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Improvement of power quality by fuzzy rules using particle swarm intelligence

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ABSTRACT

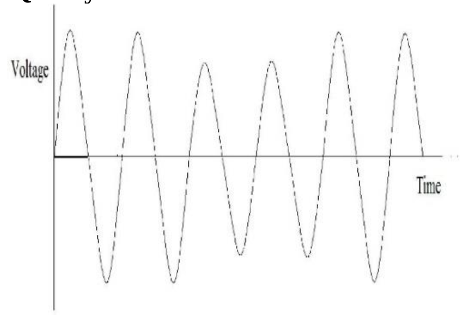
The proposed approach is used to address the drawbacks of the traditional sag detection process. With the suggested model, the controller is able to detect various types of power quality issues without the need for an error and injects the necessary voltage part to fix any irregularity in the terminal voltage instantly to maintain the load voltage at the nominal value balanced and steady. The experimental findings and simulation show that the suggested series compensator efficiently defends against voltage decreases the most critical charge

Keywords: *Sag, Swell, Optimization, Fuzzy*

1. INTRODUCTION

Voltage swell or sag represents the significant problems that arise in the form of sudden voltage drop or increase, which occurs significantly due to limited conditions of the circuit. [1] There are several multiple kinds of power electronic devices for improving power quality however DVR is indeed a very simple, versatile, and cost-effective system to reduce voltage swelling and sag. [2] DVR's main components as filter, power storage device, inverter, isolation transformer, and controller to eject or inject the suitable voltage to release the issue of power quality. The most common inverters as current source inverter (CSI) and voltage source inverter (VSI) have major drawbacks: the first disadvantage as AC output power would be less than DC Input power therefore only worked in buck mode, and the second disadvantage as two switches in the very same phase leg could never turn on at the same. Although this generates a power surge or short circuit. A high-frequency network here between the inverter bridge and voltage source has also been developed to address this issue. Thus, the impedance channel used between the bridge and the voltage source of the inverter. The voltage can indeed be adjusted in the Z-source inverter by adjusting the shooting and modulation index (MI) via the duty ratio. A simple Z-source network implementation, with appropriate configurations for switching, has been used. As well as accurate modulation methods and control lower the quantity of energy conversion phases within the energy conversion string. This increases the efficiency and reliability of the electronic power systems. [3, 4] The impedance networks have added as many changed topologies with passive and active elements to increase the voltage stress and gain in the network elements. Through changing the impedance networks to increase voltage gain, respectively., so many enhanced impedance networks have been implemented as a magnetically coupled impedance source (MCIS) including the T-source, upper-zone source, TZ-source, Trans-Z-source, high-frequency Z-source, LCCT-Z-source, Quasi-LCCT-Z-source transformer. Both Quasi-LCCT-Z and LCCT-Z -source derive constant current from respective sources within these networks. The d is a continuous form of input currents from many other networks that can cause issues when renewable sources such as fuel cells, PV, etc. are used. Different methods have been developed to smooth the currents from the sources. To address these or certain altered system issues as discontinuous input current, and to smooth the current, etc., three winding systems named the Y-source Network is implemented. Y- Source inverter as modulation index (MI) has three freedom degrees, firing via duty ratio, and one additional concept named winding factor (K), and a Quasi Y-source inverter is often used with DVR as part of this study. The Quasi Y-source gets all of the benefits of the initial Y-source Inverter. But it could also generate a really high voltage gain, which operates consistently at quite a greater modulation index. So, this can take consistent input current that suits renewable sources better, etc.

1.1 Power Quality



There are broad ranges of issues with power quality; all of those can have a large number of distinct causes, various impacts, and various approaches that may be utilized to boost the efficiency and power quality of the equipment. Power Quality concerns about the utility ability to supply the uninterrupted power supply. The standard of electrical power is characterized by parameters like "continuity of supply, voltage magnitude variation, transients and harmonic contents in electrical signals". Synchronization of electrical quantities allows electrical system to function properly and without failure or malfunction of an electrical device.

In order to prevent the consequences of poor PQ and to improve the utility performance the electric power is analysed to resolve the PQ issues in order to determine the efficient compensation technique.

1.2 Importance of Power Quality

- PQ expresses the degree of similarity of practical power supply with ideal power supply.
- If PQ is Good, then any load connected to the electric network runs efficiently without decreasing its performance.
- It is cost effectiveness.
- If PQ is good, then variation in voltage magnitude will be stable.

1.3 Demerits of Poor Power Quality

- Breakdown or malfunction of Machine.
- Damage sensitive devices.
- Overheat the machine like motor and transformer.

1.4 Power Quality problems

Poor PQ problems ultimately results in economic loss of the power system network. PQ mainly concerns to maintain voltage and current profile i.e. any deviation in these parameters can cause severe damage to the electrical utility and end consumers. An overview of many PQ problems along with their causes and consequences are presented.

1.4.1 Voltage sag/dip: The voltage sag or dip can be stated as decrease in nominal voltage level by 10-90% for short duration for half cycle to one minute as shown in fig.1.1. Sometime, voltage sag last for long duration such prolonged low voltage profile referred as 'under-voltage'. Voltage sag is further divided in three categories: instantaneous, momentary and temporary sags respectively. Voltage sag are mainly caused due to occurrence of faults in power system, overloading of the electrical network and starting current drawn by heavy electrical loads like motors and refrigerators. Voltage sag in power system network results in failure of relays and contactor, dim light and fluctuating power. Variations of learning styles that every individual reflects. Learning style is a personality characteristic that is innate and affected by environmental factor and evolves over a period of time. It is also determined by many variables such as mental abilities, child rearing practices, school environment, peer interaction, self- awareness, involvement in learning on the part of students etc. It gradually develops from birth and stabilizes at certain age i.e. adolescent age. Students reveal their learning style preference by everything they say or do. A student may possess one or more than one learning style

2. RELATED WORK

Abolfazl Kazemdehdashtii, Ali Reza Seifi, Amin Shabanpour Haghighi., In this paper, dynamic voltage restorer (DVR) compensation methods are compared to each other for the load side connected shunt converter topology of z-source inverter-based DVR to choose the best method. There are Four different topologies are recognized for DVR that two of them have energy storage devices, and two topologies have no energy storage that take energy from the grid during the period of compensation. Here the load side connected shunt converter topology that takes necessary energy from the grid is used. Pre-sag compensation, in-phase compensation, energy-optimized methods are the three DVR compensation methods which are studying and performing in this paper. A deep analysis through different diagrams would show the advantages or disadvantages of each compensation method. Equations for all methods are derived and the characteristics of algorithms are compared with each other. The simulation results show compensating based on the compensation methods.by this topology.

Geena Sharma, Dr. Vinay Bhatia, Dr. Jaydeep Chakarvorty., The Dynamic Voltage Restorer (DVR) is fast, flexible and efficient solution to voltage sag problem. The DVR is a power electronic based device that provides three-phase controllable voltage source, whose voltage vector (magnitude and angle) adds to the source voltage during sag event, to restore the load voltage to pre-sag conditions. The DVR is designed for protecting the whole plant with loads in the range of some MVA. The DVR can restore the load voltage within few milliseconds. Several configurations and control methods are proposed for the DVR. In this paper, an overview of the DVR, its functions, configurations, components, compensating strategies and control methods are reviewed.

Yam P. Siwakoti, FredeBlaabjerg, Poh Chiang Loh, introduces a new inverter topology called a "quasi-Y-source inverter". The proposed inverter inherits all the advantages of the original Y-source inverter. In addition, the new topology draws continuous current from the source which is required for many renewable sources. It also has dc-current-blocking capacitors, which avoids saturation in the transformer core. Simulations and experimental results have proved the validity of the proposed inverter.

Mohana Priya, G., Vijay, S., & Mohanvel, S., et al. presents about mitigating of voltage sag using Dynamic Voltage Restorer (DVR) integrating with Proton Exchange Membrane Fuel cell. When the sudden changes in the system voltage occurs, DVR works as a compensation device to protect the system. During voltage sag the amount of compensating voltage is injected by DVR through injection transformer. The simulation results obtained using MATLAB are analyzed to prove the effectiveness of the proposed method.

Kevin Olikara explained the vast majority of power quality issues experienced by industrial customers can be attributed to sags, harmonics, and transients. However, several other power quality conditions can also disrupt processes and equipment, such as swells, under voltages, over voltages, interruptions, DC offsets, notching, noise, voltage fluctuations, and frequency variations. Solutions exist for all of these types of conditions, but the biggest step that needs to be taken to reduce the capital and operational expenditures that are a direct result of power quality is to have the capability to measure, detect, and visualize your power quality events and conditions.

Daniel Johnson, Ogheneovo, & Kabiru Alani Hassan., properly expatiated what power quality is. It pointed out the causes of power quality problems as inadequate grid, voltage variations/deviation, frequency fluctuations and waveform distortions. The effect of power quality problems include inefficiency, overheating and shortening service-life of equipment, loss of data, process interrupt, insulation breakdown. While, it is not feasible to completely eliminate the causes, the quality of power supply can be improved and the remaining effect in the supply can be mitigated. The proven mitigating techniques are adequate energy availability in the grid, use of interfacing devices (UPS, AVR, DVR etc.), use of power quality improving devices (tap changing transformer, lightning arrestor, SVS), use of filter to block harmonics, as well as proper grounding of electrical installations.

Rakeshwri Pal & Dr. Sushma Gupta., provided a brief literature review on DVR configurations and its control strategies. By selecting any one of them we can provide solution to various power quality problems like voltage harmonics, voltage sag/swell compensation. To improve the performance of DVR, efforts needs to be made on energy savings, reduced parts and losses, minimum power injection, reduced rating, and selective harmonics mitigation.

R. Abirami, G.Kirthika., Dynamic Voltage Regulator (DVR) is one of the most comprehensive FACTS devices which can controls three system parameters independently. In this system a novel configuration of DVR which consists of a ten-switch converter parallel with a series. Here capacitor has been proposed to inject desired series voltage. It means that operation of ten-switch converter in this configuration be the same as combination of two converters in conventional DVR. Here in this configuration requirements less power electronics switches and gate drive circuits and control scheme becomes simpler than conventional DVR configuration, using series capacitor parallel by ten switch converter reduce the injection voltage's THD, eliminate output filter, also decrease the converters power rating in comparison with conventional DVR composed of series and shunt converters. Good operation of the new DVR. are presented by this proposed DVR.

D. M. Vilathgamuwa, C. J. Gajanayake et al., The dynamic voltage restorer has been gaining acceptance as an effective device for voltage sag compensation. The compensation capability of a dynamic voltage restorer (DVR) depends primarily on the maximum voltage injection ability and the amount of stored energy available within the restorer. A new topology based on Z-source inverter for the DVR is proposed in order to enhance the voltage restoration property of the device. Z-source impedance network along with shoot-through capability of the proposed inverter would ensure a constant dc-voltage across the dc-link despite dwindling voltage in the storage devices connected in the dc-link during the process of voltage compensation. Even when the dc-link energy is supplied through a shunt connected auxiliary supply, the voltage rating of the shunt converter, shunt transformer and the dc-link capacitor can be kept smaller with the proposed topology. The proposed converter topology and control methods are validated by simulation and laboratory tests carried out on a proto-type of the restorer.

Ravilla Madhusudan and G. Ramamohan Rao, presents the systematic procedure of the modeling and simulation of a Dynamic Voltage Restorer (DVR) for power quality problems, voltage sag and swell based on Sinusoidal Pulse Width Modulation (SPWM) technique. Power quality is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure of end use equipment's. The major problems dealt here is the voltage sag and swell. To solve this problem, custom power devices are used. One of those devices is the Dynamic Voltage Restorer (DVR), which is the most efficient and effective modern custom power device used in power distribution networks. The control of the Voltage Source Converter (VSC) is done with the help of SPWM. The proposed DVR is modeled and simulated using MATLAB software.

3. PROPOSED WORK

The grid-VOLTAGE OPTIMIZATIONs, which use the cascaded connection of dc-dc converters, provide high boosting gain for the grid output voltage. Nevertheless, the series connections of the two boost converters reduce the conversion efficiency of the system. In addition, the conventional grid-VOLTAGE OPTIMIZATIONs, which are controlled by the Synchronous Reference Frame (SRF) theory and in-phase compensation strategy, inject the additional power to compensate the voltage disturbances and outages in the power distribution system. In this work, a two-winding coupled inductor–based bidirectional dc-dc converter-fed three-phase four-wire (3P4W) grid-VOLTAGE OPTIMIZATION with a fuzzy logic controller (FLC)-based minimal energy injection technique is presented to compensate the long-term voltage disturbances and to minimize the power injected from the dc–link of the VOLTAGE OPTIMIZATION. The simulation study using MATLAB (Math Works, Natick, MA) software and the experimental implementation using a field-programmable gate array (FPGA) are made to validate the feasibility of this scheme. The results are presented in a broad way in terms of performance assessment concerning the injected power, total harmonic distortion (THD) contents of the load voltage, and the utilization of the proposed VOLTAGE OPTIMIZATION. The designed PSO-VOLTAGE OPTIMIZATION with FLC-based minimal energy injection technique yields favorable solutions ensuring the reliability in the field of energy conservation and voltage disturbance mitigation .Y-Source Inverter has more degree of freedom to change the voltage gain as compared to Z-source inverter.

3.1 Fuzzy Logic

The word fuzzy represents the thing which is not clear. In the daily life we encounter some situation in which we can't determine the true or false state but the fuzzy logic provides a way and a flexible reasoning. The computer system depends on the binary approach in which 0 represents the false and 1 represents the true but in the fuzzy logic there is also a logic for partially and partially false condition.

- **Fuzzification:** This system converts the crisp input into fuzzy sets and then this input is send to inference engine.
- **Inference Engine:** It is used for matching degree for the crisp input and then rule according to input field.
- **Defuzzification:** It changes the fuzzy set from the inference engine into the crisp value for output.

3.2 Particle Swarm Optimization

PSO remains for particle swarm optimization. PSO is a stochastic optimization calculation which depends on the conduct of flying creatures.

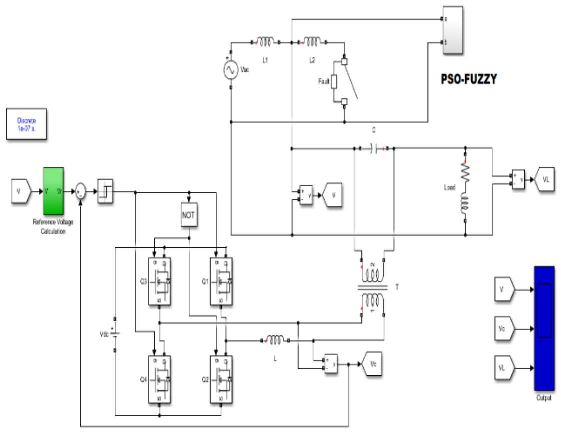


Fig. 1: Single phase with Fuzzy-PSO approach

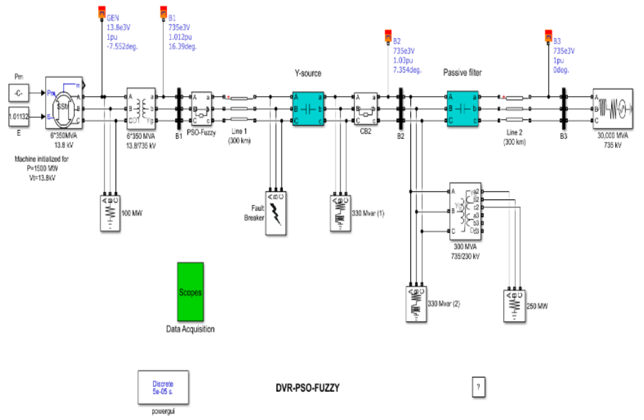


Fig. 2: Three phase with Fuzzy-PSO approach

It works like the hereditary calculation. In PSO is instated with a gathering of irregular particles. In each cycle, every particle is refreshed by the two "best" qualities. The principal best arrangement demonstrates the wellness of the particles and this called as pbest. The second best esteem is followed by the enhancer is the best esteem. This esteem is called as worldwide best (gbest).When a particle removes a portion of the populace as its topological neighbors; the best esteem is a nearby best and is called best.

4. RESULT ANALYSIS

Voltage dip arises caused by sudden system faults or load disconnection when voltage swell takes place because of capacitive load contact. Voltage unbalance occurs throughout the network occurs for some time caused by network faults. During this time, voltage disruption occurs at PCC (Point of Coupling), and the voltage profile is restored. Here all voltages are measured in per unit values, this can be noted that the magnitude voltage profile increases or decreases from its rated value when a failure occurred. To account for the voltage dip/rise, works, and injects the required voltage. Upon compensation, minor disruption occurs at the start or endpoint of the sag / swell throughout that time caused by the addition of compensating voltage.

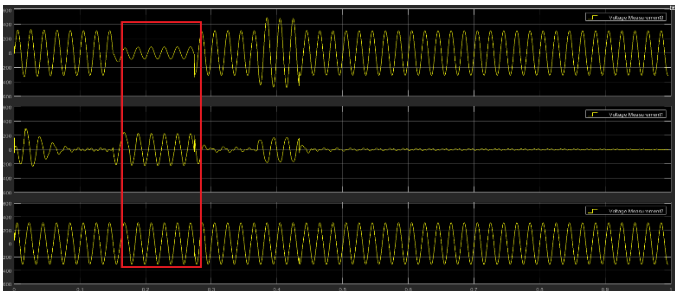


Fig. 3: Single phase sag with fuzzy and fuzzy pso

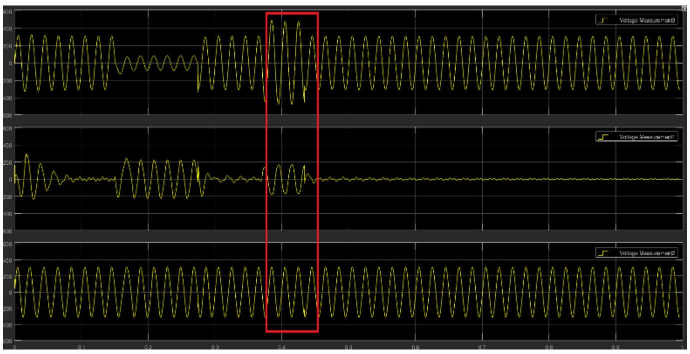


Fig. 4: Single phase swell with fuzzy and fuzzy pso

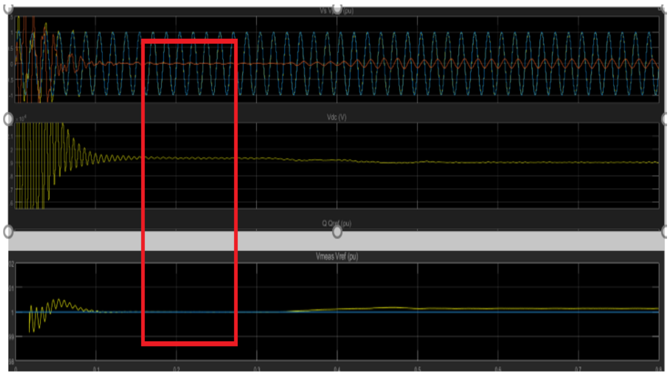


Fig. 5: Two phase sag with fuzzy and fuzzy pso

A three-phase balanced voltage swell arises by adding a capacitive load of 0.04s to 0.1s throughout the network over a time span. The PCC voltage for this time after voltage unbalances is demonstrated in fig.4.3(a). injected compensating voltage is shown in fig. 4.3 (b) That is, the paid load voltage is seen in fig.4.3, after positive compensation.

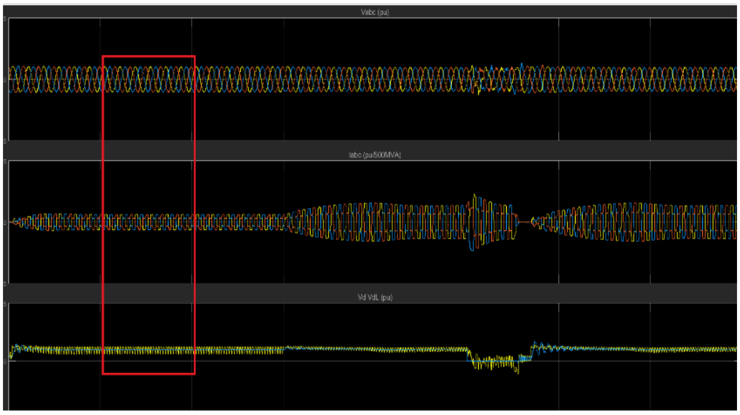


Fig. 6:Two Phase Swell with Fuzzy and Fuzzy PSO

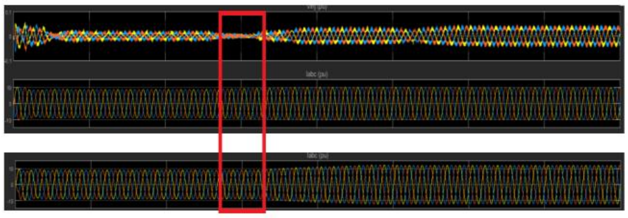


Fig. 7: Three Phase Sag with Fuzzy and Fuzzy PSO

An unbalanced voltage drop in the network occurs from 0.04s to 0.1s due to SLG fault. Fig.4.2(a) displays the PCC voltage after the sag arises for 0.06s duration. For this period infuses the desired voltage. The DVR-injected compensating voltage seen in Fig.4.2(b). The compensated load voltage is shown in fig.4.2(c) after effective process of DVR and sag compensation

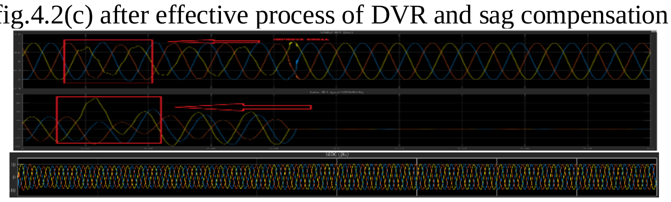


Fig. 8:Three Phase Swell with Fuzzy and Fuzzy PSO

In the device, a three-phase fault is created to produce a balanced voltage sag of 0.04s to 0.1s over a time period. The PCC voltage following the sag can be seen in fig.4.1(a) for a time of 0.06s. The reacts to this disruption and the compensating voltage is injected. The compensated voltage is indicated in fig.4.1 (b). The load voltage tries to regain its former profile after compensation for the sag. Following compensation, the load voltage is represented in fig.4.1

5. CONCLUSION

In the stationary frame, the controlling system that is based on a proportional-repetitive controller is implemented to improve simultaneously fast dynamic response and zero steady-state error. Such a controller can account for fluctuations in power quality, like harmonic voltages, voltage imbalance, and voltage sag while at the same time focuses on implementing a new method of sag detection and a compensating voltage generation. The traditional method of sag detection cannot detect voltage falls below a definite point. As an example, this approach cannot calculate a single phase to ground fault resulting in voltage sag as its method used the three-phase voltage average and views the single-phase voltage sag as the three-phase average value

6. REFERENCES

[1] Abolfazl Kazemdehdashtii , Ali Reza Seifi, Amin Shabanpour Haghighi "Comparison between Different Control Strategies of a Z-Source Inverter Based Dynamic Voltage Restorer" volume 11, number 3, pp 174-185, power engineering and electrical engineering, june 2013.

[2] Jaydeep Chakravorty; Geena Sharma; Vinay Bhatia;"Analysis of a DVR with Molten Carbonate Fuel Cell and Fuzzy Logic Control" Engineering, Technology & Applied Science Research Vol. 8, No. 2, 2018, 2673-2679 2673.

[3] Siwakoti, Yam P., Frede Blaabjerg, and Poh Chiang Loh. "Quasi-Y-source inverter." In *2015 Australasian Universities Power Engineering Conference (AUPEC)*, pp. 1-5. IEEE, 2015. DOI: 10.1109/AUPEC.2015.7324804

[4] Eswaran, S., Karthick, S., Mohana Priya, G., Vijay, S., & Mohanvel, S., "PEMFC Supported DVR for Mitigating Voltage Sag in Industrial Automation."

[5] Olikara, Kevin., "Power Quality Issues, Impacts, and Mitigation for Industrial Customers." *Power and Energy Management Products* (2015).

[6] Johnson, Daniel Ogheneovo, and Kabiru Alani Hassan., "Issues of power quality in electrical systems." *International Journal of Energy and Power Engineering* 5, no. 4 (2016): 148-154.

[7] Pal, Rakeshwri, and Sushma Gupta, "Simulation of dynamic voltage restorer (DVR) to mitigate voltage sag during three-phase fault", In *2016 International Conference on Electrical Power and Energy Systems (ICEPES)*, pp. 105-110. IEEE, 2016.

[8] Abirami, R., and G. Kirthika, "Compensation of Voltage Sags and Swells by using Dynamic Voltage Restorer (DVR) and Active Power Filter." *International Journal of Applied Engineering Research* 13, no. 11 (2018): 9127-9130.

[9] D. M. Vilathgamuwa, C. J. Gajanayake, P. C. Loh, Y. W. Li, "Voltage Sag Compensation With Z-Source Inverter Based Dynamic Voltage Restorer", IEEE, Volume 5, Pp 2242-2248, 2006.

[10] Ravilla Madhusudan and G. Ramamohan Rao, "Modeling and simulation of a Dynamic Voltage Restorer (DVR) for power quality problems-voltage sags and swells", ICAESM, Pp 442-447, 2012.

[11] Zhikang Shuai, Peng Yao, Z. J. Shen; Chunming Tu, Fei Jiang, and Ying Cheng, "Design Considerations of a Fault Current Limiting Dynamic Voltage Restorer (FCL-DVR)", IEEE, Volume 6, Issue 1, Pp 1-12, 2014.

[12] Khirod Kumar Senapati, Mousumi Bala Panda, Rafiya Sultana Syed, "A novel algorithm for power quality improvement using dynamic voltage restorer with fuzzy logic", ICSCOPES, Pp 376-381, 2016.

[13] Aziz Tashackori, Seyed Hossein Hosseini, Mehran Sabahi, Tohid Nouri, "A three-phase four-leg DVR using three dimensional space vector modulation", ICEE, Pp 1-5, 2013.

[14] S. Surendar, G. Madhusudanan., "Design and implementation of Dynamic Voltage Restorer using Space Vector Modulation Technique for Improving Power Quality" 2016 International Conference on Computation of Power, Energy Information and Communication (ICCPEIC).

