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Smart Monitoring and Controlling of the Battery and Motor

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Abstract

The demand for effective battery and motor monitoring and management to guarantee dependability, safety, and peak performance has increased due to the quick development of electric vehicles and smart industrial systems. The smart monitoring and control methods used in battery management systems and motor control systems are thoroughly reviewed in this paper. In addition to speed, torque, efficiency, and fault situations in motors, it emphasizes important characteristics like temperature, voltage, current, state of charge, and state of health in batteries. The importance of data-driven methods such as machine learning and artificial intelligence for improving fault detection, predictive maintenance, and system optimization is examined. Also examined is the integration of cloud-based platforms with Internet of Things (IoT) frameworks to enable remote monitoring, data storage, and smart decision-making. Additionally, crucial challenges like system reliability, cybersecurity issues, and scalability problems are examined to offer a thorough viewpoint on implementation. Future research directions centred on intelligent, autonomous, and energy-efficient systems are discussed. The main aim of this analysis is to help developments in sustainable and intelligent energy systems by offering a comprehensive grasp of existing technology and new trends in smart battery and motor monitoring and control. Real-world applicability and performance enhancements in various industrial settings for future implementations and research progress are underscored through practical case studies and experimental validations, guaranteeing global improvements in efficiency, reliability, safety, and cost-effectiveness.

Keywords: Electric vehicle, battery management system, motor, state of charge, temperature, smart monitoring

INTRODUCTION

Electric vehicles (EVs) are becoming an important solution for sustainable transportation. The end result is that the uptake of electric vehicles keeps rising. A few years back, there were several restrictions that made individuals reluctant to use electric vehicles. In the past, EVs were not as efficient, encountered various problems like overheating, and lacked widespread trust. However, this situation is gradually changing, and many people now prefer battery-powered vehicles due to their lower running costs compared to internal combustion engine vehicles. EV technology bear problems in battery management system (BMS) like failure in measuring battery temperature, indicating the wrong state of charge, improper control of charging and discharging, etc. This may be mainly due to sensor failure, unstable voltage, overheating of motor, high current flow due to overload leading to reduced efficiency.

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To address the problems occurring in electric vehicles, a smart monitoring and control system for the battery and motor is preferable. Both battery and motor are the most crucial components of an EV and any damage to these components can affect the entire system. This paper discusses the review on the design impact of smart monitoring and controlling the battery and motor of electric vehicles and its crucial need in the developing scenario. This project's development will help avert damages and enhance the system's efficiency. The battery and motor are often affected by fluctuations in voltage and current. It is well known that an increase in current and voltage leads to an increase in temperature. By continuously monitoring these parameters, the chances of damage in electric vehicles can be significantly reduced.

RESEARCH REPORTS – A SURVEY

Md. Robiul Islam et al. developed an IoT-based real-time battery monitoring system that measures key battery parameters, including voltage, current, and temperature, to improve the safety and performance of electric machines. The system uses Node MCU ESP8266 with Wi-Fi connectivity to transmit battery data continuously to an online platform, allowing users to monitor battery health remotely. Sensors such as the DHT22 temperature sensor and voltage/current sensors collect battery data, while the microcontroller processes this information and sends it to the cloud server. The methodology includes battery voltage checking, charging status monitoring, and automatic alerts when abnormal conditions or critical battery levels are detected. The proposed system improves battery life, energy efficiency, and reliability by enabling real-time monitoring, data analytics, and preventive maintenance through IoT technology [1].

Gayatri Eadaskar et al designed a State of Charge (SOC) estimation method for the Battery Management System (BMS) of electric vehicles using the Extended Kalman Filter (EKF) algorithm for accurate battery monitoring. The methodology involves collecting battery parameters such as voltage, current, and temperature and using these values in a MATLAB-based EKF model to estimate the SOC of lithium-ion batteries. The EKF algorithm processes nonlinear battery behaviour by approximating the system through mathematical modelling and filtering noise, which improves the accuracy of SOC estimation during charging and discharging [2].

Kishore S et al developed a low-cost Battery Management System (BMS) using an Arduino microcontroller to monitor and manage a 3.7 V lithium-ion battery pack. The methodology involves using voltage sensors to continuously measure battery cell voltage, while the Arduino processes this data to estimate the State of Charge (SoC) of the battery. The system implements protective functions such as preventing overcharging and over-discharging to ensure safe battery operation. The Arduino-based BMS also helps in cell monitoring and balancing, maintaining stable battery performance and extending battery lifespan [3].

Ranney et al uniquely integrated that Artificial Intelligence with electric motor design to optimize performance and efficiency. It uses AI techniques such as neural networks, genetic algorithms, and reinforcement learning, along with digital twin and hybrid modelling methods. The study discovered that AI can significantly reduce design time while improving accuracy in thermal prediction and motor optimization. The system enables real-time analysis and adaptive motor control using sensor data and predictive models. This project is important because it helps develop more efficient, reliable, and sustainable electric motors for EVs and renewable energy systems [4].

Haoming Tan et al found that Electric vehicles (EVs) are becoming essential for sustainable transportation and reducing carbon emissions, with the electric motor as the core component. Traditional motor design methods face challenges in efficiency, weight, thermal performance, and cost optimization. The study introduces Artificial Intelligence (AI) techniques such as machine learning and neural networks to improve motor design and performance. AI enables faster design optimization, predictive analysis, and better control of efficiency, thermal management, and reliability. The project concludes that AI-driven motor design improves EV performance, reduces costs, and supports the development of smarter and sustainable transportation systems. [5].

I M. Mara identified that the rising global temperatures have encouraged the automotive industry to shift toward electric vehicles (EVs) as an environmentally friendly solution. The study focuses on the Battery Management System (BMS), which improves battery safety, performance, and reliability in EVs. The BMS controls important functions such as charger operation, cooling system management, contactors, and ground isolation protection. Experimental results show that cell capacity depends on the discharge rate, which affects accurate State of Charge (SOC) estimation. The system maintains SOC between 80–100% for battery health and can automatically disconnect the circuit if SOC drops below 80% [6].

Dr. Ratnababu Mamidi explained that Battery Management Systems (BMS) are essential in electric vehicles, energy storage systems, and electronic devices to monitor battery parameters like voltage, current, temperature, and State of Charge (SOC). BMS helps prevent problems such as overcharging, deep discharge, and thermal runaway, ensuring safe and efficient battery operation. Advanced techniques are used to estimate important battery parameters such as State of Charge (SOC), State of Power (SOP), and State of Health (SOH). Cell balancing methods (passive and active) are used to maintain equal charge among battery cells and improve battery life. Recent developments integrate Artificial Intelligence and Machine Learning for better fault detection, predictive maintenance, and improved battery system reliability [7].

Rishav Kumar et al discussed that the safety of lithium-ion batteries in electric vehicles is a major concern for the automobile industry. This study aims to reduce risks and improve battery protection systems through continuous monitoring. Important battery parameters such as temperature, voltage, current, and gas levels are monitored to detect abnormal conditions. Problems like internal short circuits, overheating, explosions, and fire can occur if battery faults are not detected early. A sensor-based monitoring system helps maintain battery health, improves performance, increases battery life, and protects vehicle investment [8].

Sharan D et al the project developed a Smart Battery Management System (BMS) to improve battery performance, safety, and lifespan in electric vehicles. The system monitors voltage, current, and temperature and prevents issues such as overcharging, deep discharging, and overheating. Cell balancing techniques are used to maintain equal charge among battery cells and ensure efficient energy utilization. The system includes real-time monitoring through a CAN bus dashboard and is tested using MATLAB/Simulink simulations and practical experiments. Results show improved battery efficiency, reliability, and vehicle safety, supporting future advancements in EV battery technology [9].

Hrushikesh Narayan Aher et al discussed that batteries are widely used in applications such as electric vehicles, hybrid cars, power tools, and backup power systems. A Battery Management System (BMS) ensures safe and efficient battery operation by monitoring and controlling lithium-ion batteries. The BMS estimates key parameters like State of Charge (SOC) and State of Health (SOH) to maintain battery performance. It also protects the battery from overcharging, over-discharging, and overheating, which can damage the battery. Thermal management systems in BMS help control battery temperature and maintain optimal operating conditions for better efficiency and longer battery life [10].

Abdelrahman O. Ali et al identified that Electric vehicle (EV) technology began with the first hybrid car in 1902, later growing rapidly with models like the GM EV1, Toyota Prius, Tesla Roadster, and Nissan Leaf. The EV market has expanded quickly in the last decade due to climate change concerns and demand for cleaner transportation. Lithium-ion batteries are widely used in EVs because of their high energy density, long life, and low self-discharge rate. A Battery Management System (BMS) is essential to manage battery safety, charging, thermal control, and cell balancing. This review analyses battery cooling methods, charging strategies, battery states, and modern BMS technologies used in EV development [11].

Bilash sah et al declared that Battery Management Systems (BMS) are essential for safe operation, longer battery life, and improved performance in electric vehicle battery packs. Differences between individual cells can cause imbalance, overvoltage, deep discharge, and temperature variations, which affect safety and efficiency. Modern BMS includes advanced functions such as cell balancing, state estimation, and thermal management to maintain reliable battery operation. The proposed Intelligent Battery Management System (IBMS) uses cloud computing, artificial intelligence, and predictive maintenance for better battery monitoring and diagnostics. The future smart mobility platform integrates digital twin technology, secure communication, and intelligent driving assistance to improve EV performance and safety [12].

Jaisiva et al found that Artificial Intelligence (AI) is increasingly being integrated into Electric Vehicle Battery Management Systems (BMS) to improve battery performance, safety, and lifespan. AI-based BMS can predict battery health, optimize charging cycles, and manage energy usage using data such as voltage, temperature, and usage patterns. However, challenges include system integration, real-time processing, data privacy, cybersecurity, and high implementation costs. The proposed Hybrid AI-based Battery Management System (HAI-BMS) combines traditional control methods with machine learning, neural networks, and reinforcement learning. Results show that HAI-BMS improves battery efficiency, reliability, and EV performance, supporting future smart grid integration and sustainable transportation [13].

Gopal Krishna et al found that the electric vehicles and energy storage systems have increased the need for reliable lithium-ion batteries and advanced Battery Management Systems (BMS). Batteries degrade over time due to charge–discharge cycles, and they are considered at end-of-life when capacity drops below 70–80% of the original value. Important battery parameters such as State of Health (SOH) and Remaining Useful Life (RUL) help evaluate battery condition and predict maintenance needs. IoT-based BMS enables real-time monitoring of voltage, temperature, and current, allowing predictive maintenance and improved safety. The study proposes an LSTM machine-learning model that accurately predicts battery RUL using IoT data, improving battery reliability and energy management systems [14].

Poshitha B et al determined that thermal management systems are essential in electric vehicles to improve efficiency, reduce energy loss, and maintain optimal motor performance. Climate control systems like air conditioning consume significant energy, reducing fuel efficiency in HEVs and driving range in EVs. Various cooling methods are employed, including air and liquid cooling, with the latter providing superior thermal performance. The methodology uses a coolant circulation system with a pump, radiator, and thermostat to absorb and dissipate motor heat effectively. Results show that liquid cooling maintains optimal motor temperature, improves performance, and increases motor lifespan, especially under high-load conditions. [15].

CONCLUSION

Electric vehicles (EVs) have emerged as a key enabler of sustainable transportation, with growing adoption driven by improved technology, reduced operating costs, and increased environmental awareness. This review emphasizes that the battery and motor are the most vital components of an EV, and their efficient operation is essential for overall system reliability and longevity. The integration of smart monitoring and control systems plays a crucial role in addressing these challenges by enabling real-time tracking of key parameters such as voltage, current, temperature, state of charge, and motor conditions. In conclusion, the implementation of smart monitoring and control strategies is not only beneficial but essential for the future development of electric vehicles. Such systems can significantly reduce the risk of component failure, improve energy efficiency, and extend the lifespan of EV components. Future research should focus on developing more robust, cost-effective, and intelligent solutions to ensure reliable and sustainable EV operation in increasingly demanding environments.

REFERENCES

1. Mathew SA, Prakash R, John PC. A smart wireless battery monitoring system for electric vehicles. In2012 12th International Conference on Intelligent Systems Design and Applications (ISDA) 2012 Nov 27 (pp. 189-193). IEEE.
2. Hu JN, Hu JJ, Lin HB, Li XP, Jiang CL, Qiu XH, Li WS. State-of-charge estimation for battery management system using optimized support vector machine for regression. Journal of Power Sources. 2014 Dec 10;269:682-93.
3. Roslan NF, MUDA WM. Development of battery monitoring system using arduino uno microcontroller. Universiti Malaysia Terengganu Journal of Undergraduate Research. 2020 Oct 31;2(4):41-50.
4. Papa G, Koroušić-Seljak B. An artificial intelligence approach to the efficiency improvement of a universal motor. Engineering applications of artificial intelligence. 2005 Feb 1;18(1):47-55.
5. Tan H. Electric Motor Optimization Based On Artificial Intelligence. Advances in Engineering Technology Research. 2025 Nov 20;15(1):847-.
6. Lee BH, Kim SW. Development of battery management system for nickel–metal hydride batteries in electric vehicle applications. Journal of Power Sources. 2002 Jun 15;109(1):1-0.
7. Mamidi R, Obulesu D, Dutta SR, Rao PU, Selvan RS, Prabha M. Enhancing Battery Health in Electric Vehicles: AI-Enhanced BMS for Accurate SoC, SoH, and Fault Diagnosis. Metallurgical and Materials Engineering. 2025;31(1):491-500.
8. Dhanani S, Coreth S, Simpson T, Daly AJ, inventors; Kidde Technologies Inc, assignee. Lithium ion battery protection system. United States patent US 11,276,891. 2022 Mar 15.
9. Manonmani N, Sharan D, Sri Tarun Desigan G, Sundar R, Vivin SR. Smart Battery Management System for Automotive Electric Vehicles. IJSAT-International Journal on Science and Technology. 2025 Sep 28;16(3).
10. Kumar MN, Balakrishnan K. Functional safety development of battery management system for electric vehicles. In2019 IEEE transportation electrification conference (ITEC-India) 2019 Dec 17 (pp. 1-6). IEEE.
11. Ali AO, Abdelrehim O, Saafan MM, Elmarghany MR, Hamed AM. Comprehensive review of battery management systems for electric vehicles: Thermal management, charging strategies, and emerging technologies. Journal of Power Sources. 2025 Dec 1;658:238269.
12. Mulpuri SK, Sah B, Kumar P. An intelligent battery management system (BMS) with end-edge-cloud connectivity–a perspective. Sustainable Energy & Fuels. 2025;9(5):1142-59.
13. Samanta A, Karnehm D, Sharma M, Neve A, Williamson S. Thermal Behavior Forecasting for Battery Management Systems Using iTransformer and Kolmogorov–Arnold Network. InIECON 2025–51st Annual Conference of the IEEE Industrial Electronics Society 2025 Oct 14 (pp. 1-6). IEEE.
14. Krishna G, Singh R, Gehlot A, Almogren A, Altameem A, Ur Rehman A, Hussen S. Advanced battery management system enhancement using IoT and ML for predicting remaining useful life in Li-ion batteries. Scientific Reports. 2024 Dec 5;14(1):30394.
15. Rahmani A, Dibaj M, Akrami M. Design and simulation of battery thermal management systems for electric vehicles using MATLAB Simulink. Journal of Energy Storage. 2025 Mar 1;111:115398.

