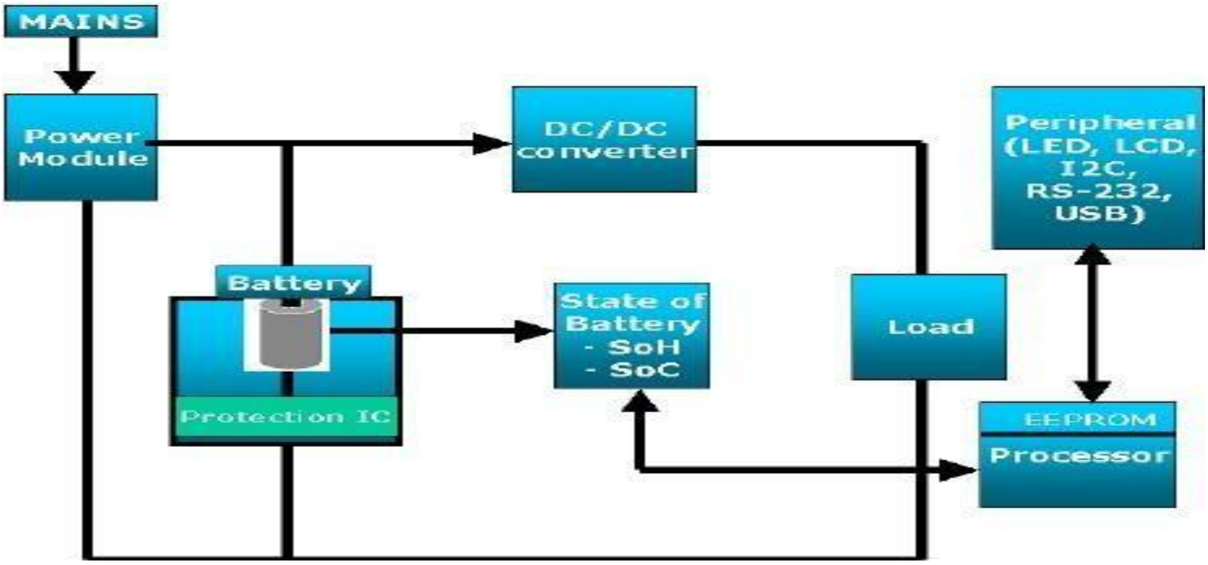

Fig.2 Design Of Electric Two wheeler

The BMS architecture consists of several components that are:

MAINS: This is the primary power source for the system.
Power Module: This component receives power directly from the MAINS and manages the distribution of power to the rest of the system.
DC/DC Converter: This component converts the type or voltage of power. It's connected to both the Power Module and the Battery, indicating that it plays a role in managing power flow between these components. **Battery:** The battery stores power for use. It has an embedded Protection IC (Integrated Circuit) that safeguards the battery from potential damage due to overcharging, overheating, etc.

State of Battery - SOH - SOC: This block likely represents metrics for the State of Health (SOH) and State of Charge (SOC) of the battery. These metrics help monitor the battery's condition and performance.

Load: This block represents where the converted power is being utilized.

Peripheral (LED, LCD, I2C, RS-232, USB): These are additional components that receive power or data. They could be various devices or interfaces connected to the system.

EEPROM Processor: EEPROM stands for Electrically Erasable Programmable Read-Only Memory. This component likely handles data storage and processing for the system.

BMS architectures are categorized into four primary groups:

Centralized BMS: A single controller manages all battery cells and modules, simplifying system design and reducing component count. While this design streamlines management, it may limit scalability for a larger battery systems and introduces the potential for a single-point of failure.

Distributed BMS: Multiple controllers operate across specific modules or cell groups essential for large batteries requiring individual monitoring. This scalable design enhances system reliability through built-in redundancy.

Modular BMS: Independent units, each capable of autonomous operation, are comprised of a modular BMS. This scalable configuration facilitates flexibility in battery size and supports the easy addition or removal of modules.

Hybrid BMS: Combining centralized and distributed elements, a hybrid BMS employs a central controller for overall management alongside local controllers at the module level for detailed cell monitoring and control. This structure offers comprehensive system management with granular control capabilities.

The design of a battery management system (BMS) involves several key considerations to ensure the safe and reliable operation of a battery energy storage system (BESS). Here are the main aspects to focus on:

State of Charge (SOC) and State of Health (SOH) Monitoring: Monitor the battery's voltage, current, and temperature to estimate its SOC and SOH. This helps in predicting battery life and preventing overcharging or over-discharging.

Thermal Management: Monitor and control the battery's temperature to prevent thermal runaway and ensure safe operation. This can be achieved through thermal sensors and cooling systems.

Overcurrent and Overvoltage Protection: Implement overcurrent and overvoltage protection to prevent damage from excessive charging or discharging. This can be done through sensors and fuses that disconnect the circuit when limits are exceeded.

Real-Time Operating System: Implement a real-time operating system to monitor battery health, predict risks, and prevent them in real-time. This ensures the BMS can respond quickly to any issues and maintain the battery's safety and reliability.

Sensor Integration: Integrate various sensors to monitor the battery's voltage, current, temperature, and other parameters. This helps in accurate estimation of the battery's state and prevents any potential issues.

Algorithmic Control: Implement algorithms to control the battery's charging and discharging based on its state and health. This ensures the battery is charged and discharged safely and efficiently.

By considering these key aspects, a BMS can be designed to ensure the safe and reliable operation of a BESS

IV. WORKING

The working principle of a battery management system (BMS) involves several key functions to ensure the optimal performance and safety of rechargeable batteries. Here are the main components.

Components:

Battery Terminal Module: Collects data such as voltage, current, temperature, and communication signals.

Intermediate Control Module: Communicates with the vehicle system, controls the charger, and manages the power supply loop.

Display Module: Presents data and facilitates human-computer interaction. Monitors the remaining battery power to prevent overcharge. collects terminal voltage and temperature data from each battery in the pack to prevent overcharging or over discharging.

Cell Balancing: Maintains a balanced state among individual cells and the battery pack to prevent damage.

Thermal Management: Monitors and regulates battery temperature to prevent overheating.

High Voltage and Insulation Detection: Ensures the battery operates within safe voltage and insulation limits.

Fault Detection and Diagnosis: Identifies and reports faults, such as overcharge, over discharge, or short circuits.

Communication: Data is transmitted between modules using internal CAN bus technology.

Fuel Gauge Monitor: Tracks charge flow and calculates the available electric charge. Cell Voltage Monitor cell voltage to ensure standard voltage levels and enhance safety.

LITHIUM-ION (Li-ion) BATTERIES :-

Lithium-ion is the most popular rechargeable battery chemistry used today. Lithium-ion batteries power the devices we use every day, like our mobile phones and electric vehicles.

Lithium-ion batteries consist of single or multiple lithium-ion cells, along with a protective circuit board. They are referred to as batteries once the cell, or cells, are installed inside a device with the protective circuit board.

Fig 3: Lithium-ion Battery

The BMS ensures the ESD's lifelong service, safety, and balanced facility for EV driving. The BMS is an extensive structure containing inclusive mechanisms and performance assessment for numerous ESD types, cell monitoring, power, thermal management, charging/discharging procedures, health status, data acquirement, cell protection, and lifetime.

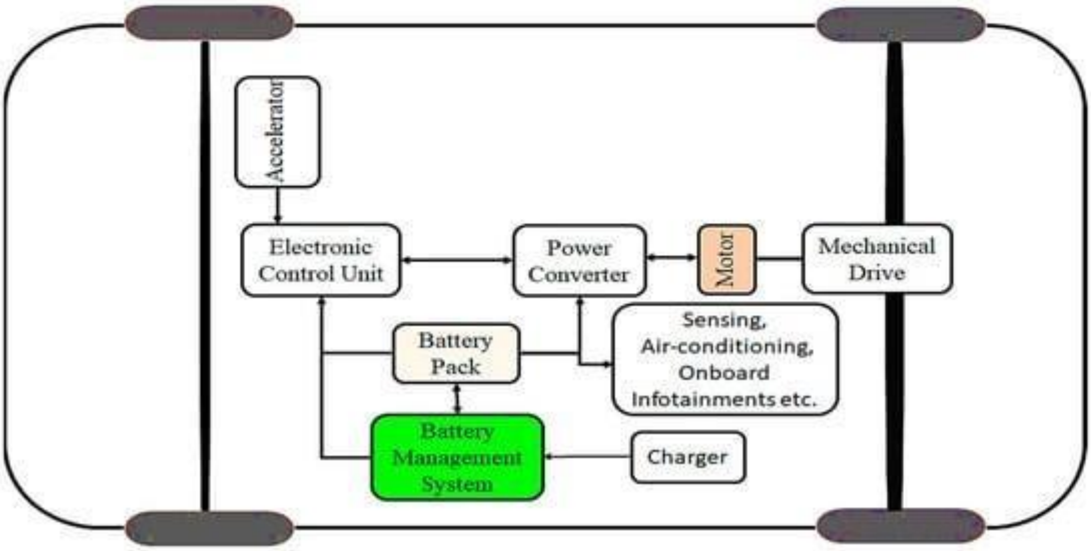

Figure 1. BMS operation inside the EV.

Cell voltage imbalance occurred during the charging/discharging time for internal electrochemical reactions in ESD. In BMS, cell voltage balancing is the leading work to improve cell life span and safety. Researchers and scientists are working on BMSs to develop highly efficient cell voltage/charge balancing systems to balance the cell voltage/charge, protect the cell from hazardous explosions, and improve its reliability.

Motivation and objectives: Much research has been conducted on the BMS working environments for EV systems. The BMS study field creates more attention and increases the research scope at the academic or industrial level. The significance of BMS research is illustrated, where we present the number of publications since 2010. Shen and Gao analyzed BMSs based on modeling efforts. Lelie et al. reviewed BMS hardware concepts. In there is a discussion of battery modeling and state-of-charge estimations. Lin, Jiayuan, et al., reviewed battery thermal management systems and See, K.W. et al., reviewed safety issues on BMSs on a large Tran, Manh-Kien, et al., reviewed cloud-based smart BMSs.However, most of the study focused on BMS-specific parameters (i.e., battery modeling, state-of-charge estimation, voltage balancing, heat, safety, etc.), for which some points are still lacking. Considering these lacking points, the primary objective of this study is to present a brief survey and to summarize the existing BMSs, descriptions, issues, challenges, and recommendations based on various researchers' efforts. This study started with background on ESSs, BMSs, and EV-applicable batteries. Then a brief overview of BMSs, their issues, and challenges are presented. Finally, the perspective of BMS improvement for the future is presented illustrates the taxonomy of an overview of the study.

V. RESULT

The Battery Management System (BMS) is a critical component in electric two wheeler, ensuring the safety, efficiency, and longevity of the battery pack. Its primary functions include monitoring battery parameters, balancing cell voltages, and protecting against overcharging, over-discharging, and overheating. An effective BMS enhances the overall performance and reliability of electric scooters by optimizing battery usage and extending battery life. As electric mobility continues to advance, the development and integration of sophisticated BMS technology will play a vital role in meeting the increasing demands for sustainable and high-performance transportation solutions.

A. Reading

S.No	Feature	Description
1	Weight Carrying Capacity (Kg)	120
2	Battery capacity (Ah)	48
3	Battery voltage (v)	60
4	Distance travelled (KM)	65
5	Top Speed	60
6	Battery Capacity (Kw/h)	2.5
7	Motor Type	BLDC Motor
8	Charging Duration	4hr

B. Comparison

Comparison	Electric Bike	IC Engine Bike
Distance travelled per charge/per liter (KM)	30	50
Cost to travel per KM(Rs)	0.33	1.42
Charging time/refuelling time(h)	3.5	0.05
Air pollution	No	Yes
Maintenance cost month (Rs)	100	500

VI. CONCLUSION

Now a days, utilization of fuel vehicles are increased rapidly which result into more air pollution. To control this, utilization of EV is must because it's several advantages like electric scooter is an eco-friendly product, Itis more suitable for city as it can avoid the emission of harmful gases and thereby it can reduce the atmospheric pollution. Due to frequent increase in fuel prices, the electrically charged vehicle seen to be the cheapest one compared to the traditional vehicle. E-scooters are more suitable for rural areas where the numbers of petrol bunks are not adequate, so that the rural people can charge the vehicle with the help of electricity. To understanding the EV technology, this study helps to provide outline of EV (Scooter) and there various components.

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