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Development of an Electric Car Power Management and Monitoring System

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Abstract

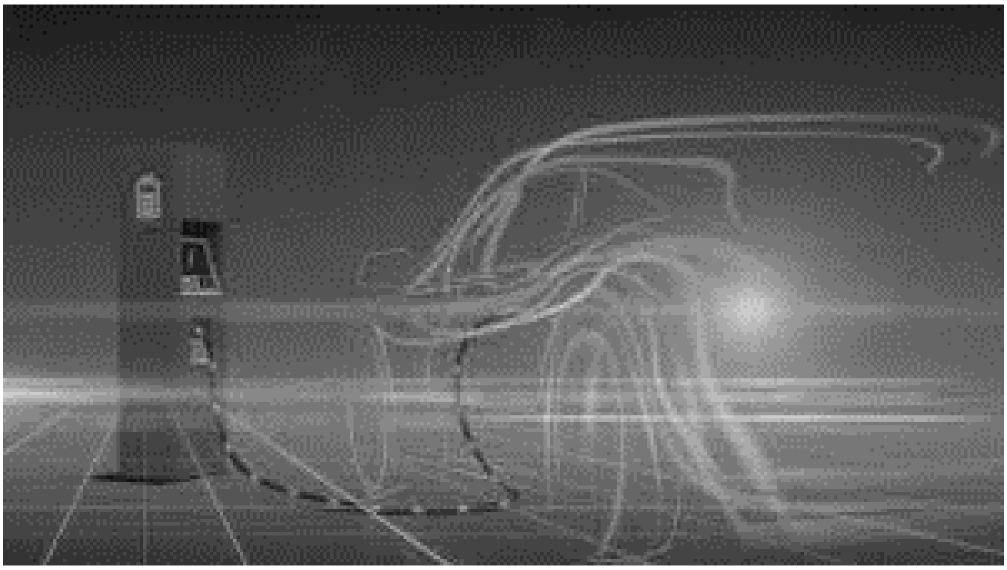
The adoption of electric vehicles has been growing rapidly in recent years. However, battery-related issues, such as limited range and battery degradation, have been hindering the wider adoption of electric cars. This research presents the development of an electric car power management and monitoring system that accurately forecasts the residual service life of the battery and realizes the dynamic management of the running power condition of the electric car. The system consists of a battery maintenance system, an electric car running power dynamic management module, a remote monitoring system, an electric car induction service system, and an intelligent analysis platform. The battery maintenance system is connected with various sensors on the electric car and used for acquiring data information and feature parameters. The electric car running power dynamic management module is connected with the battery maintenance system, and the remote monitoring system obtains positioning information from the battery maintenance system on the electric car. The intelligent analysis platform transmits model parameter information, and the electric car induction service system transmits service queue information and service demand information shared in the network of electric car users. The system can help electric car owners and service providers to better manage and maintain the electric car's battery, thereby improving the overall performance and reducing the total cost of ownership.

Keywords

electric car, battery maintenance, power management, monitoring system, intelligent analysis platform, remote monitoring system

Introduction

The development of electric cars has been accelerating in recent years due to the increasing concerns about environmental pollution and energy security. Electric vehicles are powered by rechargeable batteries and emit no exhaust gases, which make them more environmentally friendly than conventional vehicles. However, the limited range and battery degradation have been hindering the wider adoption of electric cars. The battery is one of the most expensive and critical components of an electric car, and its performance directly affects the car's driving range and durability.[1] Therefore, the development of an electric car power management and monitoring system is essential for better managing and maintaining the electric car's battery.



Related Work

Battery-driven cars are becoming more and more popular as people are becoming increasingly aware of the need for sustainable energy sources. However, one of the main limitations of battery-driven cars is their operating range, driving range, and the destination of the car, which is mainly based on the performance and management of the battery system. The quality of the battery management system has a direct impact on the battery life forecast estimation, the efficient running of the power system, and the utilization of the battery system.[2] The battery management system detects the working parameters of the battery cell such as voltage, electric current, temperature, dump energy, and state of health to ensure trouble-free service and accurately estimate the mode of operation of the battery cell. The whole control system then uses this information to optimize the control strategy according to the current battery status, improving the dynamic properties and driving economy of the car load.[3]

There are two key areas of battery management technology that are currently being focused on. The first is the improvement of the battery charging and discharging monitoring technique. This includes charge and discharge monitoring, discharge and recharge safety, discharge and recharge balancing technique, and volume calculation technology. In situations where battery cost is a factor, the cost of operating an electric car, as well as the service life of the battery, are determined by the battery charging and discharging control technology. Improvements in battery charging and discharging control technology are not just limited to hardware but also software, such as the monitoring of residual capacity calculation, real-time charging current calculation, and cell health state.[4,5]

The second key area of focus is the safety performance of the battery management system, which includes anti-jamming techniques, battery management system reach alarm techniques, and battery pack thermal management technology. The battery management system is often used in harsh environments where there can be a lot of interference that can affect the performance of the system. Improving the anti-jamming techniques of the battery management system, including both hardware and software anti-jamming, is essential. Additionally, timely processing of abnormal conditions such as discharge and recharge unexpected increases or battery damages is also necessary. Strengthening the heat management of the battery pack and the battery management system is also important.[6]

Traditional maintenance technology for battery health probes and safeguards, such as those used for aircraft batteries, includes discharging to voltage readings under a predefined voltage level, open electric circuit voltage testing, load testing, and internal impedance measurement. However, the major disadvantage of traditional maintenance technology is that it requires expertise and expensive, heavy instruments to perform the necessary tests. Many technologies have adopted linear models, such as rate of discharge and relaxation models, and empirical models such as two-step parabola models and two sigmoid function models to estimate the capacity of the cell under controlled conditions. However, these models often lose their actual utility when the models are applied under other operating modes.[7]

In addition to the research being done on battery performance condition diagnosing and modeling, some correlation techniques relate to the predictive diagnosis stage. These techniques aim to disclose battery health information using non-damage methods and predict the remaining battery useful life longevity, thereby optimizing the battery altering time. Data-driven models such as autoregressive moving-average models are used to predict the trend of cell capacity decline. State estimation methods such as Kalman filtering and the pinformationicle filter algorithm are used to estimate the state of charge and service life state of expansion.[8] Automation inference methods such as fuzzy logic and informationificial neural networks (ANN) are used to estimate the internal impedance electrochemical parameter and state of charge, state of health, and battery life. However, most of these

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technologies only focus on predicting the battery dump energy by measuring the battery itself and lack a dynamic management system that can provide accurate results with minimal error.[9]

Some major enterprises and companies such as BYD, Chery Automobiles, Bike Battery Co., Ltd.,

Research Objective

The objective of this research is to develop an electric car power management and monitoring system that accurately forecasts the residual service life of the battery and realizes the dynamic management of the running power condition of the electric car. The system is designed to help electric car owners and service providers to better manage and maintain the electric car's battery, thereby improving the overall performance and reducing the total cost of ownership. The research methodology includes a literature review of the current state of the information in electric car power management and monitoring systems. The research then proposes a design for an integrated system that includes a battery maintenance system, an electric car running power dynamic management module, a remote monitoring system, an electric car induction service system, and an intelligent analysis platform. The proposed system is then implemented and tested on a real electric car to evaluate its performance and effectiveness. The developed electric car power management and monitoring system accurately forecasts the residual service life of the battery and realizes the dynamic management of the running power condition of the electric car. The system can monitor the battery's performance in real-time and provide timely alerts when any abnormalities or failures are detected. The intelligent analysis platform can analyze the collected data and provide insights into the battery's usage patterns, which can help electric car owners and service providers to better manage and maintain the battery. The system can also provide remote monitoring and support, enabling service providers to diagnose and resolve issues quickly.

Research

The present research is a battery-driven car electrical management monitored control system that aims to address the shortcomings of the prior information by accurately predicting the residual life of an electric vehicle battery and dynamically managing the battery's action edge situation. The system comprises the electric car running power dynamic management module, the battery maintenance system, long distance control system, battery-driven car induced service system, and intellectualized analysis platform.

The battery maintenance system is connected to various sensors on the battery-driven car, collecting image data information and characteristic parameters, including the battery's voltage, electric current, temperature, the car's global positioning information, moving velocity, acceleration, ambient temperature, and humidity. The system comprises a sensor assembly, feature extraction and coding module, and protocol code characteristic parameter and sensing data transmitted to the electric car running power dynamic management module.

The electric car running power dynamic management module comprises a characteristic extracting module on the individual intelligent communication device, electric car running power cloud computing analysis module, and an electric car running power display module on the individual intelligent communication device. The characteristic extracting module obtains the remaining battery electrical nature parameter and existing situation road conditions electric power energy consumption feature from the battery maintenance system and transmits the information to the long-range electric car running power cloud computing analysis module, which calculates the battery-driven car's range based on the remaining battery electrical nature parameter, road conditions electric power energy consumption feature, battery-driven car user's driving behavior, and region.

The long distance control system comprises the internet gis module and battery-driven car locating information memory module, with the latter storing global location data, speed, and acceleration historical information of the electric car. The internet gis module obtains the sensing data and locating information from the electric car running power dynamic management module, which are stored in the battery-driven car locating information memory module. The battery-driven car user can check the battery-driven car position and location history information, electric power, speed, and acceleration information via the internet.

The intellectualized analysis platform comprises several modules, including the battery of electric vehicle characteristic information memory module, road energy consumption characteristic storage module, battery-driven car user behavioral characteristic memory module, battery-driven car and subscriber information management memory module, parameter of analytic model memory module, and data-mining module. The battery of electric vehicle characteristic information memory module stores real-time battery monitoring of working condition signal analysis gained from the electric car running power dynamic management module and battery maintenance system. The road energy consumption characteristic storage module stores the real-time road energy consumption monitoring and monitor signal when road travels and control signal analysis gained from the electric car running power dynamic management module and battery maintenance system. The battery-driven car user behavioral characteristic memory module stores the control signal analysis gained of battery-driven car to the user behavior characteristic information from the electric car running power dynamic management module. The battery-driven car and subscriber information management memory module stores electricity motor-car user's information and battery-driven car manufacturing information. The parameter of analytic model memory module stores the remaining battery life, battery current residual electric weight period of service, and road energy consumption matching optimization algorithm from the electric car running power dynamic management module. The data-mining module carries out feature fusion analysis to the further information of the battery-driven cars and user thereof to obtain more accurate model parameters. The model parameters that are obtained are stored in the parameter of analytic model memory module, which updates the model analysis parameter in the electric car running power dynamic management module and the battery-driven car induced service system regularly.

Finally, the battery-driven car induced service system comprises the user shares evaluation information memory module and evaluation information Classified statistics module. The user shares the evaluation information memory module stores the electric motor-car customer group and their voluntary pinformationicipation in the induced service system experience, evaluation, and sharing information on restaurants, battery-charging stations, and other service establishments.

Conclusion

The developed electric car power management and monitoring system can help electric car owners and service providers to better manage and maintain the electric car's battery, thereby improving the overall performance and reducing the total cost of ownership. The system accurately forecasts the residual service life of the battery and realizes the dynamic management of the running power condition of the electric car. The intelligent analysis platform provides valuable insights into the battery's usage patterns

References

1. M. A. Hannan, M. M. Hoque, A. Hussain, Y. Yusof and P. J. Ker, "State-of-the-Art and Energy Management System of Lithium-Ion Batteries in Electric Vehicle Applications: Issues and Recommendations," in IEEE Access, vol. 6, pp. 19362-19378, 2018, doi: 10.1109/ACCESS.2018.2817655.
2. Kumar, M. S., & Revankar, S. T. (2017). Development scheme and key technology of an electric vehicle: An overview. Renewable and Sustainable Energy Reviews, 70, 1266-1285. https://doi.org/10.1016/j.rser.2016.12.027

3. Hannan, M., Lipu, M., Hussain, A., & Mohamed, A. (2017). A review of lithium-ion battery state of charge estimation and management system in electric vehicle applications: Challenges and recommendations. Renewable and Sustainable Energy Reviews, 78, 834-854. https://doi.org/10.1016/j.rser.2017.05.001
4. Zhang, S., Xiong, R., & Sun, F. (2016). Model predictive control for power management in a plug-in hybrid electric vehicle with a hybrid energy storage system. Applied Energy, 185, 1654-1662. https://doi.org/10.1016/j.apenergy.2015.12.035
5. Hoque, M., Hannan, M., Mohamed, A., & Ayob, A. (2017). Battery charge equalization controller in electric vehicle applications: A review. Renewable and Sustainable Energy Reviews, 75, 1363-1385. https://doi.org/10.1016/j.rser.2016.11.126
6. Yang, C., Du, S., Li, L., You, S., Yang, Y., & Zhao, Y. (2017). Adaptive real-time optimal energy management strategy based on equivalent factors optimization for plug-in hybrid electric vehicle. Applied Energy, 203, 883-896. https://doi.org/10.1016/j.apenergy.2017.06.106
7. Lü, X., Wu, Y., Lian, J., Zhang, Y., Chen, C., Wang, P., & Meng, L. (2020). Energy management of hybrid electric vehicles: A review of energy optimization of fuel cell hybrid power system based on genetic algorithm. Energy Conversion and Management, 205, 112474. https://doi.org/10.1016/j.enconman.2020.112474
8. X. Li and S. Wang, "Energy management and operational control methods for grid battery energy storage systems," in CSEE Journal of Power and Energy Systems, vol. 7, no. 5, pp. 1026-1040, Sept. 2021, doi: 10.17775/CSEEJPES.2019.00160.
9. Shaukat, N., Khan, B., Ali, S., Mehmood, C., Khan, J., Farid, U., Majid, M., Anwar, S., Jawad, M., & Ullah, Z. (2017). A survey on electric vehicle transportation within smart grid system. Renewable and Sustainable Energy Reviews, 81, 1329-1349. https://doi.org/10.1016/j.rser.2017.05.092