Advanced Control Techniques for Doubly-Fed Induction Generators Based Wind Energy Conversion Systems

Hamid Chojaa
Laboratory of Technologies and Industrial Services
Higher School of Technology, USMBA
Fez, Morocco
[0000-0001-9408-4687]

Aziz Derouich
Laboratory of Technologies and Industrial Services
Higher School of Technology, USMBA
Fez, Morocco
[0000-0003-4598-5002]

Seif Eddine Chehaidia
Industrial Mechanics Laboratory
Badji Mokhtar Annaba University
Box 12, Annaba 23000, Algeria
[0000-0003-3475-6503]

Mohammed Taoussi
Laboratory of Technologies and Industrial Services
Higher School of Technology, USMBA
Fez, Morocco
[0000-0002-8425-0677]

Othmane Zamzoum
Laboratory of Technologies and Industrial Services
Higher School of Technology, USMBA
Fez, Morocco
[0000-0001-9339-3963]

Mohamed I. Mosaad
Yanbu Industrial College (YIC)
Alnahdah, Yanbu Al Sinaiyah, Yanbu 46452, Saudi Arabia
[0000-0002-6531-5455]

Habib Benbouhenni
Research Unit on Embedded Systems, Research Center on Scientific and Technical Information CERIST,
Algiers, Algeria
[0000-0001-8253-4863]

Mourad Yessef
Laboratory of Engineering, Modeling and Systems Analysis
Faculty of sciences Dhar El Mahraz, USMBA
Fez, Morocco
[0000-0001-6344-7174]

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***Abstract*— Due to their advantages especially the capability of operation at wide wind speed ranges, doubly-fed induction generators (DFIGs) are widely used in wind energy conversion systems (WECSs). This paper introduces a performance enhancement of WECS-DFIG by extracting the maximum power from WECS-DFIG in addition to active and reactive powers control. The maximum power point is extracted by capturing the optimal speed by an intelligent controller. While Integral Sliding Mode Controller (ISMC) and the Field Oriented Control (FOC_PI) are presented for active and reactive powers control. The proposed controllers were applied to control a 1.5 grid-connected DFIG. All simulations were done using Matlab Software.**

Keywords*— *ANNC, Doubly Fed Induction Generator, Integral Sliding Mode Controller (ISMC), Wind Energy Conversion System (WECS).

I. Introduction

Due to the huge demand for electrical power and the environmental concerns of global warming, many renewable sources of energy are integrated into the electrical grids recently [1]. Among these sources PV, wind, fuel cells, and biomass[2-5]. Wind energy is one of the dominant source of renewable energy as 24% of the renewable sources is from wind [6, 7]. This extensive use of wind energy is due to its various advantages, although the nonlinearities and wind speed dependence [8]. This wind speed dependence requires a generator that has the capability of operation under a variable speed range; Double-Fed Induction Generator (DFIG) [9]. Thus, it is essential to have a controller that can track the maximum power by maximum power point tracking technique (MPPT) whatever the wind speed [1, 10]. Using DFIG is an interesting solution because of its rigid structure, long life, and the ability to control active as well as reactive powers with variable speed [6, 11]. In order to have a high quality of electrical power generated by a WECS based on DFIG, it is recommended to use control strategies that allow the control of the generated power by the DFIG, namely: the active power that will be controlled at the reference power generated by the turbine to ensure better efficiency, and the reactive power that will be kept at zero in order to keep a UPF. Fig. 1 presents the schematic diagram of this system.

Currently, AI based controllers (Human expertise or data driven approaches) and nonlinear control techniques are widely used to improve the DFIG performances [3-6, 8-10, 12]. In [10], an intelligent Fuzzy Gain Scheduling of PI controller is proposed, the obtained results shown the effectiveness of the fuzzy tuning of P and I gains, however the tuning of fuzzy rules and membership function is too much time taken and requires high human expertise. In [12] a comparative PI Neural Network controller is proposed and compared to conventional Sliding Mode and Backstepping controller.

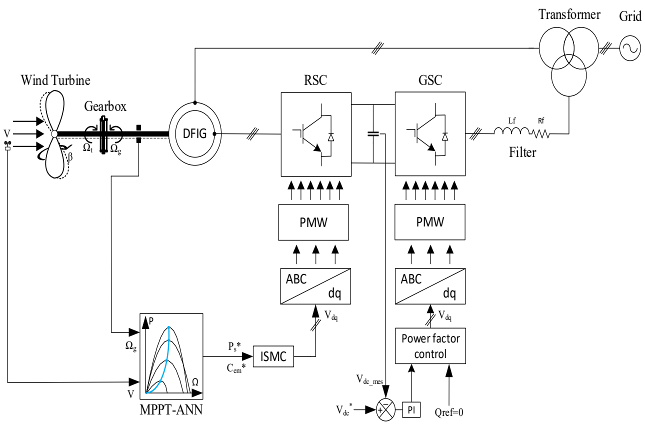

Fig. 1. Diagram of the system.

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