

Hysteresiscontrolled Quasi Z-Sourceinverter Fed Induction Motordrivesystem with Enhanced Response

D. Himabindu, G. Sreenivasan, R. Kiranmayi



Abstract- "-This-effort deals with-enhancement in-dynamicresponse-of-OZSIfed-induction-motorframework". The objective of this effort is to develop-a-closed-loop-controlled-QZSI-fed induction-motor-framework that provides a steady-rotor-speed. -This has been realized using -closed-loop-controlled-OZSI-IMD framework. The 'OZSI' is exploited to switch it to 'threephase-AC'. The yield of-3phase-inverter is sorted before it is applied to a '3phase-Induction-motor using a OTT--filter'. The methodology involves simulation of open-loop QZSI-IMD system and closed loop PR and HC controlled QZSI-IMD systems. The result obtained using Proportional-Resonant(PR) controlled **QZSI-IMD** system is compared with Hysteresis controlled **QZSI-**IMD system and it is proved that HC based QZSI-IMD system produces better dynamic-response than PR controlled QZSI-IMD system . The proposed Hysteresis controlled QZSI-IMD system has advantages like low settling time and less peak -over-shoot.

Keywords: QZSIFIM, PRC (Proposnal Resonent Controller), Hysteresis Controller, OTT filter, THD,

I. INTRODUCTION

Future interest contemplations, lead diverse nations to utilize sustainable power sources as a brilliant option for petroleum derivatives. With the development of use of the sustainable power sources, PE converters have been progressively appropriate in this field. Contingent upon the application, the power converter requires explicit highlights, for example, voltage increase, measure, productivity, cost, and so forth.

"-A-control-procedure for parallel-activity-of -single-phase-VSI: investigation, structure and test outcomes" was created by Telles. The control framework for every inverter comprises of two fundamental circles, which both utilize immediate qualities[1].

"-Enhanced-ZSI with diminishedZ-source stress &delicate-begin-ability" capacitor-voltage was introduced by Tang. This work proposes an enhanced ZSI topology. Contrasted with the conventional ZSI, it can diminish the ZSI- voltage stress essentially to play out a similar voltage help, and has innate restriction to inrush--startup. -The-control-technique of current-at the recommended ZSI is actually equivalent to the conventional one, so all the current control system can be utilized legitimately.

Revised Manuscript Received on February 28, 2020. * Correspondence Author

D. Himabindu1*, Research Scholar, Department of EEE, JNTUA, Ananthapur, Andhra Pradesh, India. E-mail:sribindu262004@gmail.com

Dr. G. Sreenivasan, Professor, Department of EEE, SRIT, Ananthapur, Andhra Pradesh, India. E-mail:gsn.anusree@gmail.com **Dr. R. Kiranmayi,** Professor &-Head, Department of EEE,JNTUA,-

Dr. K. Kiranmayi, Professor & Head, Department of EEE, JN1UA,-Ananthapur, Andhra Pradesh, India. E-mail: kiranmayi0109@gmail.com

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an <u>open access</u> article under the CC-BY-NC-ND license <u>http://creativecommons.org/licenses/by-nc-nd/4.0/</u>

A delicate begin system is additionally recommended to smother the-inrush-surge&the -reverberation of Z-source-capacitors&inductors[2].

"-Based on the traditional-ZSI, this exhibits a created impedance-type power-inverter that is named the exchanged inductor (SL)ZSI". To extend voltage-movability, the recommended-inverter utilizes an interesting SL-impedance system to -couple the-principle-circuit &the-power-source[3].

Two exchanged inductor semi ZSI was created by Lim. In this investigation, two topologies are displayed for exchanged inductor-qZSI, to be specific a ripple information current exchanged inductor -QZSI and a ceaseless-infocurrent-exchanged-inductor-QZ-SI. The recommendedinverters have high—lift-voltage reversal capacity &a lower-voltage-stress over the dynamic exchanging gadgets. Contrasted and a customary exchanged-inductorZSI, the recommended SLQZSI's for a similar information &yieldvoltage give a constant information-current& a diminished voltage-weight-on-the-capacitors [4].

Examination and PWM control of exchanged boost-inverter was recommended by Joshi[5]. This permits shoot through exchanging condition of inverter legs to support the information voltage. The altered-PWMtechniques utilized to consolidate the shoot through interim in each exchanging cycle. The harmonic- range of the inverters yield voltage likewise plotted. Current-Fed Switched Inverter[6].

Expanded boost-dynamic exchanged capacitor/exchanged inductor-QZSI was introduced by Ho. In the event that a-higher-boosting-rate is entaild, extra-cells can without much of a stretch be fell-at-the-impedance-arrange by including linductor &3diodes[7].

A class of quasi-switched boost inverters was given by Ho[8]. Created installed exchanged ZSI was displayed by Laali[9]. In this investigation, another topology for exchanged ZSi was proposed. Decrease of weight, size and cost are the primary favorable circumstances of the proposed topology. Likewise, this inverter can take care of the issue of short out over the inverter leg and comprises of higher estimation of voltage gain when contrasted and the regular exchanged boost-inverter. Additionally, the created topology of the proposed inverter dependent on exchanged inductor cells is introduced[10].

"-Upgraded boost-ZSI with excahnged-Zimpedance" was introduced by Fathi[11]. This proposed another topology for an upgraded boost-ZSI with joined two Z-impedance systems. In customary ZSIs for elevatedboosting-voltage, a diminish adjustment record is entailed; subsequently, -under-these circumstances, the yield -voltage will have diminished-quality.

Published By: Blue Eyes Intelligence Engineering & Sciences Publication



Retrieval Number: C8503019320/2020©BEIESP DOI: 10.35940/ijitee.C8503.029420 Journal Website: www.ijitee.org

3286

Contrasted and the traditional-elevated-boost-ZSItopologies, the recommended-inverter utilizes shorter-shoot-through-term & a bigger regulation record to improve the yield waveform quality.

'Inputyield-criticism linearization-basedcontrol for-QZSI in PV-application" was given by Gong. The 'QZSI' had been displayed sensible for sun-based PV-applications on a very basic level because of its one-stage buck/boostcapacity &enhanced steady quality. -CascadedQZSI as to moreoverventure-up-voltage had even put on superiorcontrolling prerequisites –because-of-the clever effect of 1cascaded-fell –module-on-another[12].

'Lyapunovcontrol-approach with cascaded-PRcontrollers for single-stage-gridtied-LCL-filtered-QZSI' was exhibited by Rub. "-The recommended-controlapproach guaranteed the overall trustworthiness of the closed-loop framework and zero consistent state-error in the grid-current"[13].

"-Frequency-adaptive-PRcontroller-for-

remuneration-of-current-harmonics" was proposed by Uphues. Especially its capacity for remunerating -harmonics in the present-waveforms was a fundamental-component. "As an outcome of the displace of the generator-sideconverter by a direct diode-rectifier, harmonics with variable-frequencies into reliance of the generator recurrence shown-up in the present-waveforms" [14]

'Complex-controllers' (for-e.g., diverse turning dqplots or resonant-based) were much of the time required to reimburse low repeat grid-voltage foundation mutilation and a LCL-channel was regularly gotten for the elevatedrecurrence-one. The possible broad assortment of gridimpedance regards (distributed-generation was appropriate for remote domains with spiral scattering plants) challenge the-consistent quality & effectiveness. It had been found and the use of dynamic damping settles the framework with respect to a wide scope of sorts of resonances-[15].

RESEARCH GAP: "-The-exceeding-writing doesn't covenant with cascaded-rectifier-QZSIfed induction-motordrive". This work Proposes QZSI with OTT--filter between rectifier and IMD. The above papers do not compare the response of P-R and H-C controlled QZSI-IMD systems. "This effort-convenants with evaluation of time-responses of PI,PR&HC controlled-QZSI-IMDsystems".

II. SYSTEM DESCRIPTION

The 'blockdiagram of PR controlled QZSIsystem' is exposed in Fig1.1. 'DC is converted to three-phase AC using QZSI'. The yield of QZSI is transmitted toTPIM. Thespeed is regulated-using a PRcontroller.



Figure-1.1 '-BlockDiagram of PRC controlled QZSISystem'

The 'blockdiagram of proposedHC-QZSIsystem' is delineated in Fig1.2 .-The-speed-is-evaluated-with- the-referencespeed&-the-error-is-directed-to-a HCcontroller. The '-yield of HC' controls the-pulsewidth of the rectifier.



Figure-1.2 'Block-diagram of Proposed-Hysteresis controlled-QZSI IMD System'

Utilizing the PR controllers, the converter reference following execution can be upgraded and recently realized inadequacies related with traditional PI controllers can be reduced.

These inadequacies incorporate unfaltering state mistakes in single-phase-frameworks and the requirement for synchronous d-q change in 3phase-frameworks.

Another preferred position - related with the PRcontrollers & filters is the likelihood of actualizing particular harmonic-remuneration without requiring inordinate computational assets. A portion of the benefit of PRcontroller is-that-it is broadly utilized in the grid-interfaced converters.



Figure 2. Schematic diagram of PR- controller

The hysteresis -band is estimated-as -follows:

$$I_{u} = I + r/2$$
"
" $I_{1} = I - r/2$ "

٠.

The advantage of HC is that lower and uppercurrent-limits are fixed.

III. SIMULATION RESULTS

Closed-loop-PR-controlled-QZSI-IMD-system' is appeared in Figure-3. Speed of the TPIM is-sensed & it is evalauted-with- the-reference-speed. -The yield of PI is applied to two-comparators to create pulses shifted by 180° .



Figure 3 Closed loop PR controlled-QZSI-system

Published By: Blue Eyes Intelligence Engineering & Sciences Publication



Retrieval Number: C8503019320/2020©BEIESP DOI: 10.35940/ijitee.C8503.029420 Journal Website: www.ijitee.org



The Input-voltage' of CLQ ZSI-TPIM with PRC is appeared in-Fig4 & -its-value-is 240V.



Figure 4 Input voltage to PR-controlled QZSI-IMDS

-The-Outputvoltage-of- inverterCLQ-ZSI-TPIM with PRC is appeared in Fig-5 &its value is 300V.



Figure 5 Output voltage of inverter of PR-controlled QZSI-IMDS

The -Load-current of CLQ ZSI-TPIM with PIC is appeared in Fig-6 & its value is 0.02A.



Figure 6 Load- current of PR-controlled QZSI-IMDS

The '-Motor-Speed' of CLQ ZSI-TPIM with PIC is delineated in Fig-7 & speed settles at 1400RPM.



Figure 7 Motor speed of PR-controlled QZSI-IMDS

The 'Zoomed-view of Motor-Speed CLQ ZSI-TPIM with PIC' is appeared in Fig 8 & its value 1296.5 RPM. The speed increases due to increase in voltage. But the speed is regulated using PR-controller.



Figure 8 Motor Speed of PR-controlled QZSI-IMDS

The 'Torque-Response' of CLQ ZSI-TPIM with PIC is delineated in Fig-9 & its value is 0.4N-m. The increase in starting torque is due to increase in starting current of CLQ-ZSI-TPIM.



Figure 9 Torque of PR-controlled QZSI-IMDS

Closed-loop-Hysteresis-controlled-QZSI-system' is appeared in-Fig10. The PR-controller is-substituted by a-HC. Actual speed is compared with reference-speed to obtain speed-error. The error is applied to HC-controller. The output of HC is used to update the pulse-width of semi—converter.



Figure 10 Closed loop with Hysteretic controlled-QZSIsystem

-The-Input-voltage of-CLQZSI-TPIM with HC is appeared in Fig-11 & its peak value increases from 200 to 250V.



Figure 11 Input voltage of Hysteretic controlled-QZSI-IMD-system

The 'voltage of CLQZSI-TPIM with HC is delineated in Fig-12 & its value is 350V. The voltage of CLQZSI-TPIM increases and comes back to normal value.



Figure 12 Output voltage of inverter of Hysteretic controlled-QZSI- IMD-system





Retrieval Number: C8503019320/2020©BEIESP DOI: 10.35940/ijitee.C8503.029420 Journal Website: <u>www.ijitee.org</u> The 'current of CLQZSI-TPIM with HC is appeared in Fig-13 & its value is 0.02A. The current of CLQZSI-TPIM increases and comes back to normal value.



Figure 13 load- current of Hysteretic controlled-QZSI-IMD-system

The '-Motor-speed' of CLQZSI-TPIM with HC is delineated in Fig-14 & its value 1350RPM.



Figure 14 Motor speed of Hysteretic controlled-QZSI-IMD-system

The '-Zoomed-view of Motor-speed' CLQZSI-TPIM with HC is appeared in Fig-15. "-A-step-change in input-voltage is applied at t=2.5Sec. Therefore, the- inverter-voltage increases''.

1300						
1298						
1.000		1.	1 months			
1230		M	V			
1294						
1292						
1290						
	1		, , , , , , , , , , , , , , , , , , , ,	 	1	1 12

Figure 15 Motor speed of Hysteretic controlled-QZSI-IMD-system



Figure 16 Torque Response of Hysteretic controlled-QZSI- IMD-system

"-The-Comparison-of time domain parameters-of-QZSI-IMD-system with PI,PR &HC" are given-in-Table 1. The-rise-time is diminished-from 3.8Sec to 3.5Sec; thepeak-time is diminished-from 5.6Sec to 3.9Sec; the-Settlingtime is diminished-from 6.8Sec to 4.0Sec and -steady-stateerror is diminished-from 6.4 Volts to 2.3Volts by substituting PI,PR controller with Hysteresis-controller. Dynamic response is also improved by using Hysteresis controller.

Table1:"-Comparison-of-Time-domain -Parameters with-PI,PR and-HC"

Controller	T _{r(s)}	T _{s(s)}	T _{p(s)}	E _{ss(rpm})
PI	3.8	6.8	5.6	6.4
PR	3.6	5.3	4.5	4.8
HC	3.5	4	3.9	2.3

IV. EXPERIMENTAL RESULTS

Hardware snap shot of QZSI-Fed IMDS with OTT-Filter is appeared in Fig 17.



Fig 17 Hardware snap shot of QZSI-IMDS

The input voltage of QZSI- IMDsystem is outlined in Fig18. -The-hardware of QZSI-Fed IMDS consists of a converter-board,-inverter-board, -transformer-board andcontrol-board, -QZ-network-and-OTT-filter.



Fig 18 Input voltage of QZSI-IMDS

'-Output-voltage-across-Quasi-Zsource" is delineated in Fig19.



Fig 19 Voltage across Quasi Z-source of QZSI-IMDS

"-Switching-pulses for-M1&M2 of- inverter' are appeared in Fig20.



Fig20 "-Switching-pulses for-M1 &M2 of -inverter"

Published By: Blue Eyes Intelligence Engineering & Sciences Publication



Retrieval Number: C8503019320/2020©BEIESP DOI: 10.35940/ijitee.C8503.029420 Journal Website: <u>www.ijitee.org</u>



"-Switching-pulses for-M3&M4 of-inverter" are appeared inFig21.



Fig 21 Switching pulses for M3 & M4 of inverter

"-Switching-pulses-for-M5&M6 of-inverter" are appeared in Fig22.



Fig 22 Switching pulses for M5 & M6 of inverter

Output voltage across inverter of - QZSI-IMDS is shown n Fig 23.



Fig 23 Output voltage across inverter of QZSI-IMDS Table 2. List of components for QZSI-IMDS

Name	Rating	Туре	
Capacitor	1000E-03	Electrolytic	
Capacitor	4.70E-05	Electrolytic	
Capacitor	3.30E-11	disc	
Capacitor	2.20E-03	Electrolytic	
Diode	1000V ,3A	PN Junction	
Inductance	10uH	ferrite coil	
MOSFET			
(IR840)	600V,8A	N-channel	
Resistor	1k	Quarter watts	
Regulator	12V	L7812/TO3	
Regulator	5V	L7805/TO220	
IC	IR2110	Opto-coupler	
PIC			
controller	PIC16F84A	RISC	
PCB	V105	General	

Hardware Circuit diagram of QZSI-IMD is appeared in Fig 24. Crystal and capacitors are connected to support the operation-of-pic.

The out-put-port signals are connected to the driver-2110 s .Ho and Lo of drivers are connected to the upper and lower-gates of MOSFETS-of each-leg.



Fig 24 Hardware Circuit diagram of QZSI-IMDS

V. CONCLUSION

MATLAB based QZSIIMD system is successfully designed, formed &simulated utilizing PI, PR & hysteresis-Controllers. The speed is successfully regulated using HCcontroller.Closed-loop-simulation results are analysed and they are summarized here. The 'steady-state-error' is 2.3 RPM &the 'settling-time' is 4.0 Sec. The simulation results indicate that the response of of HC-QZSI is better than that PI,PR-QZSI systems. The contribution of this effort is to enhance-the- dynamic-response-of QZSI-IMD utilizing HC. The benefits of HC-QZSI are high gain and low THD. The disadvantage is that the circuit requires eight switches. The closed loop system needs two additional controlled switches.

The-present-effort-pacts-with-evaluation of PI,PR & hysteresis-controlled QZSI'. The comparison between HC and Slide Mode Controlled-QZSI-IMDS will be done in future. The HC-QZSI-IMDS can be extended to handle high power. The control circuit may be implemented using FPGA to increase the switching frequency.

REFERENCES

Published By:

- T.B.Lazzarin, -G.AT.Bauer, &- I.Barbi, "-A-control-strategy-forparallel-operation-of-single-phase-voltage-source-inverters:-Analysis,-design &-experimental-results," –IEEE- Trans. -I.E., -vol-60, -no-6, -pp-2194–2204, -Jun- 2013.
- Y.Tang, -S.J.Xie, -C.H.Zhang&-Z.G.Xu, "-Improved-Z-sourceinverter-with-reduced-Z-source-capacitor-voltage-stress&-soft-startcapability," –IEEE-trans. -PE., -vol- 24, -no- 2, -pp-409–415, -Feb-2009.
- M.Zhu, -K.Yu, &-F.L.Luo, "-Switched-inductor-Z-source inverter," IEEE-Trans.-PE., -vol- 25, -no-8, -pp- 2150–2158, -Aug-2010.
 M.K.Nguyen, -Y.C.Lim &-J.H.Choi, "-Two-switched-inductor-quasi-
- M.K.Nguyen, -Y.C.Lim &-J.H.Choi, "-Two-switched-inductor-quasi-Z-source-inverters," -IET-PE., -vol-5, -no-7, -pp-1017–1025, -Aug-2012.



Retrieval Number: C8503019320/2020©BEIESP DOI: 10.35940/ijitee.C8503.029420 Journal Website: <u>www.ijitee.org</u>

- Ravindranath.A, -Mishra.S.K, &-Joshi.A, "-Analysis&-PWMcontrol-of-switched-boost- inverter," –IEEE-trans.-on-I.E., -vol-60, no- 12, -pp-5593–5602, -Dec-2013.
- S.S.Nag &-S.Mishra, "-Current-fed-switched-inverter," –IEEE-trans.-On-I.E., -vol-61, -no- 9, -pp-4680–4690, -Sept-2014.
- A.V.Ho, -T.W.Chun &-H.G.Kim, "-Extended-boost-active-switchedcapacitor/-switched-inductor-quasi-z-source-inverters," –IEEE-trans.on-PE., -vol-30, -no-10, -pp-5681–5690, -Oct-2015.
- M.K.Nguyen, -T.V.Le, -S.J.Park &-Y.C.Lim, "-A-class-of-quasiswitched-boost-inverters," –IEEE-trans.-on-I.E., -vol-62, -no-3, -pp-1526–1536, -Mar-2015.
- E.Babaei, -E.ShokatiAsl, -M.Hasan Babayi, &-S.Laali, "-Developedembedded-switched-Z-source-inverter," –IET-PE., -vol-9, -no- 9, -pp-1828–1841, -Jul-2016.
- Y.P.Siwakoti, -F.Blaabjerg, -V.P.Galigekere, -A.Ayachit &-M.K.Kazimierczuk, "-A-source –impedance-network," –IEEE-trans.on-PE., -vol- 31, -no-12, -pp-8081–8087, -Dec- 2016.
- H.Fathi &-H.Madadi, "-Enhanced-boost-Z-source-inverters-withswitched-Z-impedance," -IEEE-trans. -on-I.E., -vol-63, -no-2, -pp-691-703, -Feb-2016.
- H.Gong, -Y.Li, Y.Wang&- R.Zhang, "-Input-output-feedbacklinearization-based-control-for-quasi-Z-source-inverter-inphotovoltaic-application,"-2016-IEEE-Energy-Conversion-Congress&-Exposition- (ECCE), -Milwaukee, -WI, -2016, pp- 1-6.'doi: 10.1109/ECCE.2016.7855205'.
- -H.Komurcugil, -S.Bayhan&-H.Abu-Rub, "-Lyapunov-functionbased-control-approach-with-cascaded-PR -controllers-for-singlephase-grid-tied-LCL-filtered-quasi-Z-source-inverters," -201711th-IEEE- -International-Conference-on-Compatibility,-Power-Electronics&-Power-Engineering-(CPE-POWERENG), -Cadiz,-2017, pp-510-515. 'doi: 10.1109/CPE.2017.7915224'.
- A.Uphues, -K.Ntzold, -R.Wegener, -S.Soter, "-Frequency-adaptive-PR-controller-for-compensation-of- c-urrent-harmonics", -Proc.-IEEE-Indust. –Elec-Society-(IE-CON),-pp.num-2103-2108,-[2014].
- M.Liserre, -R.Teodorescu, -F.Blaabjerg, "-Stability-of-photovoltaic&wind-turbine-grid-connectedinverters-for-a-large-set-of-gridimpedance-values", -IEEE-Trans-P.E.,-volum-21,-num-1,-pp.num-263-272-Jan-[2006].

AUTHORS PROFILE



D. Himabindu, currently pursuing Ph.D. in the Department of EEE JNTUA University, Ananthapur and also working as an Assistant-Professor-Department of EEE in SOET,SPMVV,Tirupati AP, India. Herresearch-interests include Power-Electronics, Electrical-Machines, & Modeling& Analysis of AC-Drives. She is

a life-member of 'ISTE'.



Dr. R.Kiranmayi, Presently working as a Professor &Head-Department of EEE in JNTUA' Collegeof Engineering, Anantapur, AP. Her-areas of interest include Renewable energy resources &Electrical power systems'. She is a 'life-member' of "**ISTE** and **IEI**".



Dr. G. Sreenivasan, Presently working as a 'Professor-Department of EEE' in SRIT, Anantapur, AP. His-areas of interest include Power Systems, Control-Systems &Electrical- Machines. He is a life-member of "ISTE and IEI".

