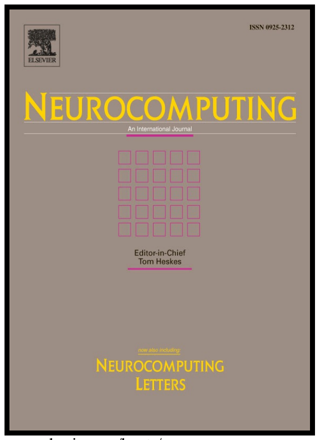
Author's Accepted Manuscript



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PII: S0925-2312(16)30882-7
DOI: http://dx.doi.org/10.1016/j.neucom.2016.08.040
Reference: NEUCOM17452

To appear in: *Neurocomputing*

Received date: 4 March 2016
Revised date: 23 July 2016
Accepted date: 11 August 2016

Cite this article as: G. Rigatos, P. Siano, Z. Tir and M. Assad, Flatness-basec adaptive neurofuzzy control of Induction Generators using output feedback *Neurocomputing,* http://dx.doi.org/10.1016/j.neucom.2016.08.040

Flatness-based adaptive neurofuzzy control of Induction Generators using output feedback

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Abstract: The functioning of doubly-fed induction generators (DFIGs) under harsh and varying conditions makes their control a non-trivial task. The article proposes an adaptive control approach that is capable of compensating for model uncertainty and parametric changes of the DFIG, as well as for lack of measurements for the DFIG's state vector elements. First it is proven that the DFIG's model is a differentially flat one. This means that all its state variables and its control inputs can be written as differential functions of key state variables which are the so-called flat outputs. Moreover, this implies that the flat output and its derivatives are linearly independent. By exploiting differential flatness properties it is shown that the 6-th order DFIG model can be transformed into the linear canonical form. For the latter description, the new control inputs comprise unknown nonlinear functions which can be identified with the use of neurofuzzy approximators. The estimated dynamics of the generator is used by a feedback controller thus establishing an indirect adaptive control scheme. Moreover, to robustify the control loop a supplementary control term is computed using H-infinity control theory. Another problem that has to be dealt with comes from the inability to measure the complete state vector of the generator. Thus, a state-observer is implemented in the control loop. The stability of the considered observer-based adaptive control approach is proven using Lyapunov analysis. Moreover, the performance of the control scheme is evaluated through simulation experiments.

Keywords: doubly-fed induction generators, adaptive neurofuzzy control, H-infinity control, output feedback-based control, neurofuzzy approximators, state-observer, Riccati equations, asymptotic stability.

1 Introduction

The article presents new results on the control of Doubly-fed Induction Generators (DFIGs) with the use of differential flatness theory and adaptive control theory. The control problem of DFIGs is nontrivial because the dynamic model of such electric machines is a multi-variable and nonlinear one. Moreover, under