wjert, 2019, Vol. 5, Issue 2, 535-545. *Review Article* ISSN 2454-695X

World Journal of Engineering Research and Technology
WJERT
www.wjert.org SJIF Impact Factor: 5.218

ENHANCEMENT OF POWER FLOW CONTROL AND VOLTAGE STABILITY USING UNIFIED POWER FLOW CONTROLLER

R. Srinivasan*[1], V. Nandhini[2], S. Preethika[3] and J. G. Rajeswari[4]

[1]Assistant Professor, EEE Department, Muthayammal College of Engineering, Rasipuram.
[2,3,4]UG Students, EEE Department, Muthayammal College of Engineering, Rasipuram.

Article Received on 06/02/2019 **Article Revised on 27/02/2019** **Article Accepted on 17/03/2019**

***Corresponding Author**
R. Srinivasan
Assistant Professor, EEE Department, Muthayammal College of Engineering, Rasipuram.

ABSTRACT

in this paper, UPFC (unified power flow controller) is used to enhance power flow and voltage stability. The special features of UPFC are that it can control active and reactive power in a transmission line and can adjust the voltage at the bus at which it is located. UPFC offers unique control of the power flow and voltage stability. The operation of UPFC in the field of control flow of power in transmission-line is carried out in a 2-bus systemby locating this controller at the sending end using simulation tools. The circuit model for UPFC is developed using rectifier and inverter circuits. The results of bus voltage are obtained without and with UPFC and are compared. On the basis of simulation results and the performance of UPFC, it is concluded that UPFC is an ideal controller for enhancing power flow and voltage stability.

KEYWORDS: FACTS, UPFC, real& reactive power, voltage stability, power system simulation.

I. INTRODUCTION

A power grid system is a combination of electrical constraints utilized to offer, transfer and utilizethe electrical power. The electrical power demand is growing rapidly and due to economic and environmental facts, building of new generating unit and transmission circuit is much complicated. So power utilities are pressured to rely on utilization of existing generating unit and to load existing transmission line near to their thermal limits. For economic purpose the power grid system is deregulated inwhich generation, transmission and distribution occur separately.[1] Stability should be maintained at eachinstant so as to operate power system effectively, with unchanged system security and with good quality of supply in case of abnormal condition like transmission line loss, generating unit loss which happens frequently and it will most possibly happen at higher frequency.[2] In 1980, a new technology program Flexible AC transmission system which is famous as FACTS has been introduced by EPRI. The basic idea behind this program is to increase controllability and optimize the utilization of the existing power system capabilities through replacement of mechanical controller by reliable and high speed electronic device.[3] At present solid state synchronous concept devices are used. The UPFC is the most efficient and powerful device broadly utilized to manage the power flow through the grid system.

II. Scope of Work

The aim of this work is to model UPFC and its control circuit using SIMULINK and to analyse the control circuit for effective power flow control and system stability in power transmission system using three different control schemes

1. Real and Reactive power flow control
2. Sending bus voltage magnitude control
3. DC voltage magnitude control.

UPFC is installed in transmission line to control both real and reactive power and also control the output voltage of the system.

III. The Unified Power Flow Controller

The unified power flow controller (UPFC) is an associate of the cluster of FACTS equipment's that offers synchronous Voltage source theory for offering efficient control on the grid system. Within the structure of traditional power transmission concepts, the UPFC is able to control simultaneously or electively all the parameters affecting power now in grid system. The study of Unified Power Flow Controller and its role in damping power oscillations to improve system performance has been discussed in.[4]-[6] A. Real and reactive flow control using UPFCA simple two machine system with sending-end voltage V_s. receiving-end voltage V_r and line impedance X is shown in Figure 1 (a). Figure 1 (b) shows the system voltages in the form of a phasor diagram with transmission angles δ.The elementary system of Figure 1 (a) has been used as a building block to explain the capability of the UPFC to control the real power P and reactive power Q_S and Q_R at the sending-end and the receiving end of line respectively.

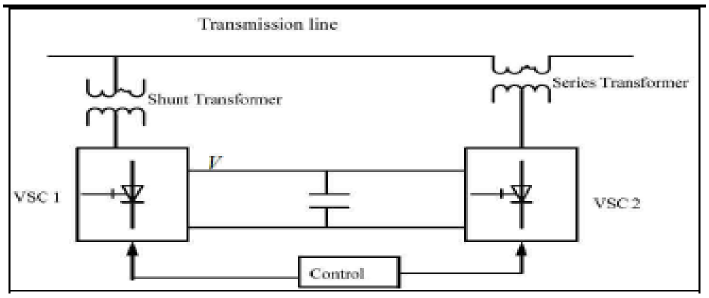

Fig. 1.1: The Schematic diagram of UPFC.

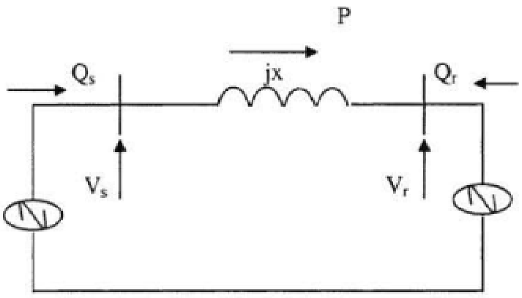

Fig. 1.1: (a) A basic two machine system.

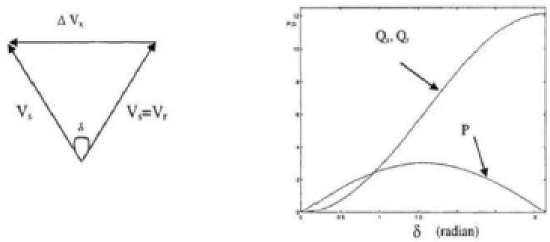

Fig. 1.1 (b) Voltage phasor, (c) Real.

Figure 2 shows the power system included with a UPFC. The UPFC is represented by a controllable voltage source in series with the line which can generate or absorb reactive power from the sending-end generator. The voltage injected by the UPFC is in series with the line is represented by Vpq having magnitude Vpq and phase angle. To represent the UPFC properly, the series voltage source is designed to generate only the reactive power Qpq it exchanges with the line.[7]

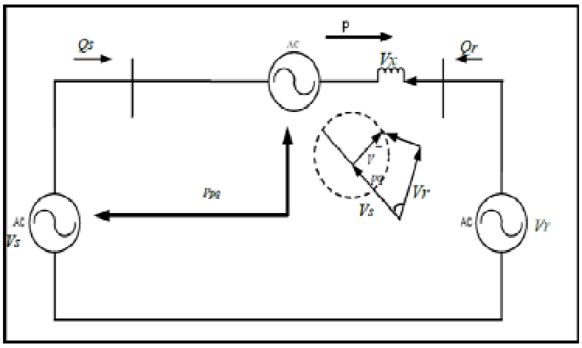

Figure 2: Two machine system with UPFC.

IV. Active and Reactive Power Control By Upfc

In figure (1.1) a simple two machine (or two bus ac inertia) system with sending-end voltage Vs, receiving-end voltage Vr, and line (or tie) impedance X (assumed, for simplicity, inductive) is shown.The Control of the UPFC the most common approach is to modelthe UPFC as a power injection model.[8,9] The power injection model neglects the dynamics of the UPFC and uses the UPFC active and reactive power injection as the control inputs into the power system. At (b) the voltages of the system in form of a phasor diagram are shown with transmission angle δ and Vs = Vr = V. The basic principleson how bus bar voltage regulation, reactive power compensation, and power flow control can be achieved by a UPFC have been described in.[10,11] At the receiving ends of the line, the transmitted active and reactive power are P and Q.P=V2/X sinδ and Q =Qs = Qr= V2/X (1 − cosδ).[12]

V. SIMULATION AND CASE STUDIES

A UPFC is used to manage the power flow in a 500KV /230 kV transmission systems. The system, associated in a loop arrangement, comprises of five buses (B1, B2, B3, B4, B5)Joined by three transmission lines (L1, L2, L3) and two units of 500 kV/230 kV transformers bank named as T1 and T2. Two power plants situated on the 230 kV system produce a total of 1500 MW (Fig. 4) which is spread to a 500 kV, 1500 MVA and to a 500 MW load attached at bus B3. Every plant model comprises a speed regulator, and an excitation system and a Power System Stabilizer (PSS). In usual process, mainly of the 1200 MW generation power of power plant 02 is given to the 500 kV equivalents in the course of two 400 MVA transformers attached among buses B4 and B5. For this design, we think about a special case in which only two transformers out of three units are accessible. The load flow depicts that the majority part of the power developed by plant02 is spread in the course of the 800 MVA transformer banks and the 96 MW is spreading in the loop pattern. Transformer T2 is then extra loaded to 99 MVA. This would be demonstrating that will a UPFC device can mitigate this power blocking. The UPFC placed at the right hand side end of line L2 is utilized to adjust the real and reactive powers to the 500 kV bus B3, and the voltage at bus named B_UPFC. The UPFC device comprises of two 100 MVA, IGBT type, converters (one series converter and one shunt converter coupled by a DC bus). The series converter will gives a maximum of 10% of rated line-to- ground voltage in series attached with line L2. The single line diagram demonstrated in Fig 4is implemented in MATLAB SIMULATION in sim-power system to test the existence of the UPFC device. The model of UPFC device will give two types of outcomes. The measurements system and model of UPFC controller are depicted in Fig.6 respectively. Initial outcome is regarding the simulations at power flow adjustment module and second outcome is voltage injection Module. The essential keys to message in the block diagram are, elements of the UPFC device are specified in the dialog box. The UPFC device has reference value of real and reactive powers are put in the magenta blocks named Pref (pu) and Qref (pu). At start the bypass breaker is blocked and the resulting natural power flow at bus B3 is 587 MW and -27 Mvar. The P_{ref} box is programmed with a preliminary active power of 5.87 pu related to the natural power flow. Thus, at t = 10s, P_{ref} is amplified by 1 pu from 5.87 pu to 6.87 pu, whereas Qref is held at constant value at -0.27 pu. The results of optimal power flow like voltage profile, real and reactive power flow in electrical transmission lines are evaluated and argued. The outcome of occurrence of UPFC and impact of positions of UPFC on buses of power grid system in voltage amplitude and phase angle of voltage and real and reactive of power flow in transmission lines are evaluated and performances are analyzed.

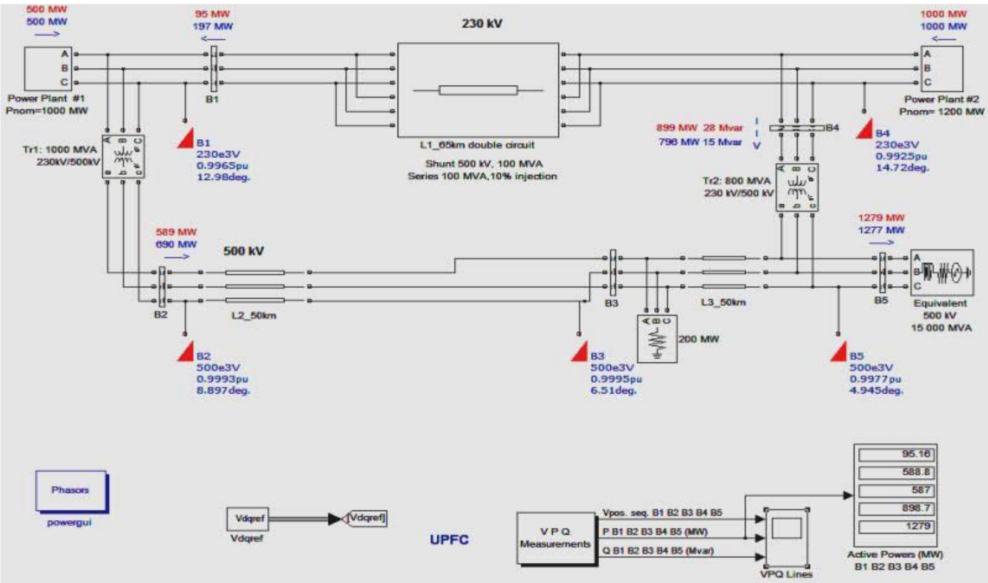

Figure 4: Simulink model of test power system without UPFC.

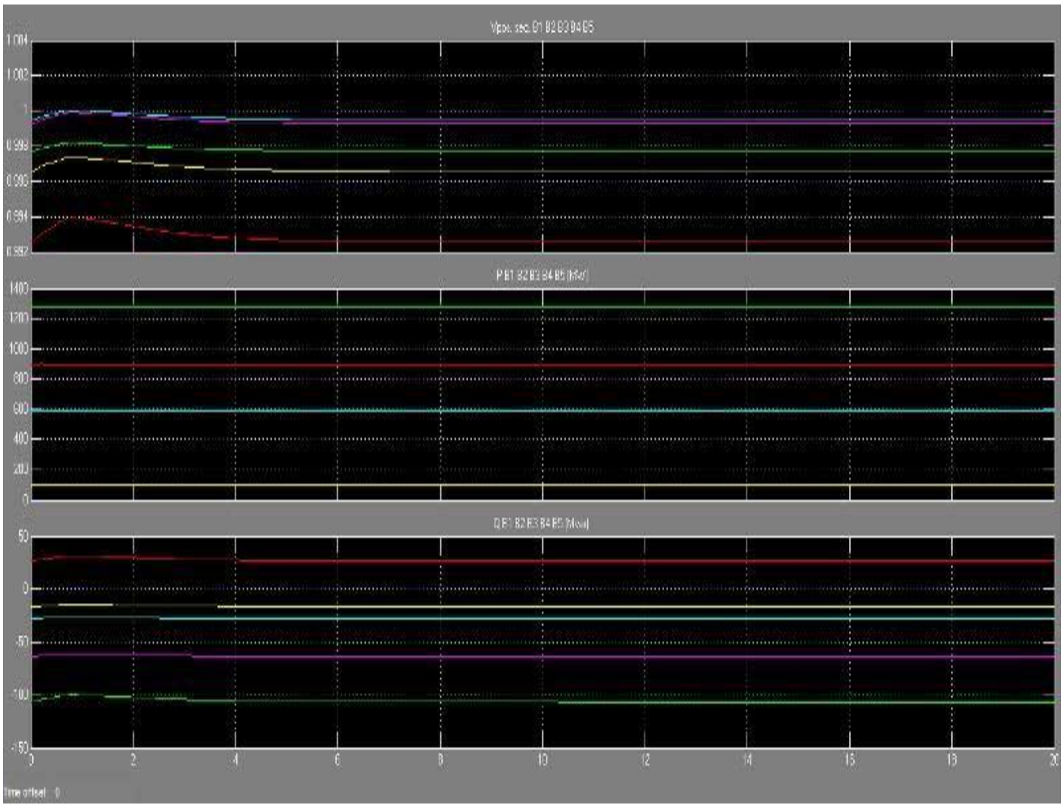

Figure 5: VPQ waveforms without UPFC.

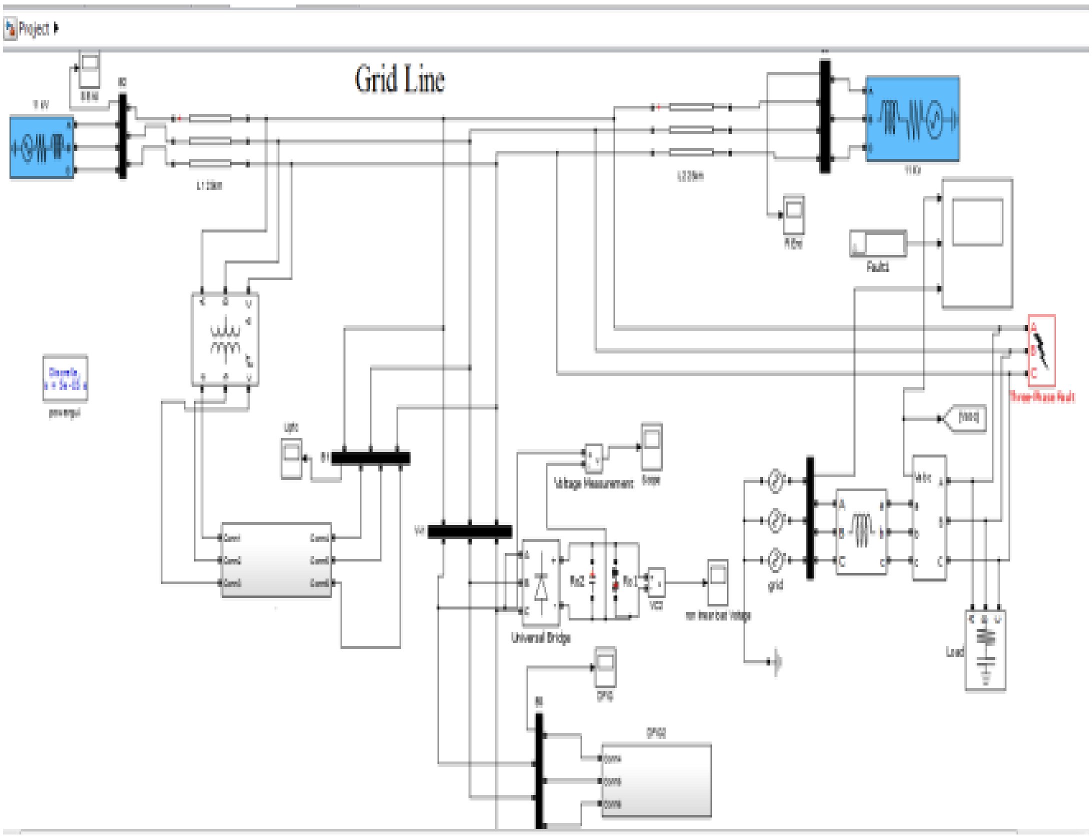

Figure 6: Simulink model of test power system with UPFC.

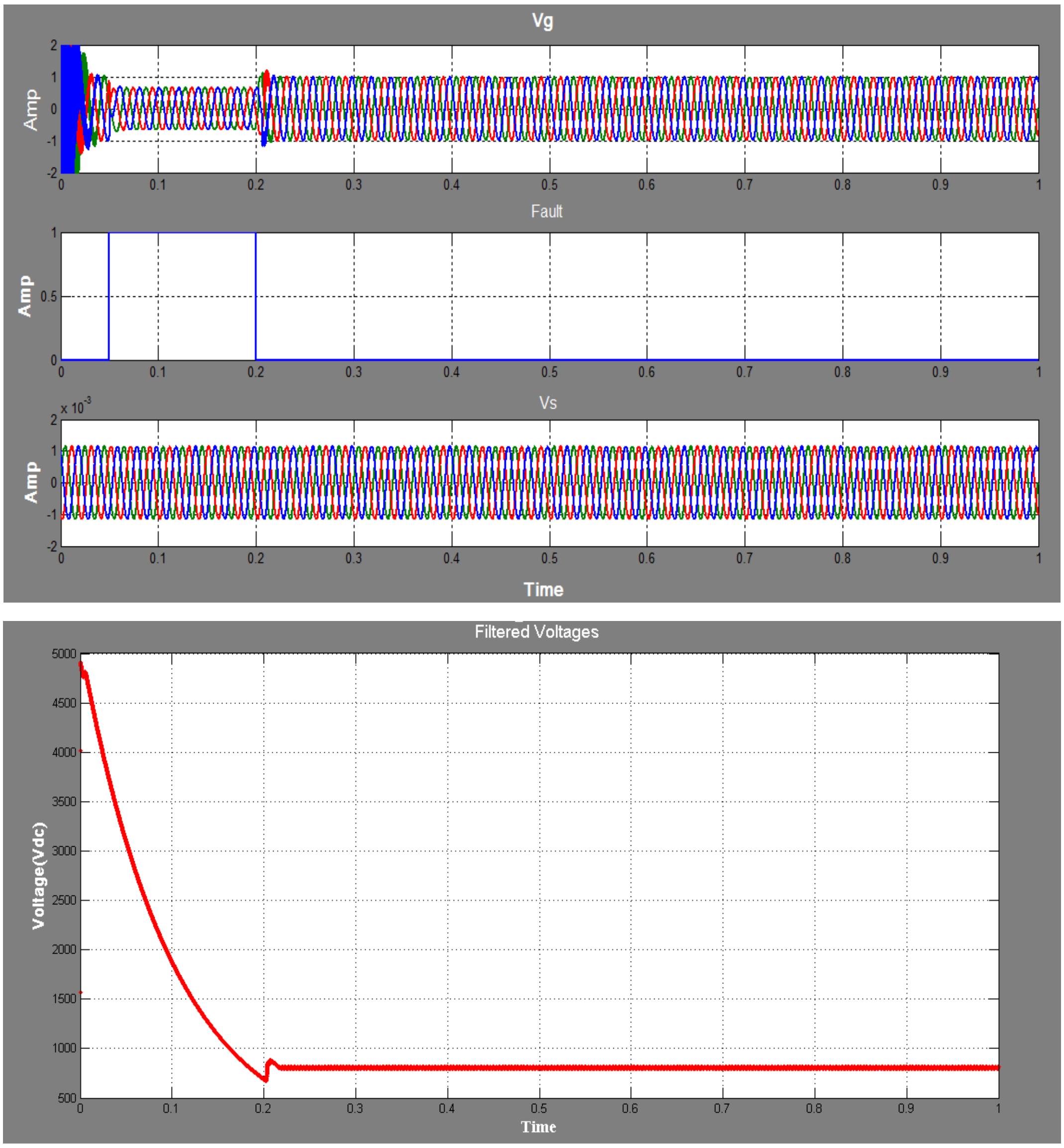

Figure 7: VPQ waveforms.

VI. CONCLUSION

In power grid system transmission, it is enviable to control the voltage amplitude, phase angle and line parameters. So, to manage the power from one place to other place, this theory of power flow adjustment and voltage injection is applicable. Analyzing the electrical system and on taking the results, it is found UPFC are extremely valuable when it brings to arrange and control power system. The impacts of UPFC positions are examined on voltage profile and transmission lines power flows as active and reactive power are examined. This paper has dealt with simulation of power system utilizing UPFC to enhance the power transfer ability and system stability by an electrical transmission line by introduction of UPFC at the supplying terminal using modern simulation. The performances of network with and without UPFC are evaluated by means of real and reactive power flows in the electrical transmission line. It has been found that with UPFC l power system performance have improved when compared to without UPFC model.

REFERENCES

1. R.Srinivasan et.al, “Design and Implementation of Multilevel Chopper using Bidirectional Control Technique” International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), 2018; 7(10).
2. R.Srinivasan, et.al “Analysis and Design of Solar Power Fed DC-DC SEPIC Converter” IJAREEIE, 2018; 7(10).
3. C.Nagarajan and M.Madheswaran, ‘Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter with fuzzy controller’ - *Journal of Electrical Engineering*, 2012; 63(6): 365-372.
4. R.Raja and C.Nagarajan, “Performance Analysis of LCL-T Filter Based 2 Stage Single Phase Gird Connected Module with ANN Controller using PV Panel," *Current Signal Transduction Therapy*, 2018; 13(2): 159-167.
5. C.Nagarajan and M.Madheswaran, “Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis” *Springer, Electrical Engineering*, 2011; 93(3): 167-178.
6. E.Geetha, C. Nagarajan, “Stochastic Rule Control Algorithm Based Enlistment of Induction Motor Parameters Monitoring in IoT Applications," *Wireless Personal Communications*, 2018; 102(4): 3629–3645.
7. M.Madheswaran, C.Nagarajan, “DSP Based Fuzzy Controller for Series Parallel Resonant converter”, *Frontiers of Electrical and Electronic Engineering*, 2012; 7(4), 438-446.
8. C.Nagarajan, “Single-Stage High-Frequency Resonantac/AC Converter Using Fuzzy Logic and Artificial Neural networks’, *Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March*, organized by mahendra Engineering College, Mallasamudram, *2018;* 30-37.
9. E Geetha, C Nagarajan, “Induction Motor Fault Detection and Classification Using Current Signature Analysis Technique”, *Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March*, organized by mahendra Engineering College, Mallasamudram, 2018; 48-52.
10. GS SatheeshKumar, C Nagarajan, ST Selvi, “A Virtual Impedance Based Analysis of Dynamic Stability in a Micro-Grid System”, *Conference on Emerging Devices and Smart*

Systems (ICEDSS), 2nd and 3rd March, organized by mahendra Engineering College, Mallasamudram, 2018; 38-41.

11. CS Lakshmi, C Nagarajan, "Neural Controlled Multi-Level Inverter Based DVR for Power Quality Improvement", *Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March*, organized by mahendra Engineering College, Mallasamudram, 2018; 42-47.
12. S Thirunavukkarasu, C Nagarajan, "Performance Analysis of BLDC Motor Drive for Feed Drives", ", *Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March*, organized by mahendra Engineering College, Mallasamudram, 2018; 67-70.
13. JP Daniel, C Nagarajan, "Hybrid Filter for Distorted Voltage Source in Microgrids*", Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March*, organized by mahendra Engineering College, Mallasamudram, 2018; 11-15.
14. K Umadevi, C Nagarajan, "High Gain Ratio Boost-Fly Back DC-DC Converter using Capacitor Coupling", *Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March*, organized by mahendra Engineering College, Mallasamudram, 2018; 64-66.
15. C.Nagarajan and M.Madheswaran, "Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis", *Iranian Journal of Electrical and Electronic Engineering*, 2012; 8(3): 259-267.
16. C. Santhana Lakshmi and C. Nagarajan, "Multiconverter Technology Based Voltage Compensation for Photovoltaic System" Ecology, Environment and Conservation, 2017; 23: 226-229.
17. C.Nagarajan and M.Madheswaran,"Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques", Electric Power Components and Systems, 2011; 39(8): 780-793.
18. C.Nagarajan, M.Muruganandam and D.Ramasubramanian – 'Analysis and Design of CLL Resonant Converter for Solar Panel - Battery systems- *International Journal of Intelligent systems and Applications*, 2013; 5(1): 52-58.
19. C.Nagarajan and M.Madheswaran, "Experimental Study and Comparative Analysis of CLL-T and LCL-T Series Parallel Resonant Converter with Fuzzy/ PID Controller", *Journal of Electrical Engineering*, 2011; 11(3): 122-129.
20. C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has

been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai, 2007; 1: 190-195.

21. C. Nagarajan, M.Madheswaran and D.Ramasubramanian, "Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model," *Acta Electrotechnica et Informatica Journal*, 2013; 13(2): 18-31.
22. S.Sathish Kumar and C.Nagarajan, "Performance - Economic and Energy Loss analysis of 80 KWp Grid Connected Roof Top Transformer less Photovoltaic power Plant," *Circuits and Systems*, 2016; 7(6): 662-679.
23. R.Srinivasan et.al have published a paper titled "Design and Analysis of Active Filter based Unbalanced Load Correction" in the International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), 2015; 4(6).
24. R.Srinivasan et.al have published a paper titled "A Cascaded Multilevel H- Bridge Inverter for Electric Vehicles with Low Harmonic Distortion" in the International Journal of Advanced Engineering Research and Science (IJAERS) ISSN: 2349-6495, 2014; 1(6).
25. R.Srinivasan, M.Kannan and G.Neelakrishnan have published a paper titled "AC/DC SEPIC Converter for Non-Linear Controller" in the IJAREEIE, 2014; 3(11).
26. R.Srinivasan et.al have published a paper titled "Analysis of Low Power Dual Dynamic Node Hybrid Flip-Flop" in the International Journal of Advanced Engineering Research and Science (IJAERS), 2014; 1(6).
27. R.Srinivasan et.al have published a paper titled "A Hybrid Text Classification Approach Using Knn and Svm" in the International Journal of Advances Foundation and Research in Computer (IJAFRC), ISSN: 2349-6495, 2014; 1(3).
28. R.Srinivasan and D.Vinoth have published a paper titled "Protection of Wireless Sensor Network from Gang Injecting False Data Attack" has been published in International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering(IJAREEIE), 2014; 3(2): 7301-7311.
29. R.Srinivasan et.al have published a paper titled "Probabilistic Based Rock Texture Classification" has been published in International Journal of Advances in Engineering & Technology (IJAET), 2014; 6(6): 2439-2447.
30. R.Srinivasan, R.Vinoth and D.Kalidass have published a paper titled "Remote Admittance & Demonstrate For Client Control Mobile Computing" has been published in International Journal of Scientific Engineering and Technology (IJSET), 2014; 3(1) 13-16.

31. R.Vinoth, R.Srinivasan, D.Vimala and M.M.Arun Prasath have published a paper titled "Characterization of Color and Texture Features from Retrieved Images using CBIR" has been published in International Journal of Research in Advent Technology (IJRAT), 2013; 1(5): 61-67.
32. R.Srinivasan et.al have published a paper titled "FPGA Implementation of Efficient Modified VLSI Architecture for Multiplier" has been published in International Journals of latest research in Engineering and Computing (IJLREC), Nov-Dec 2013; 1(2): 7-10.
33. R.Srinivasan and S.Ravindar have published a paper titled "Stability Analysis of ARM Based Control of Brushless DC Motors Using Digital PWM Technique" has been published in International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), 2013; 2(11): 880-884.