BIOGRAPHICAL SKETCH

Chinemerem Christopher Ibe-Ekeocha was born in Lagos, Nigeria. He received the BS.c. degree in electrical engineering from Tennessee Technological University, TN, USA in 2015 and is currently a Masters candidate in electrical engineering at Tennessee Technological University in Cookeville, TN, USA.

His master's research are focused on energy storage devices and the development of control algorithms for optimal estimation of various battery parameters for battery powered devices such as electric vehicles.

He interned as a software engineer who handles software calibrations with Cummins Inc. Cummins is a top company in the field of engine design and implementation.

EDUCATION

M.Sc., Electrical Engineering
Tennessee Technological University
Cookeville, TN, expected 2017

B.Sc., Electrical Engineering
Tennessee Technological University
Cookeville, TN , 2015

College of Engineering
TENNESSEE TECH

College of Engineering
TENNESSEE TECH

The Department of

Electrical & Computer Engineering

Announces the Thesis Defense

Of

Chinemerem Christopher Ibe-Ekeocha

In Partial Fulfillment of the Requirements

For the degree of

Master of

Friday, March 31, 2017 at 4:30 p.m.

Held at

Brown Hall, Room 208

115 W 10th Street

Tennessee Technology University

Cookeville, TN 38505

FIELD OF STUDY

Power Systems
(Energy storage devices)

THESIS TOPIC

"Machine Learning Based Diagnosis of Lithium Batteries"

EXAMINING COMMITTEE

Dr. Indranil Bhattacharya, Committee Chairperson (ECE)

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ABSTRACT

The depletion of the world's current petroleum reserve, coupled with the negative effects of carbon monoxide and other harmful petrochemical by-products on the environment, is the driving force behind the movement towards renewable and sustainable energy sources. Furthermore, the growing transportation sector consumes a significant portion of the total energy used in the United States. A complete electrification of this sector would require a significant development in electric vehicles (EVs) and hybrid electric vehicles (HEVs), thus translating to a reduction in the carbon footprint. As the market for EVs and HEVs grows, their battery management systems (BMS) need to be improved accordingly.

The BMS is not only responsible for optimally charging and discharging the battery, but also monitoring battery's state of charge (SOC) and state of health (SOH). SOC, similar to an energy gauge, is a representation of a battery's remaining charge level as a percentage of its total possible charge at full capacity. Similarly, SOH is a measure of deterioration of a battery; thus it is a representation of the battery's age. Both SOC and SOH are not measurable, so it is important that these quantities are estimated accurately. An inaccurate estimation could not only be inconvenient for EV consumers, but also potentially detrimental to battery's performance and life. Such estimations could be implemented either online, while battery is in use, or offline when battery is at rest.

This thesis presents intelligent online SOC and SOH estimation methods using machine learning tools such as artificial neural network (ANN). ANNs are a powerful generalization tool if programmed and trained effectively. Unlike other estimation strategies, the techniques used require no battery modeling or knowledge of battery internal parameters but rather uses battery's voltage, charge/discharge current, and ambient temperature measurements to accurately estimate battery's SOC and SOH. The developed algorithms are evaluated experimentally using two different batteries namely lithium iron phosphate ($LiFePO_4$) and lithium titanate (LTO), both subjected to constant and dynamic current profiles.

Results highlight the robustness of these algorithms to battery's nonlinear dynamic nature, hysteresis, aging, dynamic current profile, and parametric uncertainties. Consequently, this methods are susceptible and effective if incorporated with the BMS of EVs', HEVs', and other battery powered devices.