بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / سلوي محمود عقل

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد

ENHANCING THERMAL PERFORMANCE AND LIFE TIME CYCLES OF LI-ION BATTERY IN ELECTRIC VEHICLE BASED ON HYBRID ENERGY STORAGE SYSTEM

By

Karim Mostafa Fayez Ali

A thesis submitted to the

Faculty of Engineering at Cairo University

In Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

In

Electrical Power and Machines Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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2022

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Title of Thesis:

Enhancing Thermal Performance and Life Time Cycles of Li-ion Battery in Electric Vehicle Based on Hybrid Energy Storage System

Key Words:

Battery lifetime cycle, Electric Vehicle (EV), Hybrid Energy Storage System (HESS), Thermal performance of battery, Wavelet Transform.

Summary:

Hybrid energy storage system has essential priority in electric vehicle applications. Therefore, the design of an appropriate power sharing algorithm among energy storage components is necessary to improve the battery thermal performance and provide extra extension of battery lifetime cycles. The thesis presents an analytical study on the effect of using wavelet decomposition-based power sharing algorithm to force the high frequency component to be fed by the supercapacitor and accordingly reduces the thermal stress on the battery.

Neural Networks pattern recognition tool is also applied to classify the driving cycle to the nearest reference cycles chosen to represent the different driving conditions which help to detect the appropriate wavelet decomposition level, achieving better battery thermal performance and battery lifetime cycles.

The proposed approach was investigated by applying it on electric vehicle model in ADVISOR Tool/MATLAB using different driving profiles such as Urban Dynamometer Driving Schedule profile, Highway Fuel Economy Test, New York City Cycle, Los Angeles 1992 and new European driving cycle. The results declare that by using proposed power sharing algorithm, the working temperature of Li-ion battery decreases significantly while the battery lifetime cycles increase. For urban dynamometer driving schedule, the operating temperature of Li-ion battery is improved much at maximum decomposition levels reaching to only 25.6 °C compared to 35 °C when using the battery only. In addition, the battery lifetime cycles increased from 2213 to 2585 cycles.

DISCLAIMER

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

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Date: -- / -- / 2022

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▪ Symbols

A	:	Battery surface area (m^2)
$a_{N_{max}}$	:	Approximation signal at level N_{max}
$CL(\mathrm{T})$	:	Battery lifetime cycles (cycles)
Cp	:	Heat capacity (J·g^{-1}·K^{-1})
C_{SC}	:	SC capacity (Farad)
$D(i)$	:	Duty cycle of the DC-DC converter (%)
$d_{N_{max}}$	:	Detail signal at level N_{max}
fc	:	Battery characterization frequency (cycles/second)
$fr_{bat-usable}$	:	Usable fraction of battery stored energy (kilo-watt hour).
fs	:	Sampling frequency (cycles/second)
h	:	Convection heat transfer coefficient (W·m^{-2}·K^{-1})
I_{bat}	:	Battery charging or discharging current (Amp.)
I_{SC}	:	Charging or discharging current of SC (Amp.)
$KWH_{bat-usable}$	:	Usable energy from the battery (kilo-watt hour)
Ni	:	Number of samples according to the drive cycle profile.
N_{max}	:	Maximum allowable wavelet decomposition levels
N_{min}	:	Minimum limit of decomposition levels
N_{SB}	:	Number of series batteries
N_{SSC}	:	Number of series supercapacitor units
P_{bat}	:	Battery output or input power (Watt)
P_D	:	Demand power signal of EV (Watt)
P_{SC}	:	Power delivered by supercapacitor (Watt)
Q_{rated}	:	Supercapacitor rated charge (Coulombs)
q	:	Battery heat generated (Joule)
R_{bat}	:	Battery internal resistance (Ohm)
R_{bat_tot}	:	Battery total resistance (Ohm)
R_{SC}	:	SC internal resistance (Ohm)
SOH_{bat}	:	Battery state of health (%)
SOC_{SC}	:	State of charge of supercapacitor (%)