論 文 の 内 容 の 要 旨

論文題目　Hybrid Energy Storage System for Electrical Vehicles using Battery and Super Capacitor
（電池とスーパーキャパシタを用いた電気自動車用ハイブリッドエネルギー貯蔵システムの研究）

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This thesis focuses on the application of super capacitor to the energy storage system to electric vehicles (EV).The aim of battery and super capacitor (SC) hybrid energy storage system (HESS) is to realize high power density and high energy density in one system to satisfy the requirement from EV powertrain system. By applying HESS to EV, the battery life can be extended, and acceleration performance can be improved. More importantly, efficiency of energy recovery from regenerative break can be increased based on the characteristic of SC charging. Several aspects of HESS applied to EV are researched in the thesis.

At first, the topologies of the two energy sources combination with power interfaces are introduced and analyzed for EV application. Three types of converter topologies, bidirectional half bridge converter, half controlled converter, three-level converter, operated as power interface for SC linked to DC bus, are compared and analyzed. The operation conditions and topology advantages are given for different dc bus voltage classes, considering the converter scales, efficiency and available operation ranges of sate of charge of SC banks.

Then, the current control of power interface is proposed for controlling power flow from HESS to the motor system and recovering energy to SC in different EV driving stages. The current controller design principles are given, and the dynamic response and robustness of the system is analyzed. The control method is applied to the converter systems of the mentioned HESS topologies. A three layer control system is proposed as the energy management system of HESS after the power interface design. Variable frequency decoupling method is applied as the basic power sharing strategy between battery and super capacitor. The efficiency of the whole energy

management strategy is evaluated, and the state of charge of SC bank is considered for vehicular system operation.

Because wireless power transfer (WPT) is a promising solution for charging future electric vehicles, the principle of wireless charging for HESS is analyzed. A novel control method for optimized efficiency of WPT charging for HESS is proposed and verified.

Lastly a reduced-scale test platform of HESS with WPT charging, especially the power interface section, is developed. Also the system design of the electric vehicle prototype powered by HESS is given in detail. All the proposed methods are verified and analyzed by the experiment results using the designed platform and prototype.