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Fault Analysis and Simulation of A Grid Connected Doubly Fed Induction Generator for Wind Energy Conversion System

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ABSTRACT - The aim of this paper is to present the modeling and simulation of a doubly-fed induction generator driven wind turbine using Simulink modeling. Here there are two pulse width modulation based voltage source converters were connected back to back to the utility grid via a common dc link between the rotor terminals. The reactive power in the grid side converter itself is compensated rather than providing an additional compensating device and from the rotor side all remaining power is also extracted. To supply the required reactive power to a DFIG, the rotor side converter is used to attain maximum power extraction. The dc-link voltage is controlled by the grid-side converter which makes the reactive power drawn from the utility to zero and ensures the operation by using the stator voltage-oriented control technique in system controls. The performance of DFIG wind system during various fault conditions and during dynamic loading are analyzed for variable wind speeds. All these methodologies were simulated with the help of components in simulation software program using MATLAB provided in SIMULINK library.

Keywords: Fault Analysis, MATLAB, SIMULINK, Conversion System, Wind power, Transmission, Fed Induction, generator.

I. INTRODUCTION

For the innovation and development of better control systems, the design and implementation of intelligent systems has become an essential factor [1]. In such a situation, the implementation of artificial neural networks gives solutions to the questions that linear systems are not able to solve. Artificial neural network is a replication of our human brain [2]. The understanding, recognizing, classifying, clustering, error detection and correction are the sixth sense of human brain and this capability is incorporated with the help of artificial neural network. This is an emulation of biological neural system [3]. Neural network can be said to resemble human brain in following the below mentioned things.

- It acquires knowledge through learning.
- The knowledge is stored within inter-neuron connection strengths known as synaptic weights.

The artificial neural network is capable of representing both the linear and non-linear relationships. It is having ability to learn these relationships directly from the data being modeled [4], [5]. Hence, a neural network can be implemented in following cases:

- Algorithmic solution cannot be formulated
- More samples of the required behavior is available
- Pick out the structure from the available data

II. EXISTING SYSTEM

The stability of any permanent magnet induction generator (PMIG) based wind turbines can be improved by a StatCom that are well known to be documented in the literatures for an balanced grid voltage drops [6]-[8]. During the unbalanced grid voltage drop conditions of negative sequence voltage which causes heavy generator torque oscillations which may reduce the lifetime of a drive train. Here a FSIG-based wind farm is analyzed combined with a StatCom operating under a unbalanced grid voltage fault condition that were carried out by theory, measurements and simulations [9].

A StatCom control structure with the capability to coordinate the control between the positive and the negative sequence of the grid voltage is proposed.

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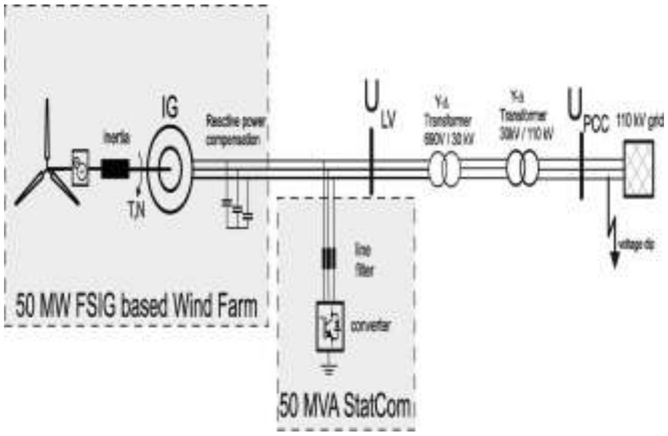

Figure-1: Existing System Design

The results clarify the effect of the positive- and the negative-sequence voltage compensation by a StatCom on the operation of the FSIG-based wind farm [10].

III. PROPOSED METHOD

The system of the wind turbine with DFIG and back-to back converter connected to the grid is shown in In this configuration, the generator rotor operates at a variable speed to optimize the tip-speed ratio. Therefore the generator system operates in both a sub-synchronous and super-synchronous mode, normally between +/- 30% of synchronous speed. The rotor winding is fed through a power converter, typically based on two AC/DC/IGBT based linked voltage source converter

a) Overall Circuit Diagram

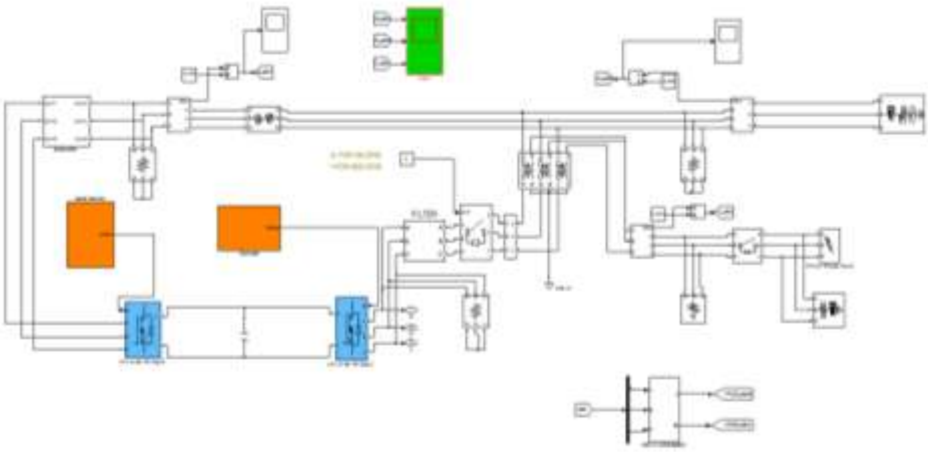

Figure-2: Overall Simulation Circuit Diagram

1) Methods relying on wind speed;
2) Methods relying on output power measurement and calculation; and
3) Methods relying on characteristic power curve

b) Modification

A permanent magnet synchronous generator (PMSG) with adaptive load control strategy for standalone wind turbine system is presented. To improve the operation performance under the nonlinear load and the unbalanced load, a PI based predictive current control technique is adopted in the inner loop current controller to improve the performance of transient response.

IV. RESULT AND DISCUSSION

The permanent magnet synchronous generator is simulated in a SIMULINK MATLAB program and obtained results of waveforms are displayed in figure -4, 5. The simulation work is carried as before and the comparisons are made between the conventional and neural network controllers for the integrated SSSC/SMES combination. During the unbalanced grid voltage drop conditions of negative sequence voltage which causes heavy generator torque oscillations which may reduce the lifetime of a drive train.

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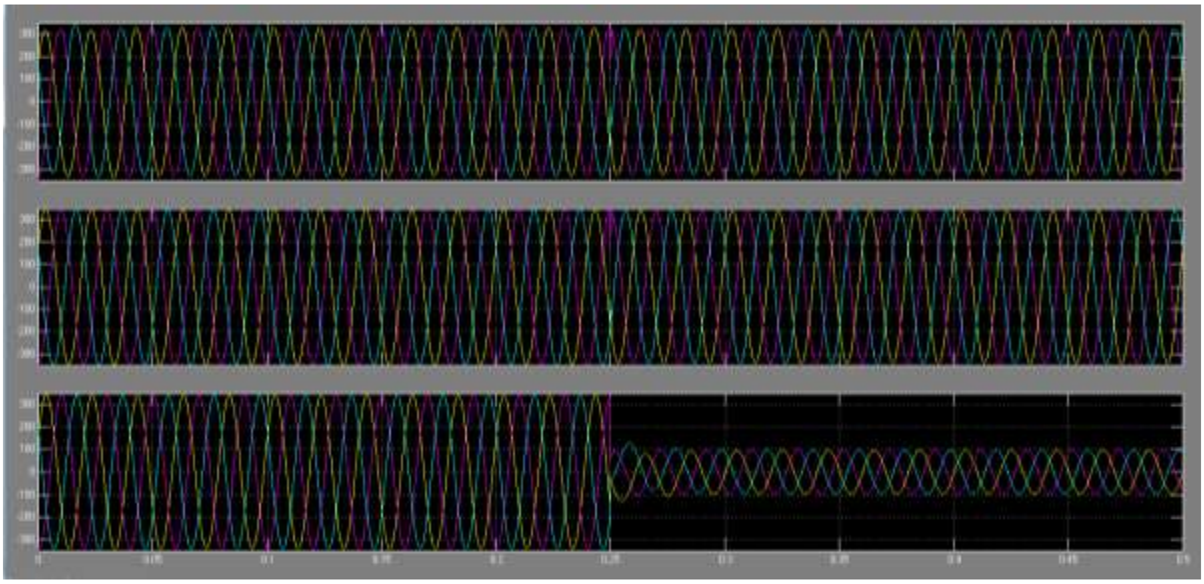

Figure-4: Simulation Output-1

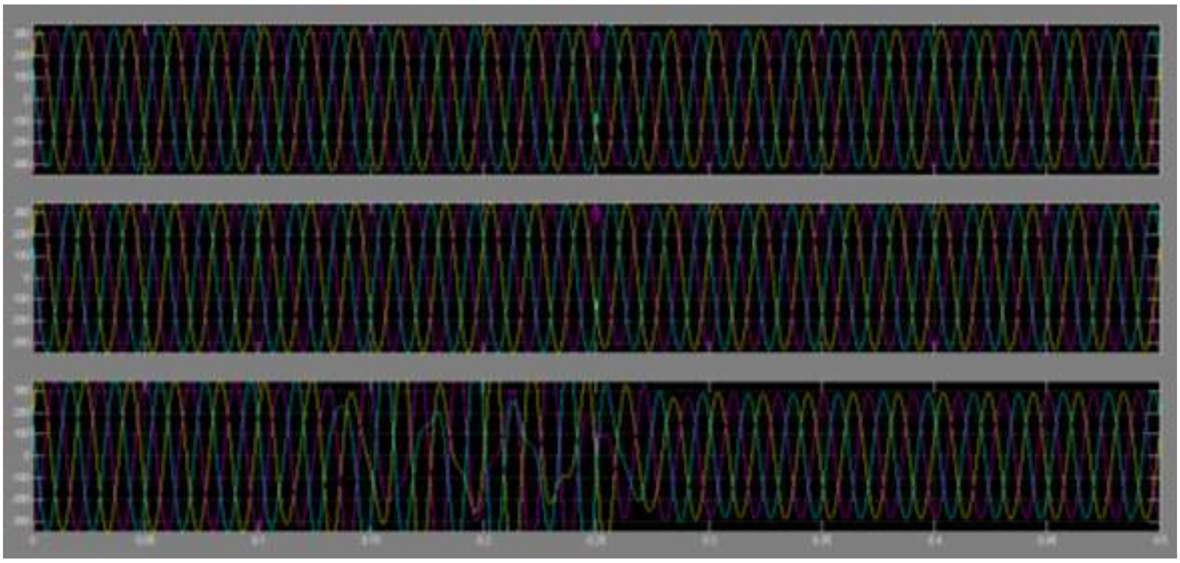

Figure-5: Simulation Output-2

The back- propagation algorithm for the proposed work and its algorithm have been discussed. The simulation work is carried as before and the comparisons are made between the conventional and neural network controllers for the integrated SSSC/SMES combination.

V. CONCLUSION

The applications and advantages of the neural networks have been discussed. The simple neural networks, architecture of the neural network and the activation functions that can be used in the neural networks have been elaborated. The learning methods have been discussed. The back- propagation algorithm for the proposed work and its algorithm have been discussed. The simulation work is carried as before and the comparisons are made between the conventional and neural network controllers for the integrated SSSC/SMES combination. It is inferred from the comparison that the integrated system is performing better compared to the system with SSSC and the neural controllers are better than the conventional controllers in obtaining good performances.

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