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Unbalance Source Voltage and Load Current Mitigation Using UPQC based on Power Impelling Optimization Technique

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Abstract--- *Power quality is the most important one of the transmission and distribution system, in recent year the various power electronics devices is implemented so the load voltage is various and it cause different problems. The voltage sag, swell and harmonics is the power quality problem are presented, in this problem causes damages in the system load, so the power quality is improve in this system is very important. The Unified Power Quality Control is used to reduce the power supply problems it can be implemented based on proposed Power Impelling Optimization Technique(PIOT) it can attain the improvement of power quality in the power transmission system. In this UPQC system contain series and shunt converter to compensate the unbalanced voltage and reduce the problem like sag, swell voltage and harmonics of this system. The proposed system is getting the reference voltage and current value in the transmission line and analysis the problem of this process and give the proper switching to the converter via controller. The active power filter of shunt and series is used to reduce the loss in the transmission line and gives the quality power to the load. The proposedPower Impelling Optimization Technique(PIOT)is utilized to increase the quality of power and reduce the losses. This proposed system analysis in the Simulink software to get the result of this system, the simulation shows the system input, output voltage and Total harmonics distortion.*

Keywords--- *Power Impelling Optimization Technique (PIOT), Unified Power Quality Conditioner (UPQC), Active Power Filter.*

I. INTRODUCTION

In the transmission system the quality of power is supplied to the customer is very important. Because the various types of electronic load is utilized in the user side it will create many problems like sag, swell voltage and harmonics in the system. In this cause the load side equipment is damaged, which can be important for monitoring and compensating for LV grid dominant interference. As a result, local utilities need to reconfigure the system to retain the most important customers on the line. The different types of technique isused to reduce for these disturbances. The new technique is to increase the level of improved distribution network or low voltage distribution cable, i.e. short circuit to MV / LV substation transformer, thereby improving the quality of power to all end users And, from entry load (i.e., all harmonics are converted), line faults or malfunctions are reduced by the common coupling (PCC) method. Thus, while this solution does not effectively reduce the depth of the voltage change, it does not prevent load transients and short interruptions.

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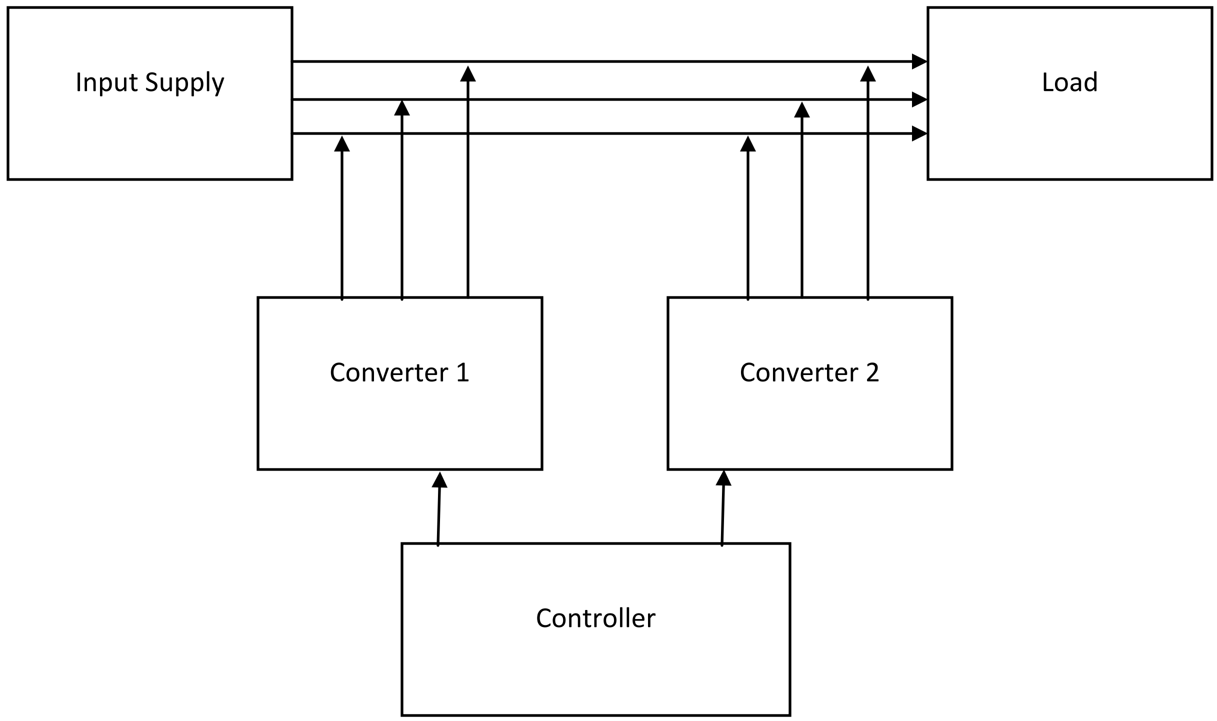

Figure 1: UPQC control Block diagram

A second obstacle to any type of solution that can be installed offline, online installation, and compensation for line-interactive UPS systems and hybrids, such as interrupts. In general, they are so expensive that these model cannot be used by end users or local power distribution system to improve power quality, they produce. However, there are many cheap solutions to choose from. In particular, to improve the international scientific community. It was all implemented in a single device analysis. The various connecting technique are used to implement these devices. The upstream circuit protection device is series connected with the load detection means and the shunt. In general, series and parallel circuit is having to improve the quality levels of these two types of device load power regulators.Other studies have previously considered combining solutions from a single device (e.g., UPS, UPQC, etc.). The power compensating device of UPQC in particular seems promising. The device consists of a bypass section with a DC connection that can be switched in and out of the power supply. Those features can improve the power quality and the load current will be absorbed. However, these devices power quality is increase of all of them end users, so local dealers can't be sure that they have different levels of quality demands on end customers. The investment level of PQ is relatively high. Production recommends similar features and benefits as a cost solution, as well as public UPQC.

II. LITERATURE SURVEY

The various kinds of technique is used to improve the quality of power and reduce the power system problem, the UPQC is important to mitigate the power quality problem and its used to compensate the unbalanced load voltage. The two set of converter is used in UPQC to improve the power quality and various techniques are used in previous research are given below.

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With this work, the highest VA rated UPQC converter, for compensation of system requirements. The shunt and series converters are evaluated and optimized variables obtained in the power converter UPQC maximum utilization, PAC method based on two-phase algorithm [1].Three-phase single-stage design and performance, such as photovoltaic, relate to integrated analytical UPQC (PV-UPQC). Moving average filter to extract synchronization reference frame control to improve performance of photovoltaic UPQC active current component of improved load [2].Its power quality is improved by using a UPQC. A power system that creates more complex network stations connected through the distribution line load centers [3]. Today, the demand for power systems is increasing. In the last years of reducing the distribution side. The power loss due to the consumer increase is using more nonlinear loads. Power quality issues created by sensitive loads. Modifications here means UPQC to reduce voltage distortion [4].

An improved power UPQC-DG for angle control method is used for effective compensating offset loads. UPQC is offers integrated power quality and renewable energy while solving. PAC method has implement the UPQC system and its improve UPQC active power filter of utilizing VA [5].This describes any partially parallel transformer of a multi-level inverter (CHB) based on a phase 4-wire UPQC (UPQC) without an H-bridge. Power quality issues such as voltage harmonics, brownouts, harmonic currents and reactive power compensation current imbalance topologies are proposed to mitigate this [6].It requires an ANN controller to convert the model and propose based on the multi-level converter UPQC (MLC-UPQC), is rejected the need for DSP and FPGA, thereby reducing the complexity and cost of the model. This model shares relational further discussion by adjusting the angle between the new scheme for control of reactive power by the load and power converter [7].The power distribution systems must solve power quality issues. UPQC, average power or image quality adjustment, distribution system voltage and issues related to current solutions [8].

The model shows a reduction in harmonics in the distribution network, is related on harmonics of the load voltage and supply current and DC voltage to reduce UPQC. UPQC is downgraded here by reducing the DC link voltage and the system switches evaluation [9].This model proposes a general study (UPQC) UPQC, analysis and practical implementation that can be connected to a 3-phase 4-wire power distribution system for 2-phase 3-wire and series-parallel power line conditioners [10].A modular multi-level matrix converter (UPQC) (M3C) is presented here to improve a single integrated power quality adjustment in power quality / high voltage distribution systems. M3C-UPQCis has four identical arm multi-level converters and associated filter inductors [11].The model is based on research and optimal size of the UPQC requirements of the compensation system. General UPQC optimization strategy, determine the parallel conversion system, evaluate the basic size of the converter in series[12].

Active filter coupling with active power filter like shunt and two double UPQC active filters in series.UPQC harmonic unbalance ends the combination of 2 active filters, a series active filter connected in parallel with the active filter (parallel with the active filter) [13]. It presents a new topology called UPQC. Typically, 3-phase 3-wire power structure UPQC is connected to the switching of six inverters in two back-to-back [14].Here, parameter estimation (VSC) in series and parallel voltage source converters is a 3-phase 3-wire designto easily analysis the control strategiesof UPQC VSC operation. UPQC design parameters, the desired DC link voltage can be desided as the value of the capacitor, the shunt inductor interface, the series inductance and the series capacitance value of the

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interface [15]. It introduces a system (UPQC) design unified power quality adjustment that may be the best way to minimize is based on the voltage rating is required compensation. Novel way to design the proposed algorithm as transformer series inverter, shunt and series inverter is corresponding to such possible minimum total VA evaluation and corresponding size, principal component of UPQC [16].

UPQC is a custom power supply device that alleviates power system voltage, current and power quality issues. Proposed topology achieved to minimize the DC voltage and it's compensatethe ability to compensate UPQC [17].It presents a UPQC to make a comprehensive review to the power quality is improved at distribution level [18].A linear discrete-time control scheme based on multi-level three single-phase power (UPQC) unity power regulator mass is presented. Nonlinear multivariate of these topologies, as well as the difficult task of combining the functions of control strategy design [19].It propose an implemented model to integrated UPQC and fault current limiter in this system, forward attitude (SFCL) [20].It presents a new Synchronous Reference Frame (SRF) with three phase 4-wire PQ unified regulator circuit control method (UPQC) that compensates for power quality (PQ) for unbalanced load conditions and torsion problems [21].

III. Materials And Methods

The UPQC is a device is used to compensate unbalanced load voltage with help of the proposed Power Impelling Optimization Technique (PIOT) controller in this controller gives the proper pulse to the converter circuit. In this system the shunt and series filter is used minimize the losses and increase the stability of the load. The proposed controller is getting the reference voltage and current from the transmission line to analysis if any problem is occur in this system the controller will optimize the problem and control through the converter.

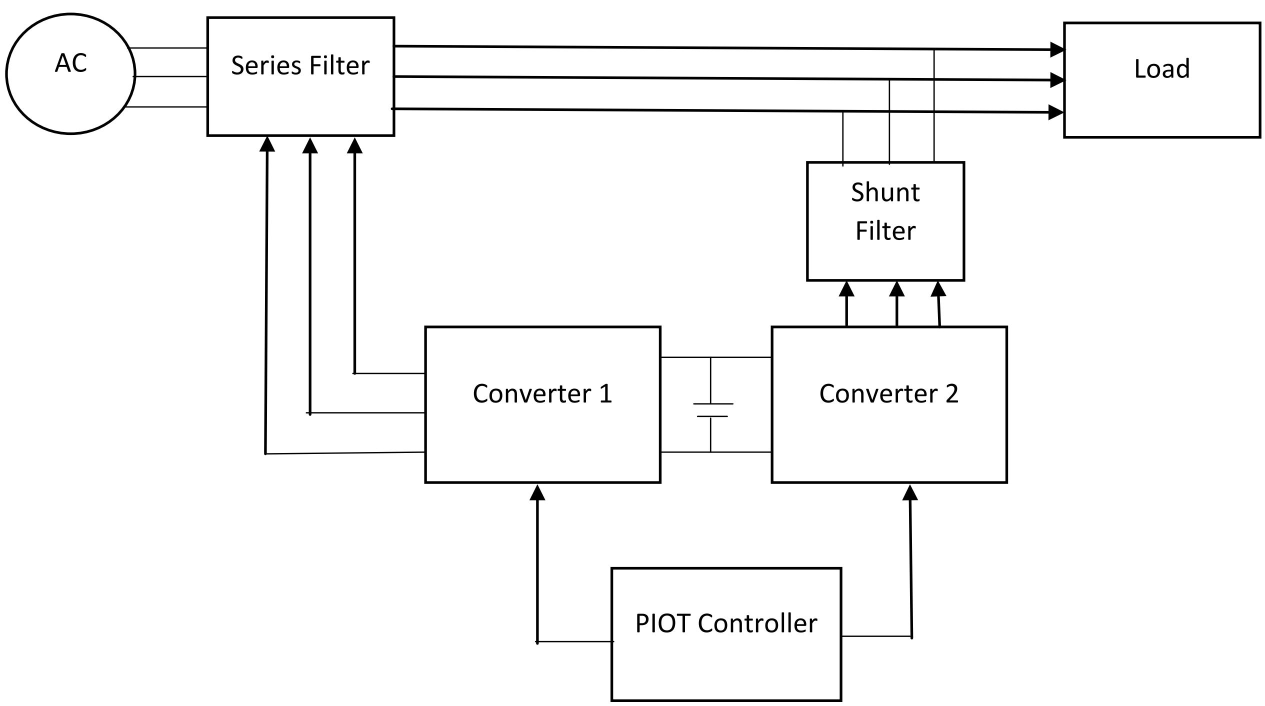

Figure 1: Proposed Block diagram

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The splitter section UPQC VSI includes a DC side connected to a DC link is used supply the converter, and it is connected in parallel with a three-phase AC shunt interface shunt inductor and connected via a star connected load LSH side autotransformer coupled there on. A series of active filters are sources of interference on the supply side called unbalanced voltage is compensate with help of this system. The UPQC series filter section further includes a low-pass filter (LPF) and a series of 3-phase series, the VSI is connected to DC energy storage on the same side of the capacitor C, and it is connected to the series feeder AC side Combine transformers.

3.1 Control Scheme

In this system the Power Impelling Optimization Technique (PIOT) controller is used via UPQC model and the UPQC works on the combination of shunt and series active power filter and also the converters are used to inject the reactive power to the transmission line. In this Power Impelling Optimization Technique (PIOT) controller is generate the pulse with respect to the reference voltage and current of this system, and it gives to the converter circuit. This converter circuit having the 12 switches like MOSFETS.

3.1.1 Active Power Filter for shunt control

In this active power filter is connected in parallel to the transmission line, this filter is a combination of inductor and resistor is used to reduce the noise in the output power supply. The dc supply connected converter is used to give a proper injected voltage to the transmission line to compensate the unbalanced voltage. This converter is controlled with help of the proposed Power Impelling Optimization Technique (PIOT) controller is based on the reference voltage and current. The filter circuit is reject the unwanted problems like harmonics are reduced and give the proper power to the transmission line via load.

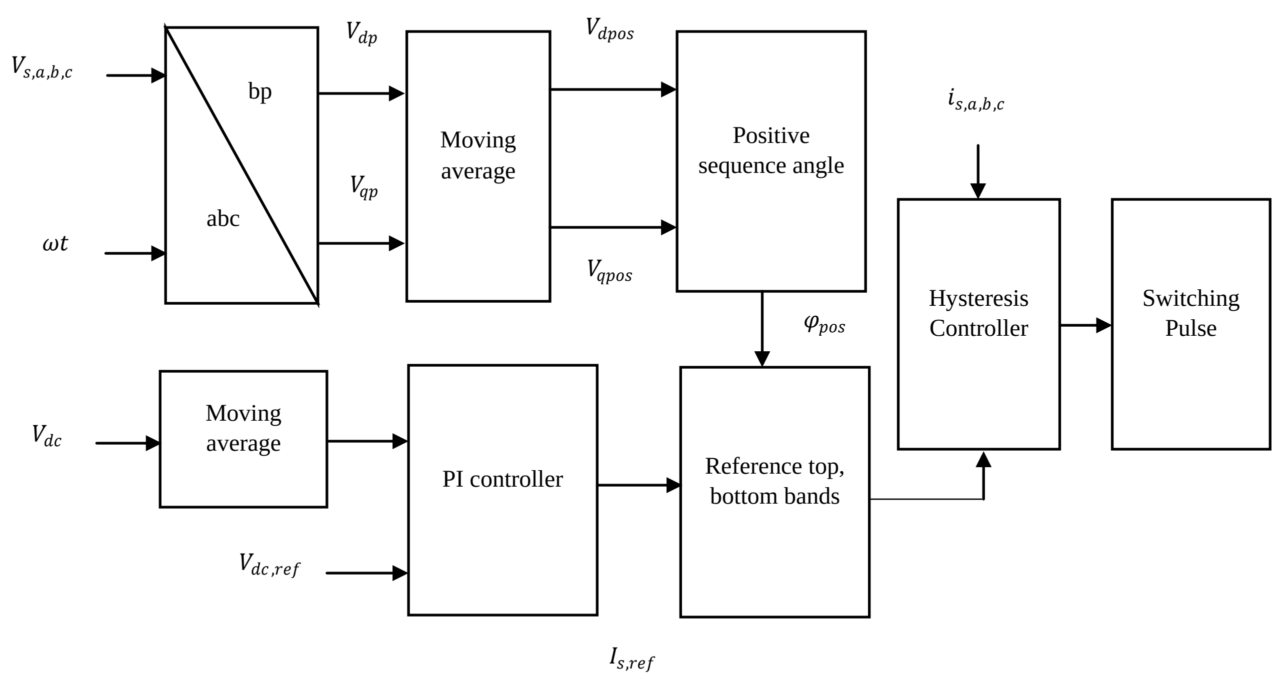

Figure 2: Shunt Active Power Filter

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$V_{dpos} = \frac{1}{T}\int_{t-T}^{T} v_{dp}\,dt$ ---- (1)

$V_{qpos} = \frac{1}{T}\int_{t-T}^{T} v_{qp}\,dt$ ---- (2)

$\varphi_{pos} = tan^{-1}(\frac{V_{qpos}}{V_{dpos}})$ ---- (3)

$\varphi_{pos} = tan^{-1}\left(\frac{V_{qpos}}{V_{dpos}}\right) + \pi$ ---- (4)

Where,

φ_{pos} is positive phase angle

V_{dpos} andV_{qpos} is positive voltage.

The purpose of a shunt converter is to regulate for power loss of the load current, so that the supply current is balanced when supplied non-linearly with UPQC / inductive load, and reactive power imbalance (ie (Distortion within a predetermined range, by standard) The voltage at the point of the common coupling phase and (PCC). Shunt APF control current source through electrode voltage and sine fundamental current control and indirect source of positive sequence component of phase. Therefore, the system tracks the current source rather than tracking the current shunt APF. Includes current measurement technology to control the source only in combination with hysteresis current control.

3.1.2 Active Power Filter for series control

A series of active filters are controlled to control the voltage on the VSI. Maintain the voltage source in the event of anomalies, such as a predetermined level of voltage sag and unbalanced load voltage. The series APF prototype UPQC has limited ability to injection voltage. Alternatively, the top discharge voltage regulator is determined by the rating of the inverter and the associated injection transformer. Rated power inverters and transformers are determined by demand to maintain low equipment costs. Therefore, account assessment considerations must be taken into account for the optimal level of device design and performance of available devices and controllers.

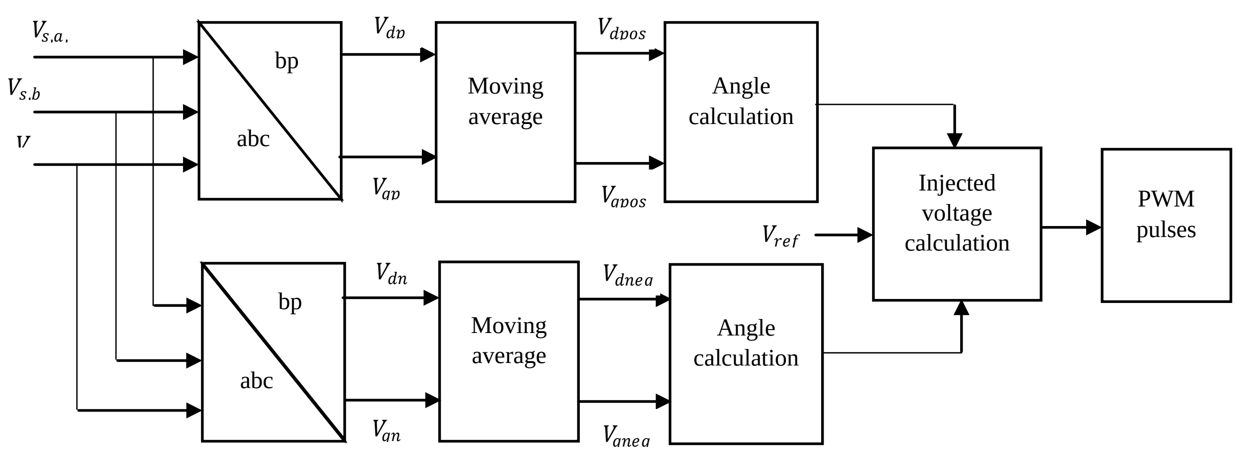

Figure 3: Series Active Power Filter

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$V_{dneg} = \frac{1}{T}\int_{t-T}^{T} v_{dn}\, dt$ ---- (5)

$V_{qneg} = \frac{1}{T}\int_{t-T}^{T} v_{qn}\, dt$ ---- (6)

The positive and negative sequence components of the magnitude and phase angle are calculated.

$V_{pos} = \sqrt{V_{dpos}^2 + V_{qpos}^2}$ ---- (7)

$V_{neg} = \sqrt{V_{dneg}^2 + V_{qneg}^2}$ ---- (8)

$\varphi_{neg} = tan^{-1}(\frac{V_{qneg}}{V_{dneg}})$ ---- (9)

The series is that the APF control target is maintained at a predetermined positive sequence component and the negative and zero sequence components are reduced at zero. Analytical sequence compensation methods have been developed for balance correction and / or input voltage imbalance that adjust the voltage based on the load. The advantage of this scheme is that the APF provides a higher rated voltage range than the negative sequence voltage swing, and in most unbalanced situations, the series APF controller can completely compensate for the imbalance. This control strategy based on sequence analysis to realize the optimal control strategy based on the above control. The feed forward control loop continuously measures the supply voltage and the reference voltage held at the load. The voltage is calculated and injected into an insulated gate bipolar transistor (IGBT) switch and transmitted to the appropriate switching signal.

3.1.3 ANALYSIS OF THE POWER-RATING IN UPQC

The MC-UPQC rated power is amost wanted factor in terms of cost. In the structure before MC UPQC VSC calculated for each power rating, the UPQC two models were analyzed, requiring the best model to be considered the minimum power rating. All phase voltages, currents, and fundamental frequency phasors used in this section.UPQC quadrature compensation (UPQC-Q) and phase compensation (UPQC-P): There are two types. In the quadrature compensation method, the series of VSCs previously did not have actual power, but the steady-state voltage VSC injection supply current trace consumption by vertical series of relations. This is a significant advantage where UPQC reduces sag great benefits. Series VSCs also share a load volt-ampere response (VAR) along the Vscshunt, a shunt VSC reduced power rating.

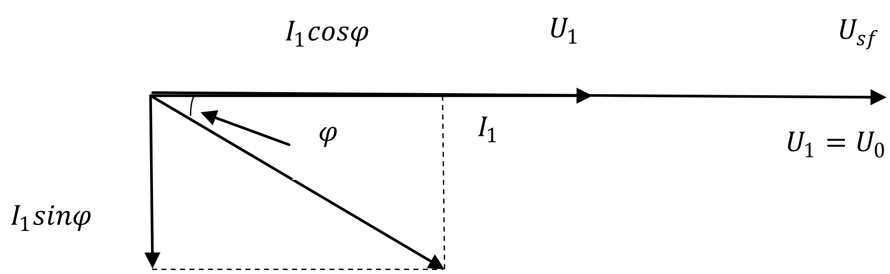

Figure 4: In-phase compensation Phasor diagram

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In one-phase compensation, the power supply voltage is supplied in equilibrium with the injected voltage phase. During the injection phase, the series VSC reduces the voltage sag for the minimum injection voltage. Comparison of in-phase (UPQC-P) and quadrature (UPQC-Q) and load power factor conditions made for different droop models. The results show a lower power rating than the model UPQC-Q shunt-Vsc UPQC-P and less than or equal to the VSC UPQC-P model-Q UPQC nominal power ratio. In addition, it shows a lower UPQC-P for higher load VAR requirements, and a more UPQC-Q total power rating.

3.1.4 Power Impelling Optimization Technique(PIOT)

Step 1: Initialize the number of search agents, number of variables, limits on maximum number of iterations. The variables here are series on location and voltage.

Step 2: Read the bus data and line data for the test distribution system.

Step 3: Set the voltages at all nodes to convergence criteria and maximum iterations.

Step 4: Set the iteration count (t) to one. Perform backward sweep to find the branch currents.

$I_{Load\ ,i} = \left(\frac{s_i}{v_i}\right) = \left(\frac{p_i + jq_i}{v_i}\right)$ ---- (10)

Step 5: Perform forward sweep to find the nodal voltages.

$V_l = V_s - (I_{branc\ h\ h,j} \times Z_{branc\ h\ h,j})$ ---- (11)

Step 6: Check for the convergence criteria.

Step 7: Evaluate the power loss as given in equation (12).

$P_{TLoss} = \sum_{j=1}^{nb} P_{loss\ ,j}$ ---- (12)

Step 8: Print the results for the load flow.

Step 9: The load current is measured to transformed into the reference frame by using the equ

$i_{l\_dq\,0} = T_{abc}^{dq\,0} i_{l\_nbc}$ ---- (13)

Step 10: The harmonic content is offset by the transformed transaction flow fundamental frequency.

$$i_{l\_d} = I_{l\_d} + I_{l\_d}$$

$$i_{l\_q} = I_{l\_q} + I_{l\_q}$$

Step 11: PWM is used to control the current, the output-compensating currents in each phase are obtained

Step 12: Execute mutation operation with low probability.

Step 13: Stop.

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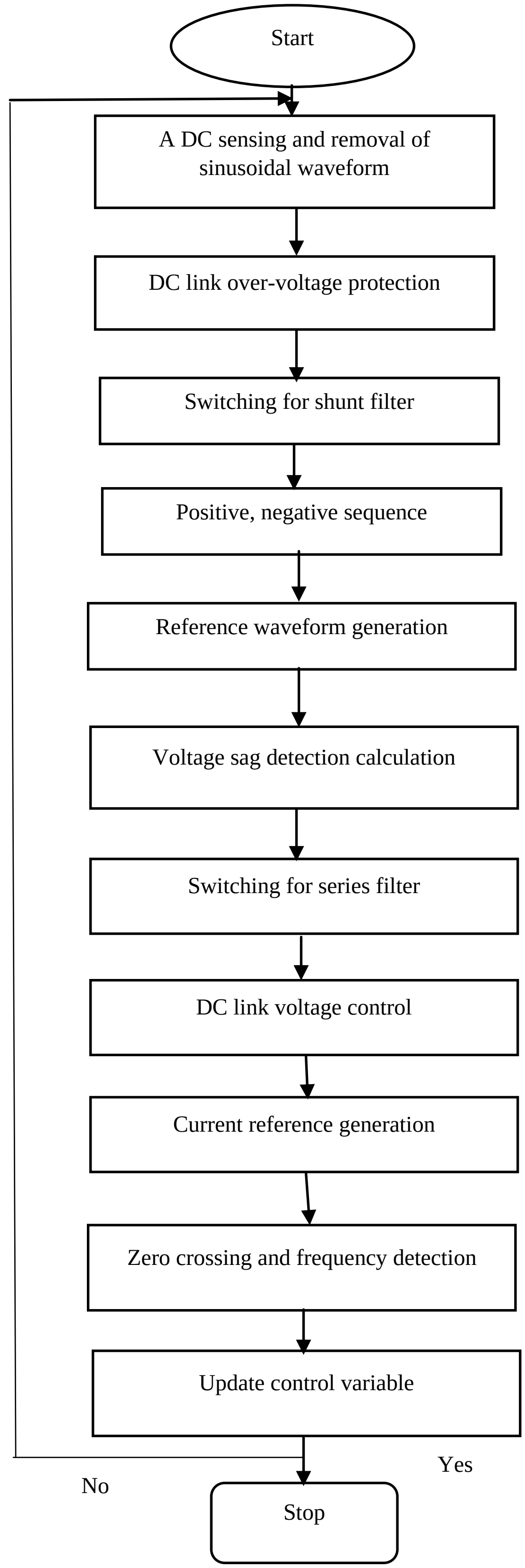

Figure 5: Proposed Power Impelling Optimization Technique(PIOT)Flowchart

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IV. RESULTS AND DISCUSSION

The proposed Power Impelling Optimization Technique (PIOT) based UPQC was developed by using Mat lab Simulink software, and the model of the system was shown in following **figure 6** In this simulation, a Power Impelling Optimization Technique (PIOT) is used to reduce the unbalanced voltage so the load voltage is balanced in various load conditions.

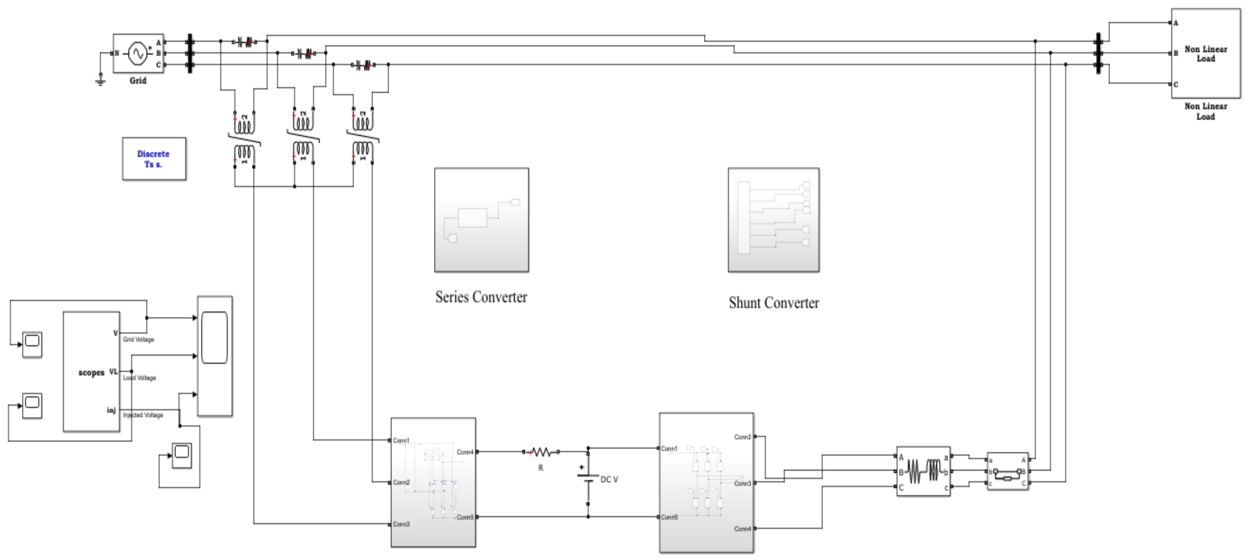

Figure 6: Simulink Model of Proposed PIOT system

The simulation model is shows in fig 6 and the proposed Power Impelling Optimization Technique (PIOT) based UPQC.

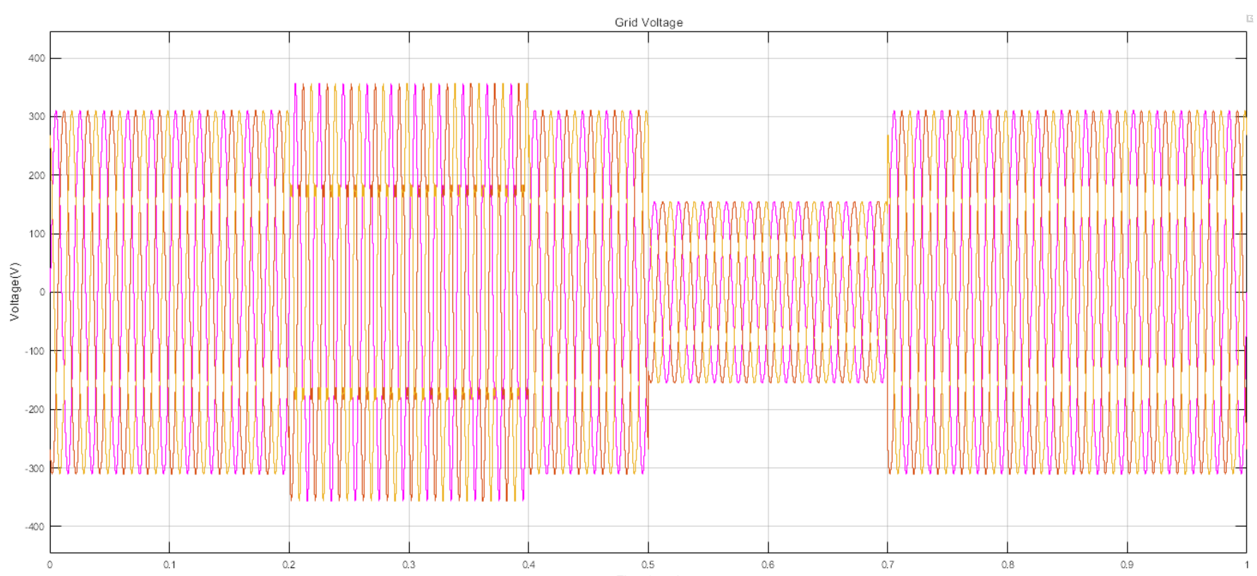

Figure 7: Source Voltage for proposed UPQC model

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The system Source voltage is shows in fig 7 and which will improve the sag voltage which is present in the source side waveform.

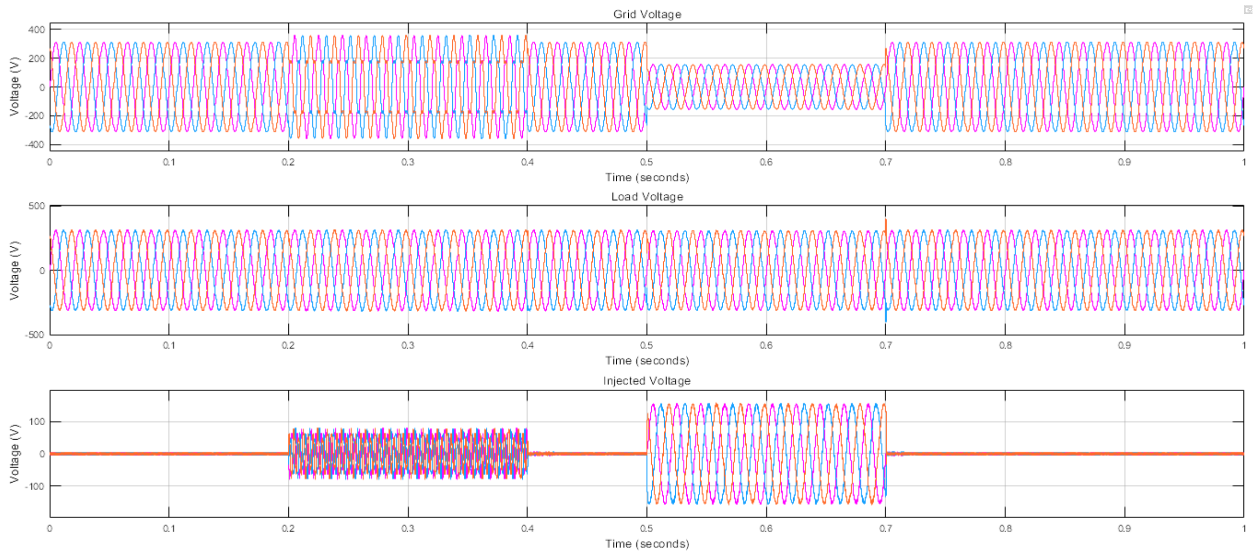

Figure 8: Load voltage and Injected voltagefor proposed UPQC model

Figure 8 shows the stability grid voltage condition is analyzed to confirm the performance of the UPQC under the proposedPower Impelling Optimization Technique (PIOT) based UPQC, and the harmonics are low in this system.

Figure 9: THD Analysis of the proposed system Voltage

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The above **figure 9** demonstrates the Voltage waveform THD investigations of the proposed active power filter using the Power Impelling Optimization Technique (PIOT), its gives the THD of 0.15%.

Table 1: Performance analysis for proposed and existing system

Parameters	**PI**	**PID**	PIOT
Steady state error (%)	1.6	0.9	0.6
Switching loss (%)	0.843	0.93	0.83
With UPQC THD (%)	11.3	7.6	0.15

Table: 1 shows a table comparing operating characteristics considered for existing systems, and a unified power and quality control system (UPQC).

Switching loss:

$P = P_{on-H} + P_{on-L} + P_D + P_G + P_{ic}$ ---- (16)

Where,

P_{on-H} is conduction loss in high side

P_{on-L} is conduction loss in low side

P_D is dead time loss

P_G is gate charge loss

P_{ic} is operating loss.

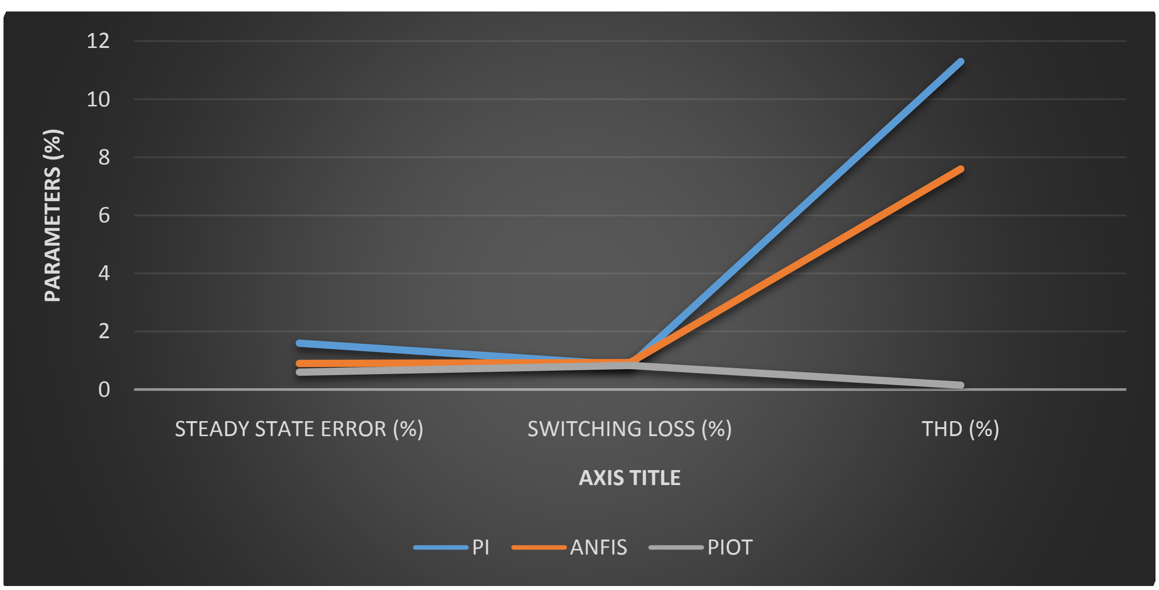

Figure 10: performance analysis of the UPQC system

Figure 10Steady-state error Comparing selective optimization methods like conventional power systems proposed by various parameters and excitation (PIOT), switching loss control performance analysis UPFC produces valid results.

V. CONCLUSION

Comprehensive review UPQC, to improve paper distribution level power quality reports. To compensate for the waveform distortion of these system UPQCs, load the fundamental components of the current and power system supply voltages to obtain reference currents and voltages. Power optimization techniques and excitations obtained by the fundamental part of the algorithm (PIOT) extract the phase angle and frequency amplitude of current and voltage sources. The results show that the proposed technique can quickly and accurately estimate the amplitude and phase angle of waveform distortion. Also, a new overall control strategy was proposed for Shunt, which extracted a series of active filter reference currents and voltages. Most control strategies, and other distortions, compensate for asymmetric harmonic content. The proposed Power Impelling Optimization Technique (PIOT) THD is (0.15%), and the control strategy can load harmonic content of asymmetric current and voltage compensation.

REFERENCES

[1] Jian Ye, H. B. Gooi, “Optimal Design and Control Implementation of UPQC Based on Variable Phase Angle Control Method” in IEEE Trans on Industrial Informatics, Volume. 14, issue. 7, page. 3109 – 3123, 2018.
[2] Sachin Devassy, Bhim Singh, “Design and Performance Analysis of Three-Phase Solar PV Integrated UPQC” in IEEE Trans on Industry Applications, Volume. 54, issue. 1, 2018.
[3] Swaroopa S. Bhosale, Y. N. Bhosale, “Power Quality Improvement by Using UPQC: A Review” in International Conf on Control, Power, Communication and Computing Technologies, 2018.
[4] Radhika Jayant Kadam, Karishma Amin Mulani, “Voltage Distortion at Distribution side reduced by Modified UPQC” in 3rd International Conf for Convergence in Technology, 2018.
[5] Ashish Patel, Hitesh Datt Mathur, “Improving Performance of UPQC-DG for Compensation of Unbalanced Loads” in IEEE India International Conf on Power Electronics, 2018.
[6] Muneer V, Avik Bhattacharya, “Cascaded H Bridge based Three-Phase Four-Wire UPQC” in 13th International Conf on Industrial and Information Systems, 2018.
[7] Venkata Reddy Kota, Sudheer Vinnakoti, “An Artificial Neural Network based Controller for MLC-UPQC with Power Angle Adjustment” in IEEE Region 10 Conf (TENCON), Malaysia, 2017.
[8] Siddharthi Lahu Nikam, Kamal Sandeep, “Analysis of Modified Three-Phase Four-Wire UPQC design’ in Third International Conf on Science Technology Engineering & Management, 2017.
[9] Jithin Sukumaran, Avik Bhattacharya, “Investigation on Reduced DC Link Voltage Based UPQC for Harmonic Compensation under Unbalanced Load” in IEEE International Conf on Technological Advancements in Power and Energy, 2017.
[10] Modesto, Silva, “Versatile Unified Power Quality Conditioner Applied to Three-Phase Four-Wire Distribution Systems Using a Dual Control Strategy” in IEEE Trans on Power Electronics, Volume. 31, issue. 8, page. 5503 – 5514, 2016.
[11] Qianming Xu, Fujun Ma, “Analysis and Control of M3C-Based UPQC for Power Quality Improvement in Medium/High-Voltage Power Grid” in IEEE Trans on power electronics, Volume. 31, issue. 12, page. 8182 – 8194, 2016.
[12] H. B. Gooi, Jian Ye, “Optimization of the Size of UPQC System Based on Data-Driven Control Design” in IEEE Trans on Smart Grid, Volume. 9, issue. 4, page. 2999 – 3008, 2016.
[13] Nikhil S. Borse, Shembekar, “Power Quality Improvement using Dual Topology of UPQC” in International Conf on Global Trends in Signal Processing, Information Computing and Communication, 2016.
[14] Abdul Mannan Rauf, Amit Vilas Sant, “A Novel Ten-Switch Topology for Unified Power Quality Conditioner” in IEEE Trans on Power Electronics, Volume. 31, issue. 10, page. 6937 – 6946, 2015.

DOI: 10.37200/IJPR/V24I3/PR200948
Received: 20 Jan 2020 | Revised: 06 Feb 2020 | Accepted: 12 Feb 2020

[15] Mashhood Hasan, Abdul Quaiyum Ansari, "Parameters Estimation of a Series VSC and Shunt VSC to Design a Unified Power Quality Conditioner (UPQC)" in 39th National Systems Conference, 2015.
[16] Bharath Babu Ambati, Vinod Khadkikar, "Optimal Sizing of UPQC Considering VA Loading and Maximum Utilization of Power-Electronic Converters" in IEEE Trans on power delivery, Volume. 29, issue. 3, page. 1490 – 1498, 2014.
[17] Srinivas Bhaskar Karanki, Nagesh Geddada, "A Modified Three-phase Four Wire UPQC Topology with Reduced DC-link Voltage Rating" in IEEE Trans on Industrial Electronics, Volume. 60, issue. 9, page. 3555 – 3566, 2013.
[18] Vinod Khadkikar, "Enhancing Electric Power Quality Using UPQC: A Comprehensive Overview" in IEEE Trans on power electronics, Volume. 27, issue. 5, page. 2284 – 2297, 2012.
[19] Javier A. Munoz, Jose R. Espinoza, "Design of a Discrete-Time Linear Control Strategy for a Multicell UPQC" in IEEE Trans on industrial electronics, Volume. 59, issue. 10, page. 3797 – 3807, 2012.
[20] Hossein Heydari, Amir Hassan Moghadasi, "Optimization Scheme in Combinatorial UPQC and SFCL Using Normalized Simulated Annealing" in IEEE Trans on power delivery, Volume. 26, issue. 3, page. 1489 – 1498, 2011.
[21] Metin Kesler, Engin Ozdemir, "Synchronous-Reference-Frame-Based Control Method for UPQC under Unbalanced and Distorted Load Conditions" in IEEE Trans on Industrial Electronics, Volume. 58, issue. 9, page. 3967 – 3975, 2011.
[22] Prakash, R. and Vasanthi, R. "Speed Control of DC-DC Converter fed DC Motor using Robust Adaptive Intelligent Controller", Journal of Vibration and Control, December, 2013. (JCR,Impact Factor: 4.355)) (Indexed in Thomson Reuters)
[23] Prakash, R. and Muruganandham. A. "A Novel Model Reference Intelligent Adaptive Control Using Neural Network And Fuzzy Logic Controller", Journal Of Theoretical And Applied Information Technology (ISSN 1992-8645), April 2014 (Indexed in Scopus)
[24] Prakash, R.and Muruganandham. A, "Design and Implementation of Fuzzy Logic based Intelligent Adaptive Speed Control for DC Motor, Australian Journal of Basic and Applied Sciences,January 2014 (Indexed in Scopus)
[25] Prakash, R. and Anita, R. "Robust Model Reference Adaptive Intelligent Control" Springer-International Journal of Control, automation and system (IJCAS)Vol.10, No 2, 2012 (ISSN1598-6446) (JCR,Impact Factor: 1.065) (Indexed in Thomson Reuters)
[26] Prakash, R. and Anita, R. "Modeling and Simulation of Fuzzy Logic Controller Based Model Reference Adaptive Control", International Journal of Innovative Computing, Information and Control (IJCIC), Vol.8, No 4, 2012 (ISSN1349-4198) (JCR,Impact Factor: 1.664) (Indexed in Thomson Reuters)
[27] Prakash, R. and Anita, R. "Design of Intelligent Adaptive Control using Neural Network and Fuzzy Logic Controller", European Journal of Scientific Research (EJSR), Vol.57, No 1, 2011 (ISSN: 1532-5016) (Indexed in Scopus)
[28] Prakash, R. and Anita, R. "Design of Model Reference Adaptive Intelligent Controller using Neural Network for Nonlinear Systems", Journal of Electric Engineering Vol 11 ,No 4, 2011 (ISSN 1582-4594) (Indexed in Scopus)
[29] Prakash, R. and Anita, R. "Neuro- PI controller based Model Reference Adaptive Control for Nonlinear Systems", International Journal of Engineering, Science and Technology (IJEST), Vol. 3, No. 6, 2011 (ISSN: 2141-2839)
[30] Prakash, R. and Anita, R. "A New Approach to Model Reference Adaptive Control using Fuzzy Logic Controller for Nonlinear Systems", International Journal of Computer Science and Information Security (IJCSIS) ,Vol.9, No 2, pp. 86–93, 2011 (ISSN: 1947-5500)
[31] Prakash, R. and Anita, R. "Design of Model Reference Adaptive Intelligent Controller using Neural Network for Nonlinear Systems", International Review of Automatic Control (IREACO),Vol.2, No 2, pp.153–161, 2011 (ISSN: 1974-6059)
[32] Prakash, R. and Anita, R. "Robust model Reference Adaptive PI Control", Journal of Theoretical and Applied Information Technology (IJTIT) (ISSN 1992-8645) Vol.14, No.1, pp. 51–59, 2010.
[33] Prakash, R. Wahidabanu, R.S.D and Vasanthi, R. "Component modeled messaging services for pervasive environment using ML-IDL", International Journal of Wulfenia Vol.20, No 2, 2013
[34] Prakash, R. and Anita, R. "Model Reference Adaptive PI Control" International Journal of Electronic Engineering Research (IJEER) (ISSN 0975 - 6450), Vol.2, No.2, pp. 189–199, 2010.

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