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Fuzzy Logic Control Algorithm of Grid Connected Doubly Fed Induction Generator driven by Vertical Axis Wind Turbine in Variable Speed

Ridha Cheikh[1], Hocine Belmili[1], Said DRID[2], Arezki. Menacer[3], Mourad TIAR[3]
[1]U.D.E.S Solar Equipments Development Unit, BP386, Bou-Ismail, 42415, Wilaya of Tipaza, Algeria
Tel /Fax : 00 213 24 41 02 00, Website: www.udes.dz
cheikh_red@yahoo.fr, chikh.redha@udes.dz, belmili.hocine@udes.dz
[2]S.P.I.E Laboratory, Electrical engineering department; University of Batna, 05000 Rue M.E.H Boukhlof, Algeria, Tel/Fax: +213.33.81.51.23 e-mail: s_drid@yahoo.fr
[3]L.G.E.B Laboratory, Department of Electrical Engineering, Biskra University, 07000 Al-Alia, Biskra, Algeria, Tel/Fax: +213.33.73.49.85 email:
menacer_arezki@hotmail.com, tiarmourad@yahoo.com

Abstract. This paper deals with a fuzzy logic control algorithm intended for grid-connected doubly fed induction generator (DFIG) which is driven by a Savonuis vertical axis wind turbine. The established control system is based on decoupling control using oriented grid flux vector control strategy. However a decoupling between active and reactive stator powers is carried out which gives an optimal operation of the DFIG at sub-synchronous region. Also the control of the stator powers works simultaneously with possibility to keeping stator power factor at unity. The power controllers are designed from an optimized fuzzy logic algorithm, which conducts to an efficiency for the controllers behavior. In addition a maximum power point tracking strategy is included as an additional solution to enhance and improve the wind energy conversion system efficiency.

Key words

Doubly Fed Induction Generator (DFIG), Vertical Axis Wind Turbine, Wind Power Generation System (WPGS), Fuzzy logic controller (FLC), Maximum power point tracking (MPPT), Variable-Speed Generation (VSG).

1. Introduction

Wind energy is one of the most rapidly growing sources of electricity all over the world. At the beginning of 2004, the total installed capacity of Wind Energy all over the world is reached 39 GW with an annual growth rate of about 30% [1]. It is predicted that 12% of the total world electricity demands will be supplied from wind energy by 2020 [2]. It is recognized as being a means ecological and economic to produce electricity. At the same time, there was a fast development relating to the wind turbine technology [3]-[4]. In the area of wind power generation systems, where the input power varies considerably, variable-speed generation (VSG) is more interesting than fixed-speed systems. In these systems, a maximum power point tracking (*MPPT*) adjusts a system quantity to maximize turbine power output [1]-[5]. The generator that operates directly at the variable speed drive is extremely attractive. So to exploit these advantages in wind power generation area, strategy of control should be made by taking into a count all the parts of the system such as the grid, the vertical axis turbine and the structure complexity of the DFIG with a view on the quality of energy to be generated, because of the lack or scarcity of control of the produced active and reactive powers many problems go to appear; when the generator connected to the grid, such as the low power factor and harmonic pollutions. Several designs and arrangements have been investigated by using predictive functional and internal mode controller, where it is a satisfactory in power response comparing with ones of the traditional methods, using a conventional PI controller. In other wise, these new methods are hard to implement, due to their complicated structures [6]. However, in this paper an alternative approach has been proposed using an optimized fuzzy logic controller to control the active and reactive powers through the rotor circuit, so this type of controller (fuzzy) has been used due to many characteristics and benefits, such as its robustness, easy to understand and design, based on the human expertise …etc [7]-[4].

2. System modelling

2.1 Wind and wind turbine modelling

The geographical choice of a wind site has the primary importance in a WPGS. Whereas the wind characteristics have the important role to determine the quantity of energy to be extracted by the wind turbine. So over a great period of time, the site properties, the wind velocity measurements as well as its direction, are very necessary to know and understand before starting the WPGS project. However in this work the wind speed is modeled as a deterministic form by sum of several harmonics as presented as following [8]:

$$V(t) = 6+0.2*\sin(0.1047*t)+2*\sin(0.2665*t)+\sin(1.2930*t) +0.2*\sin(3.6645*t) \quad (1)$$

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