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

Dr. Budi Srinivasa Rao[1],T. Krishna Mohan[2],G. V. Raman[3]
[1]Asst. Prof, Dept of EEE, SVCET, Srikakulam(India)
[2]Asst. Prof, Dept of EEE, ALIET, Vijayawada(India)
[3] Prof, Dept of EEE, SVCET, Srikakulam(India)

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 system [3]. 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.

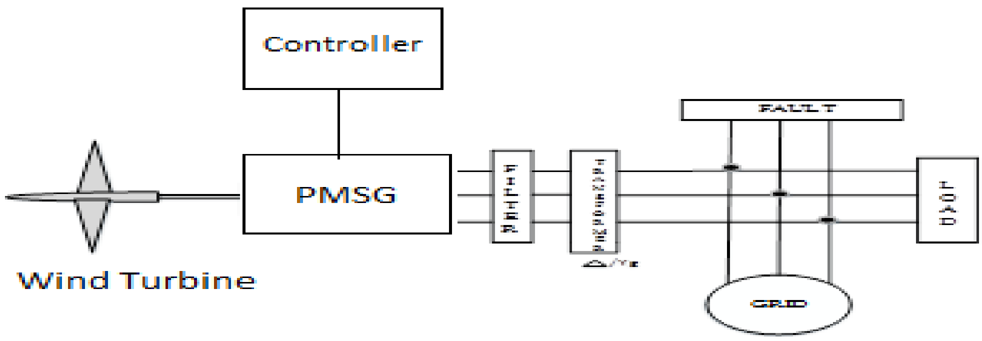

Figure 1: Hybrid System

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

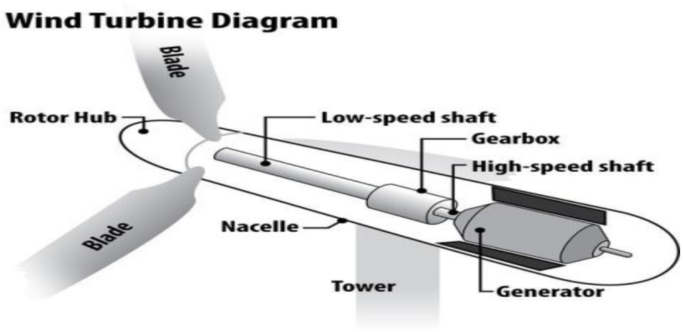

Figure 2: Basic diagram of wind turbine

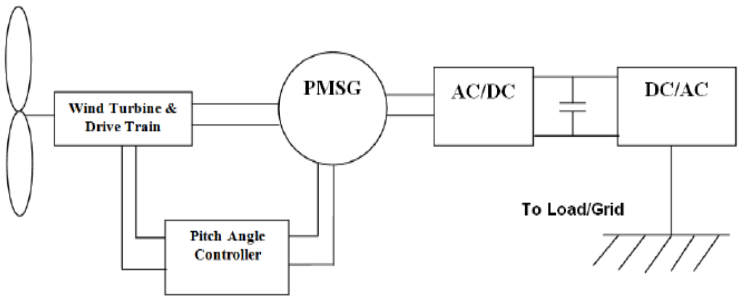

Figure 3: Structure of Permanent Magnet Synchronous Machine in Wind Turbine

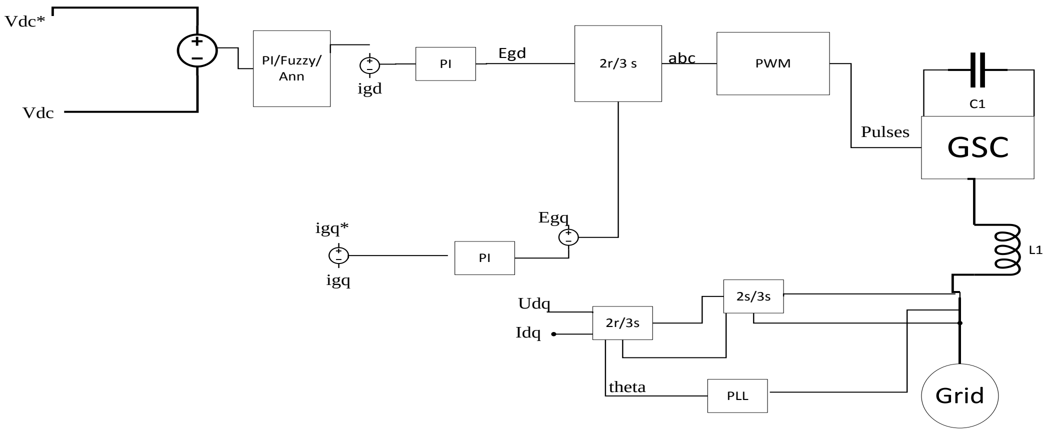

Figure 4 PMSG Control Diagram

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].

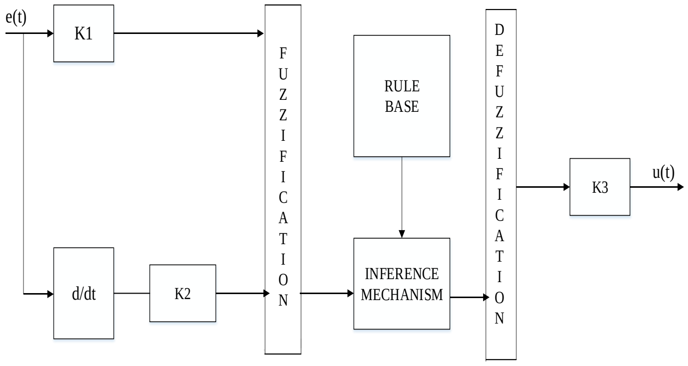

Figure 5: Basic Structure of Fuzzy Logic Controller

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.

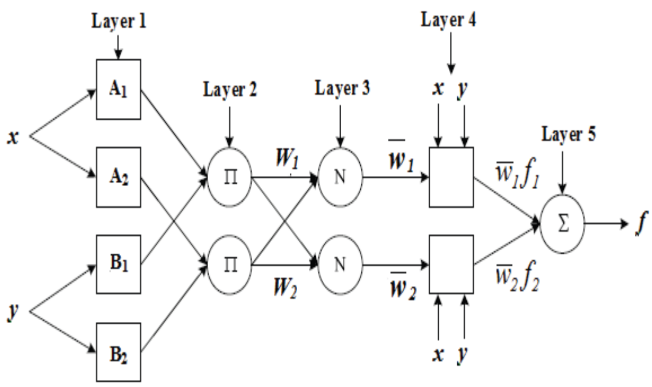

Figure 6: ANN architecture for a two-input multi-layer network

ISBN: 978-93-87793-01-9

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.

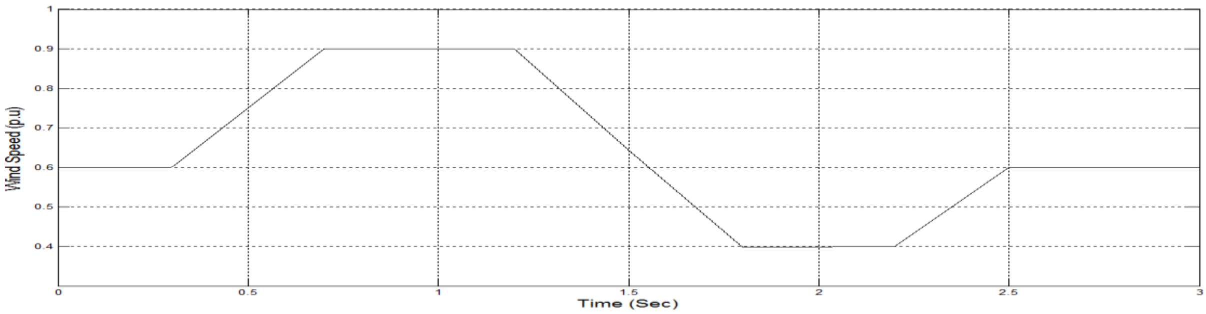

Figure 7: Wind Turbine Speed

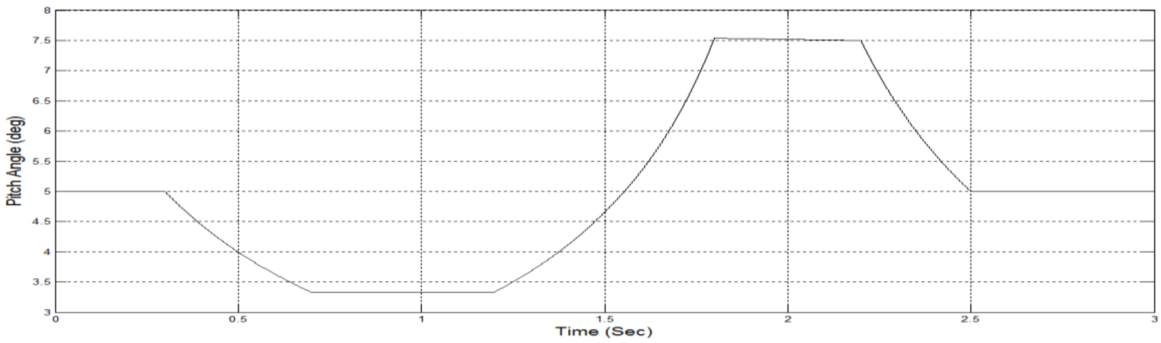

Figure 8: Wind Turbine Pitch Angle

Case 1: Single Phase to Ground Fault

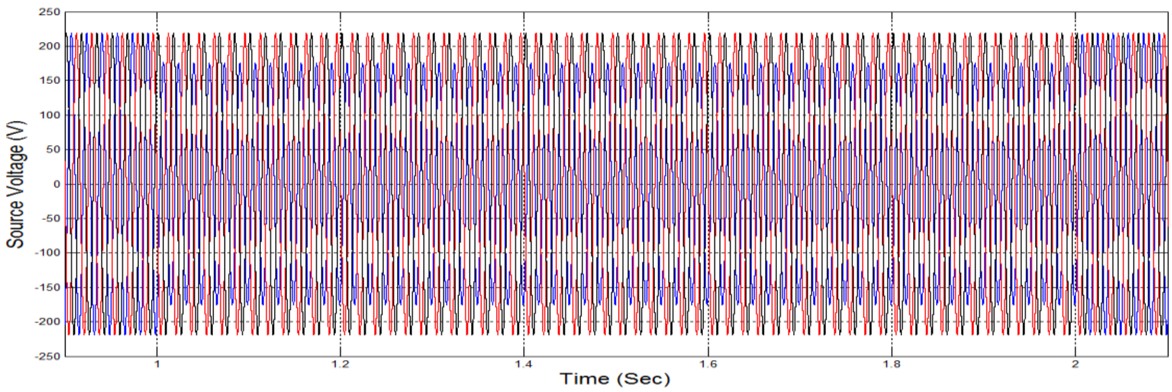

Figure 9: Three Phase Grid Volatge Under L-G Fault

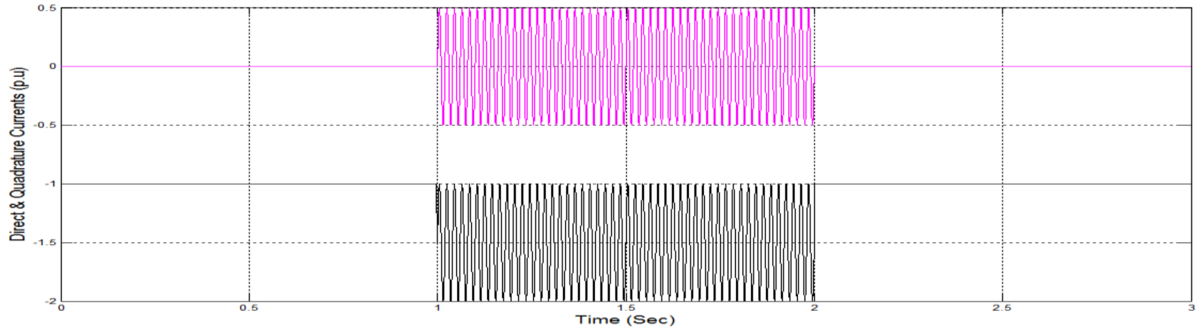

Figure 10: Direct and Quadrature Currents Under L-G Fault

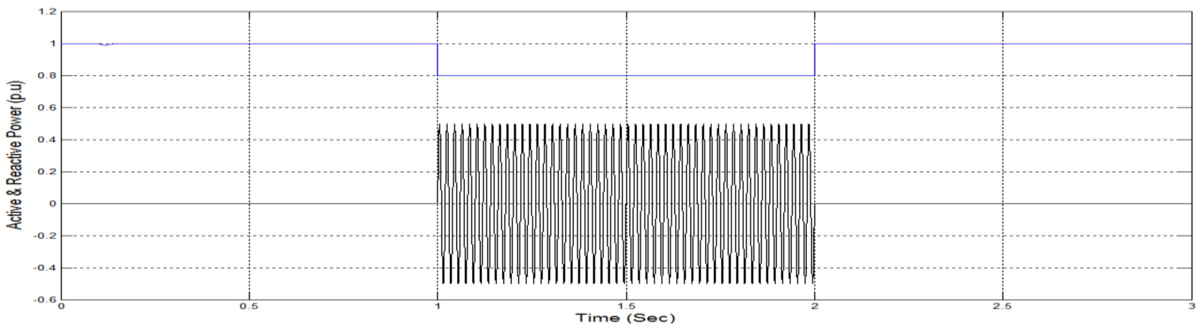

Figure 11: Active and Reactive Powers Under L-G Fault

Case 2: Three Phase Fault

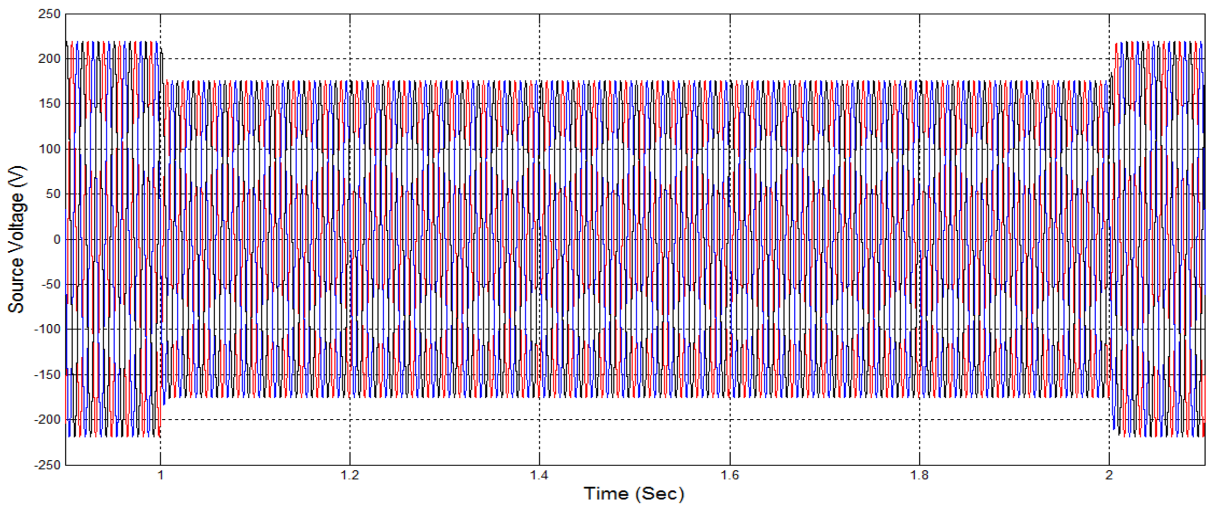

Figure 12: Three Phase Grid Volatge Under Three Phase Fault

ISBN: 978-93-87793-01-9

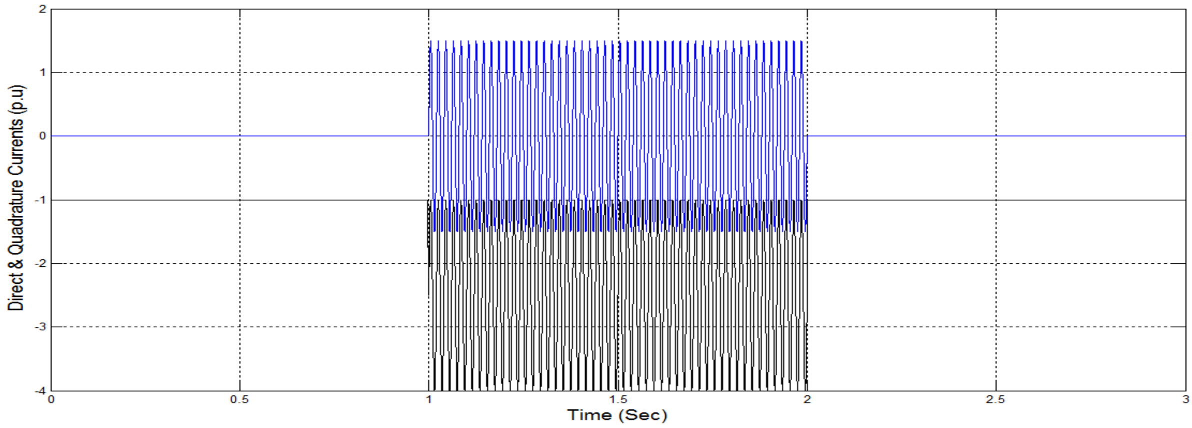

Figure 13: Direct and Quadrature Currents Under Three Phase Fault

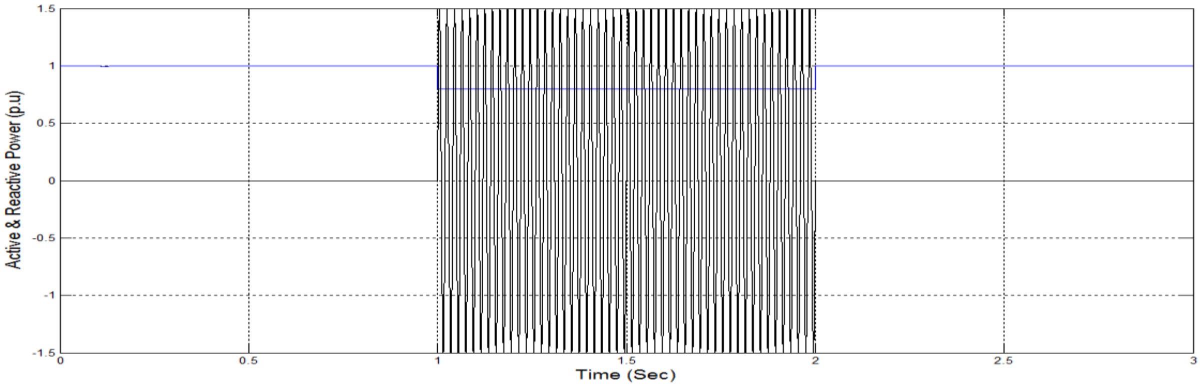

Figure 14: Active and Reactive Powers Under Three Phase Fault

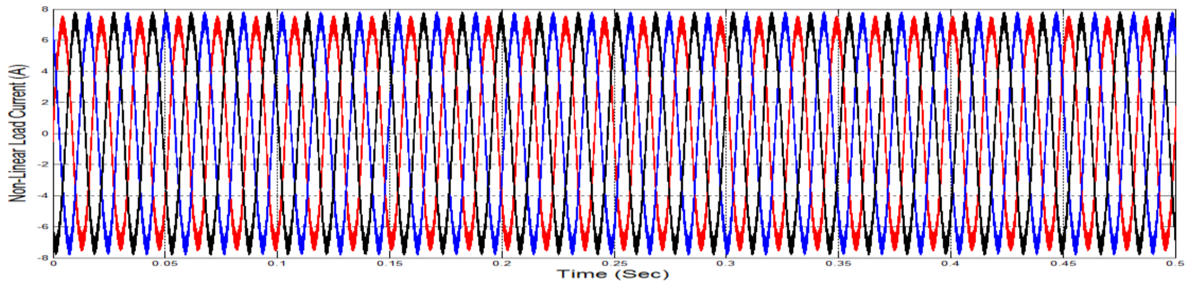

Figure 15: Non-Linear Load Current

Analysis of Total Harmonic Distrotion for Load Current:

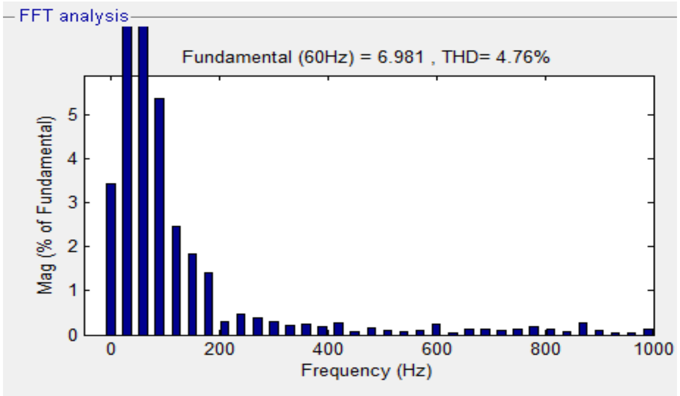

Figure 16: Analysis of THD with PI Controller

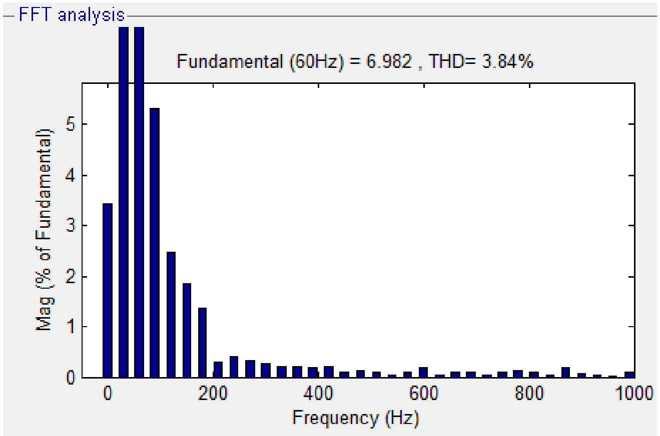

Figure 17: Analysis of THD with Fuzzy Controller

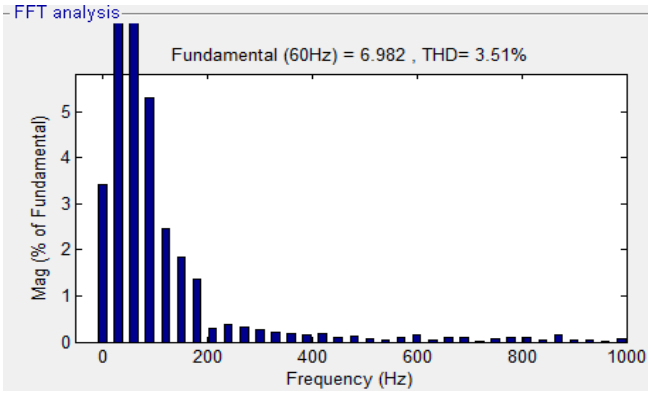

Figure 18: Analysis of THD with ANN Controller

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 distrotion factor, we conclude that the neuro controler shows the better result as compared to fuzzy and PI controllers.

REFERENCES

[1] Shuhui Dong,Yonggang Li,Aimeng Wang,Wenyuan Xi, "Control of PMSG Wind Turbines Based on Reduced Order Resonant Controllers Under Unbalanced Grid Voltage Conditions" IEEE PEDS 2015, Sydney, Australia 9 – 12 June 2015.

[2] Ng, C.H, Ran, L, Bumby, J, "Unbalanced-Grid-Fault Ride-Through Control for a Wind Turbine Inverter[J]" IEEE Transactions on Industry Applications, 2008, 44(3): 845-856.

[3] M. Nasiri, J. Milimonfared and S. H. Fathi Robust Control of PMSG-based Wind Turbine under Grid Fault Conditions Indian Journal of Science and Technology, Vol 8(13), July 2015.

[4] Hu Jiabing, He Yikang, "Modeling and control of grid-connected voltage-sourced converters under generalized unbalanced operation conditions[J]", IEEE Transactions on Energy Conversion, 2008, 23(3): 903-913.

[5] Rajesh Katyal, S. Gomathinayagam, Siraj Ahmed, Saleem Akhtar, Wind Variability Study for a Complex Wind Farm Site in India , Indian Journal of Science and Technology, Volume 3, Issue 10, October 2010.

[6] Yao Jun, Chen Xiyin, Liao Yong, LiHui, Huang Song, " A Grid-Connection Control Strategy to Suppress Negative-Sequence and Harmonic Currents for Permanent Magnet Direct-Driven Wind Power Generation System [J]", Power System Technology, 2011, 35(7): 29-35.

[7] Maziar Izadbakhsh, Alireza Rezvani, Majid Gandomkar and Sohrab Mirsaeid, "Dynamic Analysis of PMSG Wind Turbine under Variable Wind Speeds and Load Conditions in the Grid Connected Mode" Indian Journal of Science and Technology, Vol 8(14), July 2015.

[8] Yin Bo , Oruganti R , Panda S K , et al, " An output-powercontrol strategy for a three-phase PWM rectifier under unbalanced supply conditions[J" IEEE Transactions on Industrial Electronics, 2008, 55(5): 2140-2151.

[9] Busada C A, Gomez J S, Leon, A E, et al, "Current controller based on reduced order generalized integrators for distributed generation systems[J]", IEEE Transactions on Industrial Electronics, 2012, 59(7): 2898-2909.

[10] Etxeberria-Otadui I, Viscarret U, Caballero M, et al, "New optimized PWM VSC control structures and strategies under unbalanced voltage transients[J]" IEEE Transactions on Industrial Electronics, 2007, 54(5): 2902-2914.

[11] ZHAO Xin, JIN Xinmin, ZHOU Fei, LI Geliang, "Unbalanced Control of Grid-Connected Inverters Based on Proportion Integral Reduced Order Resonant Controllers[J]", Proceedings of the CSEE, 2013, 33(19): 84-92

[12] Maryam Sadeghi, Majid Gholami, Fuzzy Logic Approach in Controlling the Grid Interactive Inverters of Wind Turbines, Indian Journal of Science and Technology Volume 7, Issue 8, August 2014.

[13] Javad Aramideh, Hamed Jelodar Application of Fuzzy Logic for Presentation of an Expert Fuzzy System to Diagnose Anemia , Indian Journal of Science and Technology Volume 7, Issue 7, July 2014 .

[14] Karim Beddek, Mohamed Kesraoui, Adel Merabet, Optimization of the Artificial Neural Networks Structure for Filtering Applications in Wind Energy Conversion System, Indian Journal of Science and Technology , Volume 8, Issue 12, June 2015.