

COMPARISON OF FUZZY/ANN TECHNIQUES FOR COMPENSATION OF UNBALANCED VOLTAGES IN GRID CONNECTED PMSG BASED WIND TURBINE

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ABSTRACT

This paper proposes an effective controller for grid connected wind turbine based permanent magnet synchronous machine for improving unbalanced voltages. In this paper, we proposed a comparative analysis under different controllers like PI, Fuzzy and Artificial Neural Network Controller to PMSG system. A control structure is designed based on the positive sequence reference signals. With the help of these controllers, the double frequency oscillations in DC-link voltages and variations in active power can be eliminated. More ever, the proposed system can be implemented in Matlab/Simulink and the performance of the proposed Grid based PMSG wind system under grid fault conditions is verified.

Keywords— PMSG, Wind Turbine, PI, Fuzzy, ANN, Grid-system.

I. INTRODUCTION

Lately, many new breeze farms make use of wind turbines predicated on permanent magnet synchronous machine. This wind turbine based synchronous generators have been increasing demand in the industrial areas. The studies on the control strategies of PMSG ¹ under asymmetrical and symmetrical grid faults have become one of the key research sections of the wind power technology development. In the present scenario, for protecting the system from these problems several control strategy have been introduced. In, predicated on the examination of the dc-link voltage distortions under unbalanced grid voltages, this paper proposed an average dual PI current control strategy predicated on negative and positive series part decomposition. The operational system structure is organic, which is difficult to adapt control parameters. In, an up-to-date control design using proportional controller was suggested to control the negative and positive series components current of the grid-side converter (GSC), that are integrated in the stationary reference framework? Generally, permanent magnet synchronous machine is commonly used for wind turbine because of it rigid construction. The configuration of the proposed integrated grid and WECS based PMSG are first introduced in this paper ². Main constraints in

general wind turbine are steady-state operating conditions under various wind speeds and marine-current speeds and the dynamic stability of the studied system³. An RSC and GSC converters are introduced for improving the steady state and dynamic stability with the designed PI damping controller under different operating conditions. In this paper the controlling of PMSG is verified by using ANN, Fuzzy.

II. ARCHITECTURE OF PROPOSED GRID CONNECTED WIND SYSTEM

Grid Integration

In this paper a PMSG based WECS hybrid system with various controllers is considered, sustaining power to a load and the network as appeared in Figure 1.

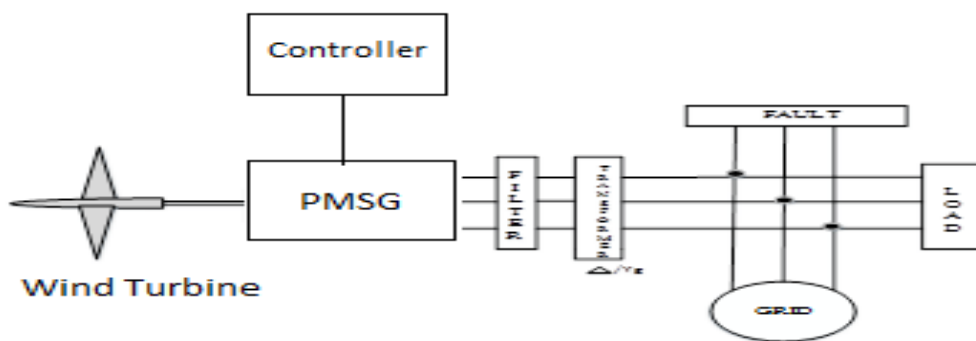


Figure 1: Hybrid System

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 farm. The wind generator system using SCIG is shown in physique 2 & 3.

Wind Turbine Diagram

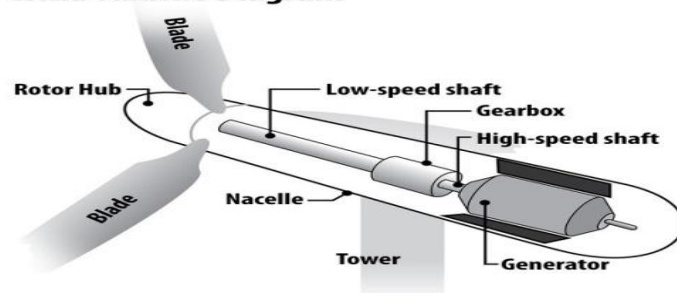


Figure 2: Basic diagram of wind turbine

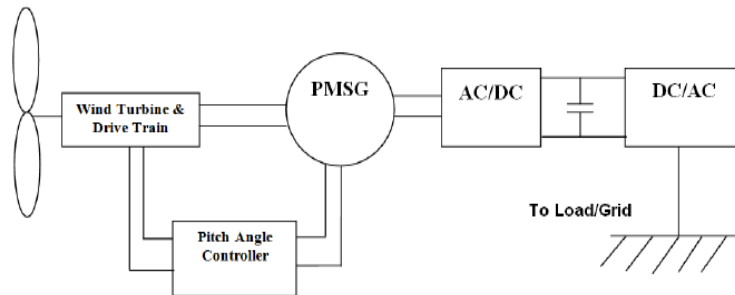


Figure 3: Structure of Permanent Magnet Synchronous Machine in Wind Turbine

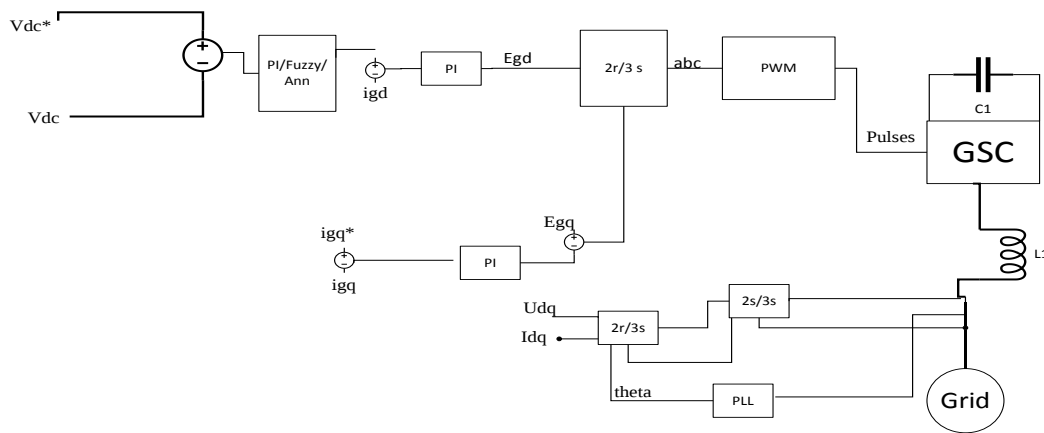


Figure 4 PMSG Control Diagram

PI Controller

A PI Controller (proportional-integral controller) is a combination of proportional and integral controller which is used for eliminating steady state error and peak overshoots ¹⁰⁻¹¹. The absence of derivative controller shows more stability under noise conditions. This is because the derivative controller is more sensitive under high frequency systems.

The general expression for PI controller is expressed as,

$$K_p \Delta + K_i \int \Delta dt$$

Fuzzy Logic Controller

In the earlier section, control strategy based upon PI controller is mentioned. But in case of PI controller, it has high settling time and has large steady point out error. In order to rectify this problem, this paper proposes the program of a fuzzy control mechanism shown in Figure 5. Generally, the FLC doze is one of the main software based technique in adaptive methods ¹³.

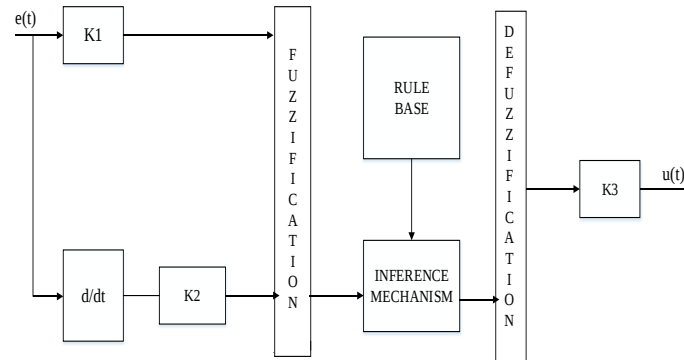


Figure 5: Basic Structure of Fuzzy Logic Controller

The input parameters such as error and error rate are indicated in conditions of wierd set with the linguistic conditions VN, N, Z ., P, and Pin this sort of mamdani fuzzy inference system the linguistic conditions are expressed using triangular membership rights functions. In this newspaper, single input and one output fuzzy inference system is considered. The quantity of linguistic variables for input and output is assumed as 3. The numbers of rules are formed as 9. The input for the fluffy system is represented as error of PI control. The fuzzy rules are obtained with if-then claims.

Artificial Neural Networks

Figure 6 shows the basic architecture of artificial nerve organs network, in which an hidden layer is mentioned by circle, an adaptable node is represented by square. Through this structure concealed layers are presented in between input and result layer, these nodes are functioning as membership functions and the rules obtained based on the if-then statements is eliminated. Pertaining to simplicity, we with the analyzed ANN 14 have two inputs and one result. In this network, each neuron and each aspect of the input vector p are linked with weight matrix W.

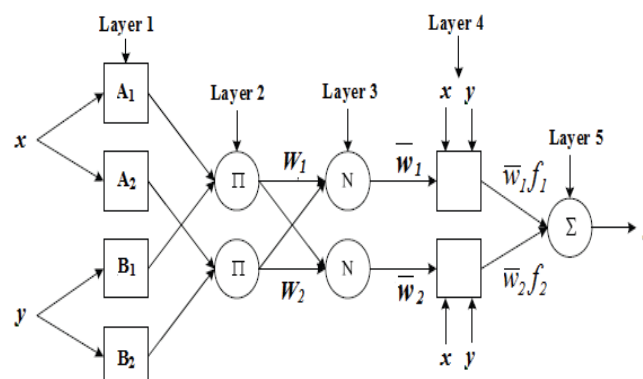


Figure 6: ANN architecture for a two-input multi-layer network

III. SIMULATION DIAGRAM & RESULT

Simulation review of proposed PMSG wind mill was completed using Simulink Library. The PMSG was making rated active GSC and power was working with unity electric power factor. Figure 7-14 shows the performance waveforms for the proposed system under different fault conditions. The GSC controller is verified by different controller (PI/Fuzzy/Ann) to attain better performance level under two cases.

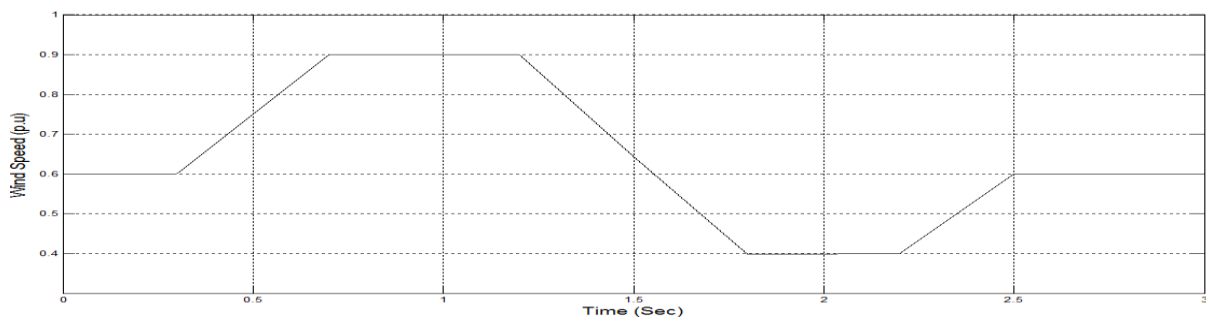


Figure 7: Wind Turbine Speed

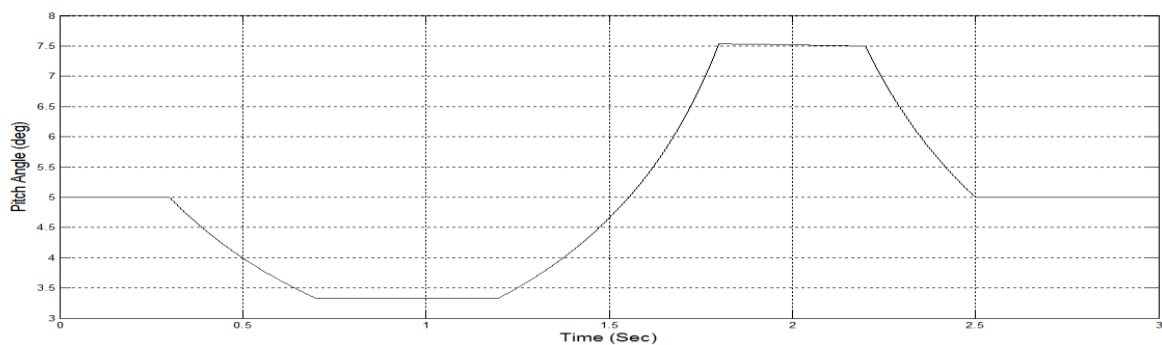


Figure 8: Wind Turbine Pitch Angle

Case 1: Single Phase to Ground Fault

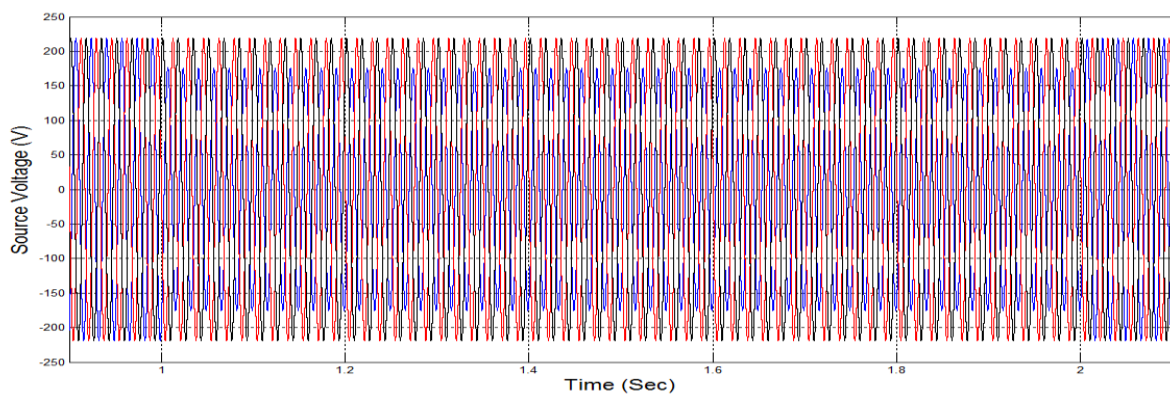


Figure 9: Three Phase Grid Volatge Under L-G Fault

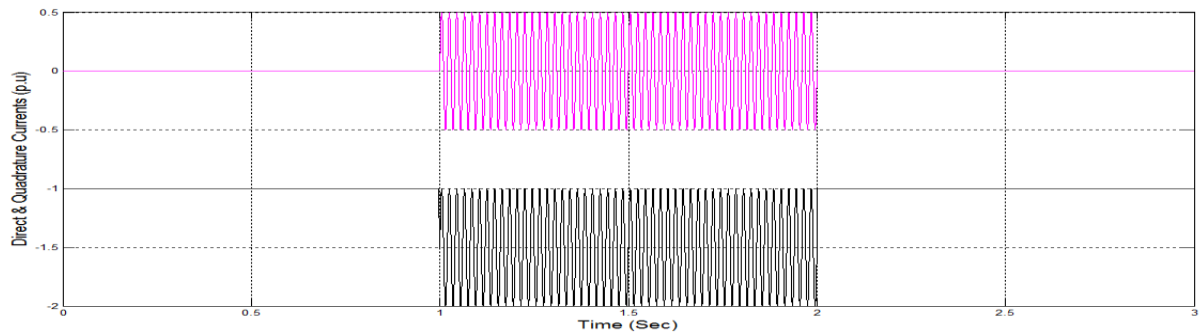


Figure 10: Direct and Quadrature Currents Under L-G Fault

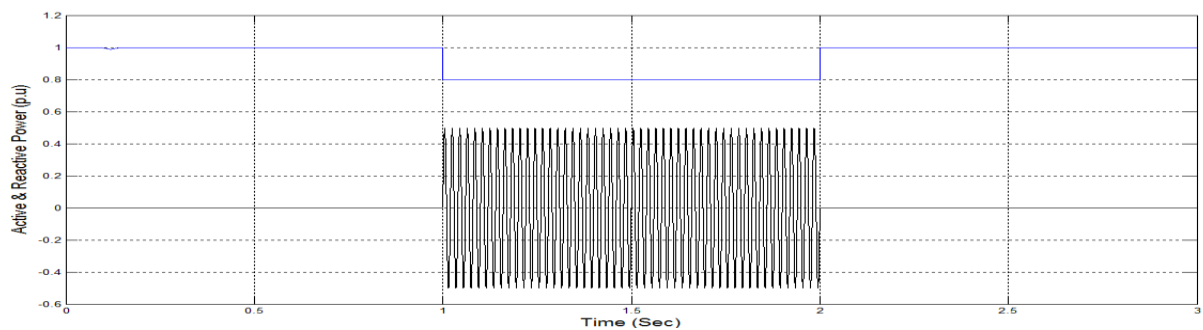


Figure 11: Active and Reactive Powers Under L-G Fault

Case 2: Three Phase Fault

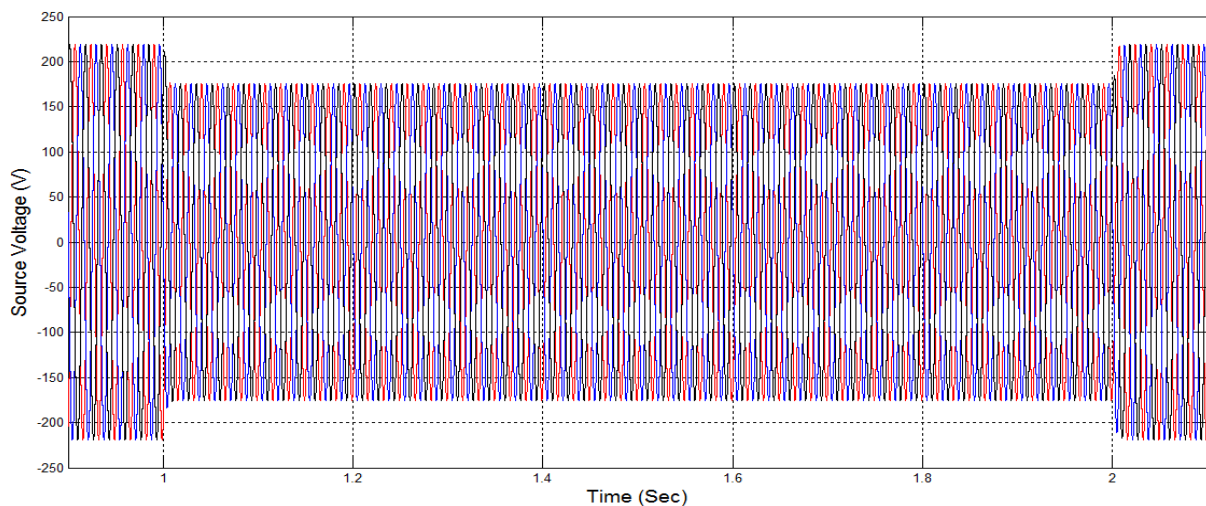


Figure 12: Three Phase Grid Volatge Under Three Phase Fault

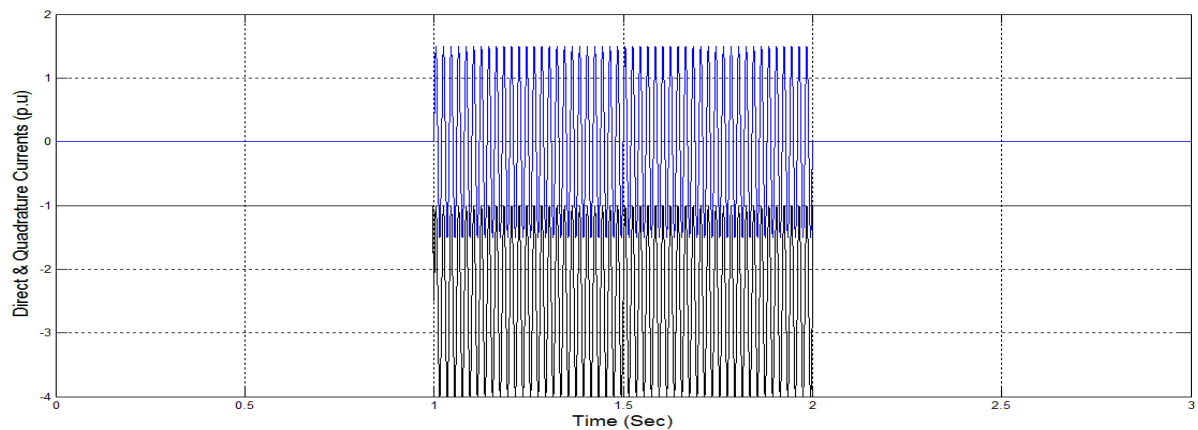


Figure 13: Direct and Quadrature Currents Under Three Phase Fault

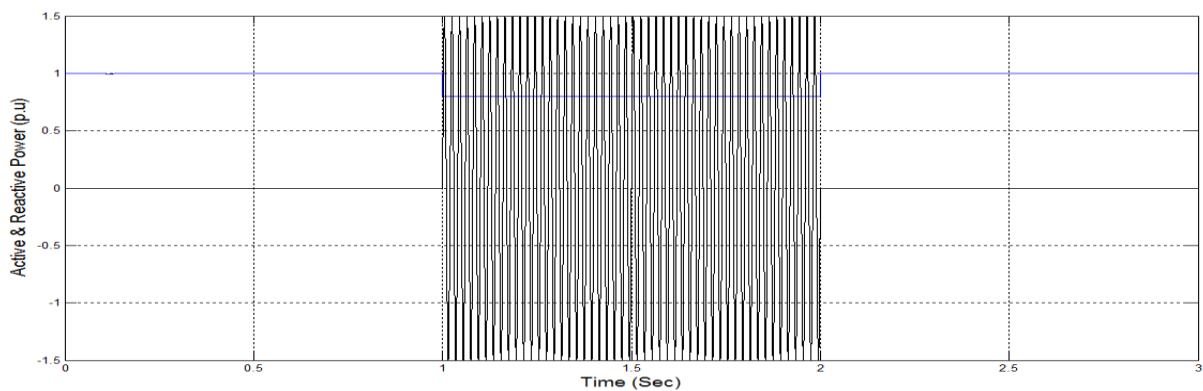


Figure 14: Active and Reactive Powers Under Three Phase Fault

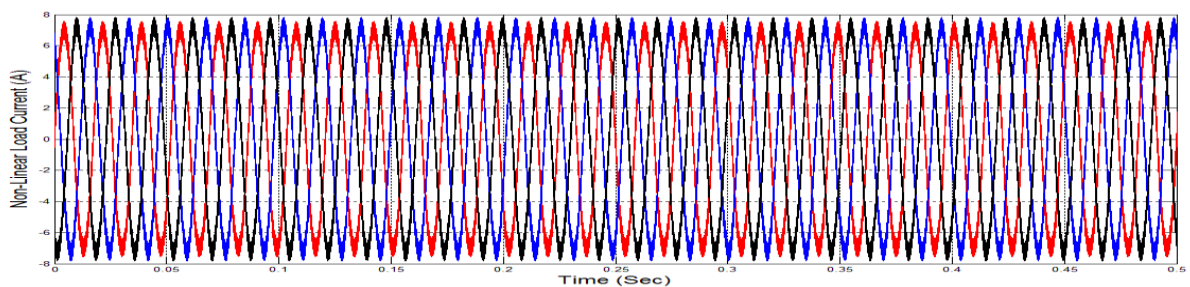


Figure 15: Non-Linear Load Current

Analysis of Total Harmonic Distortion for Load Current:

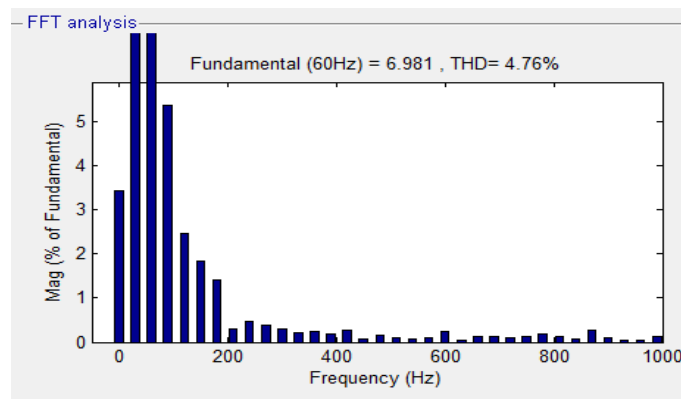


Figure 16: Analysis of THD with PI Controller

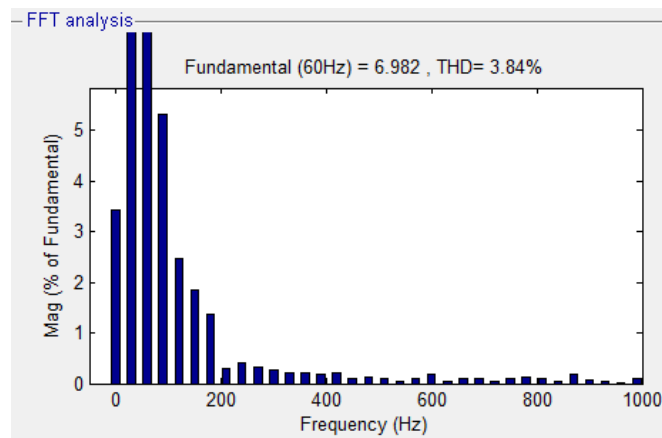


Figure 17: Analysis of THD with Fuzzy Controller

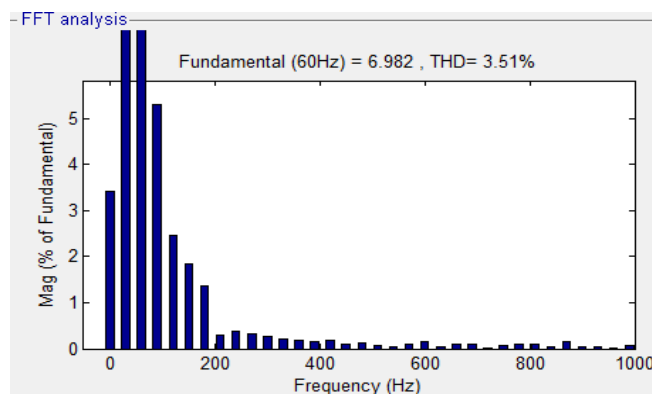


Figure 18: Analysis of THD with ANN Controller

IV. CONCLUSION

This paper proposed a different (PI/Fuzzy/Ann) control techniques for Converter which is used in PMSG for reducing unbalanced voltage conditions. For restraining the oscillation components, this paper proposed an controller with positive reference synchronous frame coordinators as reference signals. As a total result, the

suggested Ann-based control strategy is easy without any decomposition and complicated research calculation. From the simulation results and harmonic distortion factor, we conclude that the neuro controller shows the better result as compared to fuzzy and PI controllers.

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