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ANALYSIS OF OPEN, CLOSED LOOP PI , PID & FLC CONTROLLABLE WIND ENERGY SYSTEM USING G- ZSI WITH PMSM 1Jaffar Sadiq Ali*, A and 2Ramesh,G.P 1Geethanjali Institute of Science and Technology, Department of Electrical and Electronics Engineering, Professor, Nellore, Andhra Pradesh, India,ajaffi1@gmail.com* 2St.Peter's University, Department of Electronics and Communication, Professor & Head of Department, Chennai, Tamil Nadu, India,rameshgp@yahoo.com Abstract- This paper deals with the open, closed loop PI, PID, FL and ANN controlled G-ZSI PMSM drive system are modeled, simulated using Matlab.

Voltage type G ZSI is proposed for a PMSM drive in this paper. The G shaped network can boost the input voltage. The speed of the drive is controlled by using V/f Control. The advantages of this system that has high power, high voltage gain with lower maintenance. The results of open loop simulation with shoot through mode and its experimental results are presented in the section I, II respectively.The results of the comparison between PI, FLC and ANN with PID controller are performed with respect to rise time, settling time and steady state error that is presented in section III, IV and V respectively keywords: PI, PID , FLC, ANN, wind generation, G-ZSI, Controller, PMSM Drive 1 Introduction In today's world, power inverters made up using semiconductor devices have been predominantly used in the industry because of its efficiency, small size and good power density.

Any applications using power electronics devices always in need of some amount of boosting their voltage level and grid related application is an especially those directly connected to the grid. Traditional inverters like voltage-source inverters and CSI having its limitations. VSI works with step down inverters only where as CSI works only with the help of high inductance therby increasing the cost.

Hence, to get boost functionality, DC to DC converters can be chosen for all the inverter types such as buck, boost and CUK converter. But before many years ago, z source inverter is a very good single step converter and it has many topologies. It has inherent characteristics of both boost and buck operation with a single conversion having high voltage gain.

Pulse width modulation technique is mostly used in the voltage type ZSI that has dual modes of operation, that is widely known as discontinuous and continuous mode [4]. The following control techniques are available in order to work with ZSI. SBC (Simple boost control) has more voltage stress in the power electronic solid state switches whenever voltage gain is huge.

For a given modulation index (MBC) the Maximum boost control technique with low voltage stress as that of SBC. But MBC has same voltage gain but a large modulation index when compared with Harmonic Injection method. [5].Quasi-ZSI is good with its implicit characteristics of ZSI and got the very unique benefit of lower rating of components. [6].

With the help of shoot through duty cycle ranges from 0 to 0.15, Extended boost q-ZSI had given a better boost factor collection besides with input current [7]. The ZSI applications are like electric vehicles [8-9] and solar generation system [10]. The working operation of Z-source inductors and capacitors are changed with a new condition and the introduction of soft switching with new techniques to minimize the inrush spike current [11]. With the help of small signal condition of analysis for usage in stand alone application ,The vibrant behavior of Quasi ZSI are analyzed [12]. The EZ Source inverter is useful in producing the good voltage in addition to smooth voltage and current without having extra cost [13].

In order to couple power circuit and main circuit, a new T- shaped ZSI is used with unique Switched Inductor z source circuits [19]. With few loss of voltage using buck-boost capability, Parallel embedded Z-Source inverters is used with its better-quality functionality for harnessing clean energy resources [14] For increasing the voltage at the output , the duty cycle is adjusted in Cascaded quasi z source inverter [15]. Switched Inductor-q-ZSI has got only extra and three diodes and only one inductor while compared with quasi-Z network but has good very high boost factor for the same input current with providing common ground for DC source and continuous input current [16].Tapped-inductor Z-source inverters uses multiple lower rated components rather than a few higher rated ones which results into enhanced voltage boosting capability[17].The LCCT-ZSI helps to boost the output voltage by employing two built-in capacitors block DC currents in transformer windings and prevents core saturation of the transformer.

[18]. T-source inverter, has unique edge with over conventional Z-source inverter, by having common voltage source of the reactive components. [19].Trans-ZSI has better reduced voltage stress in the motoring application with incorporating current fed trans-ZSI. Tapped-inductor ZSI use many lowest rating components instead of a very few higher rated components that gives in superior voltage boosting competence [17]. Trans-z source inverter has wide operation in motoring application using current fed trans-ZSI and less voltage stress in the voltage-fed trans-ZSIs [20].

G Z source inverter had less no. of devices and a transformer coupled so that to achieve high gain and more modulation index by having less voltage switches stresses. Several types of Z source inverters with their various kinds of wind type generators are discussed [21]. PI controller is compared with PID controlled wind generator system was studied in [22].The different energy harvesting methods was studied in [23].The usage of Fuzzy logic controller in brushless dc motor with z source inverter was also studied in [24].

All the above mentioned literature survey doesn’t have the performance comparison among PI, PID,FLC and ANN using G ZSI for power quality development in the field of wind energy systems. The document is structured as mentioned: Section II deal with the simulation of wind generator fed ?-zsi controlled pmsm drive. Section III considers its implementation of the simulation work of Section II.

Section IV, V and VI presents the comparison between pi with pid, pid with flc and pid with ann controlled systems respectively. Section VII gives the conclusion. 2 Simulation of G-Zsi based Pmsm Drive 2.1 G-Z Source Inverters / Fig.1.1 G-Z source inverter Fig.1.1 depicts the G-ZSI. The position of transformer windings looks like ‘Gamma’ and this plays a major role in boosting the voltage by having a lower turn ratio that lies between 1 and 2 while other converters boost their output voltage with large turn ratio.

The advantage of G-z source inverter is that it needs a transformer and a capacitor and there is less chance to get false triggering by EMI. This converter is superior to normal ZSI by operating in the high modulation ratio, while obtaining high output voltage gain with reduced voltage stretches on the components. 2.2 Proposed System Using G- ZSI / Fig.1.2

G- ZSI based wind energy conversion system The proposed block diagram shows G- ZSI as control element as shown in Fig.1.2. This consists of a wind simulator that generates a poor level of Alternating Current (AC) output voltage and a rectifier block that converts to low Direct Current output voltage.

This output voltage is maxmised up with a very huge gain of the voltage by using G-ZSI network and PWM inverter block changes DC into three phase AC output voltage by using control pulses . The AC generated output voltage that makes the PMSM motor to run with speed greater than trans-ZSI based drive system. 2.3 Proposed Simulink diagram in Shoot through Mode: / Fig.1.3 AC to AC converter with shoot through mode / / Fig.1.4 Motor speed in Shoot Through State Fig.1.5.Torque in Shoot Through State The motor speed and its torque curves are shown in Fig 1.4 & 1.5 respectively.

3 Implementation of G-Zsi based Pmsm Drive The hardware of gamma Z source inverter systems is fabricated and tested in the laboratories as shown in Fig.2.1. The hardware consists of controller board, power board and motor load. The IRF 840 MOSFET, 1N4007 DIODE and IR2110 pulse amplifier are used in the circuit. The value of the inductance of the coil is typically 2.6 μh and capacitor value is 2400 μf. The PIC16F84A controller is used to control the entire operation.

The inverter output is used to run 3 phase PMSM motor. / Fig.2.1 Hardware snapshot of G-Zsi based Pmsm Drive The phase voltage across the motor and line voltages are depicted in Fig.2.2 & Fig.2.3 respectively. The value of peak to peak line voltage is 67v AC. The PMSM motor runs at 850 RPM. / / Fig.2.2 Line to Neutral Voltage Fig.2.3

Line to Line Voltage

4 COMPARISON b/w PI , PID CONTROLLED G- Z SOURCE BASED PMSM DRIVE SYSTEMS 3.1 PI/PID Controlled WECS Using G-ZSI / Fig.3.1 PI/PID controlled WECS with G-ZSI Fig.3.1 shows the feedback of PI/PID controller is employed to ensure the rectifier output voltage is constant. A PI/PID feedback loop is taken from the PMSM Motor and feds back to 3 phase inverter that regulates its speed to a constant even though the speed of the wind is varied. 3.2 Closed Loop system with Pi Controller The closed loop control system that includes PI controlled wind energy system is shown in Fig.3.2.A

small amount of increasing the input voltage is considered. / Fig.3.2 Closed loop PI Controlled system The response curve of speed component is shown in Fig.3.2.The speed of the motor reaches steady state condition within 1.94 seconds. The shaft torque of the motor reaches 83 nm with rise time of 0.08 seconds as shown in Fig.3.3. / / Fig.3.2 Motor Speed Fig.3.3 Torque 3.3 Closed Loop system with Pid Controller The Closed loop control system which comprises PID controller is shown in Fig.3.4.The voltage at Direct Current Link is compared with the reference voltage and the error is taken as feedback and fed to a PID controller.

The pulse width of the signals applied to the rectifier block. Thus the voltage at the output is determined by this system. / Fig.3.4 Closed loop system with PID Controller Fig.3.5 shows speed response curve .The steady state speed is achieved in 1.52 seconds. Fig.3.6 shows the torque of the motor that reaches upto 84 nm as same the previous case but steady state is attained within the rising time of 0.06 seconds. / / Fig.3.5

Motor speed Fig.3.6 Torque The closed loop PI and PID comparison responses are kept in Table 1. Table 1: Comparison of Responses b/w PI & PID Controllers _Rise time(s) _Settling time (s) _Steady state error (v) _ _PI _0.08 _1.94 _0.5 _ _PID _0.06 _1.52 _0.2 _ _ 5 COMPARISON b/w PID & FUZZY LOGIC CONTROLLED G- Z SOURCE BASED PMSM SYSTEMS 4.1 PID/FLC Controlled WECS Using G-ZSI /Fig.4.1

PID/FLC controlled WECS with G-ZSI The feedback of PID/FLC controller is employed to ensure the rectifier output voltage is constant and shown in Fig.4.1. A PID/FLC feedback loop is taken from the PMSM Motor and feds back to 3 phase inverter that regulates its speed to a constant even when the wind speed varied. 4.2 Closed Loop Controller with FLC Fig.4.2 describes the simulink model of closed loop with FLC system.The actual speed of the motor is compared with the reference speed. The error and its derivative are applied to FLC.

The output of FLC is compared with the repeating sequence to produce the pulses required by the MOSFETs. / Fig.4.2 Closed loop with FLC Controller Fig.4.3 is showing the speed curve. The steady state of the motor speed is obtained with 0.01 ess. Fig.4.4

clearly shows the motor has 82 nm as its torque at its shaft with sharp rising time of 0.025 seconds. / / Fig.4.3 Motor speed Fig.4.4

Torque The closed loop comparison b/w PID and FLC responses are inTable 2. Table 2: Comparision of Responses b/w PID & FLC Controllers _Rise time (s) _Settling time (s) _Steady state error (v) _ _PID _0.06 _1.52 _0.2 _ _FLC _0.025 _0.02 _0.1 _ _ 6 COMPARISON b/w PID & ANN G- Z SOURCE BASED PMSM DRIVE SYSTEMS 5.1

PID/ANN controlled WECS using G-ZSI The feedback of PID/ANN controller is employed to ensure the rectifier output voltage is constant. A PID/ANN feedback loop is taken from the PMSM Motor and feds back to 3 phase inverter that controls its speed and attains stedy state speed. / Fig.5.1 PID/ANN controlled WECS with G-ZSI 5.2 ANN based closed loop controller / Fig.5.2

Closed loop with ANN Controller ANN based simulink model is clearly depicted in Fig.5.2.The motor speed is compared with its speed of its reference input. The error and its derivative are applied to ANN. The output of ANN is compared with the repeating sequence to produce the pulses required by the MOSFETs and the speed and torque outputs are shown in Figs.5.3

& 5.4 respectively. / / Fig.5.3 Speed Response Fig.5.4 Torque Developed The comparison of the closed loop PID and ANN response is given in Table 3. Table 3: Comparison of Responses b/w PID & ANN Controllers _Rise time(s) _Settling time (s) _Steady state error (v) _ _PID _0.06 _1.52 _0.2 _ _ANN _0.015 _0.017 _0.16 _ _ It inferes that the output of the ANN controller is much better than PID controller.

7 Conclusions Wind generator fed G-ZSI based AC to AC converter controlled PMSM drive to open, closed loop, pi, PID, flc, Ann are simulated using Matlab/Simulink. In Section I, observed that the operation undershootthrough condition is more suitable for low input voltage situation with increased speed of the motor as output. The experimental results of open loop system of Section II are matched with the simulation results of Section I.

Results of PI & PID controlled systems were compared in Section III indicated that PID system performs better than PI in terms of quick response. In Section IV, the results of the comparison between PID & FL controlled systems indicated that FL system gives good response rather than PID based system. Finally, Section V describes the comparison between PID & ANN systems indicated that ANN system could produce quickest response as that of PID controlled system.

Table 4: Responses of PI, PID & FL Controllers for PMSM S.No. _Type of Controller _Rise Time (Secs) _Settling Time (Secs) _Steady State Error(v) _ _1. _PI Controller _0.08 _1.94 _0.5 _ _2. _PID Controller _0.06 _1.52 _0.2 _ _3. _FL Controller _0.025 _0.02 _0.1 _ _ Table 5: Responses of PI, PID & ANN Controllers for PMSM S.No. _Type of Controller _Rise Time (Secs) _Settling Time (Secs) _Steady State Error(v) _ _1.

_PI Controller _0.08 _1.94 _0.5 _ _2. _PID Controller _0.06 _1.52 _0.2 _ _3. _ANN Controller _0.015 _0.017 _0.16 _ _ Table 4 & Table 5 shows the summative comparisonwith traditional controller with intelligence controllers and the ANN system response is much faster than FLC systems with less rise time and settling time where FLC has less steady state error than ANN system. References [1] J. Kikuchi and T. A.

Lipo, “Three phase PWM boost-buck recti?ers with power regenerating capability,” IEEE Trans. Ind. Appl., vol. 38, no. 5,pp. 1361–1369, Sep./Oct. 2002. [2] G. Moschopoulos and Y. Zheng, “Buck-boost type ac-dc single-stage converters,” in Proc. IEEE Int. Symp. Ind. Electron., Jul. 2006, pp. 1123–1128. [3] F. Z. Peng, “Z-source inverter,” IEEE Trans. Ind. Appl., vol. 39, no. 2,pp. 504–510, Mar./Apr. 2003. [4] P. C. Loh, D. M. Vilathgamuwa, Y. S. Lai, G. T. Chua, and Y. W.

Li,“Pulse-width modulation of Z-source inverters,” IEEE Trans. Power Electron.,vol. 20, no. 6, pp. 1346–1355, Nov. 2005. [5] Yu Tang, Member, IEEE, Shaojun Xie, Member, IEEE, and Chaohua Zhang “An improved z source inverter” in IEEE transactions on power electronics, vol. 26, no. 12, december 2011 [6] G. Sen and M. E. Elbuluk, “Voltage and current-programmed modes in control of the Z-source converter,” IEEE Trans. Ind. Applicat., vol. 46,no.

2, pp. 680–686, Mar./Apr. 2010. [7] S. Rajakaruna and L. Jayawickrama, “Steady-state analysis and designing impedance network of Z-source inverters,” IEEE Trans. Ind. Electron.,vol. 57, no. 7, pp. 2483–2491, Jul. 2010. [8] D. Amudhavalli1 , L.Narendran2 Improved Z Source Inverter for Speed Control of an Induction Motor-International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 4, April 2013 [9] M. Hanif, M. Basu, and K.

Gaughan, “Understanding the operation of a Z-source inverter for photovoltaic application with a design example,”IET Power Electron., vol. 4, no. 3, pp. 278–287, Mar. 2011. [10] F. Z. Peng, M. Shen, and K. Holland, “Application of Z-source inverter for traction drive of fuel cell—Battery hybrid electric vehicles,” IEEE Trans.Power Electron., vol. 22, no. 3, pp.

1054–1061, May 2007. [11] Y. Tang, S. Xie, C. Zhang, and Z. Xu, "Improved Z-source inverter with reduced Z-source capacitor voltage stress and soft-start capability," IEEE Trans. Power Electron., vol. 24, no. 2, pp. 409–415, Feb. 2009. [12] J. Anderson and F. Z. Peng, "A class of quasi-Z-source inverters," in Proc. IEEE Ind. Appl. Soc., Oct. 2008, [13] P. C. Loh, F.

Gao, and F. Blaabjerg, "Embedded EZ-source inverters,"IEEE Trans. Ind. Appl., vol. 46, no. 1, pp. 256–267, Jan./Feb. 2010. [14] F. Gao, P. C. Loh, F. Blaabjerg, and C. J. Gajanayake, "Operational analysis and comparative evaluation of embedded Z-Source inverters," in Proc.IEEE Power Electron. Spec. Conf., Jun. 2008, pp. 2757–2763. [15] Ding LI ,Poh Chiang LOH, Miao ZHU, Feng GAO and Frede Blaabjerg.," Cascaded trans-Z-source inverters", 8th International Conference on Power Electronics - ECCE Asia, May 30-June 3, 2011, The Shilla Jeju, Korea [16] M. Zhu, K.

Yu, and F. L. Luo, "Switched inductor Z-source inverter,"IEEE Trans. Power Electron., vol. 25, no. 8, pp. 2150–2158, Aug.2010. [17] M. Zhu, D. Li, P. C. Loh, and F. Blaabjerg, "Tapped-inductor Z-source inverters with enhanced voltage boost inversion abilities," in Proc. IEEEInt. Conf. Sustainable Energy Technol., Dec. 2010, pp. 1–6. [18] M. Adamowicz, "LCCT-Z-source inverters," in Proc. Int. Conf. Environ.Elect. Eng., May 2011, pp. 1–6. [19] R. Strzelecki, M. Adamowicz, N.

Strzelecka, and W. Bury, "New type T-source inverter," in Proc. Compat. Power Electron.'09, May 2009,pp. 191–195. [20] W. Qian, F. Z. Peng, and H. Cha, "Trans-Z-source inverters," IEEE Trans. [21] Ali, A. Jaffar, and G. P. Ramesh. "Converters for wind energy conversion-a review." International Journal of Technology and Engineering Science (2013): 1019-1026.

[22] AJS Ali and GP Ramesh," Comparison of PI and PID controlled wind generator fed G-Z source based PMSM drives", International Journal of Science and Technology, vol. 9, no. 1: DOI: 10.17485/ijst/2016/v9i1/71289: ISSN (Print) : 0974-6846. [23] GP Ramesh, A Rajan,"Microstrip antenna designs for RF energy harvesting", Communications and Signal Processing (ICCSP), 2014, pp.1653-1657.

[24] A Sundaram, GP Ramesh ,"Sensor less Control of BLDC Motor using Fuzzy logic controller for Solar power Generation", International journal of MC square scientific research,2017, vol. 9, no. 2,pp.70-79.

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