

# Smart Battery Monitor with Driver Assistance System

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**Abstract—** Smart Battery Monitor with Driver Assistance System is an Internet of Things enabled embedded system designed to enhance safety, efficiency, and reliability. The designed system utilizes an ESP32 microcontroller along with a number of sensors to continuously monitor the vital parameters of the battery as well as of the driving environment. Such sensors include voltage and current sensors to monitor the status of the battery, temperature, gas leak detectors, and vibration sensors to detect any potential risk such as overheating, gas leak, and any collision while driving. Information gathered through these sensors can be viewed using I2C LCD and a web-based interface that provides wireless communication. The system also incorporates smart safety measures when any abnormality is detected in the system. For instance, in case of overheating and gas leak, the system automatically activates the cooling fans through relay mechanism and also stops the power supplied to the engine during important stages to protect the system from any potential damage. Moreover, in case of insufficient battery, the system slows down the driving speed of the vehicle.

**Keywords—** ESP32, IoT, Smart Battery Monitoring, Driver Assistance System, Battery Safety, Real-Time Monitoring, Voltage Sensor, Current Sensor, Temperature Sensor, Smoke Detection, Vibration Sensor,

## I. INTRODUCTION



Fig. 1. Battery management system

Electric Vehicles (EVs) are becoming increasingly popular in the transportation industry due to their eco-friendly operation, better energy efficiency, and reduced dependence on fossil fuels. Unlike conventional vehicles that use internal combustion engines, EVs run on electric motors powered by rechargeable batteries. Rising environmental pollution, increasing fuel costs, and the growing demand to reduce carbon emissions have encouraged rapid advancements in electric vehicle technology across the world.

In electric vehicles, the battery system is one of the most important components because it supplies the energy required for vehicle operation. The overall performance, driving range, efficiency, and reliability of an EV mainly depend on the condition of the battery. However, batteries are sensitive to issues such as overcharging, deep discharging, excessive current flow, and temperature fluctuations. If these factors are not monitored properly, they can reduce battery life, affect performance, and even create safety hazards like overheating and thermal runaway. Therefore, proper battery monitoring and protection

are essential for the safe and efficient functioning of electric vehicles.

To overcome these challenges, modern EVs use Battery Management Systems (BMS) to continuously monitor important battery parameters including voltage, current, temperature, and charging status. These systems help in maintaining battery balance, improving safety, and extending battery lifespan. In addition to battery management, many advanced driver assistance features are also integrated into EVs to improve vehicle performance and user safety. Features such as intelligent speed control, warning alerts, safety notifications, and energy management help reduce battery stress and provide a better driving experience.

The proposed Smart Battery Monitor with Driver Assistance System is developed as an intelligent and cost-effective embedded solution to meet these requirements. The system uses an ESP32 microcontroller along with multiple sensors to monitor important battery and vehicle conditions. Sensors for voltage, current, temperature, smoke, and vibration continuously collect real-time data from the vehicle. This data is processed by the controller to identify abnormal conditions and activate protective measures whenever required.

One of the major advantages of the system is its real-time monitoring capability through both an LCD display and a wireless web dashboard. This enables the driver to easily observe battery status and receive instant alerts during unsafe conditions. To further improve safety, the system also includes automatic protection features such as relay-based motor cutoff and cooling fan control to avoid overheating and protect the battery from damage.

## II. LITERATURE SURVEY

The rapid growth of electric vehicles has increased research activities in areas such as battery management, energy efficiency, vehicle safety, and intelligent monitoring technologies. Since the battery serves as the main power source in an EV, maintaining its health and safety is very important for reliable vehicle operation. Many researchers have worked on systems that continuously monitor key battery parameters like voltage, current, temperature, and charging status. Recent studies also focus on integrating protection circuits, thermal management

methods, and automated safety features to improve battery life and prevent system failures.

Prof. Arati Jaibhai, Vishal Hanamghar, Naresh Pawar, and Sachin Maske [1] developed a battery management and fire protection system for electric vehicles using a PIC microcontroller. Their system monitored battery voltage, current, and temperature to improve charging safety and overall battery performance. Relay circuits, LCD displays, and buzzer alerts were used to identify abnormal operating conditions. The system also supported automatic switching between fast and slow charging modes to enhance charging efficiency. However, the work mainly focused on battery safety and did not include wireless monitoring or driver assistance features.

Alok Kumar Verma, Akash Singh, Manish Kumar, Priyanka Tiwari, Raman Sharma, and Praval Sharma [2] proposed a real-time battery monitoring system capable of measuring voltage, current, temperature, humidity, and battery charge condition. Their model included cooling fans, flame sensors, display units, and relay-based protection circuits to improve system safety. The study provided better thermal management and fire prevention during charging and discharging processes. However, the inclusion of multiple sensors increased the overall complexity and power consumption of the system.

Pruthvi Sindogi, Chinta Raj Kumar, Varun, Rakshith, Rohith Purasthu, and Sucheta Roy [3] discussed the future scope and environmental benefits of electric vehicles. Their paper explained how EVs can help reduce greenhouse gas emissions, fuel dependency, and maintenance costs while improving energy efficiency. The authors also highlighted challenges such as expensive batteries, limited charging infrastructure, and recycling difficulties. However, the study mainly focused on theoretical concepts and did not present any practical battery monitoring or protection system.

Chaitanya Pandya and Angel Agrawal [4] presented a detailed review of electric vehicle technologies, charging systems, battery types, and vehicle efficiency. Their work explained different categories of EVs, including Battery Electric Vehicles, Hybrid Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Fuel Cell Electric Vehicles. Various charging methods and battery technologies were also

discussed. Although the paper provided a broad overview of EV technology, it did not include intelligent monitoring systems or embedded safety mechanisms.

Hossam A. Gabbar, Ahmed M. Othman, and Muhammad R. Abdussami [5] reviewed the development of Battery Management Systems and industrial safety standards used in electric vehicle applications. Their research explained different BMS architectures, cooling methods, communication techniques, and fault detection systems designed for battery protection. The study emphasized the importance of industrial safety standards for reliable battery operation. However, the work mainly focused on safety guidelines and frameworks rather than practical IoT-based implementations.

Binsy Joseph and Deepak Vishnu Bhoir [6] performed simulation-based analysis of electric vehicle performance using Matlab and ADVISOR software. Their work studied factors such as battery energy consumption, driving range, acceleration, and overall vehicle efficiency under different conditions. The research highlighted the importance of energy management and proper battery sizing for improving EV performance. However, the study was mainly simulation-oriented and did not involve real-time hardware monitoring or embedded control techniques.

Krishnaji Deshapande, Ritesh Killekar, Mahesh V Jadhav, Girish P Kadakol, and Ganesh Ravalaji [7] developed an electric vehicle equipped with an Advanced Driver Assistance System. Their system used radar sensors, ultrasonic sensors, and cameras to provide features such as collision detection, lane monitoring, and adaptive cruise control. The proposed approach improved driving safety and vehicle automation. However, the study mainly focused on driver assistance and did not address battery monitoring or battery protection techniques.

Pau Muñoz-Benavent, Leopoldo Armesto, Vicent Gírbés, J. Ernesto Solanes, Juan Dols, Adolfo Muñoz, and Josep Tornero [8] proposed an Advanced Driving Assistance System for a neighbourhood electric vehicle using embedded controllers and distributed architecture. The system provided visual, audio, and haptic feedback to assist the driver during vehicle operation. Their research improved intelligent vehicle control and environmental awareness through sensor integration and real-time monitoring. However, the

work did not include battery health monitoring, wireless battery management, or embedded battery protection features.

### III. TAXONOMY

The reviewed research papers on electric vehicles can be classified into different categories based on their objectives, technologies used, and application areas. The major categories identified from the literature are Battery Monitoring and Safety Systems, Electric Vehicle Development Studies, Battery Management Analysis and Simulation, and Advanced Driver Assistance Systems. This classification helps in understanding the contribution of various researchers toward improving EV performance, safety, automation, and intelligent control systems.

The first category is Battery Monitoring and Safety Systems. Research in this area mainly focuses on monitoring battery condition and protecting the battery from unsafe operating situations. Prof. Arati Jaibhai, Vishal Hanamghar, Naresh Pawar, and Sachin Maske [1] developed a battery management system that monitored important parameters such as voltage, current, and temperature using a microcontroller-based platform. Their model included relay switching, buzzer alerts, and display modules to improve charging safety and reduce overheating problems.

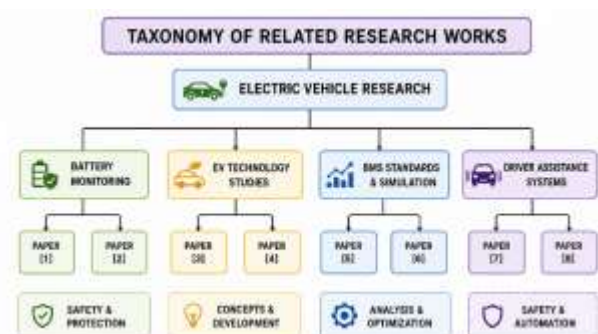


Fig. 2. Taxonomy of EV Battery management system with driver assistance system

Similarly, Alok Kumar Verma, Akash Singh, Manish Kumar, Priyanka Tiwari, Raman Sharma, and Praval Sharma [2] improved the monitoring system by adding humidity sensors, flame sensors, cooling fans, and relay-based protection circuits. Their work mainly concentrated on improving thermal safety, charging protection, and battery reliability in electric vehicles.

The second category includes studies related to Electric Vehicle Technology and Future Development. These papers mainly discuss the growth, benefits, and operational concepts of electric vehicles. Pruthvi Sindogi, Chinta Raj Kumar, Varun, Rakshith, Rohith Purasthu, and Sucheta Roy [3] explained the environmental advantages of EVs and their role in reducing pollution and dependence on fossil fuels. The authors also highlighted challenges such as limited charging infrastructure and battery recycling difficulties.

In another study, Chaitanya Pandya and Angel Agrawal [4] presented a detailed overview of different EV technologies including Battery Electric Vehicles (BEV), Hybrid Electric Vehicles (HEV), Plug-in Hybrid Electric Vehicles (PHEV), and Fuel Cell Electric Vehicles (FCEV). Their work discussed charging techniques, battery technologies, vehicle efficiency, and overall EV performance. These studies mainly provided theoretical and conceptual understanding of electric mobility systems.

The third category is Battery Management Analysis and Simulation Studies. Hossam A. Gabbar, Ahmed M. Othman, and Muhammad R. Abdussami [5] studied different Battery Management System architectures, industrial safety standards, communication methods, and protection strategies used in EV applications. Their research focused on fault detection, thermal management, and safe battery operation based on industrial regulations.

Similarly, Binsy Joseph and Deepak Vishnu Bhoir [6] carried out software-based simulation analysis of electric vehicle performance using Matlab and ADVISOR tools. Their study evaluated factors such as energy consumption, driving range, acceleration, and battery efficiency under different operating conditions. These works mainly contributed to performance analysis, energy optimization, and safety evaluation.

The fourth category includes Advanced Driver Assistance Systems integrated with electric vehicles. Krishnaji Deshapande, Ritesh Killekar, Mahesh V Jadhav, Girish P Kadakol, and Ganesh Ravalaji [7] developed an intelligent driver assistance system for electric vehicles using radar sensors, cameras, and ultrasonic modules. Their system provided features such as collision warning, lane monitoring, and adaptive cruise control to improve driving safety.

In another work, Pau Muñoz-Benavent, Leopoldo Armesto, Vicent Gírbés, J. Ernesto Solanes, Juan Dols, Adolfo Muñoz, and Josep Tornero [8] proposed an embedded ADAS platform that provided visual, audio, and haptic feedback to assist drivers during vehicle operation. Their research improved environmental sensing and intelligent vehicle guidance through real-time sensor processing.

From the above classification, it is clear that most existing research works mainly focus on separate areas such as battery monitoring, EV analysis, or driver assistance systems individually. Only a few studies combine battery monitoring, wireless communication, intelligent protection, and driver assistance into a single integrated platform. This creates the need for developing an integrated Smart Battery Monitor with Driver Assistance System using ESP32, IoT communication, and real-time sensor monitoring to improve electric vehicle safety, efficiency, and reliability.

#### IV. COMPARATIVE ANALYSIS

The reviewed research papers mainly focus on different areas of electric vehicle technology, including battery monitoring, thermal protection, EV development concepts, simulation analysis, and advanced driver assistance systems. Papers [1] and [2] primarily focused on Battery Management Systems for monitoring important battery parameters such as voltage, current, temperature, and charging status. These studies improved battery safety by implementing relay protection circuits, cooling systems, and fire detection mechanisms. However, their systems did not include advanced IoT-based communication or integrated driver assistance features.

Papers [3] and [4] mainly discussed the concepts, advantages, charging technologies, and future development of electric vehicles. These studies provided a strong theoretical understanding of EV technology, environmental benefits, and existing challenges. However, they did not include practical hardware implementation or real-time monitoring techniques.

Papers [5] and [6] focused on Battery Management System standards, safety analysis, and simulation-based performance evaluation. Their research improved knowledge related to battery safety regulations, energy management methods, and EV

efficiency analysis. Although these studies provided valuable analytical and simulation results, practical embedded implementation was limited.

Papers [7] and [8] mainly concentrated on Advanced Driver Assistance Systems (ADAS) using technologies such as sensors, radar modules, cameras, and automation systems to improve vehicle safety and driving support. These works enhanced intelligent vehicle control and environmental monitoring capabilities. However, they did not address battery health monitoring or battery protection mechanisms.

From the comparative analysis, it can be observed that most existing studies focus either on battery monitoring or driver assistance systems separately. Very few works combine battery monitoring, IoT communication, protection features, and intelligent driver assistance into a single embedded platform. Therefore, there is a strong need for an integrated Smart Battery Monitor with Driver Assistance System using a low-cost controller like ESP32 to improve vehicle safety, battery performance, and overall operational reliability.

TABLE I

COMPARATIVE ANALYSIS OF  
METHODOLOGIES USED FOR GRID STABILITY

| Pape<br>r No. | Main Focus         | Advantages                        | Limitations                  |
|---------------|--------------------|-----------------------------------|------------------------------|
| [1]           | Battery Monitoring | Charging control, fire protection | No IoT support               |
| [2]           | Smart BMS Safety   | Multi-sensor protection           | High hardware complexity     |
| [3]           | Future of EVs      | Environment al benefits           | No practical implementatio n |
| [4]           | EV Technologice s  | Charging & EV study               | No monitoring system         |
| [5]           | BMS Standards      | Safety analysis                   | No embedded implementatio n  |

|     |               |                         |                       |
|-----|---------------|-------------------------|-----------------------|
| [6] | EV Simulation | Performance evaluation  | No real-time hardware |
| [7] | ADAS System   | Driving safety features | No battery monitoring |
| [8] | Embedded ADAS | Intelligent automation  | No battery protection |

## V. CHALLENGES

The reviewed research papers identify several important challenges related to electric vehicle battery management, monitoring systems, and driver assistance technologies. One of the major issues discussed in Papers [1] and [2] is the difficulty in achieving accurate real-time monitoring of battery parameters such as voltage, current, temperature, and State of Charge (SoC). Errors in sensor readings or improper calibration can reduce monitoring accuracy and affect system reliability during charging and discharging processes.

Thermal safety is another critical challenge highlighted in battery-related studies. Papers [1], [2], and [5] explain that excessive heat generation inside battery packs can lead to overheating, thermal instability, and even fire hazards. Although cooling systems and relay-based protection mechanisms help improve safety, maintaining a stable battery temperature under different load conditions remains difficult, especially in compact electric vehicles where space for thermal management is limited.

Papers [3] and [4] discuss challenges associated with the adoption and development of electric vehicles. Limited availability of charging stations, long charging times, and the high cost of battery replacement continue to slow down large-scale EV implementation. In addition, battery recycling and disposal create environmental and operational concerns because damaged or expired batteries require proper handling and safe recycling methods.

The studies presented in Papers [5] and [6] also show that efficient energy management and accurate prediction of battery performance are still challenging tasks. Simulation tools can estimate factors such as driving range and energy consumption, but actual vehicle conditions vary depending on traffic, road

conditions, battery aging, and environmental changes. Because of these variations, achieving precise real-time battery performance analysis becomes difficult in practical applications.

Papers [7] and [8] explain several challenges related to Advanced Driver Assistance Systems (ADAS). Processing data from cameras, radar sensors, ultrasonic sensors, and embedded controllers in real time requires high-speed computation and reliable communication between different modules. Environmental conditions such as rain, dust, vibration, and poor visibility can reduce sensor accuracy and affect the overall reliability of the system.

Another important challenge observed from the reviewed studies is system integration. Most existing works focus either on battery monitoring or driver assistance systems separately. Integrating battery protection, wireless monitoring, thermal safety, and intelligent driver assistance into a single low-cost embedded platform increases both hardware and software complexity. Proper coordination between sensors, controllers, communication modules, and protection systems is necessary for smooth and reliable operation.

Power consumption is also a significant concern in smart monitoring systems. Continuous operation of sensors, displays, cooling fans, wireless communication units, and safety circuits increases battery energy consumption. Therefore, designing a monitoring system that provides high performance while consuming minimum power remains a major challenge in EV applications.

Finally, IoT-based communication and remote monitoring introduce additional challenges related to network stability and cybersecurity. Real-time wireless monitoring depends on secure and uninterrupted data transmission. Any network failure or unauthorized access may affect system operation and vehicle safety. As a result, developing secure, reliable, and energy-efficient smart battery monitoring systems continues to be an important research area in modern electric vehicle technology.

## VI. CONCLUSION

The reviewed research papers indicate that Battery Management Systems and intelligent driver assistance technologies are essential for improving the safety,

efficiency, and reliability of electric vehicles. Papers [1] and [2] showed that continuous monitoring of important battery parameters such as voltage, current, temperature, and charging status can help reduce overheating risks and improve battery protection. These studies used relay control systems, cooling mechanisms, and warning alerts to enhance battery safety and overall system reliability.

Papers [3] and [4] highlighted the increasing importance of electric vehicles in reducing environmental pollution, dependence on fossil fuels, and vehicle operating costs. The studies also discussed major challenges in EV technology, including limited charging infrastructure, battery efficiency issues, and charging time limitations.

The research presented in Papers [5] and [6] emphasized the role of battery safety standards, thermal management, energy optimization, and performance analysis in improving EV reliability and operational efficiency. Their studies showed that proper battery monitoring and thermal protection are important for extending battery life, improving driving range, and maintaining stable vehicle performance.

Papers [7] and [8] explained how Advanced Driver Assistance Systems (ADAS) improve vehicle safety through intelligent monitoring, collision detection, automated driving support, and environmental sensing using sensors and embedded control systems. These technologies help enhance driver safety and overall vehicle control during operation.

From the literature review and comparative analysis, it is clear that most existing research mainly focuses either on battery monitoring systems or driver assistance systems individually. Only limited work has been carried out on integrating battery protection, IoT communication, wireless monitoring, and intelligent driver assistance into a single embedded platform. Therefore, the proposed Smart Battery Monitor with Driver Assistance System using ESP32 offers a cost-effective and efficient solution by combining battery monitoring, safety protection, real-time wireless communication, and intelligent energy management within one integrated system for future electric vehicle applications.

## REFERENCE

- [1] Jaibhai A, Hanamghar V, Pawar N, Maske S. A Research Paper on Electric Vehicle BMS (Battery Management System) Charge Monitoring and Fire Protection. *International Journal of Scientific Research in Engineering and Management (IJSREM)*. 2024 Apr;8(4). ISSN: 2582-3930.
- [2] Verma AK, Singh A, Kumar M, Tiwari P, Sharma R, Sharma P. EV BMS with Charge Monitoring and Fire Protection. *International Journal of Science and Research Archive*. 2026;18(03):1270-1276.
- [3] Joseph B, Bhoir DV. Design and Assessment of Electric Vehicle Performance Parameters based on Drive Cycle. *ITM Web of Conferences*. 2021;40:01007. ICACC-2021.
- [4] Deshapande K, Killekar R, Jadhav MV, Kadakol GP, Ravaloji G. Electric Vehicle with Advance Driver Assistance System. *International Journal of Research Publication and Reviews*. 2023 May;4(5):2062-2067. ISSN: 2582-7421.
- [5] Muñoz-Benavent P, Armesto L, Gírbés V, Solanes JE, Dols J, Muñoz A, Tornero J. Advanced Driving Assistance Systems for an Electric Vehicle. *International Journal of Automation and Smart Technology*. 2012 Dec;2(4):329-338. DOI: 10.5875/ausmt.v2i4.169.
- [6] Pandya C, Agrawal A. A Detailed Study on Electric Vehicles. *IJCRT*. 2021 Jul;9(7). ISSN: 2320-2882.
- [7] Raut MW, Dhore KS, Kapse PA, Pardhi ST. Design and Analysis of Battery Management System for Electric Vehicles. *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*. 2025 Apr;13(IV). ISSN: 2321-9653.
- [8] Raut MW, Dhore KS, Kapse PA, Pardhi ST. Design and Analysis of Battery Management System for Electric Vehicles. *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*. 2025 Apr;13(IV). ISSN: 2321-9653.
- [9] Rashid MIM, Osman JRAJ. Design and Implementation of Battery Management System for Electric Bicycle. *MATEC Web of Conferences*. 2017;97:01111. ETIC 2016.
- [10] Lawder MT, Suthar B, Northrop PWC, De S, Hoff CM, Leitermann O, Crow ML, Santhanagopalan S, Subramanian VR. Battery Energy Storage System (BESS) and Battery Management System (BMS) for Grid-Scale Applications. *Proceedings of the IEEE*. 2014;102(6):1014–1030.
- [11] Vincent TA, Gulsoy B, Sansom JEH, Marco J. A Smart Cell Monitoring System Based on Power Line Communication—Optimization of Instrumentation and Acquisition for Smart Battery Management. *IEEE Access*. 2021 Nov 30;9:158312–158325.
- [12] Chen C, Man KL, Ting TO, Lei CU, Krilavičius T, Jeong TT, Seon JK, Guan SU, Wong PWH. Design and Realization of a Smart Battery Management System. *Proceedings of the International MultiConference of Engineers and Computer Scientists (IMECS 2012)*. 2012 Mar 14-16; Hong Kong. Vol II.
- [13] Schneider M, Ilgin S, Jegenhorst N, Kube R, Puttjer S, Riemschneider KR, Vollmer J. Automotive Battery Monitoring by Wireless Cell Sensors. *IEEE*. 2012; 978-1-4577-1772-7.
- [14] Wang B, Fernandez JH, Massoud A. A Wireless Battery Temperature Monitoring System for Electric Vehicle Charging. *IEEE*. 2019; 978-1-7281-1634-1.
- [15] Zhang G, Ge S, Yang XG, Leng Y, Marple D, Wang CY. Rapid Restoration of Electric Vehicle Battery Performance while Driving at Cold Temperatures. *Journal of Power Sources*. 2019;371:35–40.
- [16] Balan G, Arumugam S, Muthusamy S, Panchal H, Kotb H, Bajaj M, Ghoneim SSM, Kitmo. An Improved Deep Learning-Based Technique for Driver Detection and Driver Assistance in Electric Vehicles with Better Performance. *International Transactions on Electrical Energy Systems*. 2022;2022:8548172. doi:10.1155/2022/8548172.
- [17] Muñoz-Benavent P, Armesto L, Gírbés V, Solanes JE, Dols J, Muñoz A, Tornero J. Advanced Driving Assistance Systems for an Electric Vehicle.

International Journal of Automation and Smart Technology. 2012 Dec 1;2(4):271–280.

[18] C. R. Gould, C. M. Bingham, D. A. Stone, and P. Bentley, “New battery model and state-of-health determination through subspace parameter estimation and state-observer techniques,” *IEEE Trans. Veh. Technol.*, vol. 58, no. 8, pp. 3905–3916, Oct. 2009.

[19] Y.-J. Lee, A. Khaligh, and A. Emadi, “Advanced integrated bidirectional AC/DC and DC/DC converter for plug-in hybrid electric vehicles,” *IEEE Trans. Veh. Technol.*, vol. 58, no. 8, pp. 3970–3980, Oct. 2009.

[20] A. Szumanowski and Y. Chang, “Battery management system based on battery nonlinear dynamics modeling,” *IEEE Trans. Veh. Technol.*, vol. 57, no. 3, pp. 1425–1432, May 2008.

[21] A. Affanni, A. Bellini, G. Franceschini, P. Guglielmi, and C. Tassoni, “Battery choice and management for new-generation electric vehicles,” *IEEE Trans. Ind. Electron.*, vol. 52, no. 5, pp. 1343–1349, Oct. 2005.

[22] R. Peng and M. Pedram, “Battery-aware power management based on Markovian decision processes,” *IEEE Trans. Comput.-Aided Design*

*Integr. Circuits Syst.*, vol. 25, no. 7, pp. 1337–1349, Jul. 2006.

[23] A. Mills and S. Al-Hallaj, “Simulation of passive thermal management system for lithium-ion battery packs,” *J. Power Sources*, vol. 141, no. 2, pp. 307–15, Mar. 1, 2005.

[24] L. Maharjan, S. Inoue, H. Akagi, and J. Asakura, “State-of-charge (SOC)-balancing control of a battery energy storage system based on a cascade PWM converter,” *IEEE Trans. Power Electron.*, vol. 24, no. 6, pp. 1628–1636, Jun. 2009.

[25] H. Dai, X. Wei, and Z. Sun, “Model-based SOC estimation for high-power Li-ion battery packs used on FCHVs,” *High Technol. Lett.*, vol. 13, no. 3, pp. 322–326, 2007.

[26] J. Lee, O. Nam, and B. H. Cho, “Li-ion battery SOC estimation method based on the reduced order extended Kalman filtering,” *J. Power Sources*, vol. 174, no. 1, pp. 9–15, Nov. 2007.