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作品摘要

作品名稱

利用動態補償法則實現動力電池之SOC、SOH偵測及智慧充電

Improving the estimation of SOC & SOH, and intelligent charging control of power battery by using dynamic compensation approach

隊伍名稱

三個臭皮匠 / Two heads are better than one

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近年來，由於環保議題日趨重要，節能減碳成為各國努力推動的一個重要政策，在這些目標以及限制之下，同時具備環保、低汙染且節能等優點的油電混合車（Hybrid Vehicles）、電動車（Electric Vehicles）與電動機車（Electric scooter）等都將成為交通運輸業的下一代主力。然而，上述之各種電動車輛目前都面臨一個相同的問題，即系統無法準確地估測電池的電量，此將造成使用者對續航距離的誤判。

目前所提出之各種電池電量狀態（SOC）與健康狀態（SOH）的檢測方法，大多存在一些缺點及限制。例如：使用開路電壓法必須將電池靜置一段時間才能測量，且若電池電壓-電量之特性曲線並非線性，將不易正確顯示目前電量；其次，庫倫檢測法無法反映出充放電電流對電量的影響；再者，計算健康狀態時，必須在每個cell都設置測試電路，所花費成本與電路體積都相當龐大，且電池內阻值非常低，也不容易計算出正確值。

有鑑於此，本作品提出之電量狀態與健康狀態計算法則是以庫倫檢測法為主體，並結合動態補償法則來實現合理的電量狀態與健康狀態計算。其次，本作品所提出之電量計算法則並不需要花費時間等待電池的電化學反應達到穩定，所以，可以做到即時估測的功能，同時也兼顧到充放電深度對電池電量的實際影響，而作出動態修正，因此，可以計算出更為合理的電量狀態。再者，本作品所提出之健康狀態計算法則乃是直接利用電池管理系統所擷取的電池資訊進行計算，不需每個cell都加裝額外的測試電路，不但可以節省成本，同時也不需精確地計算電池的內阻值。此外，本作品中所加入的電池管理系統，能夠偵測電池模組內各個cell的電壓以及充放電電流，並且對電池模組提供必要的保護功能，同時也針對電池模組內各個cell作被動式的電壓平衡。

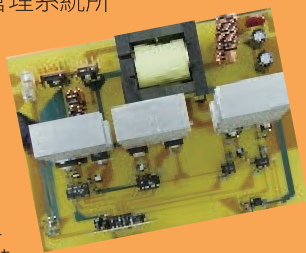

Fig.1 > 快速充電器系統

本作品所研製之充電器部分，具有高功率因數、高效率等特性，且符合國際通用輸入規格。再者，本作品所提出之智慧型充電策略讓使用者可以根據需求選擇執行快速充電模式或一般充電模式，再根據現有電量計算所需之充電電流大小，以實現智慧型充電的目的。當執行快速充電模式時，會以定電流方式在30分鐘之內讓電池充電至80%的電量；若執行一般充電模式，則會先以定電流方式對電池進行充電，縮短充電時間，當電量到達90%時再轉換成定電壓充電，直到電池電量達到100%。綜合上述所言，本作品提出了一種新式的計算法則，能夠實現及時估測並且計算出較為合理的電池電量狀態與健康狀態，不但能夠應用在智慧型充電控制，同時也兼顧了充電效率與延長電池的使用壽命。

Fig.2 > 以動態補償法則實現動力電池之SOC、SOH偵測之硬體電路

Abstract

Recently, due to the progress of environmental conservation, energy saving and carbon reduction have became the most important and common policy for all of the governments over the world. Nowadays, these issues are formed the forefront of many governmental policies. With these views in mind, "green vehicles" such as hybrid vehicles, electric vehicles and electric scooter with low carbon emission, low pollution and energy conservation will be developed as the mainstream of tomorrow's transportation. However, despite the advantages that these vehicles have to face with a common challenge – and that is the inability to accurately estimate the battery's state of charge (SOC) so that the driver can accurately judge the remaining battery power and distance to destination.

The existing current methods used for estimation of the SOC and SOH have almost many disadvantages and limitations. For examples: (1) A long settling time is required prior to measuring a battery characteristics when the open voltage measurement method is used. And it is not easy to obtain the real SOC in battery if the voltage-SOC characteristic curve is not linear. (2) The coulomb counting measurement cannot imply the effect of the various charging/discharging current to the SOC. (3) To estimate the SOH of battery, the extra test circuit is required for each cell, thus increasing the cost and battery volume. (4) Because the internal resistance of battery is very low, it is also not easy to measure and estimate.

According to the above-mentioned, the proposed method of the SOC and SOH estimation in this research is based on the coulomb counting measurement incorporating with a dynamic compensation rule to obtain a reasonable estimation value. Firstly, by using the proposed method, it will be no need to waste time for settling battery chemical response so as to implement the real-time estimation. Moreover, we utilize the dynamical correction to consider the practical effect for SOC under various C-rates charging or discharging current. And the proposed method can use directly the information from the BMS to calculate the SOH, thus, the extra test circuit for each cell is not essential and there is no need to calculate the precise internal resistance value. Besides, the battery management system integrated into the system in this research can measure the cell voltage and charge/discharging current, provide the essential protections and balance each cell voltage simultaneously.

The proposed charger system in this research is compatible with universal power input with characteristics of high power factor and high efficiency. Moreover, users can choose fast or normal charging mode according to their requirement by the proposed intelligent charging control. The required charging current is calculated by the available SOC to achieve the intelligent charging control. The battery will be charged to 80% SOC within 30 minutes by the constant current charging when the fast charging mode is selected. However, if the normal mode is selected, then the battery will first be charged to 90% SOC by the constant current charging, and then change to the constant voltage charging during 90% to 100% SOC. According to the above-mentioned, this research presents a new approach to implement reliable real-time calculation for the SOC and SOH. It is not only can be used on the intelligent charging control but also improving the charging efficiency and prolong battery lifespan.

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林教授於1991年至2007年任職於聖約翰科技大學，2000年12月取得台灣科技大學博士學位，2005年8月升等教授。自2007年8月起在大同大學電機工程學系擔任專任教授。

曾獲得第九屆金矽獎應用組評審團銅獎、第十一屆金矽獎應用組評審團銀獎，多項研究成果已發表於國際期刊，迄今已獲得3項美國專利及4項中華民國發明專利，於2004年獲得「93年度國科會電力學門新進人員研究成果優選」，於2005~2007、2010年指導學生參加國科會大專院校電力應用實作論文觀摩競賽獲得「最佳論文獎」，並獲得國科會99、100年度補助大專校院獎勵特殊優秀人才之肯定。

研究領域

光源驅動、電池管理系統、電力電子應用。