# Dynamic Performance Of DPFC In Hybrid System To Control Power Quality Problem Using Quantum Particle Swarm (QPSO) Optimization Algorithm

**Dr.B.Gopinath, P.Madhumathi**

***Abstract*— FACTS device are used to improve the power quality and maintain it over power systems. DPFC (Distributed Power Flow Controller) is one of the advanced devices used to control the power quality compared to UPFC (Unified Power Flow Controller) the operation functional is same. DPFC is same as UPFC by eliminating Dc link capacitor. In DPFC, instead of single three phase series converter it has the three individual single phase converters. DPFC is mainly used because it is distributing the power through distributing series converter. Control circuit of the DPFC is designed by using series connected voltages and the branch currents. In this DPFC device the third harmonic frequency is the major control loop with DPFC series converter control. It is highly reliable, high controllability and the cost of DPFC is low compared with the UPFC. Maximum Power Point Tracking (MPPT) is used for maximize the power output from solar and wind system. Particle Swarm Optimization is normally used to improve the efficiency of the power system and simplicity. Quantum Particle Swarm Optimization algorithm is used for solving complex problems both in constrained and unconstrained problems. QPSO algorithm is used on MPPT (Maximum Power Point Tracking). Renewable source like solar and wind system will have power quality problems are cleared by using FACTS device. The proposed QPSO algorithm is implemented in MATLAB/SIMULINK results are proved that power quality in power systems is maintained.**

***Index Terms*— Distributed Power Flow Controller, Unified Power Flow Controller, Maximum Power Point Tracking Technique, and Quantum Particle Swarm Optimization Technique**

## I. INTRODUCTION

Particle swarm optimization (PSO) important & widely used population based stochastic algorithm.PSO is computationally inexpensive & its implementation is straight forward. Proposed a variant of PSO, quantum behaved PSO (QPSO) algorithm, which is theoretically proved to be global convergent using Markov process. The global convergence of QPSO guarantees to find the global optimal solution upon unlimited number of search iterations. Thus QPSO is also likely to be trapped in local optima or with slow convergence speed when it is used to solve complex problems.

In cuckoo search optimization (CSO) is used for robust and optimal power system stabilizer (PSS) for the design of Multi-Machine Power System (MMPS). In this paper, Genetic Algorithm (GA), Particle Swarm Optimization (PSO) and the Harmony Search Optimization are used [1]. The performance of cuckoo search optimization power system stabilizer (CSOPSS) is found to be better than other types of controller. The global convergence guaranteed algorithms like Quantum behaved Particle Swarm Optimization will outperforms original of PSO in search ability [2].QPSO will have improved and has faster convergence speed and it has good performance. This method has good global searching ability and more efficient parameter to enhance the performance of QPSO. FACTS device are used to control the power flow of power transmission system and hybrid PSO algorithm is used to solve the multi objective optimization problem [3]. Hybrid PSO algorithm is used to optimize the location of UPFC in power system and performance of the method is to reduce total system and power loss.

Swarm Intelligence in particle Swarm Optimization (PSO) is used to improve the simplicity and efficiency [4]. Normally standard Particle swarm Optimization will have two demerits like stuck at local maxima and premature convergence. Hybrid PSO method have developed and used in many applications to overcome the efficiencies of standard PSO algorithm. The numerous applications are high clustering analysis, web usage mining, image segmentation, wireless sensor networks, stock market prediction. QPSO algorithm uses interpolation based operator for generating a new solution in the search space. QPSO and BPSO (Basic Particle Swarm Optimization) are compared and the better choice is chosen as QPSO because of the contemporary Optimization Algorithm [5]. QPSO is used for solving more complex problems in constrained and unconstrained optimization problems [6]. In this paper power quality problems in power systems with DC and renewable source are cleared by using FACTS device.

FACTS device are used to control the power quality problems such as instability and detection of faults. Here power devices like D-STATCOM, UPQC, UPS, TVSS, DVR used for micro grid systems. By using this it give high reliability and simple arrangement [6]. Solar and wind system will have some power quality problems are monitor and found for the most effective and high reliability maintenance. Now a days the transmission lines is getting increasing for more usage and it create the power efficiency. We are using electronics, rectifiers, frequency transducer, inverters etc [7]. Problem occurs in the system are monitored, and then reduce the harmonics for the harmonics in the distributed system [7]. By placing smart meters the cost of

**Dr.B.GOPINATH**, B.E. Electrical and Electronics Engineering, Master Degree M.E. (Power System), Professor and Head of Department of Electrical and Electronics Engineering, Vivekanandha College of Engineering Women [Autonomous], Tiruchengode.

**P.MADHUMATHI PG scholar., M.E** in Vivekanandha College of Engineering For Women, B.E [ Electrical and Electronics Engineering ] in Panimalar Institute of Technology

energy is also measured. Level of harmonics is reducing by using FACTS device in the system.

Dynamic statistical process control is used to the limit of power quality data. Statistical process control (SPC) is a known as monitor behavior and control the process of parameter by statistical analysis [8]. Power quality problems depend on the usage of load in day to day life and time of year. It will highlight issues in the grid and help to eliminate the false positives. This is known as dynamic limits. Micro grid also has power quality problems it will utilize the voltage and current unnecessary to control the wastage or excess flow of voltage and current are controlled by using controllers [9]. In the proposed work of D-STATCOM will clear the various linear and nonlinear load switching, unbalanced and balanced problems with fault conditions in micro grid. Hybrid Particle Swarm Optimization Algorithm (HPSO) is used with Genetic Mutation to improve the process of PSO in the mutation method. PSO methods will be convergence speed, solution quality, and it has ability to find the problem global and stability is maintaining [10]. It will solve the optimal problems in the system. Normally these methods have good balance between the load and global searching abilities.

## II. HYBRID SYSTEM:

### *A. PHOTOVOLTAIC CELL:*

Conversion of light energy in electrical energy is based on a phenomenon called photovoltaic effect. When semiconductor materials are exposed to light, the some of the photons of light ray are absorbed by the semiconductor crystal which causes a significant number of free electrons in the crystal. This is the basic reason for producing electricity due to photovoltaic effect. Photovoltaic cell is the basic unit of the system where the photovoltaic effect is utilized to produce electricity from light energy. Silicon is the most widely used semiconductor material for constructing the photovoltaic cell. The silicon atom has four valence electrons. In a solid crystal, each silicon atom shares each of its four valence electrons with another nearest silicon atom hence creating covalent bonds between them. In this way, silicon crystal gets a tetrahedral lattice structure. While light ray strikes on any materials some portion of the light is reflected, some portion is transmitted through the materials and rest is absorbed by the materials.

The same thing happens when light falls on a silicon crystal. If the intensity of incident light is high enough, sufficient numbers of photons are absorbed by the crystal and these photons, in turn, excite some of the electrons of covalent bonds. In a trivalent impurity doped semiconductor, a significant number of covalent bonds are continually broken to complete other incomplete covalent bonds. When one bond is broken one hole is created in it. When one bond is completed, the hole in it disappears. In this way, one hole appears to disappear another neighbor hole. As such holes are having relative motion inside the semiconductor crystal. In the view of that, it can be said holes also can move freely as free electrons inside semiconductor crystal. As each of the holes can accept an electron, the trivalent impurities are known as acceptor dopants and the semiconductors doped with acceptor dopants are known as p-type or positive type semiconductor.

In n-type semiconductor mainly the free electrons carry negative charge and in p-type semiconductor mainly the holes in turn carry positive charge therefore free electrons in n-type semiconductor and free holes in p-type semiconductor are called majority carrier in n-type semiconductor and p-type semiconductor respectively.There is always a potential barrier between n-type and p-type material. This potential barrier is essential for working of a photovoltaic or solar cell. While n-type semiconductor and p-type semiconductor contact each other, the free electrons near to the contact surface of n-type semiconductor get plenty of adjacent holes of p-type material. Hence free electrons in n-type semiconductor near to its contact surface jump to the adjacent holes of p-type material to recombine. Not only free electrons, but valence electrons of n-type material near the contact surface also come out from the covalent bond and recombine with more nearby holes in the p-type semiconductor.

The thickness of these negative and positive charge layer increases up to a certain extent, but after that, no more electrons will migrate from n-type semiconductor to p-type semiconductor. This is because; while any electron of n-type semiconductor tries to migrate over p-type semiconductor it faces a sufficiently thick layer of positive ions in n-type semiconductor itself where it will drop without crossing it. Similarly, holes will no more migrate to n-type semiconductor from p-type. If light strikes on n-type semiconductor the electrons from such light-generated electron-hole pairs are unable to migrate to the p-region since they are not able to cross the potential barrier due to the repulsion of an electric field across depletion layer. At the same time, the light-generated holes cross the depletion region due to the attraction of electric field of depletion layer where they recombine with electrons, and then the lack of electrons here is compensated by valence electrons of p-region, and this makes as many numbers of holes in the p-region. As such light generated holes are shifted to the p-region where they are trapped because once they come to the p-region cannot be able to come back to n-type region due to the repulsion of potential barrier.

As the negative charge (light generated electrons) is trapped in one side and positive charge (light generated holes) is trapped in opposite side of a cell, there will be a potential difference between these two sides of the cell. This potential difference is typically 0.5 V. This is how a photovoltaic cells or solar cells produce potential difference.

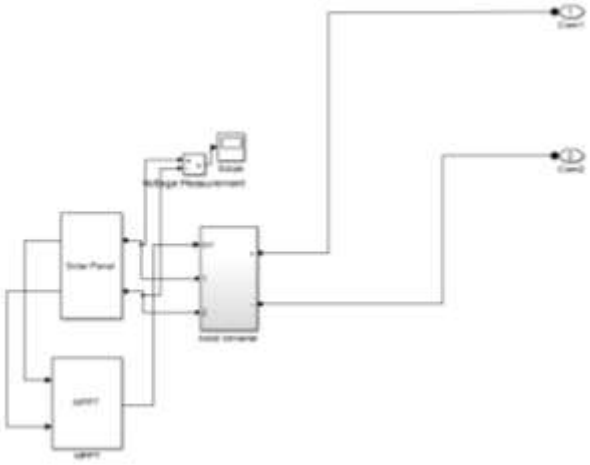

Fig.1.simulation diagram of solar system

### B. *WIND SYSTEMS:*

Wind energy is a part of renewable energy system. Wind turbines are used to converts kinetic energy into mechanical energy by using generator, which converts mechanical energy into electricity. Wind turbines of wind systems are connected to gear box. The gear box has the electrical- mechanical interface. The output of the gear box is given to the Permanent Magnet Synchronous Generator (PMSG), which produces AC output. AC output is given to the coupling capacitor to combine with the solar system. The DC output from solar is converted into AC by use of converter .The output of wind turbine generator depends on the wind speed and its depends on weather condition. The wind turbine system contains several nonlinearities because of wind flow. When a wind turbine uses its pitch controller to counteract utility grid frequency oscillations, its output power varies between maximum, or rated power, and zero power. The pitch system, which turns the pitch angle according to wind speed, introduces nonlinearity.

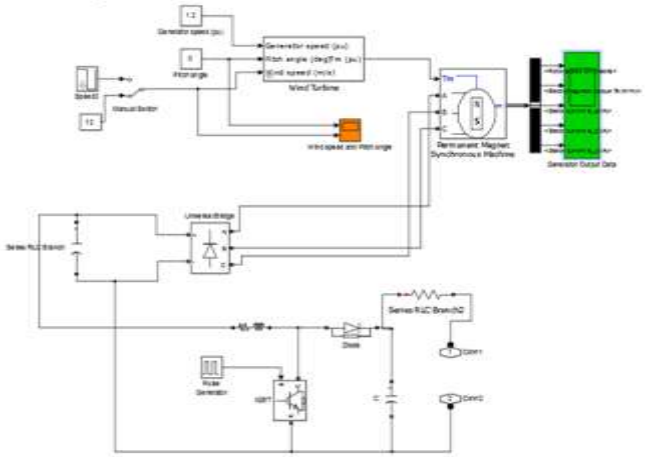

Fig. 2. Simulation diagram of wind system

### C. *SOLAR-WIND HYBRID ENERGY SYSTEMS:*

Hybrid power system combines solar and wind energy. The hybrid system is combination of photovoltaic (PV) array, wind turbine. Hybrid power system has several advantages over single system. In hybrid power system output of solar and wind energy system are added together in parallel in order to compensate absence of any one energy system. Solar and wind energy system can work individually or together.

## III. TECHNIQUES AND ALGORITHM:

### A. *MAXIMUM POWER POINT TRACKING (MPPT):*

When a solar PV module is used in the input side of the hybrid system, the operating point is decided by the load. The solar radiation varies throughout the day, so operating point changes respectively. A special method called Maximum Power Point Tracking (MPPT) is used for maximum power transfer at the output side. Maximum Power Point Tracking uses the algorithm and an electronic circuitry. Maximum power point (MPP) is extracted from the renewable source i.e., solar and wind energy. The output power of the solar module is input to the algorithm. Maximum power point tracking (MPPT) used increases the efficiency of solar photovoltaic (SPV) system. The proposed machine has the prominent advantages of high reliability. The MPPT demands speed control which is realized using vector control of the rotor side converter

### B. *QUANTUM BEHAVED PARTICLE SWARM OPTIMIZATION:*

Quantum behaved particle swarm algorithm is first introduced by Sun et al. Quantum behaved particle swarm optimization algorithm introduces quantum computing into the particle swarm algorithm, starting from the mechanical point of view that the particle in the space has quantum behavior. The algorithm overcomes the disadvantages while preserving the advantages of particle swarm algorithm, which can effectively improve the performance of optimization algorithms.

Research on the quantum particle swarm optimization mainly focuses on the following three aspects: The first one is proof theoretic research, the second one is to improve the contraction expansion factor, and the third one is combined with other algorithms. In proposed quantum particle swarm algorithm for the combinational logic circuit quantum mechanical particle swarm algorithm based on electromagnetism and is used to optimize the electromagnetic aspects.

Quantum particle swarm optimization (QPSO) is in the field of medical image watermarking for copyright protection and authentication. The trade-off between the imperceptibility and robustness is one of most serious challenges in digital watermarking system. Image watermarking can be considered as an optimization problem by utilizing human visual system characteristics. QPSO algorithm in adaptive quantization index modulation and singular value decomposition in conjunction with discrete wavelet transform and discrete cosine transform. In the literature a modified and efficient version of the QPSO combined with chaotic sequences (CQPSO) is proposed and evaluated.

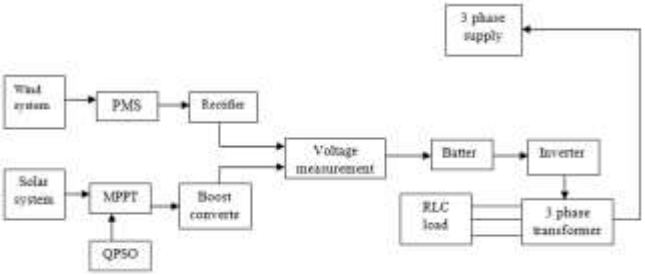


Fig . 3 Block diagram of Dynamic performance of DPFC in hybrid system

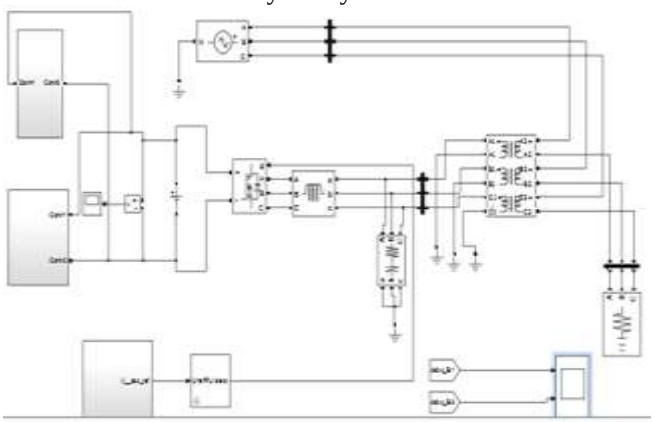

Fig . 4. Over all simulation diagram QPSO algorithm in MPPT technique in hybrid system

An improved dynamic clustering algorithm was presented, which combines the quantum particle swarm algorithm with -means algorithm by improving the encoding of quantum particles and the introduction of new distance metric rules. The algorithm has a quantum behaved particle swarm global search capability. In order to accelerate the convergence speed, the -means algorithm is used to optimize every particle. Through the adjustment of the value of the fitness function, our algorithm can search for the optimal clustering number of clusters, so the number of clusters and centers is not subject to subjective factors. Extensive experiments verified the effectiveness of the algorithm.

Based on quantum evolutionary algorithm and particle swarm optimization, a quantum particle swarm evolutionary algorithm is proposed. In this algorithm, quantum angle is used to represent the quite, new method learning from the idea of particle swarm algorithm which is presented to determine rotation angle. The gate is taken to prevent premature convergence. Analytical optimization techniques suffer from slow convergence in complex solution space. Heuristics-based swarm intelligence is an efficient alternative to analytical optimization techniques. The particle swarm optimization approach is utilized for better and efficient nano device modeling.

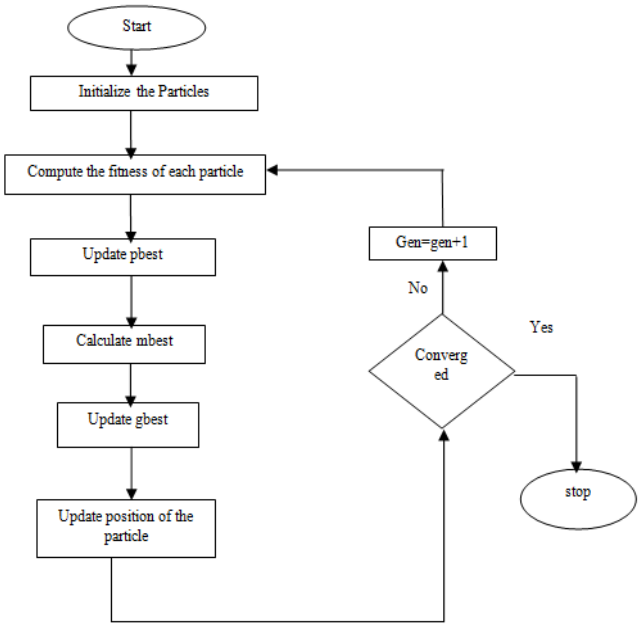


Fig .5. Flow chart of Quantum Particle Swarm Optimization Algorithm

Quantum particle swarm algorithm is proposed by Sun et al. With the help of DELTA potential well, the particle swarm optimization algorithm is applied to the quantum space. Assume that the dimension of quantum space has a population, which consists of particles. Location of the particle is, and the particle through the history of the best location is; after all the particles of the best historical position is quantum particle swarm optimization: Among them, the iteration number of algorithm is the contraction expansion factor and is the only parameter of quantum particle swarm algorithm. In order to avoid the premature convergence, Sun et al. improved quantum particle swarm algorithm, introducing best in the algorithm. That is, where the best position of the particles and is the number of particles. "Best" find the average best location of particles and solve problems based on the dimension of the variable.

## IV. ALGORITHM FLOW

Step 1. Initialize algorithm parameters (population size , particle dimension , the maximum number of iterations MAXGEN), population initialization, initialization particles history , and global history optimal value .
Step 2. Evaluate individual fitness value.
Step 3. Update the optimal population in history. The particle's fitness is better than the particle history itself, with the current value of the replacement; otherwise, the history optimal particles remain unchanged.
Step 4. Update the history global optimal particle in a population, the best fitness value of all the particles in the population.
Step 5. Update particles by using quantum behaved particle swarm optimization algorithm formula, all the particles in space.
Step 6. If the algorithm reaches the maximum number of iterations, then output the optimal solution, and the algorithm terminates; otherwise, continue to implement the Step 2.

## V. SIMULATION RESULTS:

Principle and operation of Distributed Power Flow Controller is demonstrated using MATLAB. DPFC facts device is used in the hybrid system in the maximum power point tracking technique by using QPSO algorithm for improved of power quality performance. The simulation results and waveforms are shown below in the performance of DPFC device.

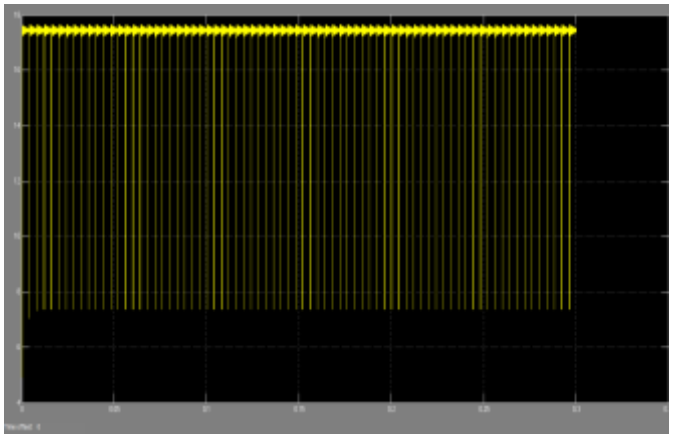

Fig . 6. Output waveform of solar system

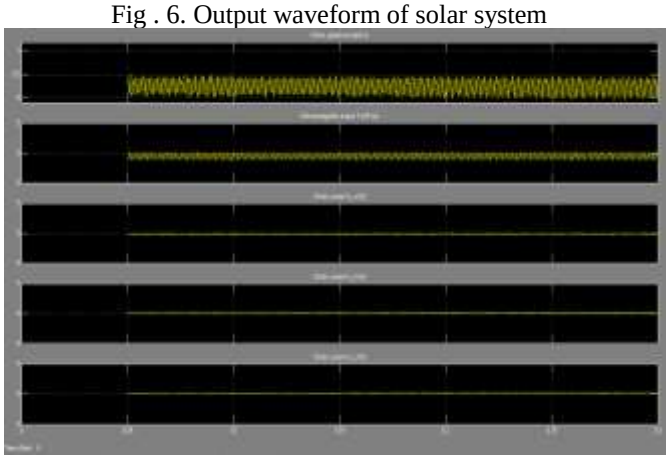

Fig .7. Output waveform of wind system

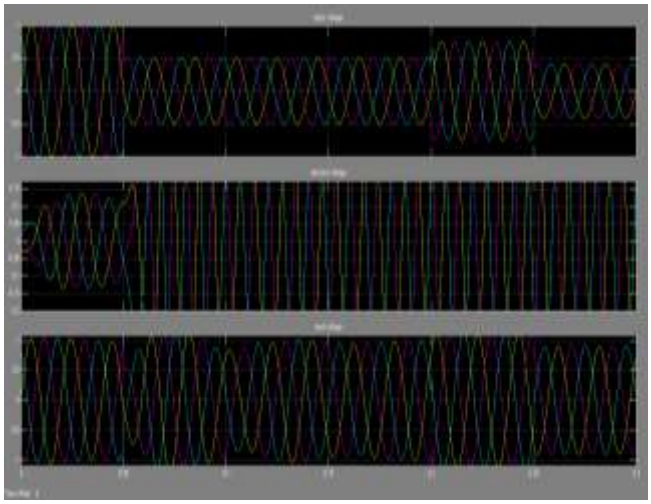

Fig .8. Overall output waveform by using QPSO algorithm

## VI. CONCLUSION:

QPSO algorithm gives the separated and ideal performance in the search ability, accuracy and robustness. The proposed method is used for solving complex problems in constrained and unconstrained problems. It has good performance of solving problems in the power systems. Improves the optimization performance and the efficiency of the power system. By using PSO algorithm and DPFC device the total system cost is reduced. Power quality enhancement like QPSO technique and FACTS device DPFC was successfully verified by MATLAB program and simulation results.

## REFERENCES:

[1] .Dhanraj Chitara , K. R. Niazi , Anil Swarnkar , Nikhil Gupta , " Cuckoo Search Optimization Algorithm for Designing of Multi-machine Power System Stabilizer " in IEEE Transactions on Industry Applications 2018.

[2] Maolong Xi , Jun Sun, Wenbo Xu " An improved quantum-behaved particle swarm optimization algorithm with weighted mean best position " in Applied Mathematics and Computation , 2008.

[3] Pinki Yadav, P.R.Sharma , S.K.Gupta " Bat Search Algorithm Based Hybrid PSO Approaches to Optimize the Location of UPFC in Power System " in International Journal on Electrical Engineering and Informatics-vol 7, num 3, Sep 2015.

[4] Stuti karola , Veenu mangat "Use of particle swarm optimization in hybrid intelligent systems " in Journal of Information and Operations Management ISSN: 0976–7754 & E-ISSN: 0976–7762 , Volume 3, Issue 1, 2012, pp-293-296.

[5] Millie Pant,Radha Thangaraj,Ajith Abraham "A New Quantum Behaved Particle Swarm Optimization" in *GECCO'08*, July 12--16, 2008, Atlanta, Georgia, USA.

[6] Eklas hossain , Mehmet rida ,Sanjeevikumar Padmanaban , Selim, and Imtiaj khan "Analysis and Mitigation of Power Quality Issues in Distributed Generation Systems Using Custom Power Devices" in IEEE access vol 6 , 2018.

[7] Konstantin Suslov, Nafisa Solonina, Dmitry Gerasimov "Assessment of an Impact of Power Supply Participants on Power Quality " in 978-1-5386-0517-2/18/$31.00 ©2018 IEEE.

[8] Thomas A. Cooke ,William R. Howe "Dynamic Statistical Process Control Limits for Power Quality Trend Data" in IEEE 978-1-5386-0517-2/18/$31.00 ©2018 .

[9] Mehdi Bagheri ,Venera Nurmanova1, Oveis Abedinia , and Mohammad Salay Naderi "Enhancing Power Quality in Microgrids With a New Online Control Strategy for DSTATCOM Using Reinforcement Learning Algorithm " in IEEE access 2018.

[10] Ahmed A. A. Esmin and Stan Matwin "HPSOM: A Hybrid Particle Swarm Optimization Algorithm with Genetic Mutation "International Journal of Innovative Computing, Information and Control ICIC International c 2013 ISSN 1349-4198 Volume 9, Number 5, May 2013.

Dr.B.GOPINATH received the Undergraduate Degree B.E. (Electrical and Electronics Engineering) 2002 in Government College of Engineering, Salem from the Madras University. He completed his Master Degree M.E. (Power System) in 2004 at Annamalai University, Chidambaram. He completed his Ph.D. degree in the area of Power Flow Controller at Anna University, Chennai. He is having 15 years of teaching experience. He is a Professor and Head of Department of Electrical and Electronics Engineering, Vivekanandha College of Engineering Women [Autonomous], Tiruchengode. He has published 35 papers in International, National journals and Conference proceedings. Life Member in International Association of Engineers (IAENG) and Life Member in Indian Society of Systems for Science and Engineering (ISSE).

**P.MADHUMATHI PG scholar., M.E** in Vivekanandha College of Engineering For Women (2017-2019) ,compelted B.E [ Electrical and Electronics Engineering ] in Panimalar Institute of Technology with 79%, HSC in VIB Higher Secondary School with 88%, SSLC in Vivekanandha Matriculation Higher Secondary School with 85%. Published 4 papers in Journals.