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Modelling and Implementation of PSO MPPT Based Wind DFIG System

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ABSTRACT

This paper presents adjustable speed generators for wind turbines. The doubly fed induction generator (DFIG) system presented in this article offers many advantages to reduce cost and has the potential to be built economically for off-shore applications. Due to the nature of the wind that is instantaneously changing, hence, an MPPT controller is proposed in this paper. A dynamic model of the DFIG was derived to develop a vector controller to decouple dynamically active and reactive power control. This paper presents the DFIG wind energy system. This paper is implemented and controlled by framing DQ- model of the wound rotor induction machine in rotor reference frame. In order to control the power flowing between the stator of (DFIG) and the grid, a control law is synthesized using PI controllers. MATLAB Simulink has been used as the tool to evaluate the system. The grid parameter variations are also discussed.

I. INTRODUCTION

Renewable energy has been developed recently because of the fossil fuel exhaustion and environmental problems. Compared with other renewable energy, such as solar energy, wind power is more suitable for some applications with relatively low cost. For rural and remote areas, the small-size standalone wind power system with a battery bank as the energy storage component is common and essential for providing stable and reliable electricity. It can be installed at selected locations with abundant wind energy resources more flexibly and effectively.

Wind energy system has gained vast populations in the past decade as one of the renewable energy sources due to the possibility of depletion of conventional energy sources and its high cost as well as its negative effects on the environment. Wind energy is preferred because it is clean, pollution-free, exhaustible and secure. Therefore, a wind energy generation system could be one of the significant candidates as an alternative energy source for the future.

The electrical system of wind turbine has become more and more important, in the interaction between the mechanical system of the wind turbine and the grid, where the wind turbine is connected. Usually for converting mechanical power, in to electrical power we use the induction machines or synchronous and permanent magnet generators. The squire1 cage introduction generator are widely used because of then simplicity height weight and little cost compared with synchronous generators. However, for extracted the maximum power from the wind potential, its needed to interposed AC-AC converter between the stator of the generator and the utility grid. However, wind energy presents an erratic nature. So, the electric power produced by a connected wind system varies brutally due to rapid variation of wind speed. For this reason, research to extract the maximum power out of wind energy is necessary to making wind energy sources much

more viable, effective and attractive [4]. This can be achieved by a maximum power point tracking (MPPT) control technique which is required to compensate the low efficiency.

II. WIND TURBINE

Wind Energy system plays a key role in non-conventional power sources, as we know, wind turbine converts Wind energy to mechanical energy and from that it converted to electrical energy with the help of Generators. The group of wind turbines called as wind form. The wind generator system using DFIG is shown in figure 1.

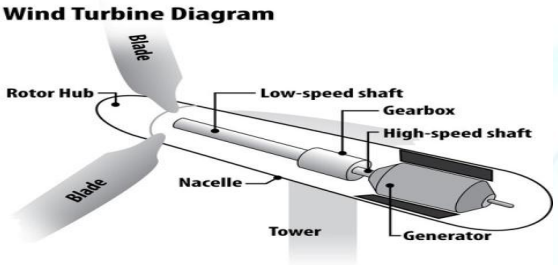

Figure 1: Basic Wind Turbine System

The Mechanical power from the wind turbine system is expressed as:

$$P_m = \frac{\rho A}{2} V_{wind}^3 C_P(\lambda, \beta)$$

Where, C_p is cofficient of Power.

DFIG SYSTEMS:

The doubly fed induction generator is the better solution for variable speed machines with tolerance ±30% of synchronous speed. The grid and the rotor are directly connected for the main stator winding is controlled with converters via slip rings as sown in figure 2.

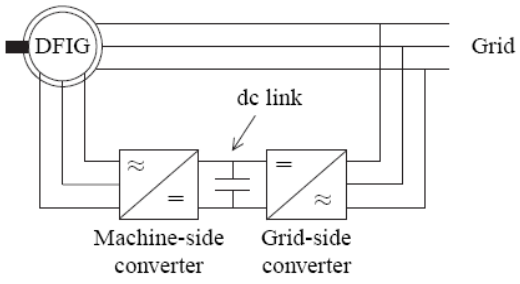

Figure 2: DFIG system with a Back to Back Converter

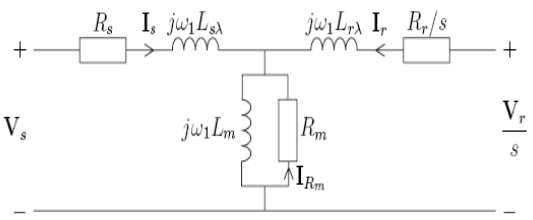

Figure 3: Equivalent circuit of DFIG

Figure 4 shows the overall RSC control scheme which is having two cascade loops. The active and reactive powers of the DFIG is controlled by the outer loop and direct axis current component Idr*, quadrature axis current component Iqr* are generated. Inner-loop current regulation is the second cascaded control loop. Vdr0 and Vqr0 are the from the two regulated current controllers outputs. And these signals are used for generating Pulses to RSC converter by PWM technique.

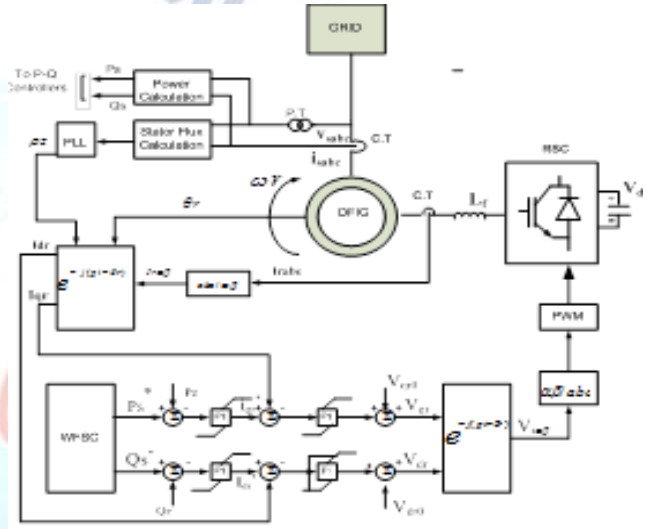

Figure 4 Control Diagram for the rotor side controller

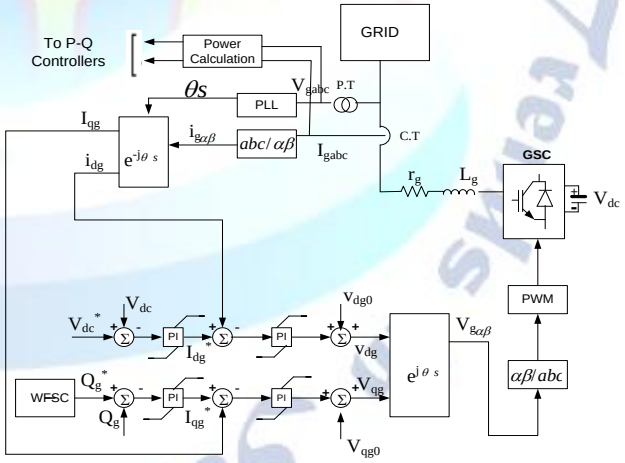

Figure 5: Grid side controller (GSC) scheme

Figure 5 shows the complete closed loop control diagram for the grid side converter and it having two cascaded control loops. The reactive power is indirectly controlled by the dc link voltage controlling done by the outer control loop for generating the reference signals of the d-axis current component idg* and q-axis current component iqg* for the inner-loop current regulation. Then these signals are used for generating pulses with the help of PWM technique

III. PSO MPPT TECHNIQUE

PSO is a bio motivating computing tool. It is developed based on the activities of birds, fish, and other animals. Who are psychiatrist and electrical engineer. It is a robust stochastic marketing technique based on the movement and intelligence of swarms. PSO applies the concept of social conversation for problem solving. There are numerous of particles in this algorithm which move around in space to search for the best or optimum value.

Velocity function

$$V_{i(k+1)} = V_{i\,(k)} + t_{1i}(P_i - X_i(k)) + t_{2i}(G - X_i(k))$$

FLOW CHART OF PSO ALGORITHM

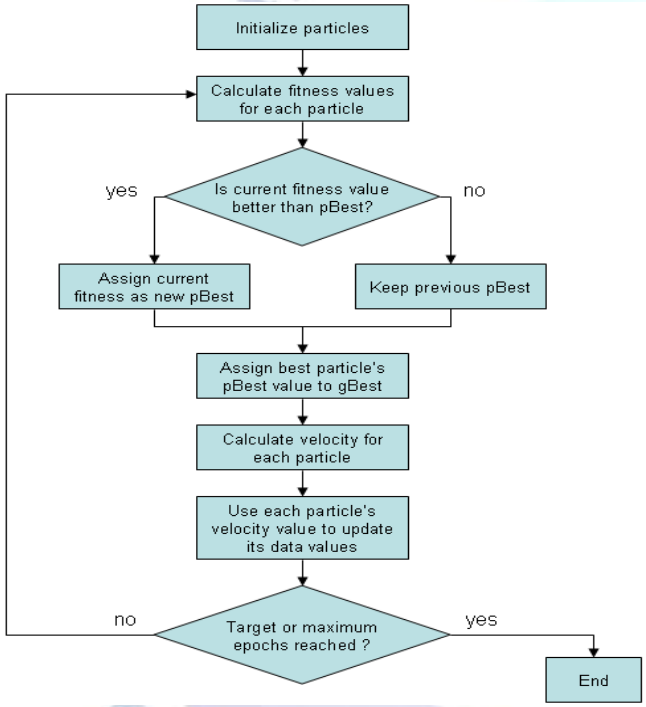

Figure 6: Algoritham for PSO MPPT

IV. SIMULATION RESULTS

The experimental wind turbine emulator system as from the figures 1 and 2. The wind turbine model is designed by the mathematical model analysis. The controller takes the wind turbine parameters and operating conditions from the user. Moreover, the controller measures the generator speed and then produces the torque command to the induction machine drive.

Case 1: Wind Turbine System with SCIG Generator

A traditional SCIG wind power system is developed in Matlab/Simulink, in order to investigate the system performances, a ramp wind speed is assumed that varies w.r.t time and, then, it remains constant to the end of simulation.

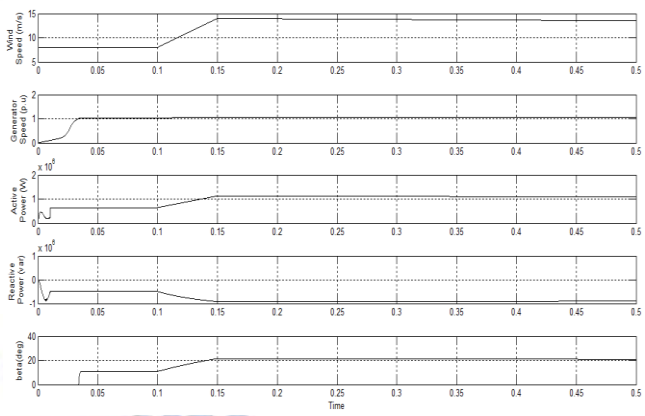

Figure 7: Simulation Result for Wind Turbine System with SCIG generator

Case 2: Wind Turbine System with DFIG Generator

The DFIG system allows the optimal (maximum) output power operation in the absence of reactive power source. Also, the independent control of active and reactive power is achieved.

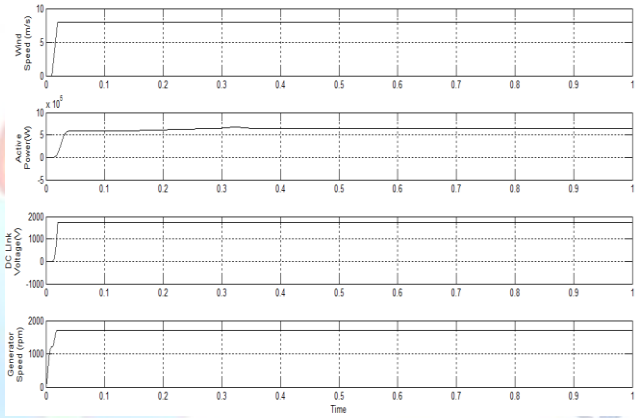

Figure 8: Simulation Result for Wind Turbine System with DFIG generator

Case 3: DFIG basedWind Turbine System with MPPT Controller

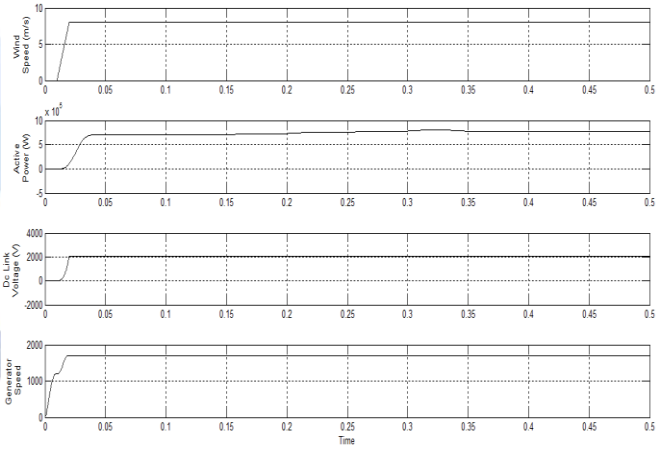

Figure 9: Simulation Result for DFIG based Wind Turbine System with MPPT Technique

V. CONCLUSION

This paper proposes a DFIG based Wind system which control is assured by two PI regulators which

are applied in order to control the active and reactive power exchanged with the grid. And also an MPPT control method is introduced that attempt to extract the maximum power from the energy conversion system despite of fluctuating wind conditions. To verify the validity and the effectiveness of the proposed MPPT control methods, simulation models are built with MATLAB Simulink.

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