International Journal for Innovative Engineering and Management Research

A Peer Revieved Open Access International Journal

www.ijiemr.org

IJIEMR Transactions, online available on 29th Jan 2019. Link :

http://www.ijiemr.org/main/index.php?vol=Volume-08&issue=ISSUE-01

Title: **DESIGNING OF FUZZY LOGIC CONTROLLER FOR DYNAMIC VOLTAGE RESTORER AND ACTIVE POWER FILTER FOR WIND POWER SYSTEMS SUBJECT TO UNBALANCED AND HARMONIC DISTORTED GRID**

Volume 08, Issue 01, Pages: 270–281.

Paper Authors

INDUPALLI MANASA, P.ANKINEEDU PRASAD

Vikas group of institutions, Nunna; Krishna (Dt); A.P, India.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

DESIGNING OF FUZZY LOGIC CONTROLLER FOR DYNAMIC VOLTAGE RESTORER AND ACTIVE POWER FILTER FOR WIND POWER SYSTEMS SUBJECT TO UNBALANCED AND HARMONIC DISTORTED GRID

[1]INDUPALLI MANASA, [2]P.ANKINEEDU PRASAD
[1]M-tech Student Scholar,Department of Electrical & Electronics Engineering, Vikas group of institutions, Nunna; Krishna (Dt); A.P, India.
[2]Assistant Professor,Department of Electrical & Electronics Engineering, Vikas group of institutions, Nunna; Krishna (Dt); A.P, India
[1] manasa.indupalli@gmail.com, [2]eeevikasexamcell@gmail.com

ABSTRACT: Renewable energy resources (RES) are being increasingly connected in distribution systems utilizing power electronic converters. Among the Renewable energy resources most abundantly available throughout the earth is wind generation system. This project presents a novel control strategy for achieving maximum benefits from these grid-interfacing inverters when installed in 3-phase 4-wire distribution systems. To alleviate the impact registered by unbalanced and harmonic distortion, a new circuit topology comprising a dynamic voltage restorer (DVR) and an active power filter (APF) is presented. A frequency shifting technique based on coordinate transformation is employed to unify the positive and negative sequence harmonics into a resonant current controller. To improve the accuracy for harmonic detection, a second-order generalized integrator (SOGI), characterized with large bandwidth at specific frequency, is capable of separating harmonics from feeder current. The fundamental and harmonic current controllers can be individually realized by the resonant current controller and combined to form voltage command for a voltage-sourced inverter (VSI) based on superposition theorem. Not only the computing time but also the harmonic currents in the feeder can be effectively reduced along with the proposed approach. To share the dc-circuit with the DVR, the APF and DVR are in back-to-back connection in favour of unbalanced and harmonic compensation for specific grid bus. The proposed system is controlled using fuzzy logic controller and performance is compared with conventional controller by using Matlab/Simulink software.

Keywords: Renewable energy resources (RES), Dynamic voltage restorer (DVR), second-order generalized integrator (SOGI), active power filter (APF), voltage-sourced inverter (VSI)

1. INTRODUCTION

WIND energy is gaining popularity all over the world as it is environment-friendly renewable energy source . It has advantage over other renewable energy sources like solar energy ,as cost per kilowatt-hour (kWh) is high in later .The contribution of these renewable energy systems to the power system has been increased rapidly. DFIG based wind turbine offer several advantage over Fixed speed induction generator (FSIG)[1]-[4]. Advantages are variable-speed operation, independent control of active [6] and reactive power[5], and its partially rated power converter. It has low converter costs and reduced power losses [6],[7With the increasing amount of sensitive devices (power electronic devices) that are quite sensitive to power quality disturbances in the supply network, the problem of compensation of power quality disturbances is ever increasing. Power quality disturbances are categorized into voltage sags, voltage swells, transients, harmonics, interruptions etc. They can cause many technical problems (such as overheating, mis-operation, early aging of the devices, etc.) and financial losses to the power system operators and their customers. There are different ways to improve power quality such as Distribution Static synchronous Compensator (DSTATCOM), Dynamic Voltage Restorer (DVR), Active Filter (AF), Unified Power Quality Conditioner (UPQC), etc. Among these, the DVR is one of the most effective and cost-efficient devices which can used in power distribution system.

Using DVR in the distribution system for power quality improvement has been analyzed and proposed through many publications. References introduced studies using a DVR for mitigating voltage sag due to starting of the induction motor and asynchronous motor, respectively. In a DVR is used to mitigate balanced voltage sags/swells. The performance of the DVR under different voltage sag conditions due to the different types of short circuit faults in the power system is presented. In other works, a DVR not only mitigates voltage sags/swells but also performs harmonics compensation, where the DVR is controlled and designed to perform one or several functions. It is the motivation of this paper where the authors focus on design and control algorithms of the DVR with multi-functional capabilities, which can solve all the cases mentioned above with efficiency, accuracy and fast response time.In, we presented a double-loop controller using proportional integral (PI) controllers in the rotating frame. In this research, PI controllers are able to achieve a good performance both for balanced and unbalanced voltage sags. The disadvantage of this method is that the controller is designed in the rotating frame so that it requires the transformation from three-phase system to the coordinate system and in consequence back to the rotating system and inversely. Consequently, the control method is effective, but its structure is complex. In proportional resonant (PR) controllers in a stationary frame were presented. Compared with PI controllers, the complexity of PR controllers is reduced considerably, combined with its good performance. However, in case when only one symmetrical sequence needs to be compensated, the PR controllers lose their advantage because they cannot regulate positive- or negative-sequence components separately. To alleviate the disadvantage of PR controllers, a sequence-decoupled resonant (SDR) controller is presented, which can deal with each sequence component individually.

2 Controller Design

2.1 APF Controller Design

Fig.1 shows an ac circuit of a VSI. The voltage across the coupled inductor can be altered by modulating the inverter output voltage (e_f). Therefore, the current fed from the inverter is controllable with appropriate inverter output voltage control. The relation among voltages and currents

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

in Fig.1 can be represented in the stationary reference frame (αβ-axis) in time domain

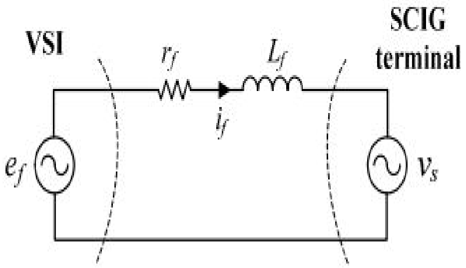

Fig.1. One-line diagram of a two-bus circuit.

$$\mathbf{e}_f^{\alpha\beta} - \mathbf{v}_s^{\alpha\beta} = r_f \mathbf{i}_f^{\alpha\beta} + L_f \frac{d\mathbf{i}_f^{\alpha\beta}}{dt} \quad (1)$$

or in s-domain

$$\mathbf{e}_f^{\alpha\beta} - \mathbf{v}_s^{\alpha\beta} = r_f \mathbf{i}_f^{\alpha\beta} + sL_f \mathbf{i}_f^{\alpha\beta} \quad (2)$$

By using the frequency-shifting theorem, (2) can be transformed to the synchronous reference frame (d-q-axis)

$$\mathbf{e}_f^{dq} - \mathbf{v}_s^{dq} = r_f \mathbf{i}_f^{dq} + (s + j\omega_0) L_f \mathbf{i}_f^{dq} \quad (3)$$

To enable the VSI absorbing the specific current harmonics presented at SCIG terminal, a controllers simplification [11] that transforms the current harmonic pair with rotating speed of $(6n\pm1)\omega_0$ to the d-q-axis and causing the current vector with respect to the d-q-axis with the same rotating speed $(6n\omega_0)$. (As shown in Fig.2, both the relative rotating speeds of the fifth- and seventh-order harmonics corresponding to the d-q-axis are equal to $6\omega_0$). To achieve sinusoidal current tracking for the model expressed in the d-qaxis, a harmonic compensator in the fashion of the PI controller can be modified in the form as

$$G_c = K_p + \frac{(K_i + \Delta)}{s} = \frac{sK_p + (K_i + \Delta)}{s} \quad (4)$$

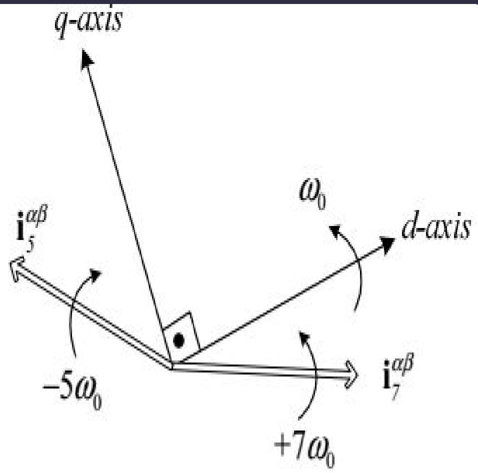

Fig.2. Harmonic vectors in d-q-axis.

Applying the frequency-shifting theorem, (4) can be tuned capable of compensating the harmonics vectors with the rotating speeds of +6nω0 and -6nω0, respectively, as

$$G_c^+ = \frac{(s - j6n\omega_0)K_p + (K_i + \Delta)}{(s - j6n\omega_0)} = \frac{K_p s + K_i}{s - j6n\omega_0} \quad (5)$$

And

$$G_c^- = \frac{K_p s + K_i}{s + j6\omega_0} \quad (6)$$

where Δ=±j6nω0 for the purpose of simplification. Summation of (5) and (6) gives a harmonic compensator for enabling the VSI to absorb one current harmonic pair $(6n\pm1)\omega_0$ at the SCIG terminal:

$$G_c = G_c^+ + G_c^- = 2\frac{K_p s^2 + K_i s}{s^2 + (6n\omega_0)^2} \quad (7)$$

2.2 Vector Representation of Symmetrical Components

Eq. (8) shows the vector representation for each phase voltage of a three-phase system.

$$\begin{aligned} \mathbf{v}_a(t) &= v_{\alpha a}(t) + jv_{\beta a}(t) \\ \mathbf{v}_b(t) &= v_{\alpha b}(t) + jv_{\beta b}(t) \\ \mathbf{v}_c(t) &= v_{\alpha c}(t) + jv_{\beta c}(t) \end{aligned} \quad (8)$$

where the real- and imaginary- parts (or components in the αβ-axis) can be extracted by the a second order generalized integrator (SOGI) that is used to convert the three-phase voltages (va, vb, vc) to three voltage vectors (vaαβ, vbαβ, vcαβ)where the components in αβ-axis are the same magnitude and orthogonal to each other. The SOGI also behaves similar to a band-pass filter which have large gain at grid frequency and is beneficial to reject the harmonic distortion and typically circuit disturbance[12].see fig 3

Because the vector representation in (8) involves the information of angular frequency, the associated symmetrical components are time dependent[13]. Expansion of (8) gives the zero sequence vector, positive sequence vector, and negative sequence vector as

$$\mathbf{v}_a^0(t) = v_{\alpha a}^0 + jv_{\beta a}^0 = \frac{1}{3}(v_{\alpha a} + v_{\alpha b} + v_{\alpha c}) + j\frac{1}{3}(v_{\beta a} + v_{\beta b} + v_{\beta c}) \quad (9)$$

$$\mathbf{v}_a^+(t) = v_{\alpha a}^+ + jv_{\beta a}^+ = \frac{1}{3}\left(v_{\alpha a} - \tfrac{1}{2}v_{\alpha b} - \tfrac{\sqrt{3}}{2}v_{\beta b} - \tfrac{1}{2}v_{\alpha c} + \tfrac{\sqrt{3}}{2}v_{\beta c}\right) + j\frac{1}{3}\left(v_{\beta a} + \tfrac{\sqrt{3}}{2}v_{\alpha b} - \tfrac{1}{2}v_{\beta b} - \tfrac{\sqrt{3}}{2}v_{\alpha c} - \tfrac{1}{2}v_{\beta c}\right) \quad (10)$$

$$\mathbf{v}_a^-(t) = v_{\alpha a}^- + jv_{\beta a}^- = \frac{1}{3}\left(v_{\alpha a} - \tfrac{1}{2}v_{\alpha b} + \tfrac{\sqrt{3}}{2}v_{\beta b} - \tfrac{1}{2}v_{\alpha c} - \tfrac{\sqrt{3}}{2}v_{\beta c}\right) + j\frac{1}{3}\left(v_{\beta a} - \tfrac{\sqrt{3}}{2}v_{\alpha b} - \tfrac{1}{2}v_{\beta b} + \tfrac{\sqrt{3}}{2}v_{\alpha c} - \tfrac{1}{2}v_{\beta c}\right) \quad (11)$$

The positive sequence component derived from (10) is the key technique to resolve the dynamic symmetrical components from the instantaneous voltage vector[14]. With the voltage vectors in hand, the phase of the positive sequence voltage can be estimated by a software phase locked loop (SPLL) and regarded as the phase command for the DVR.

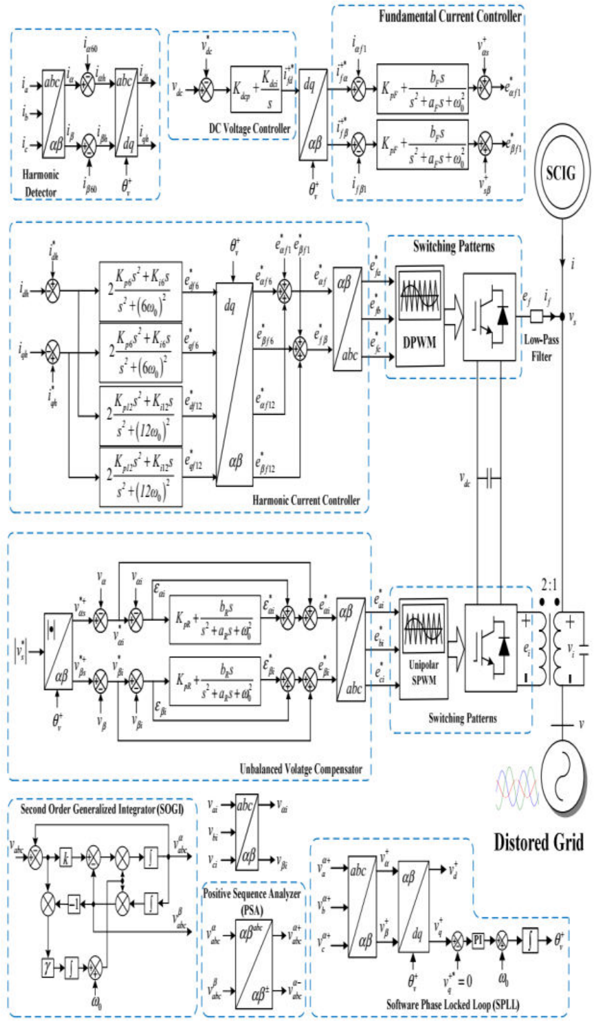

Fig.3 Block diagram of the DVR and APF controllers for a grid-tied SCIG system.

3. Proposed work:

A IMPORTANCE OF FUZZY LOGIC

Fuzzy logic is all about the relative importance of precision: use as Fuzzy Logic Toolbox software with MATLAB technical computing software as a tool for solving problems with fuzzy logic. Fuzzy logic is a fascinating area of research because it does a good job of trading off between significance and precision something that humans have been managing for a very long time. In this sense, fuzzy logic is both old and new because, although the modern and methodical science of fuzzy logic is still young, the concept of fuzzy logic relies on age-old skills of human reasoning.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

B USAGE OF FUZZY LOGIC Fuzzy logic is a convenient way to map an input space to an output space. Mapping input to output is the starting point for everything. Consider the following examples:

- With information about how good your service was at a restaurant, a fuzzy logic system can tell you what the tip should be.
- With your specification of how hot you want the water, a fuzzy logic system can adjust the faucet valve to the right setting.
- With information about how far away the subject of your photograph is, a fuzzy logic system can focus the lens for you.
- With information about how fast the car is going and how hard the motor is working, a fuzzy logic system can shift gears for you.

To determine the appropriate amount of tip requires mapping inputs to the appropriate outputs. Between the input and the output, the preceding figure shows a black box that can contain any number of things: fuzzy systems, linear systems, expert systems, neural networks, differential equations, interpolated multidimensional lookup tables, or even a spiritual advisor, just to name a few of the possible options. Clearly the list could go on and on.Of the dozens of ways to make the black box work, it turns out that fuzzy is often the very best way. As Lotfi Zadeh, who is considered to be the father of fuzzy logic, once remarked: "In almost every case you can build the same product without fuzzy logic, but fuzzy is faster and cheaper".

C CONVENIENCE OF FUZZY LOGIC Fuzzy logic is not a cure-all. When should you not use fuzzy logic? The safest statement is the first one made in this introduction: fuzzy logic is a convenient way to map an input space to an output space. Fuzzy logic is the codification of common sense — use common sense when you implement it and which will probably make the right decision. Many controllers, for example, do a fine job without using fuzzy logic. However, it take the time to become familiar with fuzzy logic, it can be a very powerful tool for dealing quickly and efficiently with imprecision and nonlinearity.

D The Fuzzy Logic Concept Fuzzy logic arose from a desire to incorporate logical reasoning and the intuitive decision making of an expert operator into an automated system. The aim is to make decisions based on a number of learned or predefined rules, rather than numerical calculations. Fuzzy logic incorporates a rule-base structure in attempting to make decisions. However, before the rule-base can be used, the input data should be represented in such a way as to retain meaning, while still allowing for manipulation. Fuzzy logic is an aggregation of rules, based on the input state variables condition with a corresponding desired output. A mechanism must exist to decide on which output, or combination of different outputs, will be used since each rule could conceivably result in a different output action.Fuzzy logic can be viewed as an alternative form of input=output mapping. Consider the input premise, x, and a particular qualification of the input x represented by Ai. Additionally, the

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

corresponding output, y, can be qualified by expression Ci . Thus, a fuzzy logic representation of the relationship between the input x and the output y could be described by the following:

R1: IF x is A1 THEN y is C1

R2: IF x is A2 THEN y is C2

. . . .

. . . .

. . . .

Rn: IF x is An THEN y is Cn

where x is the input (state variable), y is the output of the system, Ai are the different fuzzy variables used to classify the input x and Ci are the different fuzzy variables used to classify
the output y. The fuzzy rule representation is linguistically based .Thus, the input x is a linguistic variable that corresponds to the state variable under consideration. Furthermore, the elements Ai are fuzzy variables that describe the input x. Correspondingly, the elements Ci are the fuzzy variables used to describe the output y. In fuzzy logic control, the term ‘‘linguistic variable’’ refers to whatever state variables the system designer is interested in . Linguistic variables that are often used in control applications include Speed, Speed Error, Position, and Derivative of Position Error. The fuzzy variable is perhaps better described as a fuzzy linguistic qualifier. Thus the fuzzy qualifier performs classification(qualification) of the linguistic variables. The fuzzy variables frequently employed include Negative Large, Positive Small and Zero. Several papers in the literature use the term ‘‘fuzzy set’’ instead of ‘‘fuzzy variable’’, however; the concept remains the same. Table 4.1 illustrates the difference between fuzzy variables and linguistic variables. Once the linguistic and fuzzy variables have been specified, the complete inference system can be defined. The fuzzy linguistic universe, U, is defined as the collection of all the fuzzy variables used to describe the linguistic variables .i.e. the set U for a particular system could be comprised of Negative Small (NS), Zero (ZE) and Positive Small (PS). Thus, in this case the set U is equal to the set of [NS, ZE, PS]. For the system described by , the linguistic universe for the input x would be the set Ux . .A1A2 . . . An.. Similarly,

TABLE 1 Fuzzy and linguistic variables

Linguistic Variables		Fuzzy Variables (Linguistic Qualifiers)	
Speed error	(SE)	Negative large	(NL)
Position error	(PE)	Zero	(ZE)
Acceleration	(AC)	Positive medium	(PM)
Derivative of position error	(DPE)	Positive very small	(PVS)
Speed	(SP)	Negative medium small	(NMS)

The linguistic universe for the output y would be the set Uy . .CaC2 . . . Cn.

The Fuzzy Inference System (FIS) The basic fuzzy inference system (FIS) can be classified as: Type 1 Fuzzy Input Fuzzy Output (FIFO)

Type 2 Fuzzy Input Crisp Output (FICO)

Type 2 differs from the first in that the crisp output values are predefined and, thus, built into the inference engine of the FIS. In contrast, type 1 produces linguistic outputs. Type 1 is more general than type 2 as it allows redefinition of the response without having to redesign the entire

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

inference engine. One drawback is the additional step required, converting the fuzzy output of the FIS to a crisp output. Developing a FIS and applying it to a control problem involves several steps:

1. Fuzzification

2. Fuzzy rule evaluation (fuzzy inference engine)

3. Defuzzification.

The total fuzzy inference system is a mechanism that relates the inputs to a specific output or set of outputs. First, the inputs are categorized linguistically (fuzzification), then the linguistic inputs are related to outputs (fuzzy inference) and, finally, all the different outputs are combined to produce a single output (defuzzification). Figure 4 shows a block diagram of the fuzzy inference system.

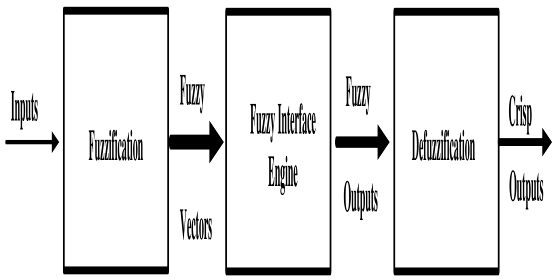

Fig .4 Fuzzy inference system.

E Fuzzification:

Fuzzy logic uses linguistic variables instead of numerical variables. In a control system, error between reference signal and output signal can be assigned as Negative Big (NB), Negative Medium (NM), Negative Small (NS), Zero (ZE), Positive small (PS), Positive Medium (PM), Positive Big (PB). The triangular membership function is used for fuzzifications. The process of fuzzification convert numerical variable (real number) to a linguistic variable (fuzzy number). Simply the process of converting a numerical variable (real number) convert to a linguistic variable (fuzzy number) is called fuzzification.

F.Defuzzification: The rules of fuzzy logic controller generate required output in a linguistic variable (Fuzzy Number), according to real world requirements; linguistic variables have to be transformed to crisp output (Real number). This selection of strategy is a compromise between accuracy and computational intensity.

The rules of FLC generate required output in a linguistic variable (Fuzzy Number), according to real world requirements, linguistic variables have to be transformed to crisp output (Real number).

Database: the Database stores the definition of the membership Function required by fuzzifier and defuzzifier.

Rule Base: the elements of this rule base table are determined based on the theory that in the transient state, large errors need coarse control, which requires coarse in-put/output variables; in the steady state, small errors need fine control, which requires fine input/output variables. Based on this the elements of the rule table are obtained as shown in Table 4.2, with' Vdc' and 'Vdc-ref' as inputs.

G FUZZY LOGIC CONTROLLER

Fuzzy logic is a method of rule-based decision making used for expert systems and process control that emulates the rule-of-thumb thought process used by human beings. The basis of fuzzy logic is fuzzy set theory which was developed by Lotfi

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Zadeh in the 1960s. Fuzzy set theory differs from traditional Boolean (or two-valued) set theory in that partial membership in a set is allowed. Traditional Boolean set theory is two-valued in the sense that a member belongs to a set or does not and is represented by 1 or 0, respectively. Fuzzy set theory allows for partial membership, or a degree of membership, which might be any value along the continuum of 0 to 1. A linguistic term can be defined quantitatively by a type of fuzzy set known as a membership function. The membership function specifically defines degrees of membership based on a property such as temperature or pressure. With membership functions defined for controller or expert system inputs and outputs, the formulation of a rule base of IF-THEN type conditional rules is done. Such a rule base and the corresponding membership functions are employed to analyze controller inputs and determine controller outputs by the process of fuzzy logic inference. By defining such a fuzzy controller, process control can be implemented quickly and easily. Many such systems are difficult or impossible to model mathematically, which is required for the design of most traditional control algorithms. In addition, many processes that might or might not be modeled mathematically are too complex or nonlinear to be controlled with traditional strategies. However, if a control strategy can be described qualitatively by an expert, fuzzy logic can be used to define a controller that emulates the heuristic rule-of-thumb strategies of the expert. Therefore, fuzzy logic can be used to control a process that a human can control manually with expertise gained from experience. The linguistic control rules that a human expert can describe in an intuitive and general manner can be directly translated to a rule base for a fuzzy logic controller.

Figure 5 shows the internal structure of the control circuit. The control scheme consists of Fuzzy controller, limiter, and three phase sine wave generator for reference current generation and generation of switching signals. The peak value of reference currents is estimated by regulating the DC link voltage. The actual capacitor voltage is compared with a set reference value. The error signal is then processed through a Fuzzy controller, which contributes to zero steady error in tracking the reference current signal. A fuzzy controller converts a linguistic control strategy into an automatic control strategy, and fuzzy rules are constructed by expert experience or knowledge database. Firstly, input voltage *Vdc* and the input reference voltage *Vdc-ref* have been placed of the angular velocity to be the input variables of the fuzzy logic controller. Then the output variable of the fuzzy logic controller is presented by the control Current *I*max. To convert these numerical variables into linguistic variables, the following seven fuzzy levels or sets are chosen as: NB (negative big), NM (negative medium), NS (negative small), ZE (zero), PS (positive small), PM (positive medium), and PB (positive big) as shown in Figure 6.

The fuzzy controller is characterized as follows:

1) Seven fuzzy sets for each input and output;
2) Fuzzification using continuous universe of dis-course;
3) Implication using Mamdani's ‘min’ operator;
4) De-fuzzification using the ‘centroid’ method.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

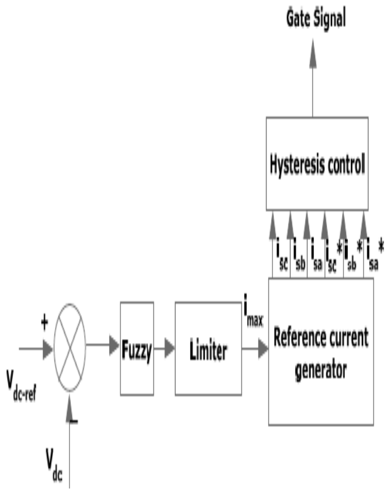

Fig.5.Conventional fuzzy controller

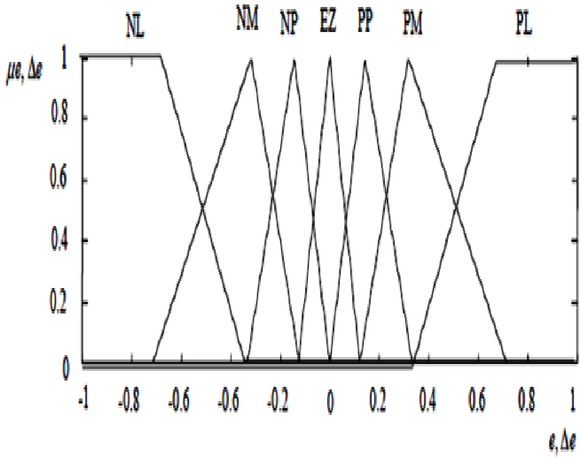

Fig.6. Input Vdc normalized membership function;

Table 2: Rules for Fuzzy System

Δe \ e	NL	NM	NS	EZ	PS	PM	PL
NL	NL	NL	NL	NL	NM	NS	EZ
NM	NL	NL	NL	NM	NS	EZ	PS
NS	NL	NL	NM	NS	EZ	PS	PM
EZ	NL	NM	NS	EZ	PS	PM	PL
PS	NM	NS	EZ	PS	PM	PL	PL
PM	NS	EZ	PS	PM	PL	PL	PL
PL	NL	NM	NS	EZ	PS	PM	PL

4 MATLAB/SIMULINK RESULTS

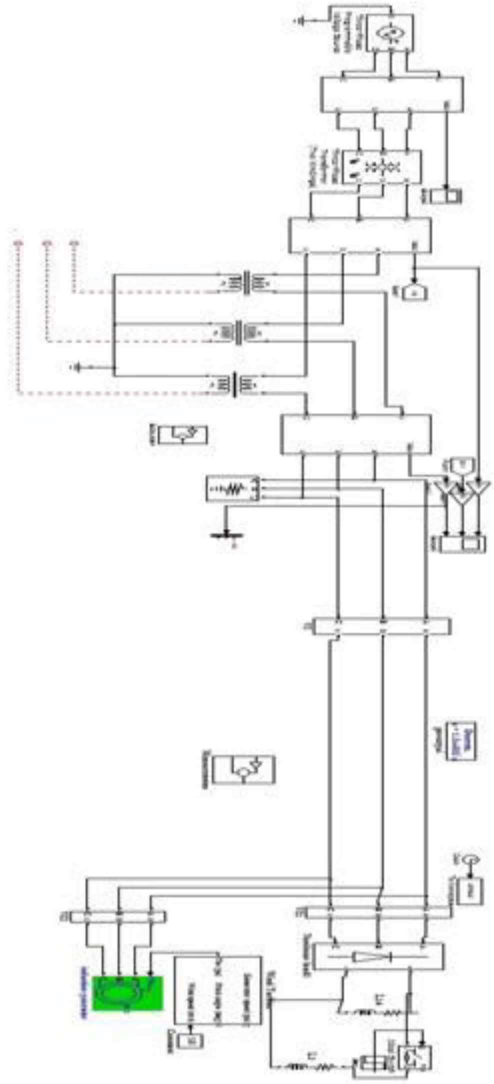

Fig 7: Block diagram of System Response of the uncompensated SCIG

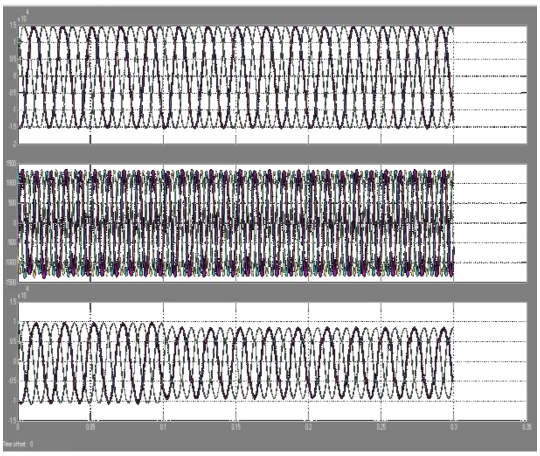

Fig 8 System response of the Uncompensated SCIG

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

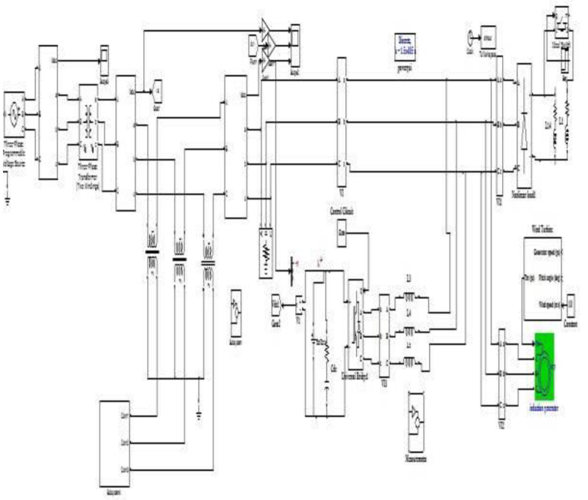

Fig 9: Block diagram of System response of the compensated SCIG

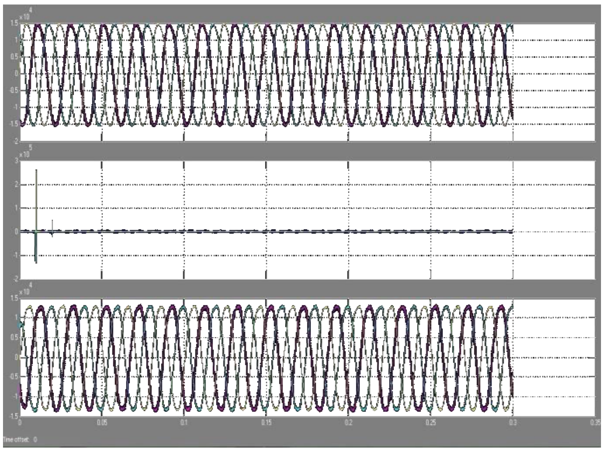

Fig 10 System response of the Compensated SCIG

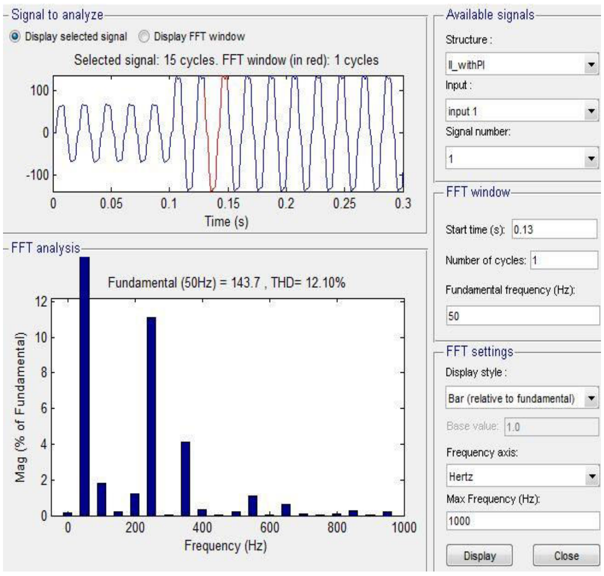

fig11 FFT analysis of the Compensated SCIG with PI controller

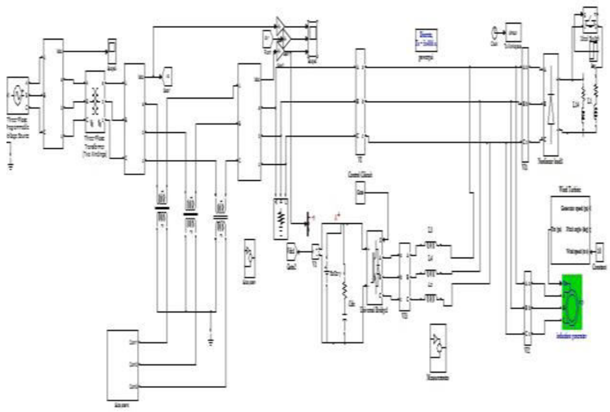

Fig: 12 Block diagram of system response of fuzzy compensated SCIG

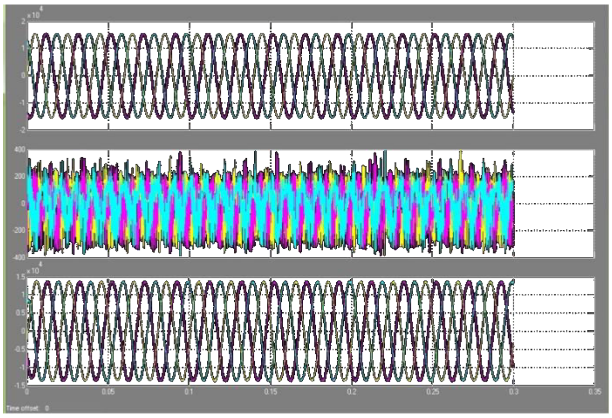

Fig: 13 system response of fuzzy compensated SCIG

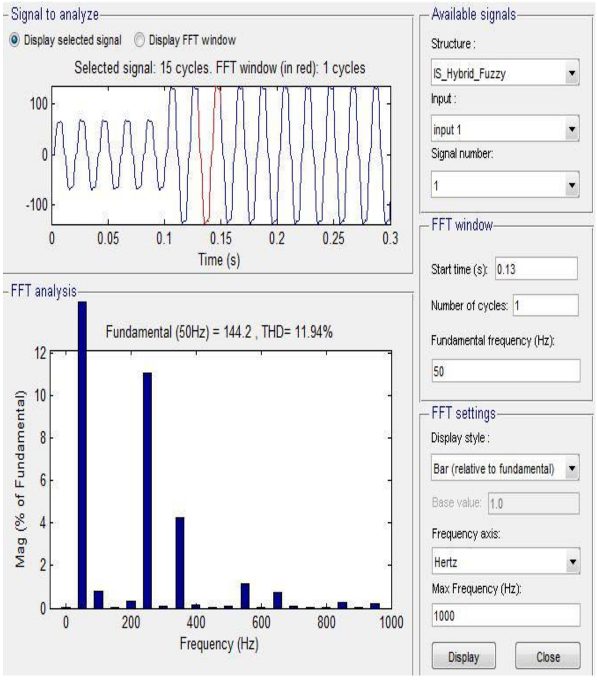

fig11 FFT analysis of the Compensated SCIG with fuzzy controller

5. CONCLUSION

The SCIG system tapped to the distorted power grid would suffer from the torque pulsation and which would damage the rotor bearings and shorten the SCIG durability. The difficulty to cope with the power quality problem lies in how to identify the distortion component from the distorted voltage or current signal. The unwanted distortions can be divided into two categories that is the voltage unbalance and the current harmonic. Because the definition of the voltage unbalance is independent to the harmonic distortion, the fundamental component should to be resolved from original voltage signal with the first priority. In this project, the three-phase fundamental voltages are first resolved and vectorized by the SOGI and the positive sequence component is then extracted. The fundamental positive sequence voltage provides with not only the grid voltage phase for the VSI to parallel with the power grid but also the degree of the voltage unbalance for the DVR to fast compensate the unbalanced component. The application of the frequency-shifting theorem and the coordinate transformation to the APF controller can simplify the harmonic compensator design and reduce the computing time.

FUTURE SCOPE:1)A new DVR Device is used to compensate the harmonics, voltage sag and voltage swell and to improve good stability2)By using Active Power Filter to reduce the total harmonic distortion and increase the power quality

REFERENCES

[1] D. N. Zmood, D. G. Holmes, and G. H. Bode, “Frequency-domain analysis of three-phase linear current regulators,” IEEE Trans. On Industry Applications, vol. 37, no. 2, pp. 601-610, 2001.

[2] D. N. Zmood and D. G. Holmes, “Stationary frame current regulation of PWM inverters with zero steady-state error,” IEEE Trans. on Power Electronics, vol. 18, no. 3, pp. 814-822, 2003.

[3] Y. Sato, T. Ishizuka, K. Nezu, and T. Kataoka, “A new control strategy for voltage-type PWM rectifiers to realize zero steady-state control error in input current,” IEEE Trans. on Industry Applications, vol. 34, no. 3,pp. 480-486, 1998.

[4] C. Lascu, L. Asiminoaei, I. Boldea, and F. Blaabjerg, “Frequency response analysis of current controllers for selective harmonic compensation in active power filters,” IEEE Trans. on Industrial Electronics, vol. 56, no. 2, pp. 337-347, 2009.

[5] W.-L. Chen, B.-S. Lin and M.-J. Wang, “Dynamic symmetrical components analysis and compensation for unbalanced distribution systems,” The 9th International Conference on Power Electronics ECCE Asia, pp. 2221 - 2226, 2015.

[6] C. Meyer, R. W. De Doncker, Y. W. Li, and F. Blaabjerg, “Optimized control strategy for a medium-voltage DVR-theoretical investigations and experimental results,” IEEE Trans. on Power Electronics, vol. 23,no. 6, pp. 2746-2754, 2008.

[7] S. R. Naidu and D. A. Fernandes, “Dynamic voltage restorer based on a four-leg voltage source converter,” IET Generation Transmission Distribution, vol. 3, no. 5, pp. 437-447, 2009.

[8] C. Lascu, L. Asiminoaei, I. Boldea, and F. Blaabjerg, “High performance current controller for selective harmonic compensation inactive power filters,” IEEE Trans. on Power Electronics, vol. 22, no. 5,pp. 1826-1835, 2007.

[9] H. K. Al-Hadidi, A. M. Gole, and D. A. Jacobson, “Minimum power operation of cascade inverter-based dynamic voltage restorer,” IEEE Trans. on Power Delivery, vol. 23, no. 2, pp. 889-898, 2008.

[10] Y. W. Li, P. C. Loh, F. Blaabjerg, and D. M. Vilathgamuwa, “Investigation and improvement of transient response of DVR at medium voltage level,” IEEE Trans. on Industry Application, vol. 43,no. 5, pp. 1309-1319, 2007.

[11] Y. W. Li, D. Mahinda Vilathgamuwa, F. Blaabjerg, and P. C. Loh, “Arobust control scheme for medium-voltage-level DVR implementation, ”IEEE Trans. on Industrial Electronics, vol. 54, no. 4, pp. 2249-2261,2007.

[12] P. Cheng and H. Nian, “An improved control strategy for DFIG system and dynamic voltage restorer under grid voltage dip,” in Proc. IEEE International Symposium on Industrial Electronics, pp. 1868-1873, 2012.

[13] S. Fukuda and T. Yoda, “A novel current-tracking method for active filters based on a sinusoidal internal model,” IEEE Trans. on Industry Applications, vol. 37, no. 3, pp. 888-895, 2001.

[14] L. Herman, I. Papic, and B. Blazic, “A proportional-resonant current controller for selective harmonic compensation in a hybrid active power filter,” IEEE Trans. on Power Delivery, vol. 29, no. 5, pp. 2055-2065,2014.