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Modeling and design of PV grid integration for GA-PSO based on fluctuating power quality

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ABSTRACT

Grid integration of renewable energy systems with majority of which is variable dc and variable ac. For example, solar systems output variable dc, while wind systems output variable ac. Power electronics now plays a significant role in the DC and AC conversion required for the grid. Power electronics now allows dc-coupled systems to be controlled for both active and reactive power, making inductively controlled for improving power quality and synchronizing renewable energy systems. The presence of harmonics in electrical systems indicates that current and voltage are distorted and deviate from sinusoidal waves; odd and even harmonics are the result of a nonlinear load. Voltage and sag and swell are examples of power quality issues, as are filters whose primary purpose is to reduce harmonics, voltage, and current in alternating-current power systems to an acceptable level. The maximum power point tracking is based on maintaining temperature and irradiance variables. We use both proposition and Maximum power point tracking (MPPT) to maximize PV power with oscillation tracking. The genetic algorithm with partial swarm optimization (GA-PSO) algorithm based on various optimization control techniques. Control techniques are proposed for systems with various unbalanced voltages to maintain control operation during fault conditions.

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1. INTRODUCTION

Grid-integrated renewable energy systems Therefore, to minimize the effect of the grid faults and the nonlinear load of the system failures, it is difficult to define all aspects in terms of a single goal. Providing multiple objectives frequently results in a better solution to a considered problem. It increases based on the renewable energy resources available for natural resources [1].

Grid connected solar PV system as shown in Figure 1. Grid computing necessitates techniques for allocating resources efficiently and adaptively resources to maintain the voltage and power of the generating system. This paper presents an optimization of genetic algorithm with partial swarm optimization (GA-PSO) for independent tasks in the grid-connected solar PV system. This improves search efficiency by utilizing the potential to an optimal level. The grid performance has been evaluated using expanded PI controllers and the partial swarm optimization (PSO) strategy for frequency PI controller control for superiority justification [2], [3].

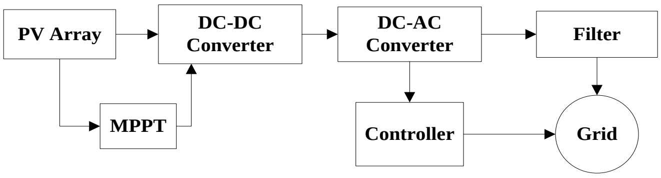

Figure 1. Block diagram of grid-connected PV system

2. PV PANEL AND MPPT METHOD

The solar photovoltaic (PV) system consists of various cells. These cells are connected in parallel or series to meet the critical requirement of generating source current and output voltage. The generating power is in unstable condition because of environmental conditions [4]. The relationship between current and voltage has been found to be non-linear. PV modules are increasing solar power generation capacity. It will be much greater than the cut. A dc-dc converter or inverter also needs a control input power interface for a dc application. Perturb observe method has been extensively utilized in the maximum power point tracking (MPPT) method because of its simple application and minimal pre-requisites for computation [5].

The I-V and P-V curves for different values of solar irradiance as shown in Figure 2. MPPT algorithms using perturb-and-observe and incremental conductance MPPT methods at various solar radiation and temperature levels under unbalanced and balanced grid voltage conditions, an IC model is used to control [6]–[8]. Because of this circumstance, MPP could be identified in the increment of conductance of the array The MPPT model used in this contribution has been observed and perturbed for optimal results. During solar irradiation, the fault would not vary abruptly and has been estimated using an effective P&O model in addition to the projected fault Ride-through (FRT) technique [9].

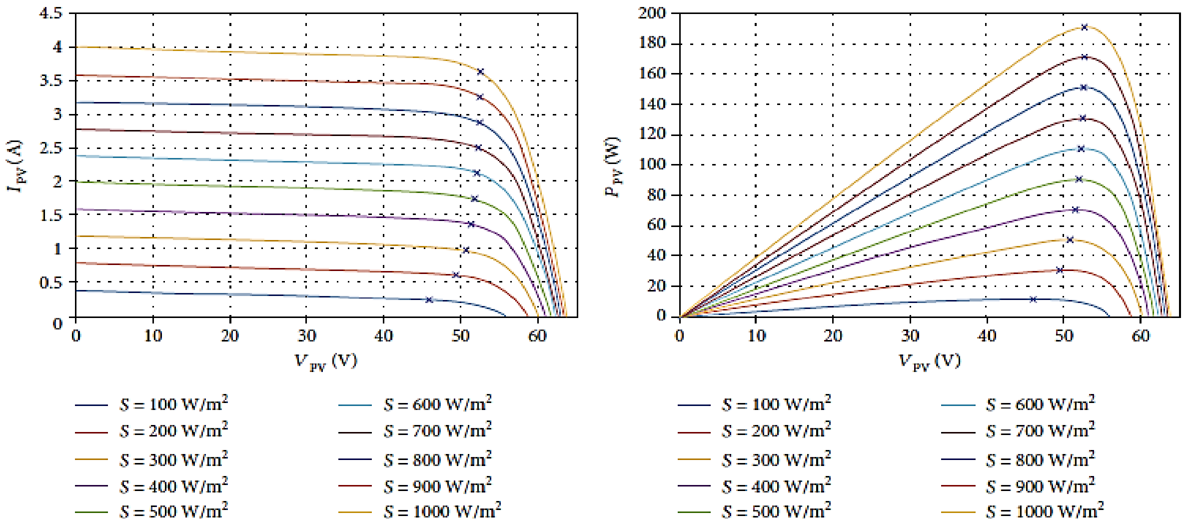

Figure 2. I-V and P-V curves for different values of solar irradiance

3. RESULTS AND DISCUSSION

3.1. GA algorithm

The main objective of this strategy is to converge on the global solution, which is achieved by utilizing three steps and operators: crossover, mutation, and reproduction. As a result, the PSO and GA algorithms are used in this investigation because they are regarded as the most powerful methods for interacting with continuous and discrete optimization problems, respectively. The GA regarded for solving load balancing control [10].

The voltage of the dc-link PI control with grid voltage feed-forward, as shown in Figure 3, is commonly used for current-controlled inverters; however, the PI controller cannot track a sinusoidal reference without steady-state error and has poor disturbance rejection capability. The PI current controller is defined as the GA-distributed version has sequential model parallelization. Some standard issues in sequential computation make it possible to establish the following parallelization rules: GA belongs to the same optimization class as optimal universal networks [11].

The GA properties of the algorithm could be effectively incorporated by varying some aspects of the evolution procedure to increase the number of GA operators' possibilities. The computational cost of sequential GA for the function of objectivity has been negligible for any network configuration that needs to solve huge equations on a metric scale. The size of the admittance Y matrix is determined by the number of measured electric MV grids. The massive network analysis leads to massive data frameworks. This part of the parallel formulation makes the depicted algorithm robust [12].

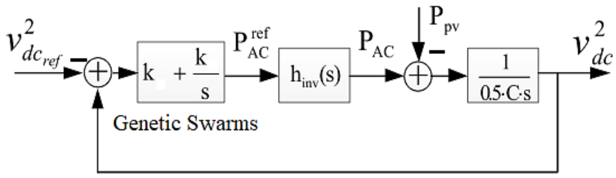

Figure 3. Control scheme for voltage of DC-link control loop GA-PSO

3.2. Particle-swarm-optimization (PSO) sub section 2

In Beernaert's and Kennedy, a PSO has been proposed as in [13]. Moreover, it has been an evolutionary computation approach, a stochastic search strategy depending on the intelligence of a swarm. Upgrading the equation of velocity, PSO inclusion: fish schooling or bird flocking direction diversity is managed in conventional PSO by a predetermined probability of craziness.

Also, particles might be crazed through the below equation before their position up gradation.

$$vi^{k+1} = vi^k + c1 \times r1 \times (PBesti - Xi^k) + C2 \times r2 \times (gbest - Xi^k) \tag{1}$$

Position updating equation:

$$Xi^{k+1} = Xi^k + vi^{k+1} \tag{2}$$

this is due to the poor performance of the integral action when the disturbance is a periodic signal.

$$vi^{k+1} = r2 \times vi^k + (1 - r2) \times c1 \times r1 \times (pBest - Xi^k) + (1 - r2) \times c2 \times (1 - r1) \times (gBest - Xi^k) \tag{3}$$

$$sign(r3) = \left\{\begin{cases} -1, & (r3 \leq 0.05) \\ 1 & (r3 > 0.05) \end{cases}\right. \tag{4}$$

$$vi^{k+1} = r2 \times sign(r3)vi^k + (1 - r2) \times c1 \times r1 \times (pBest - Xi^k) + (1 - r2) \times c2 \times (gBest\ Xi^k) \tag{5}$$

As determined by sign (r3):

$$vi^{k+1} = vi^{k+1} + \Pr(r4) \times sign(r4) \times vi^{craziness} \tag{6}$$

where Pr (r4) and sign (r4) are defined respectively as:

$$Pr(r4) = \begin{cases} -1, & (r4 \leq Pcraz) \\ 0, & (\ r4x \succ Pcraz) \end{cases} \tag{7}$$

$$\text{Sign } (r4) = \begin{cases} -1, (r4\ \geq 0.5) \\ -1(r4 < Pcraz) \end{cases} \tag{8}$$

The basic PSO algorithm includes the process of initial population flow chart of the proposed PSO method, as shown in Figure 4 calculating fitness value, finding individual and population and updating continuously through updating position. The proposed approach is intended to optimize active and reactive power outputs converter to the grid during asymmetric voltage disturbances. The technique presupposes that the grid voltage and the instantaneous active/reactive power references initially, to overcome mismatching phenomena issues associated to partial shading, the global MPPT technique was carried out using the PSO method [14], [15].

The MPP was always within reach using the PSO-based MPPT technique, which raised the PV system's efficiency, which makes use of the most power that can be extracted from the PV setups, is attained using the PSO technique [16]–[19]. Flow chart of the suggested pso technique method as shown in Figure 4. PSO simulation for definite aspects needs appropriate selection since PSO has been more sensitive towards the election of insight aspects. The effective selection maximum size of the population is 50, and the maximal enabled iteration is 100. Usually, the projected model is the basis for optimization [20].

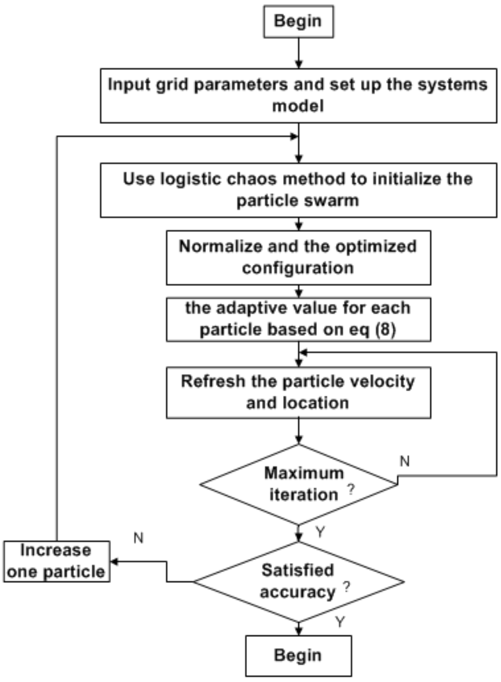

Figure 4. Flow chart of the proposed GA-PSO method

3.3. Power quality control

When the supply voltage or load current falls below 0.1 p for more than one minute, an interruption occurs. A sustained interruption is defined as a long-duration voltage variation**.** Long-duration variations include deviations in the root mean square (rms) at power frequency for more than one minute, which can be either overvoltage or under voltage. Overvoltage increases the voltage by more than 110 percent for more than one minute at the power frequency. Overvoltage can also be caused by load switching and incorrect transformer tap settings [21]–[23].

A PSO algorithm was proposed to perform the distinct PSO structures (global best, local best, velocity, and position updates) for, Active power-line conditioning and grid power injection enable load harmonic currents. Which were integrated into the PSO-based algorithm, the optimization algorithms and the proposed method The GA-PSO algorithm aims to reduce the harmonics and increase the power factor and variation time duration to balance the load of the dependent tasks over the heterogeneous resources in cloud computing environments [24]–[26].

4. RESULTS AND DISCUSSION

Comparative analyses of predictive control and genetic algorithm with partial swarm optimization (GA-PSO) algorithm by using various parameter voltage sag and swell and total harmonics distortion GA-PSO method during various faults are identified and mentioned in Table 1. It should be mentioned that in unbalanced situations, in order to compensate for the harmonic’s distraction created by the present in the simulation model grid voltage, the harmonics generated by the inverse sequence present in the grid voltage, and various faults as shown in Figures 5 to 10.

Table 1. Comparative analysis of adaptive control strategies

Parameters	Description	Predictive control	GA-PSO
Voltage	Voltage sag & swell	Actual: 415 v Swell: 450 v Sag: 390 v	Actual: 415v Swell: 430 v Sag: 340 v
Time	Settling time of voltage sag &swell	0.3-0.5 (0.2 sec) sag 0.3-0.5(0.2 sec) swell	0.2-0.3 (0.1 sec) sag 0.3-0.5(0.2 sec) swell
THD	Total harmonic distortion	17.94% to 24%	6.64% to 6.85%
Power factor	Power factor	0.6	0.7
Current	Current distortions	Max: 700 A, Min: 300 A	Max: 600 A, Min: 200 A
Faults	Faults identified	LG, LLG, LLLG.	LG, LLG, LLLG,

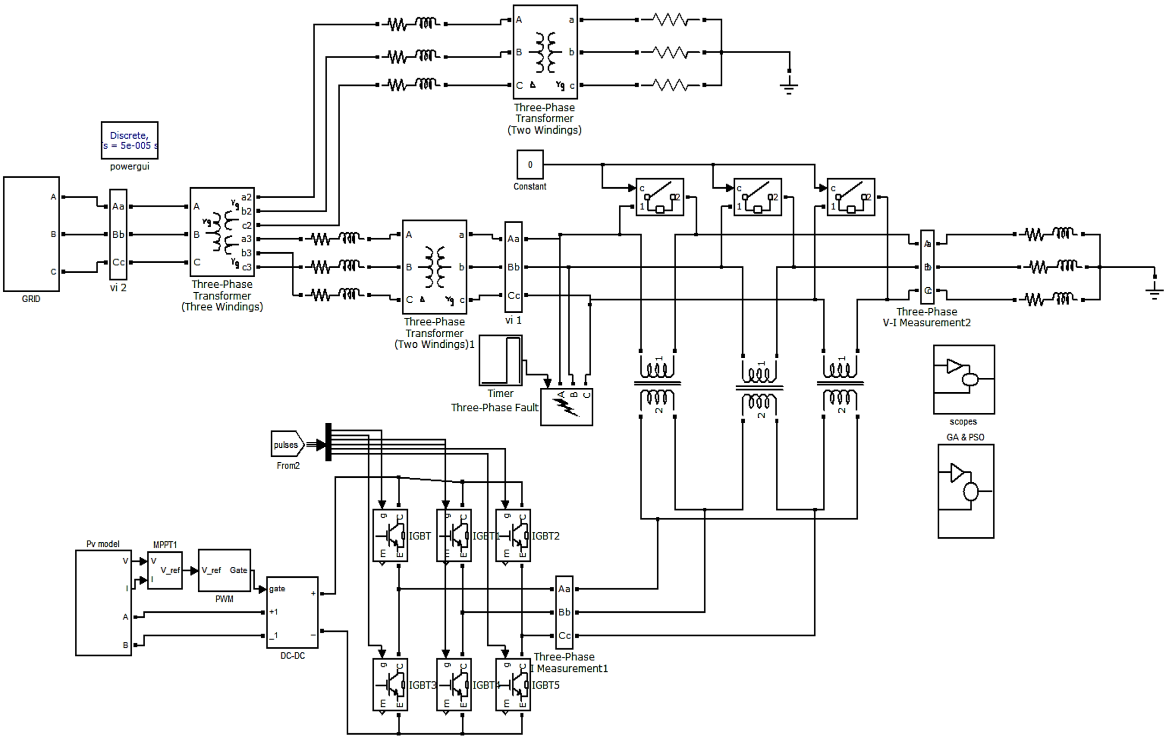

Figure 5. Simulation model of GA-PSO based PV Grid system

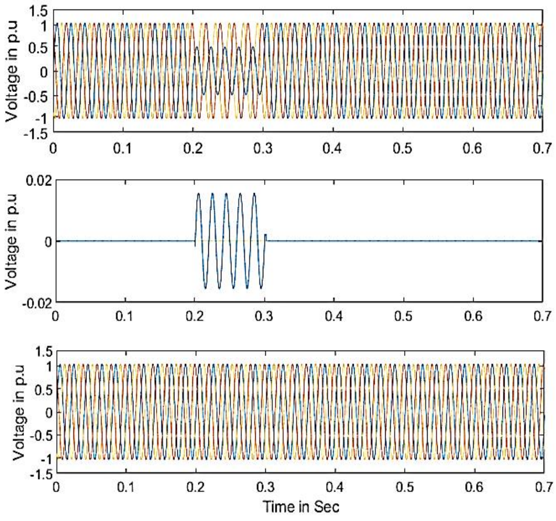

Figure 6. Voltage sag (LG fault)

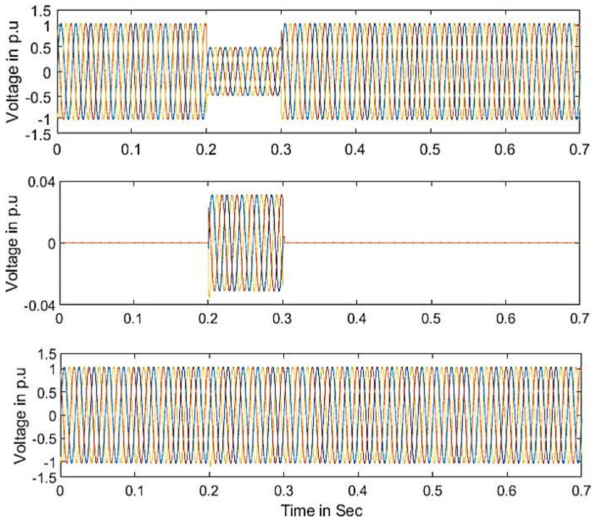

Figure 7. Voltage sag (LLLG faults)

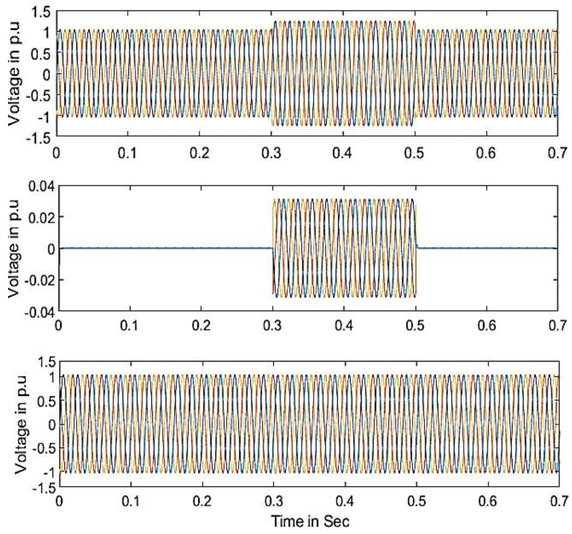

Figure 8. Voltages swell (LLLG faults)

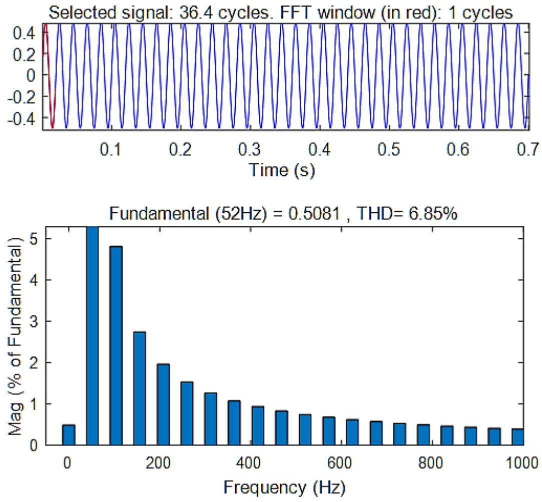

Figure 9. THD analysis of proposed grid system

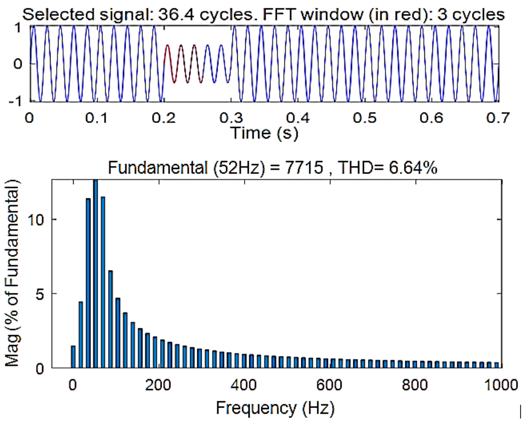

Figure 10. THD analysis of conventional grid system

The PSO method is inspired by the flocking flocks of animals, and its movement is controlled by the PSO optimizer's individual and nearby experiences at each particle step. The essential objective behind this method is to find an optimized location where each space has a chance of containing a potential solution. And analysis flow chart Figures 11 to 13 obviously.

Predictive control and GA -PSO control grid is linked to solar PV systems during voltage sag, swell, and harmonics. LG, LLG, LLLG, and grid distortions and faults have been identified. Harmonics are reduced, the power factor is unity, and an unbalanced voltage system is maintained by integrating system compression. Table A presents a comparative analysis of adaptive control. GA technique was used as optimization algorithms. In fact, the proposed method's flow chart is presented in this work to evaluate the two objective functions.

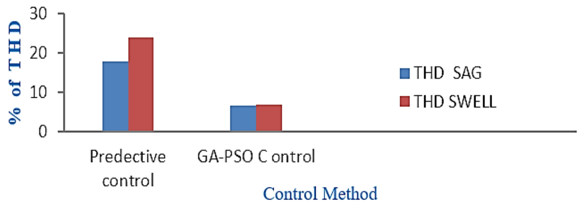

Figure 11. Total harmonics distoration voltage sags and swells analysis

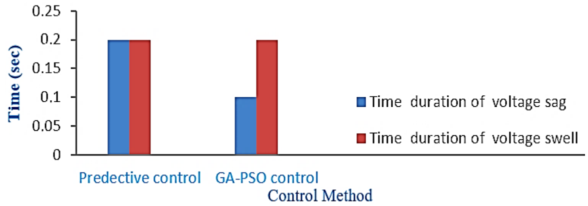

Figure 12. Time duration of voltage sags and swells analysis

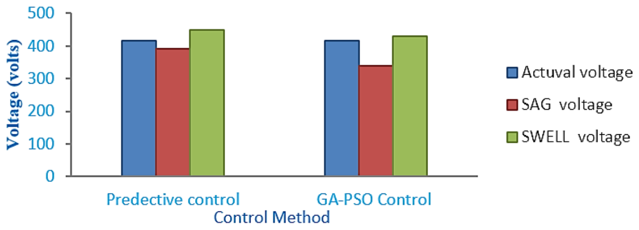

Figure 13. Voltage sags and swells analysis

5. CONCLUSION

Grid-connected solar PV systems and various control strategies the following conclusions are drawn in grid-connected coordinates with solar power to grid the source to a nonlinear load after simulation and analysis of voltage and power waveforms in various operating modes. The control of the converter can provide stable voltage and frequency for the unbalanced load. When faults occur in the unbalanced voltage of the grid, the optimal control strategy should be quick to ensure the stable voltage and reliable operation of the power load. The proposed Using renewable energy to generate power during fault conditions results in a nonlinear load by reducing faults. GA-PSO-based optimization in a variety of different operating modes Reduced fault duration, time sag and swell, and total harmonic distortion are provided as a result of the modulation and analysis technique. As a result, control is achieved in the proposed control system faults LG, LLG, and LLG. Furthermore, the remaining voltage maintains a constant magnitude under various operations.

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