Enhanced Direct Torque and Reactive Power Control of a Grid-Connected DFIG Fed by Two-Level Back-To-Back Converter

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ABSTRACT

This paper presents an improvement to direct reactive power control (DRPC) applied to two-level inverter feeds the rotor of doubly fed induction generator (DFIG) driven by variable speed wind turbine (WT). For this purpose, a reference rotor flux is obtained from the stator reactive power regulation to be applied to the direct torque control (DTC). The fuzzy logic approach seems to be a good solution to eliminate the problem of ripples that occur in conventional direct reactive power control (CDRPC). On the other hand, a direct power control (DPC) is applied to the grid side converter (GSC) to enable reactive power control at the grid connection point. The simulation results obtained with the proposed fuzzy direct reactive power control (FDRPC) show satisfactory improvements over CDRPC in terms of torque and stator reactive power ripples reduction.

Keywords: Doubly fed induction generator, Fuzzy direct reactive power control, Grid side converter control

1 Introduction

Wind power generation systems based on the doubly fed induction generator (DFIG) are an attractive option in the field of power generation because of its outstanding advantages. Compared to the other generators, DFIG has the opportunity to operate with small converters in a wide speed range [1].

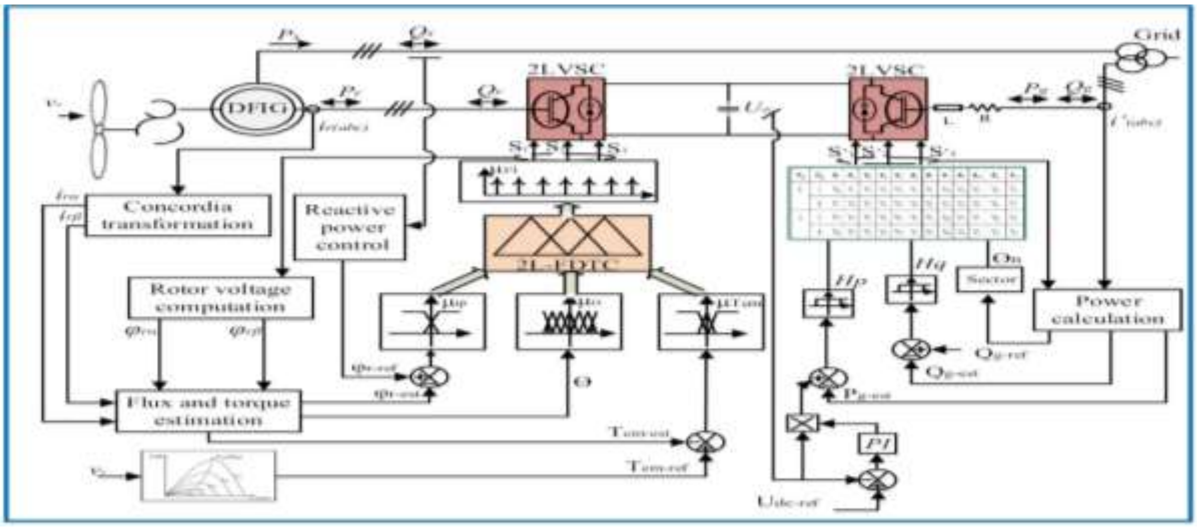


Figure 1: *Global diagram of the proposed system*

Among the algorithms proposed in the literature to control the wind turbine driven by the DFIG (WT-DFIG), direct torque control (DTC) is commonly used. This control outperforms the field-oriented control (FOC) by its simplicity, better transient response and low dependence on machine parameters [2]. However, in this type of control, both electromagnetic torque and rotor flux are subject to nonlinear hysteresis controller. In the last years, the fuzzy logic control (FLC) has emerged in the field of system control because of its advantages [3]. The fuzzy control decision is based on the degree of control variable error, which allows flexible and intelligent control. What justifies the adoption of this controller to replace the hysteresis

DOI: 10.21467/abstracts.163 ISBN: 978-81-965621-5-1 (eBook)

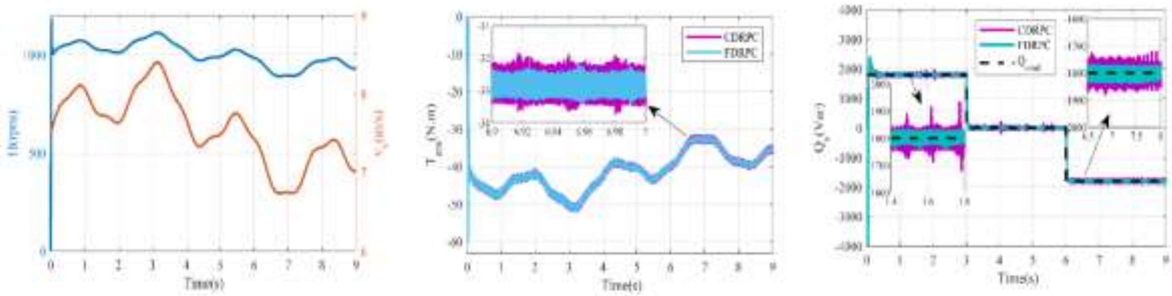
controller of the classical DTC. On the other hand, the control of the stator reactive power is made possible by the imposition of the reference rotor flux. Therefore, to achieve a net power factor to the grid, the reactive power control at the point of connection to the grid side converter (GSC) is necessary. For this purpose, direct power control (DPC) is deployed to manage the active and reactive power distributed between the DFIG rotor and the grid. MATLAB/SIMULINK software is used to test the performance of the suggested control system.

2 Proposed global control system

The schematic diagram of the proposed control is shown in the figure. 1. Fuzzy direct reactive power is designed to control the rotor side converter windings. Conventional DPC is used to control the active and reactive power in the GSC.

3 Simulation results and discussion

The results of the studied system performed by MATLAB/Simulink software are presented in this section. Figure 2 a, b and c shows the wind speed profile with the evolution of the DFIG mechanical speed, the electromagnetic torque waveform and stator reactive power, respectively. The results obtained attest to the superiority of the proposed control over the CDRPC in terms of ripple reduction.



(a) (b) (c)

Figure 2: *Proposed control results. (a): Waveforms of wind speed and DFIG mechanical speed, (b): Electromagnetic torque waveform with zoom, (c): Stator reactive power waveform with zoom.*

4 Conclusion

In this paper, an improvement of direct torque and stator reactive power control using fuzzy logic control is proposed for the DFIG in grid-connected wind energy conversion system. The main objective is to reduce the ripples that occur in the electromagnetic torque and the rotor flux with the conventional DRPC. The simulation results show high performances, significant reduction of electromagnetic torque and stator reactive power ripples by using the proposed fuzzy switching table.

How to Cite

O. Djoudi, S. L. Belaid, S. Tamalouzt, "Enhanced Direct Torque and Reactive Power Control of a Grid-Connected DFIG Fed by Two-Level Back-To-Back Converter", *AIJR Abstracts*, pp. 103–104, Feb. 2024.

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ISBN: 978-81-965621-5-1

Series: AIJR Abstracts
DOI: 10.21467/abstracts.163