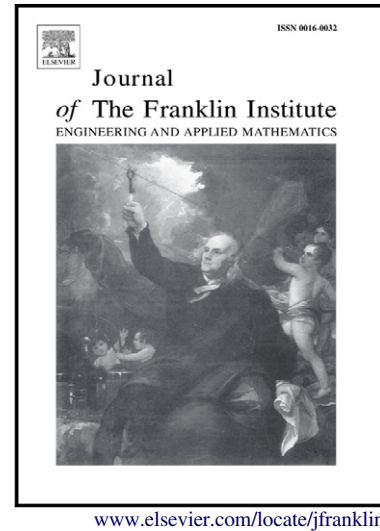


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Techniques

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PII: S0016-0032(15)00161-1
DOI: <http://dx.doi.org/10.1016/j.jfranklin.2015.04.010>
Reference: FI2317

To appear in: *Journal of the Franklin Institute*

Received date: 4 June 2014
Revised date: 27 January 2015
Accepted date: 20 April 2015

Cite this article as: Roshini Ashok, Yuri Shtessel, Control of fuel cell- based electric power system using adaptive sliding mode control and observation Techniques, *Journal of the Franklin Institute*, <http://dx.doi.org/10.1016/j.jfranklin.2015.04.010>

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Control of Fuel Cell- based Electric Power System Using Adaptive Sliding Mode Control and Observation Techniques

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Abstract- The paper deals with controlling an autonomous electric power system that comprises of a primary source of power supply, Proton Exchange Membrane fuel cell (PEMFC), DC-DC boost power converter as a power conditioner, and the ultracapacitor for an auxiliary power supply. Relative degree approach is applied for direct control of the output load voltage as well as the fuel cell and ultracapacitor current in the presence of the model uncertainties. The zero dynamics of the studied electric power system is analyzed and appeared to be stable. The non-minimum phase property of the DC-DC boost converter is eliminated by controlling the fuel cell current based on the power balance. The adaptive super-twisting sliding mode observer is employed for identification of the load resistance, which estimated value is used for generating the fuel cell current command profile. The adaptive gain second order (2-SM) super-twisting sliding mode controller is proposed for controlling the current in PEMFC. The conventional Sliding Mode Controllers (SMC) is designed for controlling the output voltage of the converter and the load current of the ultracapacitor. The efficacy and robustness of the proposed decentralized three-fold electric power system controller that consists of two SMCs and one 2-SM adaptive-gain controller are confirmed via computer simulations.

Keywords: Proton Exchange Membrane fuel cell (PEMFC), Adaptive Sliding Mode Control, Electric power systems, Non-minimum phase.

I. INTRODUCTION

Fuel Cells (FC) offer an alternative source of electric energy to power automotive applications, electric motor bikes and power storage systems [1]. Fuel cells, unlike batteries, use an external source of hydrogen and oxygen to produce power and operate as long as the hydrogen fuel and oxygen supply is maintained. Fuel cells appear as an ideal alternative because of their high power generation efficiency and power density, durability and reliability. A hydrogen FC transforms hydrogen and oxygen or air into DC power. In most stationary and mobile applications, FCs is used in conjunction with other power conditioning converters [8], [3], [22]. Integrating fuel cells with DC-DC boost converters provides increased, accurately regulated voltage relative to that produced by the FC. The fact that the FC's current cannot change fast due to slow fuel cell dynamics occurring within the feed channels and

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