ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 5, Issue 5, May 2016**

# Energetic Designing of Fault Analysis Model Using Cat Swarm Optimization with DPFC Implementations

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**ABSTRACT:** The main aim of the proposed work is to experimentally prove the efficiency of Cat Swarm Optimization Technique with Distributed Power Flow Correction (DPFC). The DPFC consists of AC-DC Serial Converter as well as Shunt Converter. Serial Converter, which connects the AC to DC converters serially and makes the fine AC output, that AC output is feeded back to IEEE-16 bus system. Each bus system consists of Cat Swarm, which monitors the incoming and outgoing voltages. If it finds any fault condition over the block it immediately notified by means of MATLAB Simulink Model. Shunt Converter, which connects the AC to DC converters parallely and it contains transformers as well as bridges, which converts DC voltage to AC voltage and given back to the transmission line. In this system we form IEEE-16 Bus System, in that one bus acts as a master, which gives power supply to all the other buses. Each bus is connected in different logic to get different output power based on the RLC load. If any fault condition occurs into the bus system, Cat Swarm algorithm identifies the fault over the buses and informs that via resulting scopes. The Cat Swarm algorithm efficiency is compared against the genetic algorithm along with DPFC model. The experimental results prove that the Cat Swarm Optimization Algorithm with DPFC improves the power factor and identify the fault conditions better than the genetic algorithm with DPFC.

**KEYWORDS***:* Cat Swarm Optimization, Genetic Algorithm, DPFC, UPFC, AC-DC, IEEE-16 Bus System, Power Flow Correction, Shunt Converter, Series Converter.

## I. INTRODUCTION

The main objective of the system is to experimentally analyze the fault over the bus system and prove the efficiency of Cat Swarm Optimization with Distributed Power Flow Correction (DPFC) as well as compare that with Genetic Algorithm and prove CSO is better than GA. Voltage dependability is the capacity of a force framework to keep up relentless voltages at all buses in the framework under typical working conditions, and subsequent to being subjected to an unsettling influence. In the event that the transport does not keep up the consistent state esteem it is called as the voltage precariousness that may bring about the type of a dynamic fall or ascent of voltages at those transports. Power System Load demonstrating is a strategy used to display the force framework and vital for voltage strength examines. In this paper, we are attempting to investigate displaying parameters of different burdens for voltage solidness thinks about. We are performing static burden demonstrating study. The exactness and rightness of the outcomes are straightforwardly identified with the heap models utilized as a part of this investigation. The technique is examined utilizing continuation power stream schedule. Truths innovation with a blend of Cat Swarm Optimization heuristic methodology is connected to give an answer for the issue of precariousness because of different burden models. The adequacy of the proposed technique is exhibited through quantitative studies on standard IEEE 16 Bus framework.

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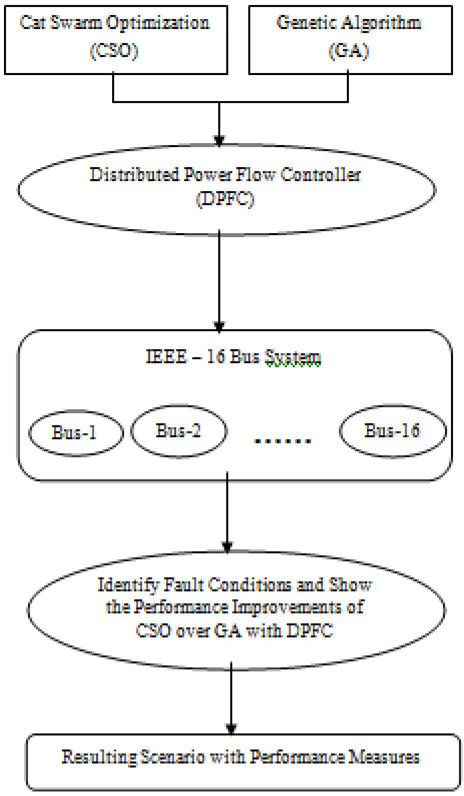


**Fig.1. Cat Swarm Optimization and Genetic Algorithm Work Flow Analysis with DPFC Modeling**

Amid the framework aggravations and their effects on other force framework components, the framework security is jeopardized and the likelihood of moving to the worldwide unsteadiness increments. This will typically make a force framework to separate in the segregated sub-frameworks known as islands and after that a complete power outage results unless a few safety measures are considered. Voltage Stability additionally termed as Load Stability is one of the worries in force frameworks which are intensely stacked, blamed or having a deficiency of receptive force. The issue of voltage soundness concerns the entire force framework, in spite of the fact that it as a rule has an expansive association in one basic region of the force framework. Case of the late monstrous dark out of India's energy framework was the most exceedingly awful in the decade, three out of the five territorial force lattices broken down leaving around 670 million individuals feeble making July 2012 as the biggest power outage month ever. In the first place, the Northern Region Grid gave way at around 2.35 am on 30th July, 2012 because of expanded load and brace unsettling influence leaving nine conditions of Northern India frail including Delhi, the capital of India. Almost 350 million individuals endured because of this force blackout which came about for around a day.

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## II. CAT SWARM OPTIMIZATION (CSO)

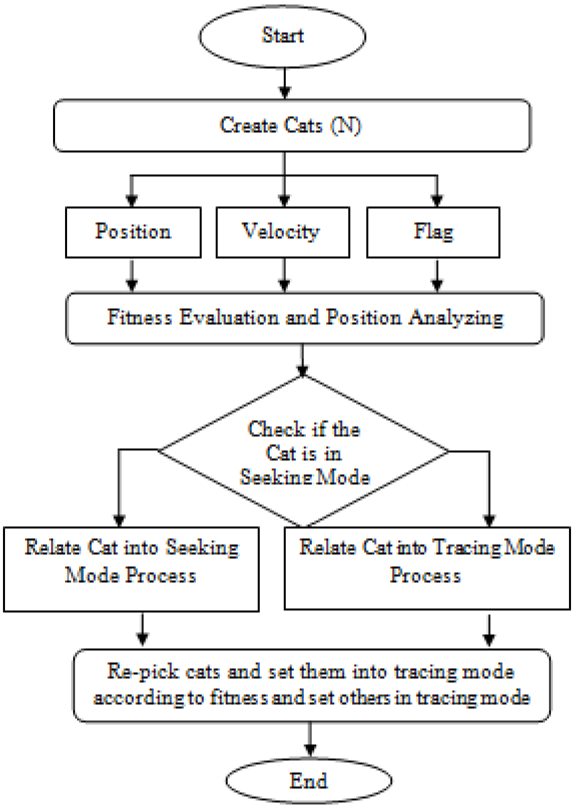


**Fig.2. Cat Swarm Optimization Algorithm Flow Design**

Optimization systems discover an assortment of utilization in numerous fields. The utilization of these strategies in force frameworks is assuming an essential part for the ideal area of FACTS gadgets. In the field of enhancement, numerous calculations were being proposed in the later past. To give some examples, Genetic Algorithm [GA], Ant Colony Optimization [ACO], Particle Swarm Optimization [PSO], Simulated Annealing [SA] and so on. Some of these advancement calculations were produced in view of swarm insight. Feline Swarm Optimization in short CSO, the calculation, is propelled from PSO and ACO. As indicated by the writings, PSO with weighting consider as a rule finds the preferred arrangement quicker over the unadulterated PSO, however as per the exploratory results, Cat Swarm Optimization [CSO] displays even much better execution. In Cat Swarm Optimization, we first model the conduct of felines into two sub-models, to be specific, looking for mode and following mode.

**Seeking Mode:**

This sub-model is utilized to display the circumstance of the feline, which is resting, glancing around and looking for the following position to move to. In looking for mode, we characterize four fundamental components: Seeking Range of the selected Dimension [SRD], Counts of Dimension to Change [CDC], and Self-Position Considering [SPC]. SMP is utilized to characterize the span of looking for memory for every feline, which demonstrates the focuses looked for by the feline.

The seeking mode can be described in 5 steps as follows:

**Step1:** Select the total number cats that have to be considered.

**Step2:** For each cat, a fixed range of velocities has to be assumed.

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**Step3:** Calculate the fitness values (FS) of all candidate points.
**Step4:** Select how many cats to be available in seeking mode.
**Step5:** Randomly pick the cat from the total number of cats and apply in seeking mode according to the following equation
.

$$Pkn = [(1 \pm 0.3)\ Rand\ (\ )]*Pk \qquad (7)$$

Where, n = 1, 2, 3, 4, 5….Where Rand ( ): is a random value in the range of [0, 1]. Here, 'P' is the pick-up of the cat from a random number of cats and Pk is the total number of cats available for application.

**Tracing Mode:**

Tracing mode is the sub-model for modeling the case of the cat in tracing some targets. Once a cat goes into tracing mode, it moves according to its own velocities for every dimension. The action of tracing mode can be described in 3 steps as follows:

**Step1:** Update the velocities for every dimension (Vk,d) according to equation.
**Step2:** Check if the velocities are in the range of maximum velocity. In case the new velocity is over range, set it be equal to the limit.
**Step3:** Update the position of catk and again calculate the best fitness value. Proceed till the best fitness value is obtained and correspondingly, the cat location and the velocity.

$$V_{k,d} = V_{k,d} + r1 \cdot c1 \cdot (P_{best,d} - P_{k,d}),\ d = 1, 2, ..., M \qquad (8)$$

Where Pbest,d is the position of the cat, which has the best fitness value. Vk,d is the velocity for every dimension. Pk,d is the position of catk, c1 is a constant and r1 is a random value in the range of [0, 1].

## III. FACTS CONTROLLERS

In the year of 1970's onwards Flexible AC Transmission Systems [FACTS] are being used in the department of power electronics and systems, to improve the dynamic performance of the system. Because of the natural, right of way, and cost issues in both packaged and unbundled power frameworks, numerous transmission lines have been compelled to work at just about their full limits around the world. Actualities controllers upgrade the static execution viz. expanded stacking, blockage administration, decreased framework misfortune, financial operation and so on., and dynamic execution viz. expanded dependability limits, damping of force framework swaying and so on. The idea of FACTS includes a group of quick acting, high power, and electronic gadgets, with cutting edge and solid controls. As of late, a wide range of FACTS controllers have been proposed, performing a wide assortment of capacities. Utilizing FACTS controllers one can control the variables, for example, voltage extent and stage edge at picked transport and line impedance where a voltage breakdown is watched. We are utilizing Unified Power Flow Controller as a part of our application.

## IV. RELATED STUDY

In the paper of "Static load modeling for voltage stability studies with optimal placement of UPFC using cat swarm optimization" the authors quoted about the UPFC implementations in Cat Swarm Optimization methods and its working. In this system, the main concentration is regarding on Voltage stability. Voltage stability is the ability of a power system to maintain steady voltages at all buses in the system under normal operating conditions, and after being subjected to a disturbance. If the bus does not maintain the steady state value it is called as the voltage instability that may result in the form of a progressive fall or rise of voltages at those buses. Power System Load modeling is a technique used to model the power system and essential for voltage stability studies. In this paper, we are trying to analyze modeling parameters of various loads for voltage stability studies. By using this nature of work, we added this as a reference to our paper but slightly modify the flow of work based on DPFC instead of using UPFC. With this modification we can attain more power stability, accuracy and portability.

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In the paper of "Loss Optimization for Voltage Stability Enhancement Incorporating UPFC Using Particle Swarm Optimization", the authors quoted on the placement of the UPFC are the major concern to ensure the full potential of utilization in the transmission network. Voltage stability enhancement with the optimal placement of UPFC using stability index such as modal analysis, Voltage Phasor method is made and the loss minimization including UPFC is formulated as an optimization problem. This paper proposes particle swarm optimization for the exact real power loss minimization including UPFC. The implementation of loss minimization for the optimal location of UPFC was tested with IEEE-14 and IEEE-57 bus system. In this proposed work we use this as a reference to create a efficient power stability and efficiency in power system management criteria. Fuerte-Esquivel and Acha proposed a new and comprehensive UPFC model which is incorporated into an existing FACTS Newton- Raphson load flow algorithm. Critical comparisons are made against existing UPFC models, which show the newly developed model to be far more flexible and efficient.

Lim et al. presented UPFC operation for minimization of delivery cost and power production in normal operation state. The delivery cost due to transmission loss is minimized by active power control of UPFC using uncoupled model of UPFC in power flow. Ambriz-Perez et al. addressed the issue of Unified Power Flow Controller (UPFC) modeling within the context of Optimal Power Flow (OPF) solutions. The nonlinear optimization problem is solved by Newton's method. The solution with several UPFCs can be obtained with equal reliability. Nabavi-Niaki and Iravani outlined an approach for mathematical modeling of unified power flow controller (UPFC) and develop steady-state model, small-signal (linearized) dynamic model, and state-space, large-signal model of UPFC. Fuerte-Esquivel et al. presented a model which is incorporated into an existing Newton-Raphson load flow algorithm. The model can be set to control active and reactive powers and voltage magnitude in any combination. A set of analytical equations has been derived to provide initial conditions. The guidelines are suggested for control coordination between two or more UPFCs.

Radman and Raje presented procedure for steady state power flow calculation of power systems with multiple flexible AC transmission system (FACTS) controllers. Three FACTS controllers namely Synchronous COMpensator (STATCOM), Static Synchronous Series Compensator (SSSC), and Unified Power Flow Controller (UPFC) are studied. Newton–Raphson method of iterative solution is used for power flow equations in polar 5 coordinate. The impacts of FACTS controllers on power flow are accommodated by adding new entries and modifying some existing entries in the linearized Jacobian equation of the same system with no FACTS controllers. Santos et al. outlined a model suitable for including UPFC devices in steady state studies. The proposed model is able to preserve the traditional Newton-Raphson technique.

The model allows easy incorporation of UPFC and automatic UPFC parameters calculation and takes into account the existence of operating limits that cannot be violated. Abdelsalam et al. outlined an algorithm to find the optimal location of the Unified Power Flow Controller in electrical power systems. The algorithm utilizes the steady state injection model of UPFC, a continuation power flow and an optimal power flow. The problem is formulated to find the location of UPFC in order to minimize the generation cost function and the investment on the UPFC device. Farhangfar et al. presented an injection model of UPFC to investigate its effect on power flow and loss reduction in power system. The location of UPFC for loss reduction is obtained by two methods. The first method increases transmission power in lines with low impedances and the second method increases the transmission power in transmission lines with impedances.

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## V. EXPERIMENTAL RESULTS

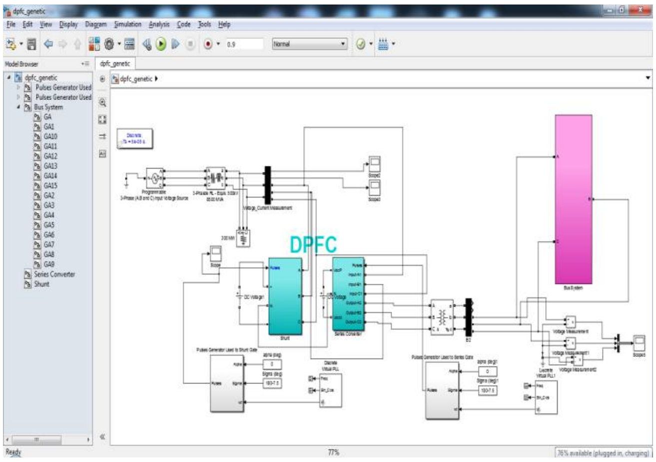

**Fig.3. Genetic Algorithm Overall Circuit View**

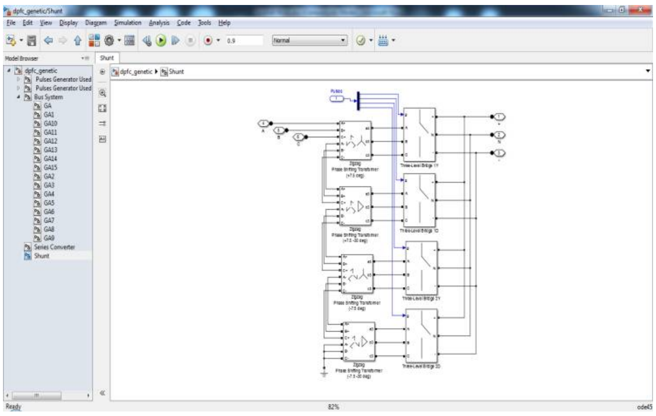

**Fig.4. DPFC Shunt Converter**

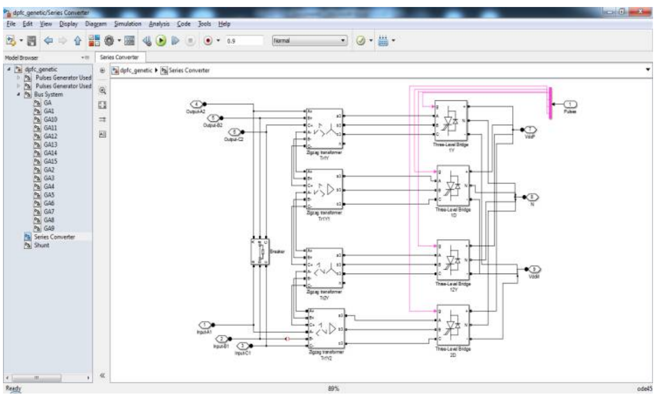

**Fig.5. DPFC Series Converter**

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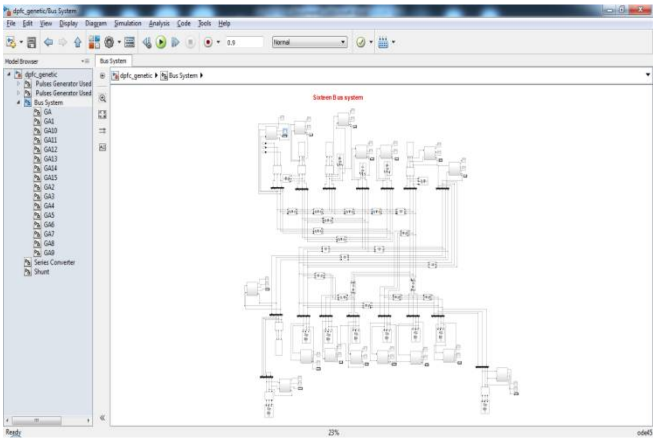

**Fig.6.IEEE-16 Bus System with genetic Implementations**

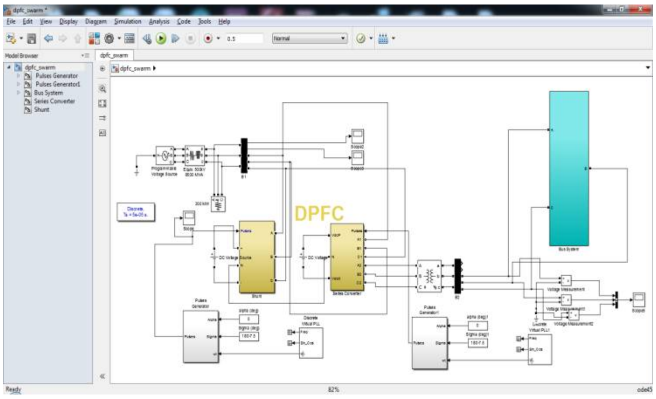


**Fig.7. Cat Swarm Implementation Overall Circuit Design**

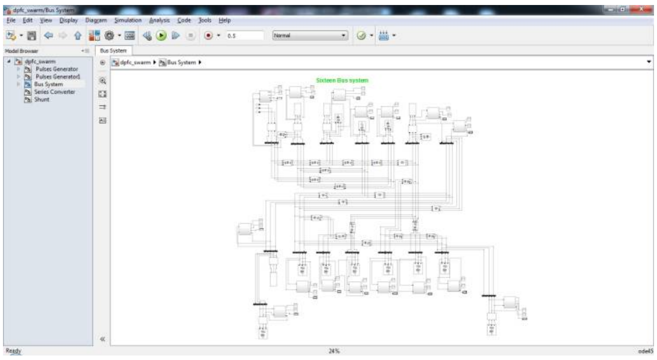

**Fig.8. Bus System with Cat Swarm Implementation**

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ISSN (Online): 2278 – 8875

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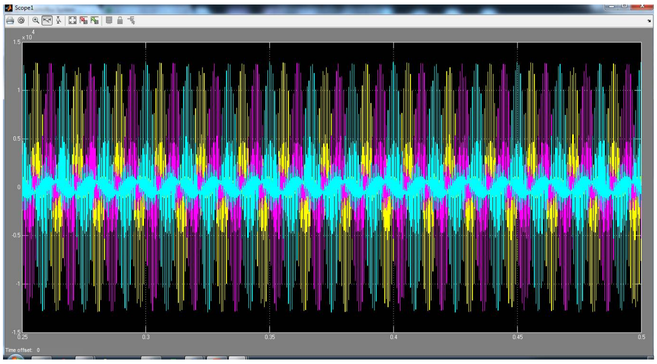

**Fig.9. Three Phase Improvised Power Quality over GA with DPFC**

## VI. CONCLUSION

The entire system of Cat Swarm Optimization based Power Quality improvement, stability enhancement and reducing the power loss is clearly analyzed with the hands of DPFC. The nature of UPFC is already discussed in earlier sections, which has certain limitations such as Huge Line Losses [Copper Losses], Great KVA rating and dimension of electrical, Greater Conductor Size and Cost, Deprived Voltage Regulation and Big Voltage Drop, Low Efficiency and Penalty from Electric Power Supply Company on Low Power factor. For this reasons we move on to DPFC, which provides best support in the following cases compare to UPFC, the benefits are: low cost, low voltage isolation and low component rating of the series converter. The implementation of Cat Swarm Optimization (CSO) is to be easy in process comparing to all the earlier AI techniques. It is capable of finding multiple optimal solutions to the constrained multi objective problem, giving more flexibility to make the final decision about the location of the FACTS controller. The maximum loading parameter, bus voltage profile improvement and size of device are employed as the measure of power system performance in optimization algorithm. For all the entire analysis, clearly describes the capacity and working nature of CSO Algorithm along with the survey of DPFC model.

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