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Research on SOC Key Technology of Lithium Battery Packs in Electric Vehicle

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Abstract: This paper gives a brief introduction to the background of the development of electric vehicles in China, a detailed description of the principle of the SOC of batteries in electric vehicle, introduces the new SoC technology progress, and to illustrate the author team of these technology to repeat the experiment results, and finally puts forward the SOC of batteries in electric vehicle future research route chart and conclusion.

Keywords Battery; State of charge; Algorithm; Kalman filtering; Open circuit voltage

INTRODUCTION

February 2016, Chinese Premier Li Keqiang presided over the State Council executive meeting held, continuous release of five important steps behind the new energy automotive industry; many cities in China in industrial 14th Five-Year planning will be new energy automobile industry as an important development direction of one of the five pillar industries car motorcycle during the 14th Five-Year vigorously develop automobile and parts industry.

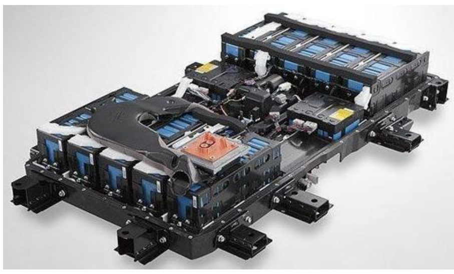

Figure 1. Lithium battery packs of electric vehicle

RESEARCH STATUS

The new energy vehicles are mainly divided into three types: pure electric vehicles, fuel cell vehicles and hybrid vehicles. At present, the pure electric vehicles accounted for the largest market share, accounting for about 92%.

Pure electric vehicles use lithium batteries as a source of power [Burton *et al.*, 1997]. The main control unit of the lithium battery is a battery management system of BMS (battery management system) [Zhao *et al.*, 2011]. It is necessary to real-time monitoring of power battery parameters, estimation of SOC (state of charge) battery state of charge, for the driver to provide the remaining power, continued driving mileage and other information, as well as to prevent battery over pressure, flow, over charge, over discharge, over high temperature cause damage, and other functions of the battery, and also a balanced battery capacity, and maintain a higher working efficiency of the battery [Kandula, 2010]. Pure electric vehicles use the situation is more complex, high power discharge (such as climbing), small power discharge (such as downhill or in low speed), and on the domestic electric vehicle used in harsh environment, high temperature, low temperature, and many other factors [Liu *et al.*, 2011]. Therefore, electric vehicle lithium battery SOC charging technology still exists following problems:

1) SOC state of charge estimate more difficult, which is currently the majority of electric vehicle use warning (red) to indicate the battery power is low and not the percentage to sign power lithium battery.

2) Because of the key technical issues of charging, power lithium battery safety and life needs to be further improved [LEE *et al.*, 2011].

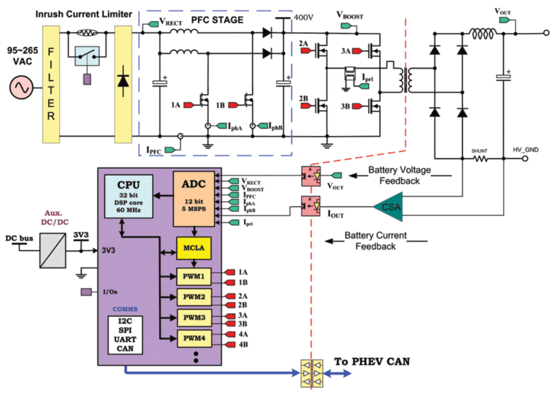

Figure 2. SOC principle of electric vehicle

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Therefore, the domestic and foreign new energy automobile manufacturers, research institutes in the electric vehicle power lithium battery SOC charging key technology in-depth study.

STATUS QUO OF EPS

In view of the project concept, the applicant team has started a part of the pre research work. The applicant team to build a platform for electric vehicles widely used three kinds of charging methods to experiment, test and obtain a large number of relevant data [Dave, 2005].

Open circuit voltage method

Team applicant through the charging and discharging experiments found that battery OCV (open circuit voltage) open circuit voltage and SOC exist some approximate linear relationship can be through the discharge test method to calibrate the OCV-SOC, establish the data model. In the practical application, by measuring the OCV of the battery, through the data model comparison, find the corresponding battery SOC. But the method is influenced by the discharge static test and temperature [Zang *et al.*, 2012]. In 2013, the battery equivalent circuit model of the model of non steady state open circuit voltage method form Wu Guoliang' team, the applicant team through the study found the algorithm can according to the battery current non steady state open circuit voltage, battery stop time and identification of parameters of battery, a fast estimation method of the remaining battery power, effectively compensate for the open circuit voltage method requires the battery for a long time static defects [Zang *et al.*, 2011].

Ampere hour integral method

An integral method is after the open circuit voltage method in engineering practice, the most commonly used SOC estimation method [Howe *et al.*, 2015]. The method can integrate the current state of the SOC value by integrating the current of the time. Ampere hour integral method to estimate battery SOC exist accumulated error and how to decide the initial value of defects in, some experts and scholars on the research and improvement, and have achieved good results.

KEY TECHNOLOGY

Through in-depth study of the current electric vehicle power lithium battery charge and discharge SOC estimation techniques, the team ready to put forward a new algorithm: card Kalman filtering algorithm based on the sampling, that OCV-Ah-SPKF algorithm (open circuit voltage - ampere hour integral sampling card Kalman filtering algorithm), combined with lithium battery discharge rules, the algorithm is applied to power lithium battery charge and discharge SOC estimation, to significantly improve power lithium battery SOC estimation accuracy and speed [Traian *et al.*, 2006].

Combined with the above research content, the main research contents are:

1) A new OCV-Ah-SPKF algorithm is proposed.

OCV-Ah-SPKF power battery SOC estimation algorithm is proposed, the proposed algorithm to be used as shown in Figure 3, the flow of power battery SOC estimation. In addition to the algorithm itself, there are some small innovations, such as in the initial stage of the algorithm increases to construct new model, first estimate and equipment down at a time when the battery state of charge (SOC) for comparison, in the algorithm estimates the second stage increased timer etc.

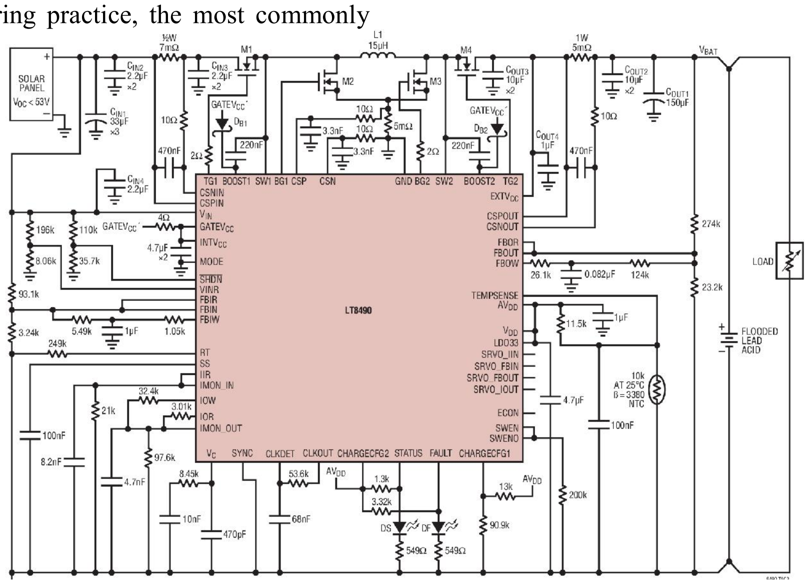

Figure 3. Battery charging circuit model

2) The current compensation technique is applied to the SOC estimation of the power lithium battery.

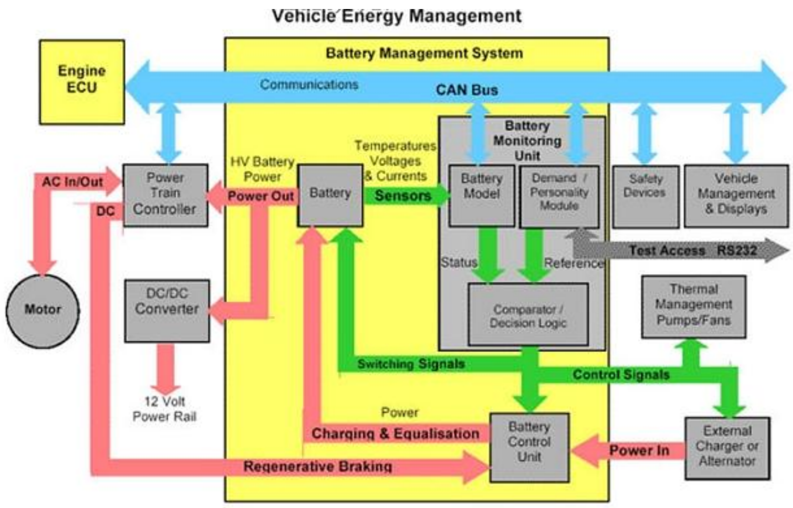

Figure 4. SOC charge estimation model

From Fig.2 can be obtained, when the battery in the discharge process, V measurement =V open -IR battery; and when the battery in charge, V measurement =V open +IR battery. It can be seen that in the process of charging and discharging, there is a big error between the actual measurement and the voltage of OCV. Therefore, this paper intends to use the current compensation technique was put forward, the closed circuit voltage (actual measured voltage) to compensate, after several iterations, find out the time optimal OCV, improve the open circuit voltage and ampere hour integral method of accuracy.

3) The OCV-SOC model and OCV-R model are established.

Combined with lithium battery normal work temperature range, intends to -10℃、0℃、25℃、50℃, respectively for lithium battery powered static experiment, get the corresponding relationship between OCV-SOC OCV-R, using the principle of linear interpolation and under different temperature, OCV-SOC model and OCV-R model.

Although the early will spend a lot of time, but can be dynamic and real-time access to lithium electric vehicle power lithium battery SOC estimation is still difficult in research on battery management system in recent years, the research Pro many difficulties [Schultz *et al.*, 2014]. Therefore, the team intends to comprehensive consideration of various methods and the characteristics of battery SOC value estimate of the actual demand, power lithium battery SOC value of battery internal resistance.

CONCLUSION

The experimental results show that the Thevenin model has high precision and can accurately simulate the dynamic effect of the battery, which is suitable for the occasion of high accuracy of the battery model. On the basis of the establishment of the battery model, using the extended Kalman filter (EKF) combined with Ah measurement method for the battery SOC estimation, and the experimental data into the simulation model to verify the analysis. Experiment and simulation results show that the UDDS and ECE working conditions, the EKF method combined with the ah counting method has a good anti-jamming and convergence, effectively compensate for the general ah counting method due to the influence of accumulative error caused by outside interference and the initial error of SOC.

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REFERENCES

Burton A. W., Thomson N. G., 1997, “Analysis and design of an electric power-assisted steering system”, Electric Product Design, vol. 18 (11), pp: 27-28.

Dave W., 2005, “Electric power steering: one good turn deserves another”, http://www.embedded.com/design/real-world-applications/4006457/Electric-power-steering-one-good-turn-deserves-another.

Howe, Hartley E., 2015, “Mr. Power Steering's ship comes in”. Popular science, vol.168, no.2, pp 161–164.

"Honda to launch S2000 type V equipped with the world's fi rst variable gear ratio steering (VGS) system", 2000, http: //world.honda.com/news/2000/4000707.html.

Kandula P., 2010, "Dynamics and control of an electric power assist steering system", Doctoral dissertation, Cleveland State University, USA.

LEE M. H., LEE H. M., LEE K. S., 2011, "Development of a hardware in the loop simulation system for electric power steering in vehicles", International journal of automotive technology, vol.12, no.5, pp 102-104.

Liu Y. H., Ji X. W., 2011, "Matching strategy of electric power steering assistant characters based on the vehicle inherent road feel", Proceedings of the institution of mechanical engineers, vol. 225, no.11, pp 481-1491.

Schultz, Mort, 2014, "Steering: a century of progress", Popular mechanics, vol. 162, no.5, pp 59.

Traian P., Paul P., Petru E., 2006, "Timing analysis of the Flex Ray communication protocol", USA: Institute of Electrical and Electronics Engineers Inc.

Zang H. P., Geng J., 2012, "Effects and solution of electric power steering system on vehicle handling stability", Journal of computational information systems, vol. 8, no.1, pp 65-72.

Zang H. Q., Chen S. Y., 2011, "Electric power steering simulation analyze based on fuzzy PID current tracking control", Journal of computational information systems, vol.7, no1, pp 119-126.

Zang H.Q., 2012, "Effects and solution of electric power steering system on vehicle handling stability", Journal of computational information systems, vol.8, pp 65-72.

Zhao W. Z., Lin Y., Wei J. W., 2011, "Control strategy of a novel electric power steering system integrated with active front steering function", Science china (technological sciences), vol.54, no.6, pp 1515-1520.