COMPARATIVE ANALYSIS UPQC WITH PARTICLE SWARM BASE FUZZY CONTROL AND ANT COLONY OPTIMIZATION

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***Abstract*-**Power quality is one of the major problems in the present time. It is very necessary to introduce the sophisticated devices which improve the power quality and sensitivity. The power quality problem is mainly occurs due to fluctuations in the voltage, current and frequency and results in disturbance in performance of the end of use equipment. The aim of UPQC is to combine a series-active and shunt-active filter which resolves the problem of negative-sequence current and harmonics. In this paper, the use of fuzzy logic with swarm intelligence approach is discussed and proposed a new UPQC system. This system reduces the sag and harmonic distortion. The PSO is used to optimize the reference signal which is generated by the fuzzy logic controller. The proposed work is done on the MATLAB/ Simulink environment. The results and output received on this is used for the analysis. It is seen that the proposed fuzzy with PSO controller is better than the existing approaches in minimizing the sag and harmonic distortion. The fuzzy logic with swarm based algorithm is used mostly due to their simplicity and has the ability to tackle the complex system. In this research, the fuzzy logic controller with swarm intelligence is utilized for the generation of reference signal controlling the UPQC. To enable this, a systematic approach for creating the fuzzy membership functions is carried out by using an ant colony optimization technique for optimal fuzzy logic control.

I. INTRODUCTION

The electric power is generated and distributed to the user at the long distance from the generation plant. This distribution of power called as a distributed generation because different electrical devices are connected to the distribution line for effective flow of power. By using these devices voltage flickering, transient, distortion and harmonics occur and reduce the power quality. The problem like voltage sag is very common on the distribution line and its effects on the sensitive load are high [1]. Dynamic voltage restorer is an alternative to solve this problem and it is connected between the supply and critical load feeder. DVR protects the sensitive loads from the voltage sags problems. DVR provides the balanced voltage and sinusoidal at the desired value to maintain the voltage sags. These issues of power are solved by using the unified power quality conditioner (UPQC). UPQC is basically a combination of series active power filters and shunt active power filters. UPQC has the quality to deal with the problem of voltage and current simultaneously. The active power filters (APF) in the UPQC compensate the harmonic current and maintain the DC-link voltage by controlling the voltage sags. Basically it keeps the load voltage at a constant level and helps when the unbalanced distribution of power is occurs [2].

The UPQC is used with different types of configurations to improve the power quality and reduce the voltage related problem. The main problem occurring in the power distribution system is voltage sags, swells, harmonics, hysteria and non-linearity in loads. The performance of the UPQC is enhanced by using different methods proposed by the researchers. These methods help to select the efficient method of power quality improvement. The A.K Panda et al. proposed a UPQC which is based on the SRF (Synchronous Reference Frame) based Power Angle Control (PAC). This controller improves the voltage harmonics profile and source current and provides an effective approach to compensation of sag, swell and unbalanced conditions of voltage [3].

Paper Structure: Section II of the paper describes the related study of the unified power quality conditioner (UPQC) and Section III describes the proposed methodology its flow chart and algorithm. Section IV describes the Results of the proposed approach and existing approach in graphical form with description. The last section of the paper presents the conclusion of work.

II. RELATED STUDY

In this section of the paper, we discuss the latest approaches and methods that are used by the researchers. The related study helps to make our approach more effective.

Chen, Xinran, et al. [4] worked on improving the quality of the grid current in the inverter. It reduces the problem of distortion that occurs due to the low frequency in the harmonic components in the output voltage. The proposed method introduces the virtual series impedance that increases the output impedance of the inverter connected to the network. The result of the proposed work using an inverter connected to the single-phase network shows the efficiency [4]. Abu-Jalala, et al. used active power filters to improve the power quality of synchronous generators. Active power filters are connected in the parallel with load at the point of common coupling. The filters in this work are used with generators to improve the performance. These filters are also used to regulate the output voltage in synchronous generators. The APF also improved the transient response when the load is sudden changed. The results of this work show that it reduced the end windings length by placement of automated coil winding [5]. Sahoo, worked on the improvement of power quality in DC micro grids by using the approach Repetitive Learning based PLL method. The proposed work overcomes the issue related to harmonic components which are presents in grid current. In this type of network it leads to distortion in voltage and leads stability. The harmonic estimation is done by using Lyapunov-based approach. The computational burden is deal with help of low-computing alternative model of the proposed strategy. The performance of the proposed work is compared with SRF_PLL and gives better performance [6].

Hock, et al.[7] proposed a voltage regulator which improves the power quality in low voltage distribution Grid. In this power stage consist of 3-phase voltage source inverter and second order low-pass filter. In control strategy 3 voltage loop with active damping and 2-dc voltage loops. The proposed work is based on frequency loop and minimum power point tracking. The feature of frequency loop allows the voltage regulator to be independent of the grid information. The results of the proposed approach show better stability on linear and nonlinear nodes. Rao, et al. [8] introduced the approach for power improvement by using UPQC with fuzzy controller. The enhancement in the power system complexity is also increased. The problem is solved by using custom power devices in Dual UPQC. In this type of UPQC there is no need of coordinate transformation and it reduces the complex calculation. This work is basically based on the improvement of power quality problems in distributes systems. The proposed approach provides the better power quality. Vijayasamundiswary and Baskaran [9] proposed a new UPQC switch for the improvement of the quality of energy. This method reduces switching overhead, less switching, less losses and reduced cost. This proposed system acts as a back-to-back converter like a shunt filter and a serial filter. This method is based on the particle swarm optimization algorithm that is used for optimized results. The result of the proposed system shows that it is tested on linear and nonlinear loads. Samal, Sarita, and Prakash Kumar Hota, [10] in this paper, the author discussed the problem related to the non-linear loads which decrease the source voltage. These problems are mainly sag, swell and voltage imbalance. All the problems are overcome by using the UPQC because it maintains the voltage and provides the better performance. In this work wind energy is used to feed in DC Capacitor to maintain the voltage level.

III. PROPOSED WORK

The proposed approach is based on the Particle swarm Optimization algorithm in which all the working is based on the biological behavior of the ants. This algorithm helps to find the shortest paths to food. The real ant communicates with the help of pheromones and finds the shortest distance between nest and food. By using the concept of PSO the proposed work is integrate with Fuzzy logic for effective response. The next part of the paper presented the flowchart of the proposed work.

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 logic for partially and partially false condition.

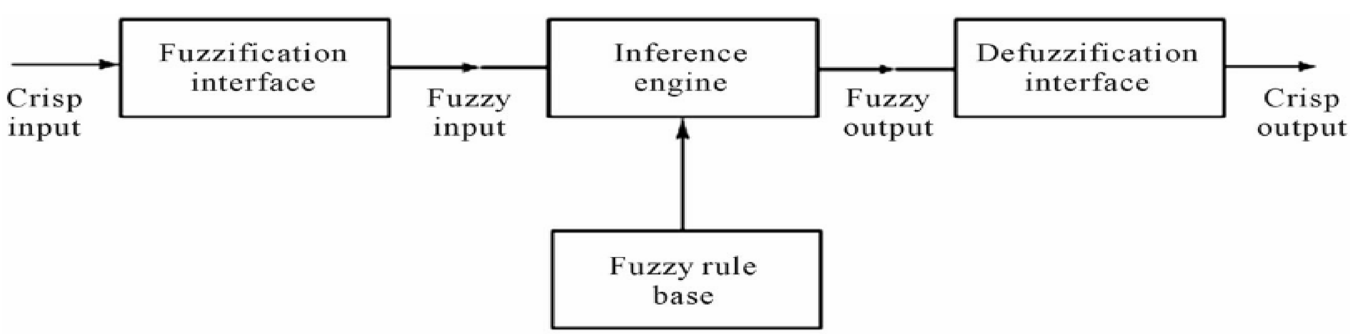

Fig.2:Fuzzy Logic Architecture

A. *Fuzzification*-This system converts the crisp input into fuzzy sets and then this input is send to inference engine.

B. *Inference Engine*-It is used for matching degree for the crisp input and then rule according to input field.

C. *Defuzzificatio*-It changes the fuzzy set from the inference engine into the crisp value for output.

4.2.2 Particle Swarm Optimization

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

Algorithm PSO

Step1: In PSO model for each particle i in S do

Step2: for each dimension d in D do

Step3: //initialize each particle's position and velocity

Step4: $x_{i,d}$ =Rnd(xmax,x_{min})

Step5: vi,d=Rnd(-vmax /3, vmax/3)

Step6: end for

Step7: //initialize particle's best position and velocity

$$vi(k+1) = vi(k) + \gamma 1i(pi - xi(k)) + \gamma 2i(G - xi(k))$$

New velocity

$$xi(k+1) = x\, i\, (k) + vi\, (k+1)$$

Where

i- index of particle

k- index of discrete time

v_i – i^{th} particle velocity

x_i –i^{th} particle position

p_i- best position found by i^{th} particle(personal best)

G- best position found by the swarm

(global best, best of personal bests)

G $_{(1,2)i}$- random number over the interval[0,1]applied to the i^{th} particle

Step8: pbi=xi

Step9: // update global best position

Step10: if f(pbi) < f(gb)

Step11: gb=pbi

Step12: end if

Step13: end for

IV. RESULTS AND DISCUSSION

This chapter gives a detail on performance evaluation process by the obtained results on different number of vehicles. The parameters for the performance are also discussed in this chapter. The graphs shown in the chapter represents the performance of the existing and proposed approach.

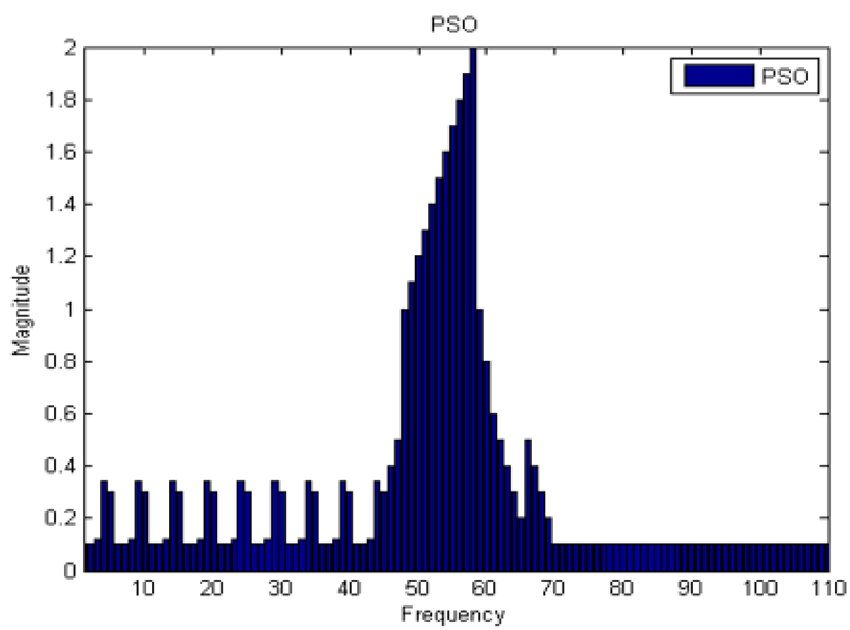

Fig.3:Output of the PSO with Fuzzy algorithm

The figure 3 presents the output of the fuzzy algorithm. The X-axis of the graph show frequency and Y-axis show magnitude values. The Fuzzy value on the frequency 45-70 is higher and the value is stable from 70-110 frequency.

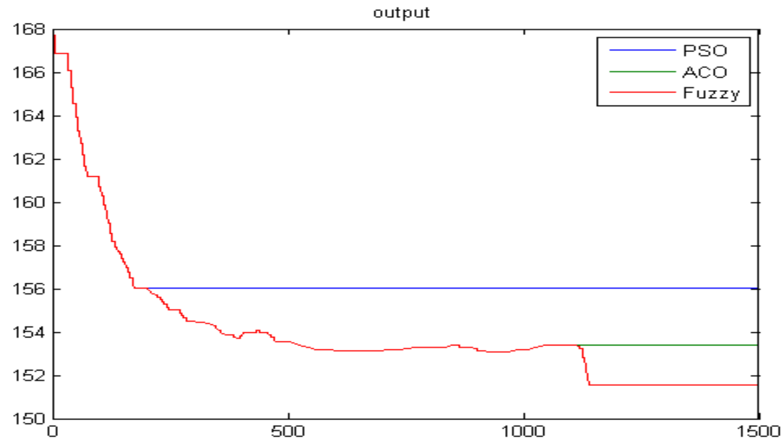

Fig.4:Output of the three algorithms

The aforementioned figure 4 represents the output of the fuzzy algorithm, ACO with fuzzy algorithm and PSO fuzzy algorithm. The X-axis of the graph show iteration and Y-axis show quality values. The Red curve represents the Fuzzy, Green represents the ACO and Blue curve represents the PSO. The stability in the output of PSO shows the effectiveness of outcomes in this figure.

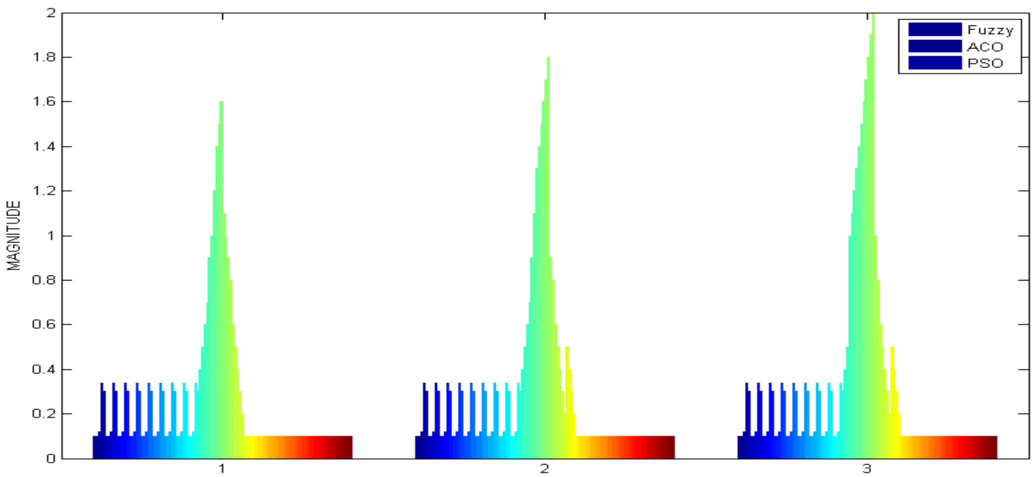

Fig.5:Comparison of results of different algorithms.

In figure 5 it depicts the outcomes of the three algorithms fuzzy algorithm, ACO with fuzzy algorithm and PSO fuzzy algorithm. The magnitude of the PSO with fuzzy is effective among all and gives best outputs.

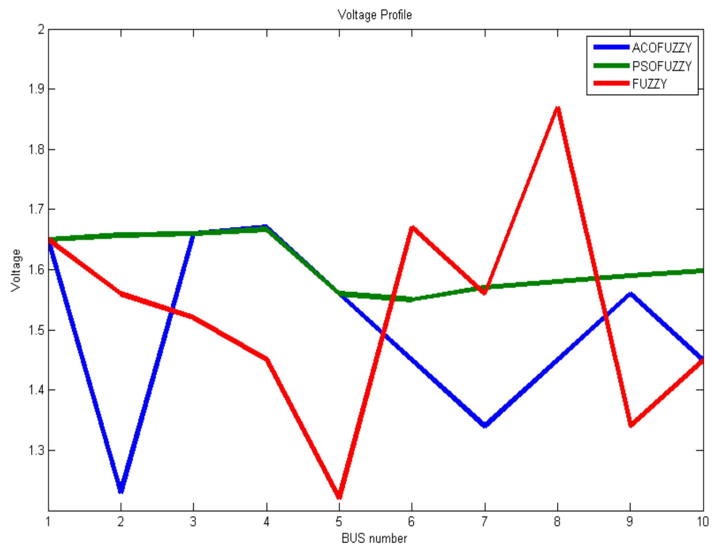

Fig.6:Voltage profile comparison of different Algorithms.

In figure 6: Comparison of the Fuzzy, PSO Fuzzy and ACO Fuzzy is presented. This comparison shows the voltage profile of the different algorithms which is based on the bus number and voltage. The voltage stability in the PSO Fuzzy is more than other two algorithms because in fuzzy and ACO Fuzzy is more fluctuating.

V. CONCLUSION AND FUTURE SCOPE

The proposed work is done by using fuzzy logic with swarm intelligence approach and proposes a new UPQC system. This system reduces the sag and harmonic distortion. The PSO is used to optimize the reference signal which is generated by the fuzzy logic controller. The proposed experiment is done on the MATLAB/ Simulink environment. The results and output received on this is used for the analysis. The proposed fuzzy with PSO controller is better than the existing approaches in minimizing the sag and harmonic distortion. The whole process is enabling by using fuzzy membership functions and optimize by swarm optimization algorithm. The main aim of using the swarm algorithm is to minimize the voltage imbalance and harmonic distortion. The reactive power and negative-sequence current parameters will be considered in the near future.

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