Int J Syst Assur Eng Manag (July-Sept 2014) 5(3):219–229
DOI 10.1007/s13198-013-0150-0

ORIGINAL ARTICLE

Optimal tuning of PI controller using PSO optimization for indirect power control for DFIG based wind turbine with MPPT

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Received: 24 November 2012 / Revised: 1 March 2013 / Published online: 20 March 2013

Abstract In this paper, an artificial intelligence method particle swarm optimization (PSO) algorithm is presented for determining the optimal PI controller parameters for the indirect control active and reactive power of doubly fed induction generator (DFIG) to ensure a maximum power point tracking of a wind energy conversion system. A digital simulation is used in conjunction with the PSO algorithm to determine the optimum parameters of the PI controller. Integral time absolute error, integral absolute error and integral square error performance indices are considered to satisfy the required criteria in output active and reactive power of a DFIG. From the simulation results it is observed that the PI controller designed with PSO yields better results when compared to the traditional method in terms of performance index.

Keywords Doubly fed induction generator · Wind turbine · Field oriented control · PI (proportional integral) · Particle swarm optimization (PSO) · Maximum power point tracking (MPPT)

1 Introduction

Wind energy has attracted great attention due to several advantages such as low pollution (Ackermann 2005). Among the different alternatives to obtain variable speed wind turbines, the system based on a doubly-fed induction generator (DFIG) has become the most popular (Rahimi and Parniani 2010). The electricity production by wind power is the most predominant source of renewable energy in Europe (Hammons 2008). By 2020 it is expected that wind power generation will supply around 12 % of the total electricity (Lobos et al. 2009).

The worldwide concern about the environmental pollution and the possible energy shortage has led to increasing interest in technologies for generation of renewable electrical energy. Among various renewable energy sources, wind generation has been the leading source in the power industry (Qiao et al. 2006). Recently, the DFIG is becoming the main configuration of wind power generation because of its unique advantages. Vector control technology is used to control the generator, and the rotor of DFIG is connected to an AC excitation of which the frequency, phase, and magnitude can be adjusted. Therefore, constant operating frequency can be achieved at variable wind speeds (Guo-qing et al. 2010).

In the last decade, various modern control techniques such as adaptive control, variable structure control and intelligent control have been intensively studied for controlling the nonlinear components in power systems. However, these control techniques have few real applications probably due to their complicated structures or the lack of confidence in their stability. Therefore, the conventional PI controllers, because of their simple structures, are still the most commonly used control techniques in power systems, as can be seen in the control of the wind turbines equipped with DFIGs. Unfortunately, tuning the PI controllers is tedious and it might be difficult to tune the PI gains properly due to the nonlinearity and the high complexity of the system (Qiao et al. 2006).

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