Comparison Between the Conventional PSO Method and Modified PSO Method for PV system Under Shading

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Abstract: - In this paper, we have studied the different output characteristics having photovoltaic modules with partial shading of the modules, in this way we have adopted an approach that achieves an effective track of maximum power point. This approach is based on the optimization of particle swarming (PSO), and in order to improve tracking performance, the linear reduction of weighting is necessary. To test the efficiency of this method, the results of the simulation are implemented, they also show the performance of the MPPT method which is based on modified PSO by comparing it with that of the known PSO methods.

Key-Words: - PV array, PSO command, MPPT, PV system under shading...

1 Introduction

the output power of the photovoltaic systems changes in a non-linear way since the temperature and the irradiation have a great impact on this kind of systems, the stabilization of the output power at the points of maximum powers depends on the tracking of MPPT, this The research theme is essential for systems producing photovoltaic energy.
of course, the voltage feedback approach is considered to be the simplest of the existing MPPT methods, but a preliminary test of the maximum power point voltage is mandatory. Moreover, the reevaluation of photovoltaic modules is very essential to avoid their failure, which results in the change of the MPP.
The voltage tracking method is considered to be the simplest method, it relies only on the great similarity between the MPP voltages exposed to varying amounts of irradiation and exploiting the MPP voltage under standard test conditions as points of reference to overcome the problem of malfunction of networks having photovoltaic modules at these points
however, the difference between the MPP voltage and the reference voltage is influenced by the change in temperature values or by a small amount of irradiation, which causes a reduction in tracking accuracy.
it is clear that classical methods and approaches only establish MPPTs on networks with modules with single-signal characteristic curves, in most cases these methods only track local MPPs and ignore those that are global, currently there is a large number of papers that deal with the case of intelligent MPPTs with regard to the networks that have photovoltaic modules, which brings a lot of benefits : the improvement of track performance in dynamic mode as well as in steady state, in addition to the tracking of MPP with a great precision, in spite of these advantages brought by the intelligent methods, they only apply to the MPPT in the case of solar modules without shading, nevertheless the fact of having multipeak curves, because of the partial shading of the modules within the module matrices, are common, which makes critical the development of an algorithm that has the ability to accurately track the true MPP output curves, which are nonlinear and complex in nature.
for photovoltaic module networks, the reference [2] presents an MPP tracker that relies on the optimization of particle spinning (PSO), and although its ability to track global MPP multipeak characteristic curves, the performance of track lack robustness, therefore, success rates are very low for the tracking case of global MPPs,
thus to effectively track the global MPP on the multipeak characteristic curves of networks composed of photovoltaic modules, this PSO-based method was used with some improvements [18-20].

2 Particle Swarm Optimization

kennedy and eberhat are the authors of the PSO algorithm in 1995 [13] which consits to the use of collective intelligence, they simulated a flying bird to a particle. An objective function as well as individual speeds have been able to determine the velocity of particles (distances and directions of movement). particle motion is impacted by two memory zones Pbest and Gbest all particles record the correct position in the most suitable individual memory area Gbest, a memory intercommunication is always established among all existing particles, after a comparison of the individual positions, the swarm chooses the most suitable position Gest.

le processus de calcul de PSO pour controler la velocité de son mouvement est le suivant :

thus by applying this method, the swarm continuously controls the characteristics of its movement (direction and speed) which results in the rapid convergence towards a global optimum, below the process of calculation of the PSO:

- The first step is to define the number of particles in the swarm, the weight and the learning factors, as well as the maximum number of iterations
- in the second step, the initialization of the particles is performed and arbitrary positions and speeds are assigned for each unit.
- At the third stage, the initial positions are replaced by the objective function in order to test the good value for each particle.
- In this step, we compare the power values as well as the individual memory positions to choose the most suitable for each particle.
- at this phase, it is a question of comparing the best memory value of the swarm and the best Gbest, and if Pbest is superior to Gbest one makes an update of Gbest
- The sixth step is to use the basic PSO formulas in order to update the velocities, directions and positions of the particles

$$v_i^{j+1} = W.v_i^d + c_1 * rand(.)*(P_{best} - P_i^j) + c_2 * rand(.)*(G_{best} - P_i^d)$$
$$P_i^{j+1} = v_i^{j+1} \qquad (1)$$

the formulas (1) above, respectively indicate the velocity and the position of a particle at an iteration j,* rand1 (·) and rand2 (·) are random number generators that randomly generate real numbers between 0 and 1.

C1 and C2 sounds learning factors, Pbest is the individual optimum of the particle; Gbest is the optimal global gold swarm.

if the stopping conditions are all fulfilled, then we stop the tracking, otherwise we redo the steps from 4 to 6 the stopping conditions are as follows: when obtaining the maximum number of iterations or when locating the global optimum .

the success of this method is influenced by values given to the weight as well as to the learning factors [16]: if, for example, the weight is high, the step of movement will be very large, consequently the search for the particles will be short of precision. on the other hand if the weight is weak, the particles will move slowly in this case, and the global optimum becomes inevitable when one is with multipeak values.For this reason, the weighting must be linked to the objective function.

3 Application of PSO on MPPT

the work space is one-dimensional, so each location represents a voltage value that can be considered as a solution of the MPPT. the output power of the photovoltaic panel with respect to the voltage value that is proposed is considered as a particle evaluator, in the equation (2) below the N particle localization matrix presents the N solutions of the problem of the MPPT.

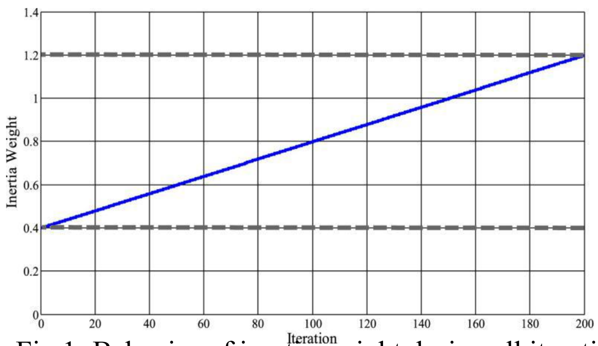

Fig.1: Behavior of inertia weight during all iteration.

$$X_i^j = [X_1^j, X_2^j, X_3^j, ..., X_i^j, ...X_{N-1}^j, X_N^j] \qquad (2)$$

With Xi which represents the location of the ith particle at the jth iteration, and as the degree of shading is partial and the variation of the insolation level, the generated power varies when the equation (3) is well satisfied, the initialization of the algorithm must obliterarily be carried out, otherwise we will have errors in the estimation of Bbest and Gbest, in this case, we can not consider them as their actual values .

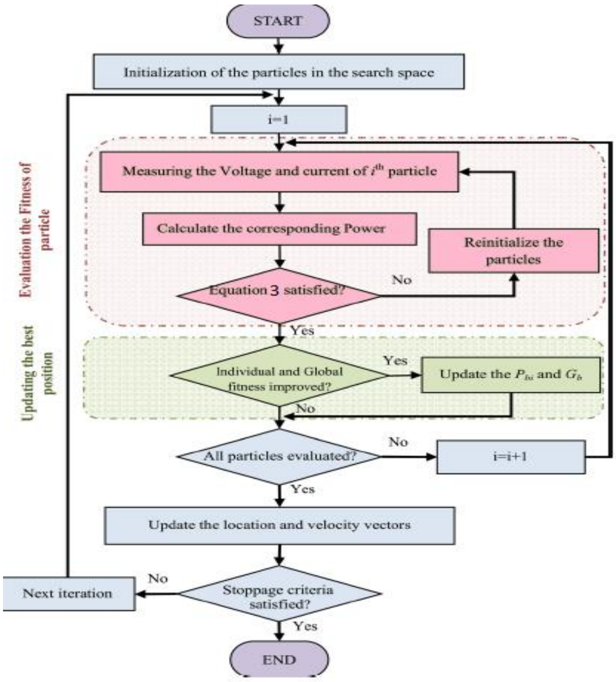

Fig.2:The fellow chart of PSO based MPPT control algorithm.

$$\left|\frac{F(X_{i+1} - F(X_i)}{F(X_i)}\right| \rangle \Delta P \quad (3)$$

the above organigram briefly describes the technique of MPPT.

we denote by the constraints the different values that can take the different values that the voltage converter voltage can take. In this case, the voltage can vary from 0 to Voc and this according to the configuration of the matrix.

Figure (3) shows the schematic diagram of the proposed model.

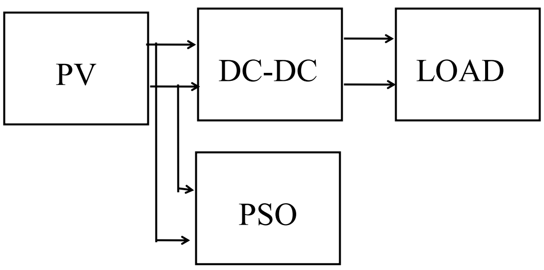

Fig.3: Block diagram for proposed model

y following the steps above, we manage to track the maximum power of the photovoltaic system fully and converted to a desired value beforehand for the load.

when it comes to research: characteristic curves of photovoltaic module systems with single peak values, the conventional PSO proves to be necessary and indispensable as it is the fastest and the most accurate of the existing methods, in the case where one is with more or less shaded modules, the classic PSO is not enough but it is rather necessary to readjust it according to the different characteristics of the multiple curves, in fact, the fact of having shaded photovoltaic modules causes a tracking error of the MPPT, so to overcome this problem and have a weighting of PSO core formulas, we made in this study, a decrease in line by using increasing iterations, below the modified weighting formula:

$$W=(W_{\max}-W_{\min})*(\frac{n-j}{n})+W_{\min} \quad (4)$$

we designate by Wmax the maximum weight, min is the minimum weight, n is the maximum number of iterations, while j is the current iteration, so the adjusted weighting formula shows us that sizes with larger steps are exploits in order to increase the search speed of the particles, which helps to avoid the local optimals, but decreasing according to many of the iterations (increase in number of iterations) the particles of the swarm can track in a way very precise, and moreover the tracking of the regions having output powers lower than zero returns to zero automatically since the output curve is only manifested in the first quadrangle since the track limit of the paticules is fixed to zero, thus preventing the track of the particles in the aberrant regions, which gives the relation (4):

$$P_{best_i} = \begin{cases} P_{best_i}, P_{best_i} \rangle 0; \\ 0, P_{best_i} \leq 0; \end{cases} \quad (5)$$

the value of Pbest is calculated from the relation (1):

$$P_{best_i} = P_i^{j+1} \quad (6)$$

4 Simulation And Resultats

For the track of the networks having photovoltaic modules in three cases, we used the software matlab in which simulations and comparisons were made between the different classical and modified methods, In the first case we introduced two shaded modules with a percentage of 30% and 55% in a matrix having three parallel modules and five series, Figure 4 (a) indicates this characteristic curve and Figure 4 (b) indicates the results of a comparison. The figures show that the characteristic curve PV has three peak values in the case where two modules of the same series are set with different shades. In this situation, the standard PSO-based MPPT method tracks only the local max, while the modified PSO method can follow the overall MPP, in addition the method has a faster response rate than the conventional method.

For the second test, two modules are used, one shaded by 25%, while the other is shaded by 30%, in the table of three parallel and five series modules. Figure 5 (a) shows the PV characteristic curve, and Figure 5 (b) shows the results of a comparison between the conventional MPPT (with a weight of 0.4) and the modified PSO methods. In this case, the characteristic curve P-V has two peaks.

The MPPT results in Figure 5 (b) show that the local PSO method increases the local trap. In contrast, the modified PSO method follows the overall MPP.

The third test case introduces three modules in parallel and five series without shading. Figure 6 (a) shows the characteristic curve P-V, and figure 6(b) shows the results of a comparison between the conventional MPPT (with a weight of 0.4) and the modified PSO. The results show that the modified PSO method follows the true MPP successfully without revealing the multi-peak characteristic curves. On the other hand, the PSP can not follow the true MPP. Figure 6 (c) shows that standard and modified PSO methods have been adjusted to 0.9. but, the modified PSO method still provides good results in the dynamic case. in our case, we set the weight at 0.4, which gave us a good follow-up in the case of shaded modules. Without shading, since the output power increases considerably, the weight of the PSO method is reduced to 0.9 followed, which allows a tracking success of up to 100% in both. case and for the modified PSO method, linear decreases of 0.7 to 0.4 were used. For tracking methods and learning factors, C1 and C2 were set to a specific value and the maximum number of iterations was kept at 100. Table 2.2 and 2.3 show the parameters in detail of the panel and the command, and Table 2.4 shows the comparison results of success rates. both methods after 100 follow-up attempts. Table 2.4 mentions the success rate of the PSO method for a good follow-up. Compared to that of the classical method since the modules were shaded, the fact that the modified PSO method uses linearly adjusted weighting, the true MPP track is successful regardless of the percentage of shading. the classic PSO method can also achieve a 100% success rate, but only in the case of single-deck and non-hatched curves, a 100% pass rate of success based on the power output is required. moreover, the fact of tracker based on the conventional method is very risky and full of trap.

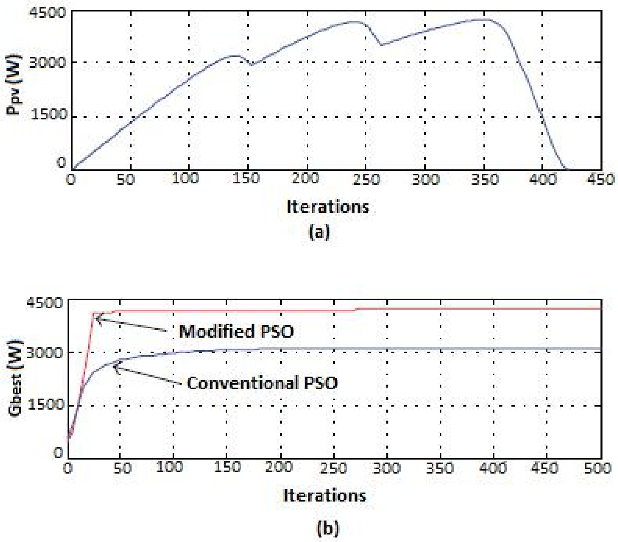

Fig.4: Simulation Results for Three Modules in Parallel and Five Series with a shaded module at 30% and a 55% shaded module and (a) P-V characteristic curve. (b) monitoring the results of the comparisonbetween the conventional PSO and the modified PSO MPPT methods.

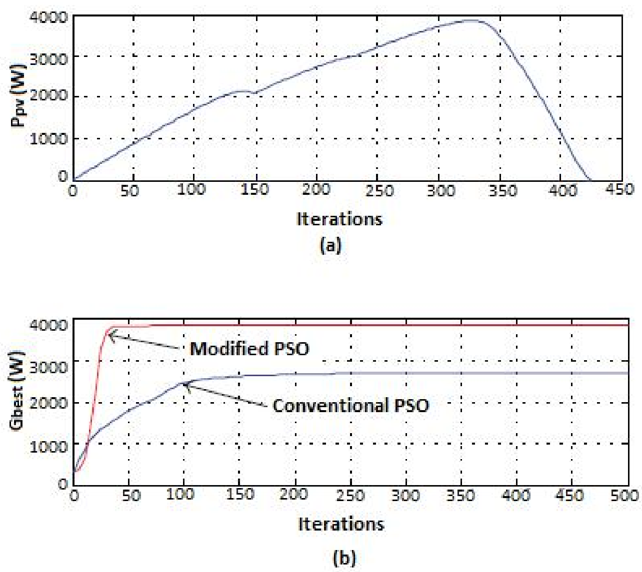

Fig.5: Simulation Results for Three Modules in Parallel to Five Series with a shaded module at 25% and a shaded module at 30% and (a) P-V characteristic curve. (b) monitoring the results of the comparison

between the conventional PSO and the modified PSO MPPT methods.

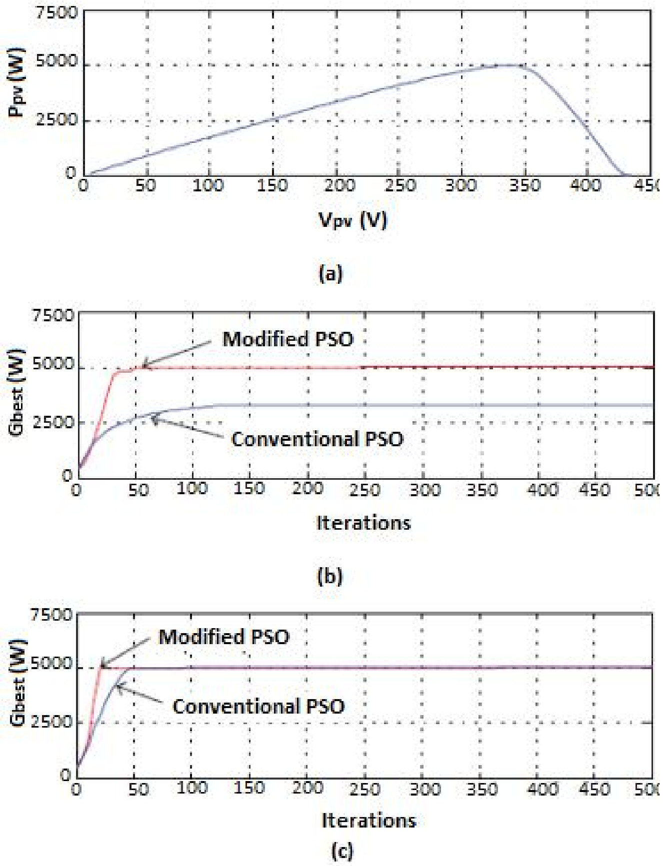

Fig.6: Simulation Results for Three Modules in Parallel and Five Series without shading: (a) P-V characteristic curve; (b) monitoring comparison results between the conventional PSO and MPPT methods based on modified PSOs; (c) follow-up comparisonresults between classic PSO and modified PSO.

Table 1.Parameters of Pannel

parameter	**value**
Iscn	5.96
Ipvn	6.10
Vocn	64.2
Ns	96
a	1.3977
Ki	0.065%/°C
Kv	0.080V/°C
Npp	3
Nss	5

Table 2. Parameters of Conventional PSO and Modified PSO

S.No	PARAMETER S	VALUE STANDARD PSO	VALUE MODIFIED PSO
1	No of particles	20	20
2	Min duty cycle	0.01	0.01
3	Max duty cycle	0.09	0.09
4	Sampline time	0.1s	0.1s
5	Max iteration	100	100
6	Wmax	0.9	0.7
7	Wmin	0.4	0.4
8	C1 min	0.1	0.1
9	C1 max	1.05	1.05
10	C2 min	0.1	0.1
11	C2 max	1.05	1.05

Table 3. Comparison Between Conventional PSO and Modified PSO

PPT methods	Conventional PSO method	Modified PSO method
Four-series one-parallel: one module with 30% shading and one module with 55% shading	75/100 attempts*	100/100 attempts
Four-series one-parallel: one module with 25% shading and one module with 30% shading	72/100 attempts	100/100 attempts
Two-series two-parallel: one module with 25% shading and one module with 30% shading	71/100 attempts	100/100 attempts
Four-series one-parallel: no module shading	(i)With weight set to 0.4: 49/100 attempts (ii)With weight set to 0.9: 100/100 attempts	100/100 attempts

4 Conclusion

the modified PSO can be considered as a solution to the problems due to the classic PSO, indeed, it is conceived essentially to adjust the weighting by using the linear decreases, it is destined to track the true MPP which is not the case with conventional PSO when it comes to shaded photovoltaic module systems, its success rate can reach up to 100%, this helps to optimize and improve the production of photovoltaic energy.

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