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Design of Fuzzy Logic Controller for DFIG Wind Power Generators in Unbalanced Microgrid

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ABSTRACT: This paper presents fuzzy logic control of Doubly Fed Induction Generator (DFIG) wind turbine in a simple control system. DFIG comprises of a common induction generator with slip ring and a partial scale control electronic converter. Fuzzy logic controller is connected to grid side converter for active power control and voltage regulation of wind turbine. Wind turbine and its control unit are portrayed in points of interest. All power system segments are simulated in MATLAB. For concentrate the execution of controller, diverse irregular conditions are connected even the most pessimistic scenario. Simulation results demonstrate the execution of fuzzy control unit as enhancing power quality and stability of wind turbine.

KEYWORDS: Doubly-fed induction generator, instantaneous power, microgrids, unbalanced grid voltage, wind energy.

I. INTRODUCTION

Wind energy is one of the additional common sources of sustainable power source because of its spotless character and free accessibility. In addition, due to lessening the cost and enhancing systems, the development of wind energy in Distributed Generation (DG) units has grown quickly regarding wind control generation innovation, as a result of various specialized advantages (higher energy output, diminishing force variances and enhancing var supply) the current MW-estimate wind turbines dependably utilize variable speed operation which is accomplished by a converter system [1]. These converters are regularly related with singular generators and they contribute essentially to the expenses of wind turbines. Between factor speed wind turbine generators, doubly fed induction generators (DFIGs) and permanent magnet synchronous generators (PMSGs) with essential converters, are developing as the favoured advances [2].

Doubly fed induction generator (DFIG) is one of the most mainstream wind turbines which incorporates an acceptance generator with slip ring, an incomplete scale control electronic converter and a typical DC-connect capacitor. Power electronic converter which includes a back to back AC-DC-AC voltage source converter has two principle parts; lattice side converter (GSC) that amends system voltage and rotor side converter (RSC) which nourishes rotor circuit. Power converter just procedures slip control hence it's outlined in halfway scale and pretty much 30% of generator appraised control [3] which makes it alluring from sparing perspective. A wide range of structure and control calculation can be utilized for control of energy converter. A standout amongst the most basic control systems is decouple PI control of output active and reactive energy to enhance dynamic conduct of wind turbine. Yet, because of vulnerability about the correct model and conduct of a few parameters such as wind, wind turbine, and so forth and furthermore parameters esteems contrasts amid operation on account of temperature, occasions or erratic breeze speed, tuning of controller parameters is one of the primary issues in this control strategy.

Utilizing fuzzy logic controller, it can create controller outputs more solid compared to the impact of other parameters, for example, noise and occasions because of wide range of control locale and web based changing of the controller parameters can be considered. More over there is no need of a detailed mathematical model of the system and just using the knowledge of the total operation and behaviour of system, tuning of parameters can be done more easily.

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II. PROPOSED INSTANTANEOUS POWER CONTROL FOR UNBALANCED VOLTAGE CONDITIONS

In the proposed technique, the rotor-side converter in Fig. 1 can be utilized for the alleviation of the torque and stator receptive control throbs. Additionally, the matrix side converter can be utilized for decrease of uneven stator voltage. In the proposed control strategy, the input circles are produced in view of immediate genuine/receptive power segments which can be specifically computed in abc outline and utilized as a part of some other reference outline. In the accompanying, first the momentary power model of a DFIG is designed and then the substitution elements of the proposed control procedure are clarified inside the accompanying segments.

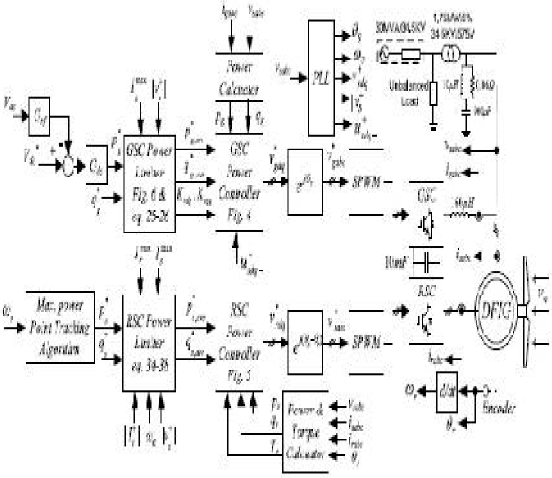


Fig.1. Schematic diagram of the study system.

Fig.1 demonstrates the schematic of the examination framework for examination of the execution and approval of the proposed control approach. The framework incorporates a 1.5 MW DFIG wind turbine-generator associated with a feeble network including an unequal stack. The control arrangement of rotor-side converter introduced and is utilized for mitigation of the torque and stator reactive control throbs through altering the stator active/reactive control.

The stator genuine/receptive power references, p_s^*andq_s^*, are changed in accordance with catch the most extreme breeze vitality and to meet a coveted power factor, individually.

The genuine power reference p_s^* can be resolved concerning an input from the shaft rotor speed,ω_r in light of any Maximum Power Point (MPPT) calculation. The controller of matrix side converter introduced in Fig. 4 is utilized to control genuine and receptive control and to moderate unequal stator voltage. The parameters for adjust working condition are outlined in view of definite technique portrayed as:

$$G_{P_s} = 1.33\left(1+\frac{10}{s}+\frac{s}{166.25}\right)\left(\frac{1}{1+0.016s}\right),$$

$$G_{Q_s} = 2.65\left(1+\frac{10}{s}+\frac{s}{331.25}\right)\left(\frac{1}{1+0.0032s}\right),$$

$$G_{P_g} = G_{Q_g}=\frac{2.65s+26.5}{s},G_{dc} = \frac{4.35s+8.7}{s},$$

$$G_{res} = \frac{7.54s}{s^2+7.54s+568489}, G_{nf} = \frac{s^2+568489}{s^2+7.54s+568489}.$$

Controller Block diagrams:

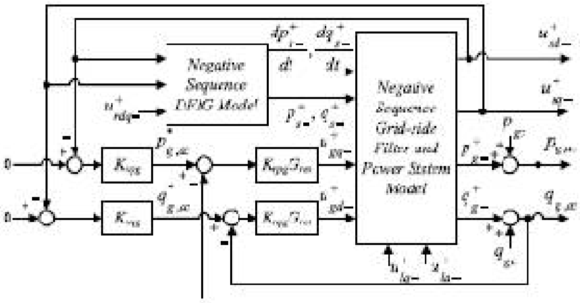


Fig.2. Schematic diagram of the GSC model for compensating the negative Sequence of the grid voltage.

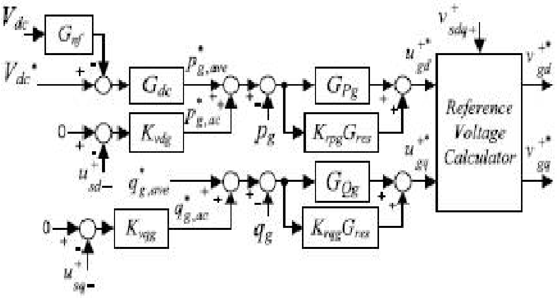


Fig.3. Details of the proposed unbalanced controllers for the grid-side Converter.

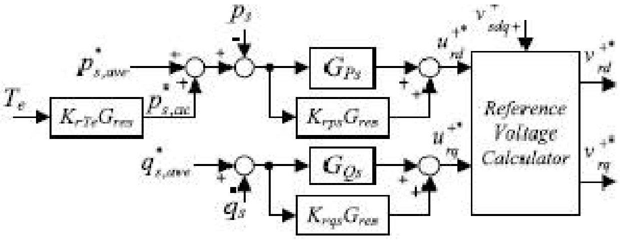


Fig.4. Details of the proposed unbalanced controllers for the rotor-side converter.

Fig. 2 demonstrates the schematic outline of the framework side converter model .In this model, control pulse references for GSC are utilized for altering the negative succession network voltage. Fig.3 delineates the proposed control framework for lattice side converter. In this control framework,G_{Pg},G_{Qg} and G_{dc} controllers are composed in view of adjusted model as expounded in [4]. At that point, additional control circles includingK_{vdg},K_{vqg},$K_{rpg}G_{res}$and $K_{rqg}G_{res}$are utilized to control pulse of converter relating to pulses of grid voltage at positive succession reference outline. The resonant compensator (G_{res}) tuned at the dual frequency of the grid which is executed in the positive sequence reference outline. Fig.4 represents the proposed unbalanced controllers for the rotor-side converter.

III.FUZZY LOGIC CONTROLLER

- FLC (Fuzzy Logic Controller) is a rule based controller.
- Fuzzy Logic Controller build by using the GUI (Graphical User Interface) tool and that is provided by the Fuzzy tool Box; it is used to build the system graphically.
- There are five primary GUI tools for building, editing and observing the Fuzzy in Fuzzy tool Box.

There are Five Function, They are

- FIS Editor
- MF Editor
- Rule Editor
- Rule Viewer
- Surface Viewer

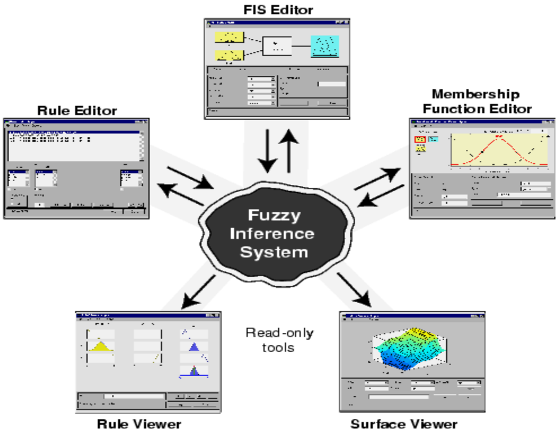


Fig.5 Fuzzy controller over view.

(A) Fuzzy Interface System:

- FIS is nothing but Fuzzy Interface System
- In FIS editor it is shown that input and output variable and able to assign the names to the input and output.
- The input and output are to be taken as per our requirement and there are no limitations for input and output.
- Between input and output there is a Fuzzy Logic Controller.
- In that Fuzzy Logic Controller the rules are designed as per the requirement.

(B) Membership Function Editor:

- By this editor the shapes of the Membership Functions are to be designed which are associated with each variable are shown in fig 6, 7 and fig 8.
- In this editor the names for the MF are assigned.
- The range of X-axis can change but the range of the Y-axis can’t change.
- By default it will take as 0 to 1, which represents MF values.
- For any MF X-axis takes as reference, because the range of the X-axis is taken as per our requirement.
- In this work three MF’s were designed.
- Two are for inputs and one is for output which are shown in fig.6, 7 and 8.

(C) Rule Editor:

- In this rule editor the rules can edit and also write the rules.
- Depends on the rules only the total logic of the FL is controlled.
- There is a possibility to change the rules here.
- The number of rules are depends on the number of Membership Functions.
- The rule base of the proposed fuzzy logic controller is shown in table.1.

(D) Rule Viewer:

- After giving the rules as per the project to see the rules go to Rule Viewer.
- In this rule viewer it shows that to how the rules are built.

(E) Surface Viewer:

- In this surface viewer
- Rule viewer and Surface viewer are Strictly read only viewer

Advantages:

- The ease to model your reasoning,
- The ability to deal with uncertainty and nonlinearity;
- The ease of implementation;
- The use of linguistic variables.

Table.1: Rule base for Five Membership Function

Change in Error ($\frac{dV}{dt}$)	Error(Voltage)				
	NB	NS	ZE	PS	PB
NB	PB	PB	PB	PB	PB
NS	PB	PB	PS	PS	PB
ZE	ZE	ZE	ZE	PS	PB
PS	NS	NS	NS	NS	PB
PB	PB	PB	NB	NB	PB

Fuzzy Membership functions:

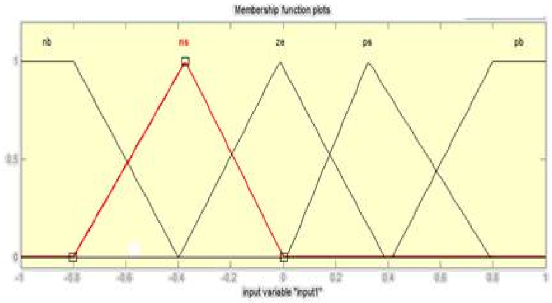


Fig.6.Membership functions for input1 (voltage)

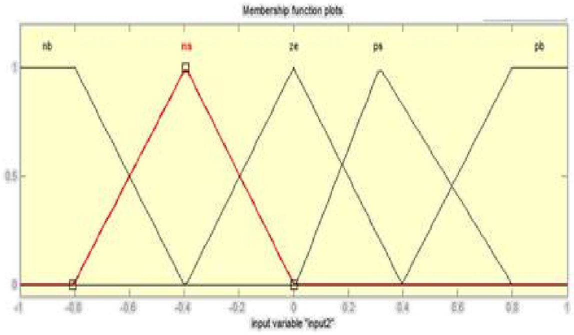


Fig.7.Membership functions for input2 (change in voltage)

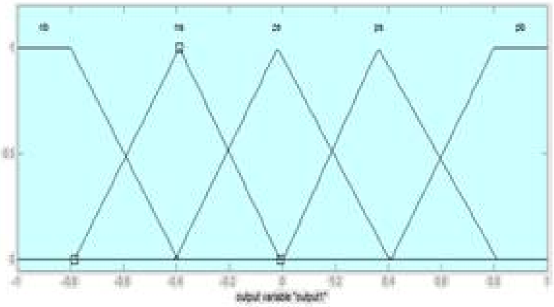
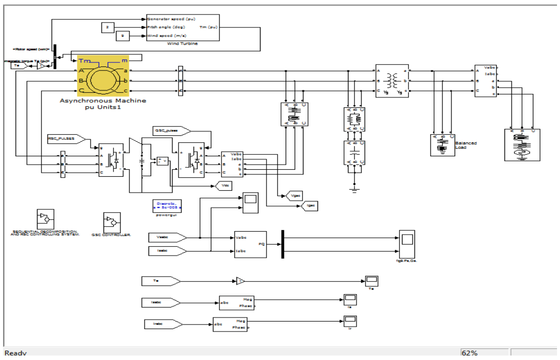


Fig.8.Membership functions for output (optimal voltage)

IV.SIMULATION RESULTS

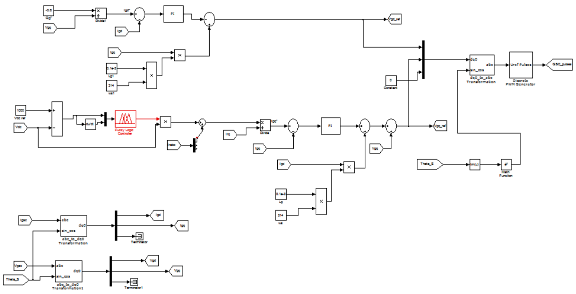
Simulation Results with fuzzy logic controller

Fig (a): Main Block diagram



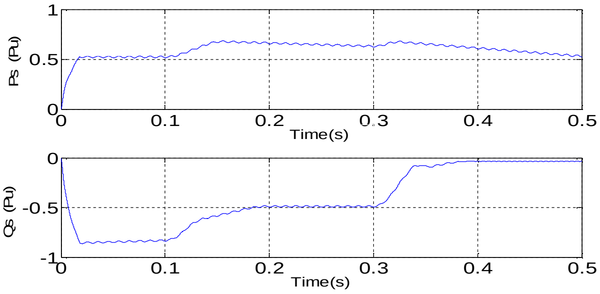
(a)

Fig (b): Controlling Block Diagram

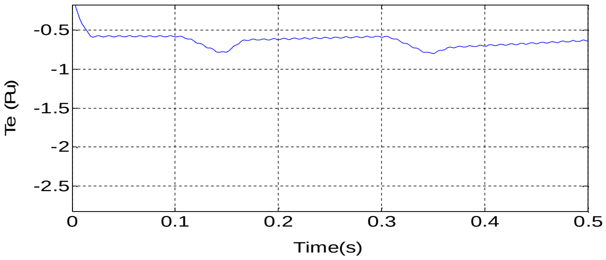


(b)

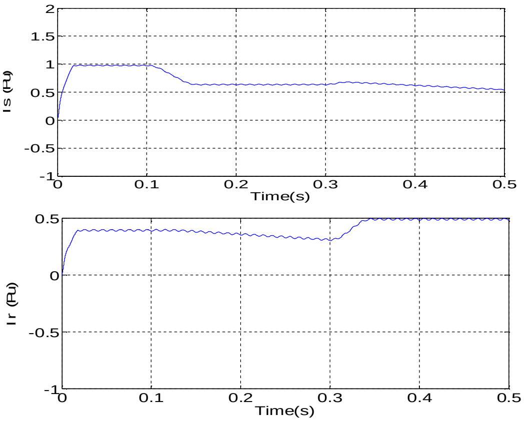
Fig.8. The DFIG performance under unbalanced voltage using balanced controller:



(a) stator real power; (b) stator reactive power;

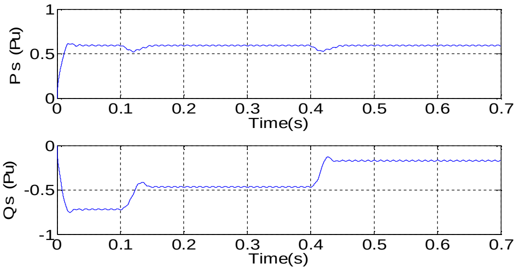


(c) Torque;

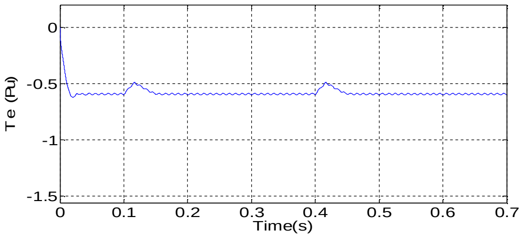


(d) Stator and rotor currents.

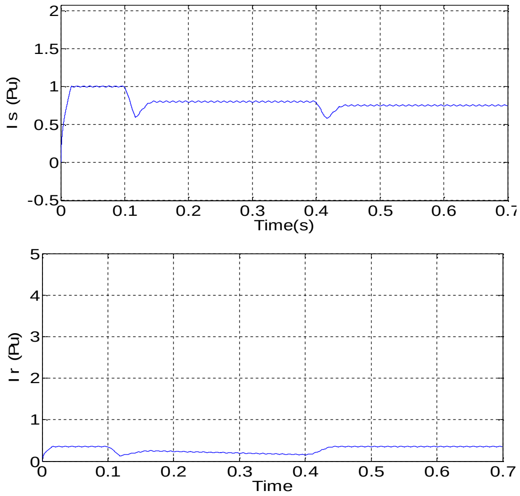
Fig.9. Unbalanced vector controller:



(a) Stator real power; (b) stator reactive power;

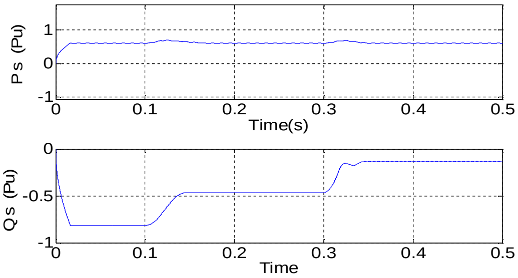


(c) Torque;

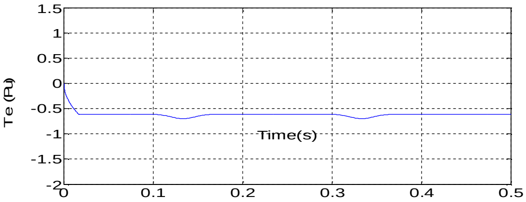


(d) Stator and rotor currents.

Fig.10. the proposed controller:



(a) Stator real power; (b) stator reactive power;



(c) Torque;

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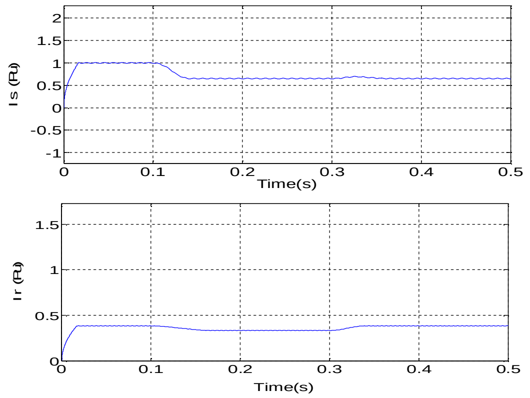
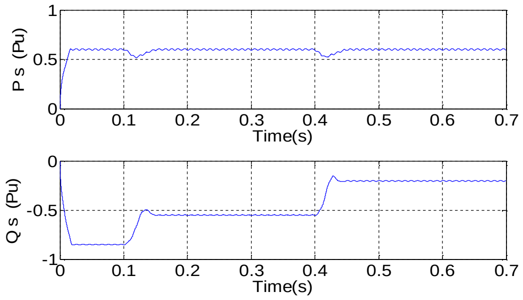
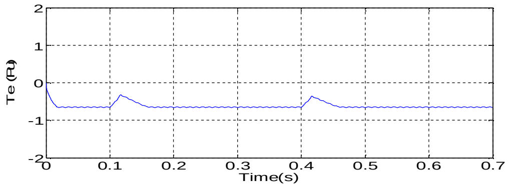


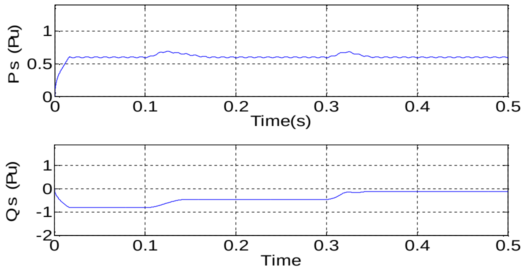
(d) Stator and rotor currents.
Fig.11. Robustness of the unbalanced vector controller:



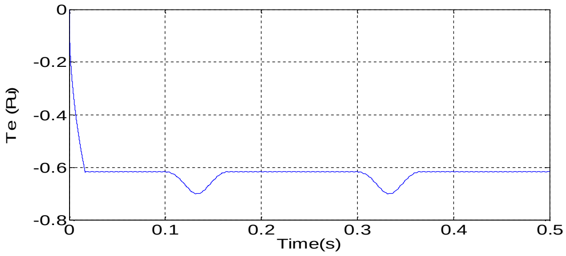
(a) Stator real power ;(b) stator reactive power;



(c) Torque.
Fig.12. Robustness of the proposed controller:

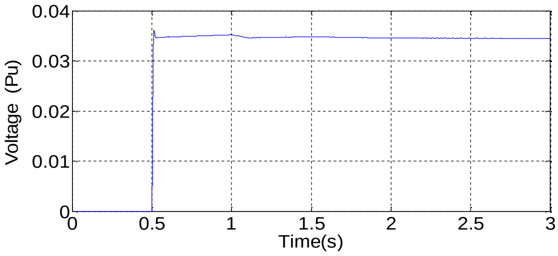


(a) Stator real power; (b) stator reactive power;

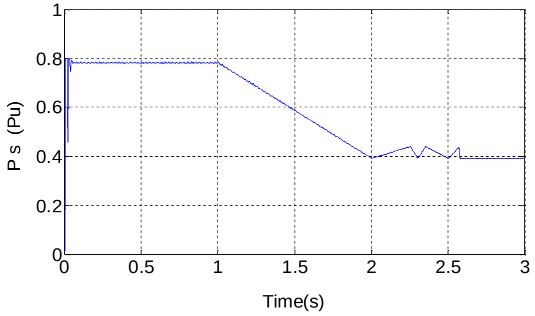


(c) Torque.

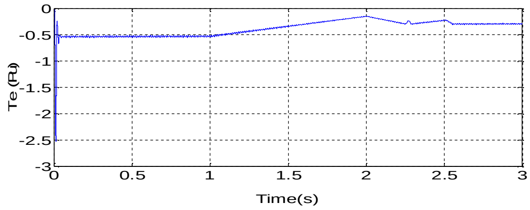
Fig.13. Partial compensation of unbalanced stator voltage:



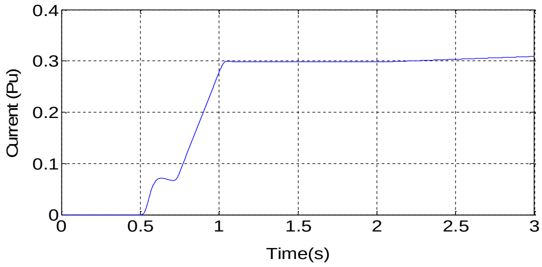
(a) Negative sequence of the stator voltage;



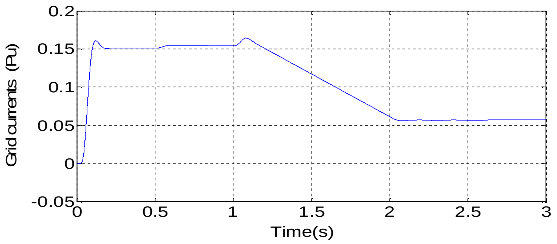
(b) Stator real power;



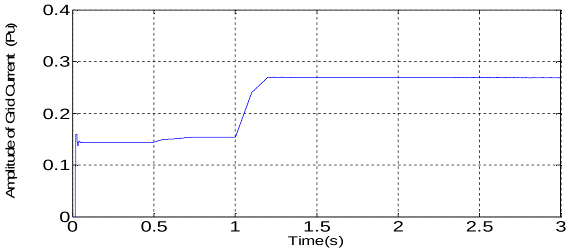
(c) Torque



(d) Negative sequence grid-side converter current.



(e) Positive sequence grid-side converter current;



(f) Amplitude of the grid-side converter current.

V. RESULTS ANALYSIS

From all the above results, observed that harmonics are reduced in rotor current and grid side current and also controlling unbalanced voltage by using fuzzy logic controller.

VI. CONCLUSION

This work investigates fuzzy logic control of DFIG wind turbine. All parameters and structures such as study system, wind turbine and control unit are described in details. To prove the performance of controller unit, in an unbalanced grid voltage condition are exerted. The control technique utilizes the grid side converter to adjust the unbalance stator voltage when the wind speed is low and turbine works below nominal power. Two current/ power limiting calculations are additionally presented for both rotor-and grid side converters to stay away from over rating of the converters. It has been demonstrated that fuzzy logic control approach is simple and powerful structure can offer a promising control of DFIG under unequal grid voltage conditions. By using fuzzy logic controller, the steady state error is reduced and the stability of the system is improved by eliminating disturbances.

REFERENCES

[1] M. Mohseni and S. M. Islam, “Review of international grid codes for wind power integration: Diversity, technology and a case for global standard,” *Renew. Sustain. Energy Rev.*, vol. 16, no. 6, pp. 3876–3890, 2012.

[2] C.Jauch, J. Matevosyan, T.Ackermann, and S.Bolik, “international comparison of requirements for connection of wind turbines to power systems,” *Wind Energy*, vol. 8, no. 3, pp. 295–306, 2005.

[3] F. Shahnia, P. J. Wolfs, and A.Ghosh, “Voltage unbalance reduction in low voltage feeders by dynamic switching of residential customers among three phases,” *IEEE Trans. Smart Grid*, vol. 5, no. 3,pp. 1318–1327, May 2014.

[4]E.Rezaei, A.Tabesh, and M.Ebrahimi, “Dynamic model and control of DFIG wind energy systems based on power transfer matrix,” *IEEE Trans. Power Del.*, vol. 27, no. 3, pp. 1485–1493, Jul. 2012.

[5] M. R. Patel, *Wind and Solar Power Systems: Design, Analysis, and Operation*. Boca Raton, FL, USA: CRC Press, 2006.

[6] R.Fadaeinedjad, M.Moallem, and G. Moschopoulos, “Simulation of a wind turbine with doubly fed induction generator by FAST and Simulink,” *IEEE Trans. Energy Convers.*, vol. 23, no. 2, pp. 690–700, Jun. 2008.