A New Meta Heuristic Algorithm based FACTs SSFC Implementation for Power Quality Enrichment in Grid Inter connected system with Renewable Energy Sources

Samanthaka Mani Kuchibhatla, Padmavathi Devasetty, Srinivasa Rao Rayapudi

Abstract*: This paper projects A Most modern Meta Heuristic based BAT algorithm for enhancing Power Quality (PQ) furthermore to diminish the harmonic falsification using the Flexible AC Transmission (FACTs) based Static Switched Filter Compensator (SSFC) in the proposed Grid Interconnected System with Photo Voltaic (PV) and Wind Energy (WE) Sources. The uniqueness of the this system is enhancing the performance of the grid associated Renewable energy system such as soothe the voltage, diminish the power losses and lessen the harmonic distortion using the SSFC with a BAT algorithm in the Controller . Here, the proposed controller is in a job to optimize the control pulses of SSFC. To attain optimal function of the controller, errors are narrowed and generating the optimal control signals. SSFC with BAT algorithm controller takes part in improving Stability of the system along with Enriched power quality. MATLAB/Simulink platform is used for the Implementation part and its performance is adequate.

***Index Terms*: Power Quality (PQ); Photo voltaic (PV); wind energy conversion system (WECS); Flexible AC Transmission System (FACTS); Static Switched Filter Compensation (SSFC); Proportional Integral Derivative (PID) Controller**

I. INTRODUCTION

Entire world is looking for Eco-Friendly Power generation to meet up the emergent power demand day by day. Dropping most of remnant stimulate assets along with escalating functioning of renewable power production accompany numerous modifications in the configuration of the power trade. By the way, Implementation of Eco friendly power generation, particularly wind and solar energies are Expanding consistency in the recent power system along with consumer fulfillment. Equally new trends in Distributed Generation (DG), for instance solar and wind power systems and sensitive load power electronic devices have altered the dynamic performance as well as the power quality. In the novel competing power market present wind power generation charge is Rs2.64 per kilowatt hour (kWh) in India and 0.05 to 0.06$ per KWH in USA. For this reason, it is quickly rising among green energy sources to pat a clean moreover eco –friendly environment.

In contrast with the Natural gases Wind Energy Sources (WES) are more eco-friendly since their emissions are very less[1].In the Similar way Solar energy is more leading in the present scenario because of pollution free , ease in installation, benefits given by Government , furthermore Both Photo Voltaic (PV) and Wind Energy Sources are ecofriendly. Voltage insecurity, Power Quality (PQ) exertions are two undesirable penalties that are posed by the assimilation of a outsized WES as they observe reactive power for the period of standard operational environment. Integration of PV and Wind energy sources to the conventional grid is usually achieved by employing power converters. Best possible operation and lithe control are the benefits from making use of power converters. But power electronic interfacing creates an excess of PQ problems [2,3].

The Flexible AC Transmission System (FACTS) device utilizes the active compensators such as Voltage-Source Converter/Inverters (VSC) which are functioning based on power-electronic devices as conduction/non-conduction states of respective switching elements with effective control objective. These are highly used to control the reactive power and enhancing the voltage quality and current quality by using series-VSC and shunt-VSC topologies in power system networks.

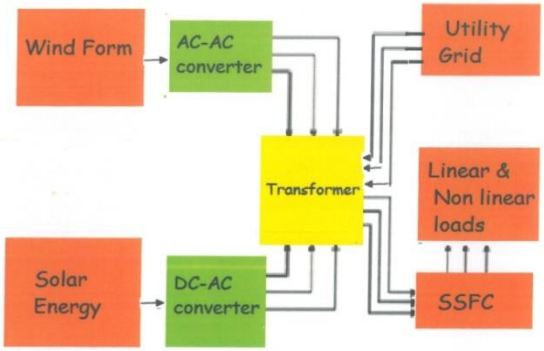

Figure.1 Control structure of proposed FACTs based SSFC with Renewable Energy Sources.

In this paper proposed a nature inspired Meta heuristic search method, called BAT Algorithm for Static Switching Filter Compensation device (SSFC) scheme in Grid Interconnected system with PV and Wind energy system. The intended method is functioned based on switching regulation process followed by dual capacitor banks relies as classical tuning schemes [4]-[7]. System performance with

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BAT algorithm is high-quality [8-10].

II. DESIGN OF PROPOSED CONTROLLER

Two shunt capacitor banks are allied based on the alternative switching by a novel Dynamic strategic control. Two Incorporated regulators A and B are implemented for dynamic control in the system .Their role is to improve power factor, soothe the buses voltage and diminishing Harmonics by means of SSFC. A and B regulators will consist of Three loops wise current, voltage and power. The proposed new tri-loop dynamic control strategy is very attractive and more flexible characteristics, as well as attained by implementing extra compensation control loops.

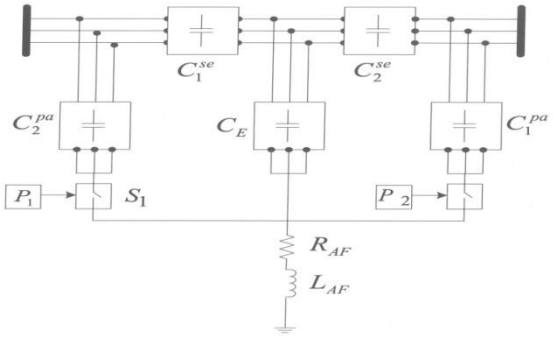

Figure.2 Structure of SSFC Scheme

A. Objective Function

The Global error (e_g) is supplied as an input to a BAT algorithm based self-tuned PID controller, it is summation of three errors, which is set by equation

$$e_g = \phi_v e_v + \phi_i e_i + \phi_p e_p \qquad (1)$$

The modulating signal of the PWM form during time province for the PID regulator has expressed in equation (2),

$$V_c = \kappa_p e(t) + \kappa_i \int_0^t e(t)dt + \kappa_d \frac{d(e(t))}{dt} \qquad (2)$$

Because of ease in scenery and vigorous performance over a range of operating environment PID controllers are most suitable for Industries. Proportional (P), Integral (I) and Derivative (D) are the three parameters implicated in this controller. The proportional part is accountable for ensuing the desired set-point, at the same time the integral and derivative part report for the accumulation of earlier period errors and the rate of change of error in the process equally.

B. BAT Algorithm

In the Present Scenario Nature stimulated set of rules present effective procedure to solve hard-hitting problems in power system environment. The Echolocation Behaviour is used by natural bats for locating their food, based on this a novel significant nature-inspired Meta-Heuristic control algorithm named as "BAT algorithm" has been explored by Yang. In the universe Bats are the only mammals having wings along with superior echolocation prospective to trace their prey. They are attention grabbing animals. Smooth in complete darkness they set their path with its radiated sounded signals named as Echo-location to identify the object.

The explored BAT algorithm can be implemented based on some-ideal features of BATS. The appropriate rules are described as below;

(i) Eco location property is used to discover remoteness along with the distinction among acquired food as continuous obstacles in their own magical attitude.

(ii) Various parameters of the Bats in their way to food/prey are X_i as position and V_i as velocity with a f_{min} frequency varying λ wave-length and A_0 loudness as hunting for prey. Pulse rate in the range [0, 1] along with frequency variation can be controlled by Bats based on the proximity of the aim

(iii) Loudness confines measured are A_0 maximum-positive to A_{min} a minimum-value.

The flow graph for BAT algorithm is shown in Figure 3.

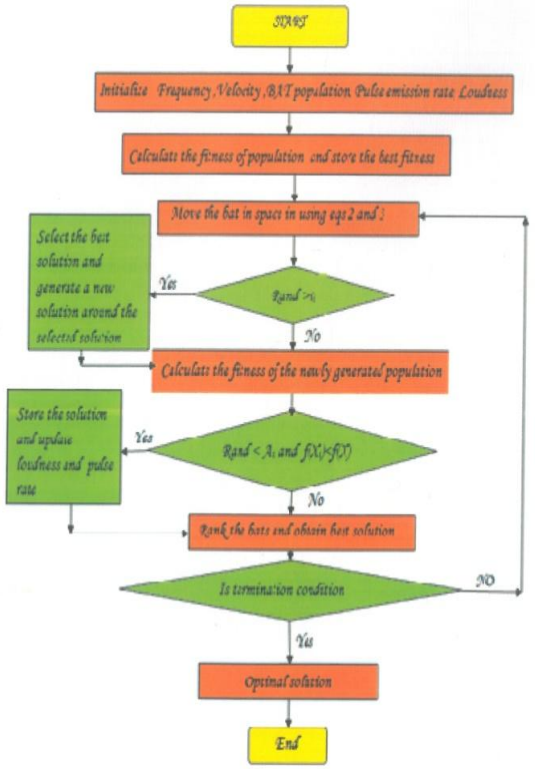

Figure.3 The flow graph for BAT algorithm

III. SIMULATION RESULTS

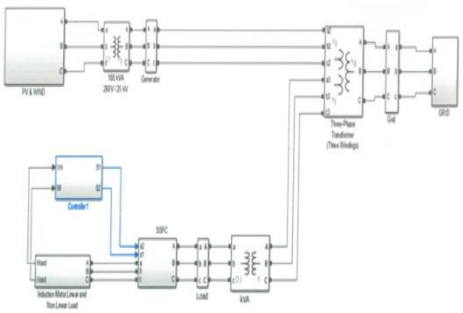

Figure 4. Simulation Model of the proposed system

This segment presents results of the proposed FACTs based SSFC with BAT algorithm to reach the evaluation of power quality problems. Here the performance of explored control methodology is developed by using Matlab/Simulink tool for attaining effectiveness based on the two cases. The Simulink representation of proposed

technique is demonstrated in Figure 4. The two cases are analyzed using simulated outcome. The source voltage and current is given to the input of the proposed system and the performances are examined. Chiefly, the PQ disturbance like harmonic misrepresentation and voltage stabilization of the WECS interconnected SPV data. These two cases are developed based on certain parameters as illustrated in Table.1.

Table 1. Input parameters of BAT algorithm

Sl. No	Parameters	Quantity
1	Loudness	0.1
2	Pulse rate	2
3	Number of generations	10
4	Population size	20

A. Analysis of Proposed system

Normally, the SSFC comprises the two series capacitor banks in series, two parallel interfaced capacitor banks and filter units. The performances of the voltage source converter are normalizing the voltage amongst the two series and shunt capacitor banks. The main advantage of proposed method is to compensate voltage and current interruption. The interruption voltage is presented in the transmission line and eliminated by BAT Algorithm based SSFC through capacitor. The purpose of this combined system is reduced the harmonics effectively. The power factor is also improved by using the combined system. The proposed model for the FACT based SSFC is to compensate input voltage harmonics and current harmonics caused by linear load, non-linear load and induction motor. The function of the proposed method is assessed at the time of the linear, non-linear and source inputs are varied in the load condition and examined their solutions. By using the analysis, the simulation results are analyzed with the utilization of proposed technique. Based on the simulated result has to verify the performance of the proposed system in different cases. These cases are given as follows,

Case 1: Irradiance is varied and constant load condition

Case 2: Non-linear load condition

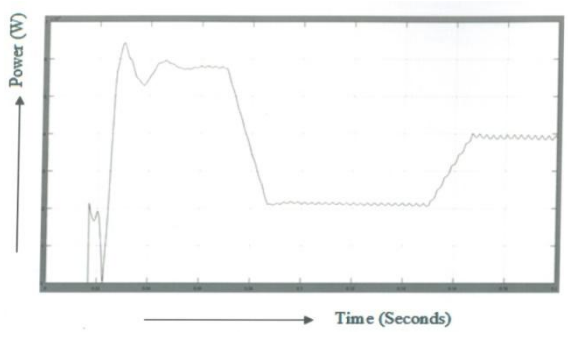

Figure 5. Analysis of PV Power with Irradiance is varied and constant load.

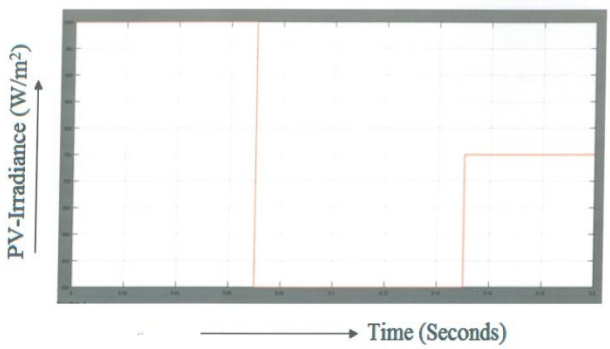

Figure 6.Analysis of PV Irradiance with Irradiance is varied and constant load.

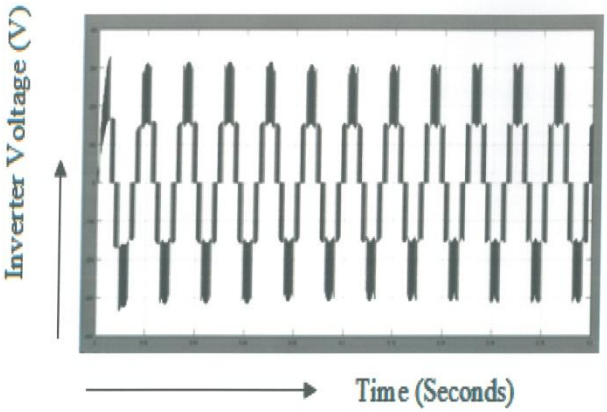

Figure.7. Analysis of Inverter voltage for varied Irradiance and constant load.

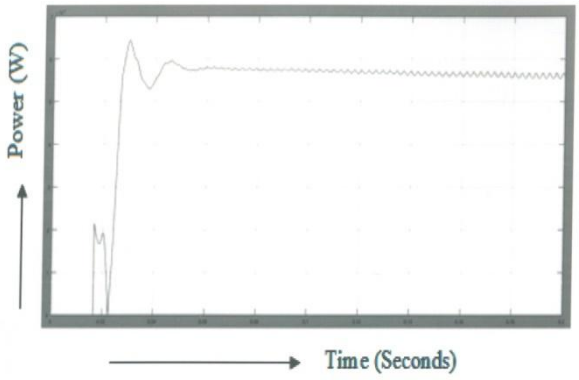

Figure.8. Analysis of PV power for Non-linear load.

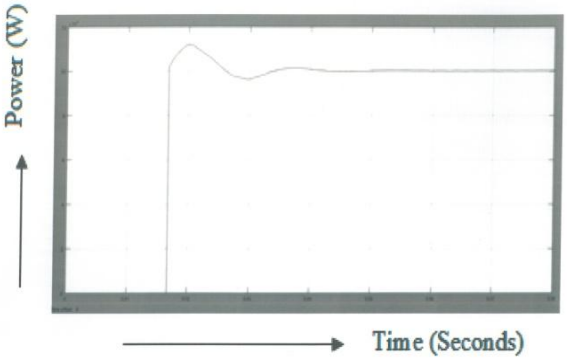

Figure.9. Analysis of Wind power with Non-linear load

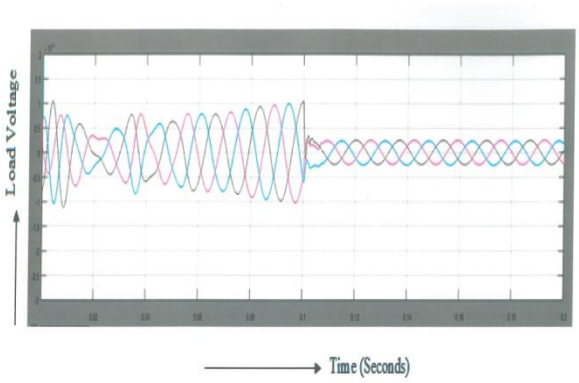

Figure.10. Analysis of Load Voltage for Non-linear load

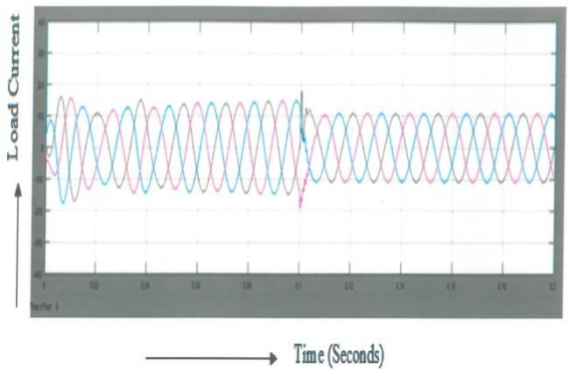

Figure.11. Analysis of Load current for Non-linear load

IV. CONCLUSION

This paper projects A BAT Algorithm based FACTS–SSFC Implementation for Power Quality improvement in Grid Inter connected system with Renewable Energy Sources. A confined hybrid load is coupled to the utility grid bus. The output responses are professed for two cases wise Irradiance varied with stable load, and for non-linear load conditions. The performance is assessed in terms of PV power, Wind power, Load voltage and load current. All are in acceptable Limits, consequently power quality is enhanced .In Extension other optimization Techniques can be implemented in preference to BAT optimization Technique in the controller.

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