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Maximum Power Point Tracking For Photovoltaic Optimization Using Seeker Algorithm

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ABSTRACT:
Solar energy is one of the most promising source of energy and which is widely available in nature. Solar cells have relatively low efficiency ratings; thus operating at the maximum power point (MPP) is desired because it is at this point that the array will operate at the highest efficiency. Hence the optimization of energy generation in a photovoltaic (PV) system is necessary to let the PV cells operate at the maximum power point (MPP) corresponding to the maximum efficiency .With frequently changing climatic conditions and load variables, it is difficult to use all of the energy available in the panel without a systematic mechanism. For the best performance, it is necessary to use any kind of maximum power point tracking mechanism to force the system to operate at its optimum power point. This paper compares the performance of PSO and SEEKER algorithm for maximum power point tracking of photovoltaic panel.

I. INTRODUCTION

A solar panel exhibits a nonlinear v-i characteristic, and its maximum power (MP) point varies with the solar insolation and temperature. At a particular solar insolation, there is a unique operating point of the PV panel at which its power output is maximum. Therefore, for maximum utilization efficiency, it is necessary to match the PV panel to the load such that the equilibrium operating point coincides with the MP point of the PV source. However, since the MP point varies with insolation and seasons, it is difficult to maintain MP operation at all solar in solations. To overcome this problem, use of an intermediate dc-dc converter is proposed which continuously adjusts the voltage, current levels and matches the PV source to the load.

In order to get a uniform characteristic for a PV module it should be built with identical cells. Suppose the photon current of a particular cell is zero or very small due to partial shading, dirt, snow etc. then that cell will operate as a load rather than a source of energy. These load points will ultimately leads to the creation of local hotspots in the panel and module can be damaged due to this local hotspots.one of the common method to avoid this problem is to connect a bypass diode across the PV modules as shown in Figure 2. These bypass diodes permit that the particular solar cell, which cannot conduct current, is bridged-over and the photon current of the remaining solar cells of a string can flow. The number of bypass diodes per module can be calculated by considering the extra cost and number of hotspots.

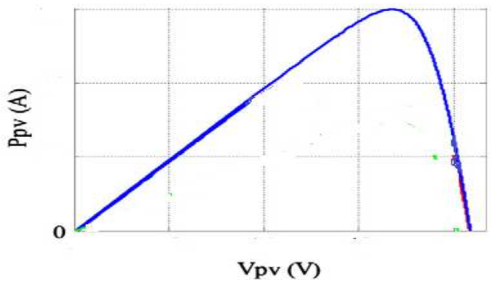

Figure 1 :PV curve with constant irradiation

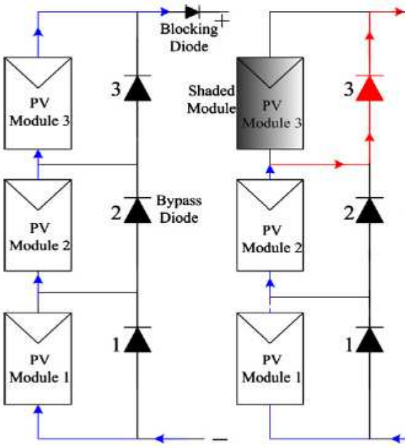

Figure 2: PV string with Bypass diodes

II. PARTICLE SWARM OPTIMIZATION

The PSO uses several cooperative agents and each agent shares the information attained by each individual during search process. Here PSO initializes the variables randomly in a given space. The number of decision variables determines the dimension of space. Each optimization problem is to search the solution space of a particle, each particle runs at a certain speed in search space, the speed of particle is in accordance with its own flight experience and flight experience of other examples with dynamic adjustments. In the optimization space each particle has decided to adapt the objective function value, and recorded their own best position Pi found so far and the entire group of all particles found in the best position xg. Velocity and position update formula are as follows

$$vi(j+1) = w \bullet vi(j) + rand \bullet c1 \bullet (xpi - xi(j)) + rand \bullet c2 \bullet (xg - xi(j)) \qquad (1)$$

$$xi(j+1) = xi(j) + vi(j+1) \qquad (2)$$

where i is the variable of the optimization vector, j is the number of iteration, xi (j) is the position of the variable i at the iteration j, vi (j) is the velocity of the variable i at the iteration j, w is an inertia weight factor, rand are random variables in the range[0, 1] c1 is the accelerate weight factor of individual particle, c2 is the accelerate weight factor of all particles. In addition, the velocity of particle is limited by v max.

III. SEEKER OPTIMIZATION ALGORITHMS

Seeker optimization algorithm (SOA) models the human searching behaviors based on their memory, experience, uncertainty reasoning and communication with each other. The algorithm operates on a set of solutions called search population (or swarm), and the individual of this population is called seeker (or agent). In SOA, every seeker has a center position vector c, which is used as the start location to find next solution. Moreover, each seeker holds a search radius r which is equivalent to the En' of cloud model, a trust degree, u described by membership degree of cloud model, and a search direction d showing him where to go. At each time step t, the search decision-making is conducted to choice the four parameters and the seeker moves to a new position x(t + 1) . The update of the position from the center position is determined by a like Y-conditional cloud generator

$$X(t+1)=A+d*r*\sqrt{-log\mu} \qquad (3)$$

In SOA, a search direction dij(t) and a step length αij(t) are separately computed for each individual i on each dimension j at each iteration t, where αij (t) ≥0 and dij (t) ∈ {−1, 0, 1}. dij (t) = 1 means that the ith seeker goes towards the positive direction of the coordinate axis on the dimension j, dij (t) = −1 means he goes towards the negative direction, and dij (t) = 0 means he stays at the current position on the jth dimension. According to the seeker's rational experience, the actual search direction is based on a humane searching behavior.

Intuitively, center position vector c is set to current position x(t). Inspired by PSO, Every seeker contains a memory storing its own best position so far p and a global best position g obtained through communication with its fellow neighbor seekers

$$A = x(t) + S1\,(p(t) - x(t)) + s2\,(g(t) - x(t)) \qquad (4)$$

Here, the expression of search direction for the ith seeker is set to the stochastic combination set of different directions

$$d = sign(\omega(sign(fit(x(t)) - fit(x(t-1))))(x(t)\ x(t\ 1))\ \text{Ø}1(p(t) - x(t)) + \text{Ø}2\,(g(t) - x(t))) \qquad (5)$$

Where the function sign (▪) is a signum function on each dimension of the input vector. ω is the inertia weight and used to gradually reduce the local search effect of di,pro and provide a balance between global and local exploration and exploitation. In the present experiments, ω is linearly decreased from 0.9 to 0.1 during a run. φ1 and φ2 are real numbers chosen uniformly and randomly in the range [0,1].

$$\mu i = \mu max - (s' - Ii)/(s'-1)(\mu max - \mu min) \qquad (6)$$

The parameter μ is viewed as quality evaluation of different positions. It is directly proportional to the fitness of x(t) or the index of the ascensive sort order of the fitness of x(t). That is, the global best position has the maximum μ =1.0, while other position has a u<1.0. μmax and μmin are the maximum and the minimum , μ is given by user.

IV. MPPT ALGORITHM

Here it is assumes that the algorithm has m number of particles with a coordinate xi=(xi1,xi2...xid) in D-dimensional space. There is a fitness function fit associated with the objective function f(xi), the fiti can also be the objective function f(xi).Here in the case of maximum power point tracking of PV panel power is the objective function and voltage is the decision variable. The expression for current passing through a solar panel is given as

I=Iph-Is[exp((v+IRs)/NVt)-1]-(V+IRs)/Rsh (7)

Hence the expression of the fitness function is as follows

fit = I * V (I, Sun, T) (8)

Power,P= V[Iph-Is[exp[(V+IRs)/NVt-1]-(V+Irs)/Rsh] (9)

In the PV systems, every output voltage is one particle in the search space, and all the particles have a fitness decided by the objective function. Here in this algorithm the total output power function as the objective function, while the variable of function is the output voltage. Here both algorithms will find out the optimum value of voltage that required for maximum power under different irradiation levels and partial shading condition.

V. SIMULATION

The MPPT control algorithm is simulated on the MATLAB. It can be seen that in figure that the global maximum power is 119.95W by the seeker algorithm and the output power is slightly improved when compared with PSO algorithm. In addition the time required for optimization and number iteration is less in seeker algorithm when compared with PSO algorithm

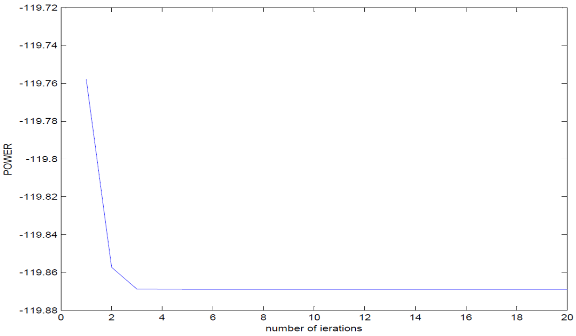

Figure 4 Plot of Power v/s number of iterations with PSO algorithm

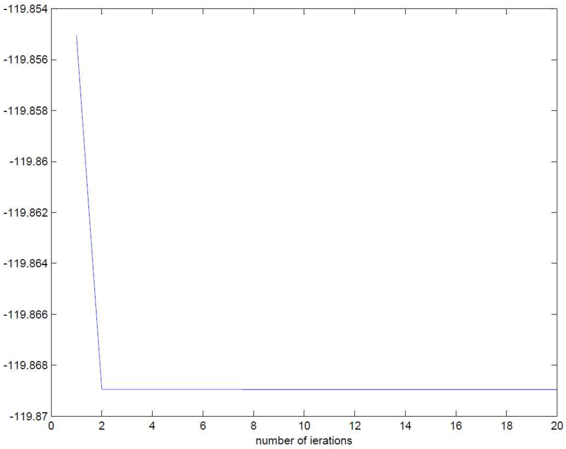

Figure 5 Plot of Power v/s number of iterations graph with seeker algorithm

VI. CONCLUSIONS

In this paper, the characteristics of the PV systems under partial shading conditions and basic PSO algorithm are analyzed. New MPPT with seeker algorithm is developed. The seeker algorithm can fast and accurately realize the MPPT in PV systems by the simulation results on MATLAB. However, there are still many areas for improvement

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