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A HYBRID MPPT TECHNIQUE BASED ON PSO AND P &O FOR PARTIALLY SHADED PV ARRAYS

P Sudheer
[1]*Department of EEE, Annamacharya Institute of Technology & Sciences, Tirupati-517520*

Abstract
Traditional MPPT algorithms such as P&O, Incremental conductance, Hill climbing are fail to track MPP (Maximum Power Point) when partial shading occurs for that purpose here introduce a new technique this is a combination of one traditional MPPT technique and one artificial intelligent is used this is called a hybrid MPPT it is a combination of P&O (Perturb & observe) with Particle Swarm Optimization (PSO) consequently, the conventional MPPT searches for the MPP in the estimated region. The proposed technique is modelled and simulated by using MATLAB R2011a/Simulink the results are compared with ANN based MPPT and PSO based MPPT for PV arrays under different shading patterns.
Index Terms-MPPT, Partial Shading Conditions (PSC), Perturb and Observe, PV array, PSO**.**

Introduction

Day by the usage of the usage of electricity greatly improves there are so many electrical energy resources are available these are non-renewable and renewable energy resources among these renewable energy resources are widely used all renewable energy resources are best way to generate electricity because these are reusable. So many renewable energy resources are available among all solar based PV arrays are mostly used. The PV array outputs are depends on the ambient temperature of the PV cell, solar irradiance on PV cell. The PV cell characteristics are usually described by using IV and PV curve. By multiplying the output current and voltage from IV curve, the output power can be calculated. There is an operating point where the output power is maximized, this point is called Maximum Power Point (MPP).Due to limited efficiency of the PV cell, and PV systems are always required to operate close to the MPP in order to gain the maximum energy. However the performances of PV cells can easily be affected by environmental conditions. The short circuit current depends on the solar irradiance level while the open circuit voltage shows a strong dependence of the cell temperature. As a consequence, the operating point which satisfies the MPP condition also varies with the environmental conditions. Thus it is essential to have a MPPT mechanism, which is a control algorithm that can track the MPP continuously during the operation in order to maximize the power production of the PV system [1], [2], [3], [4], [5], [6], [7] and [8].
PV cells are the combination of current source parallel with diode
Why its combination?

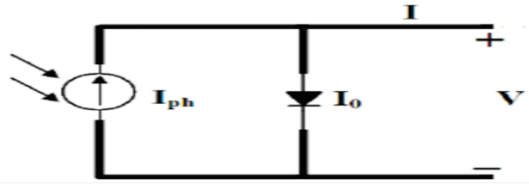

Fig: 1 PV cell equivalent circuit diagram

Generally solar panels are PV cells which are made of semiconducting materials like silicon.
Whenever these cells are exposed to sunlight carriers in semi conducting materials are energised and result in flow of charge i.e. Current so solar cells are represented as current source.

Since these currents is flowing in panel made of semiconducting materials a diode is placed in parallel with current source.
PV modules are the combination of PV cells are connected in series or parallel.

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PV Arrays are the combination of PV modules are connected in series or parallel.

If some of these cells are shaded due to passing out of clouds or adjacent trees or structure as shown in Fig.2 the shading pattern at some of the cells the unshaded cells produce more power compare to shaded cells this excess amount of power from unshaded cells it creates heat it will damages the PV cell partial shading condition. The characteristics also changes it will creates many peaks. These are shown in Fig.3

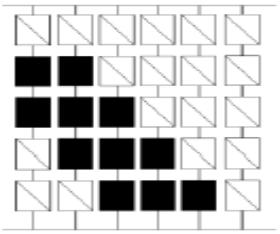

Fig .2. Photovoltaic arrays under different partial shading condition

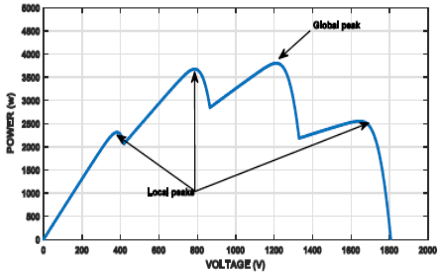

Fig.3.PV Array characteristics for different PSCs

Related Work

1. PSO based MPPT

Particle Swarm Optimization (PSO)

Particle: - A particle is a small localized object can be several physical (or) chemical properties such as volume (or) mass.

Swarm:- Collection of something that move somewhere in large numbers flock, crowd, flood.

Optimization: - The action of making the best (or) most effective use of a situation (or) resource.

Flow chart of PSO

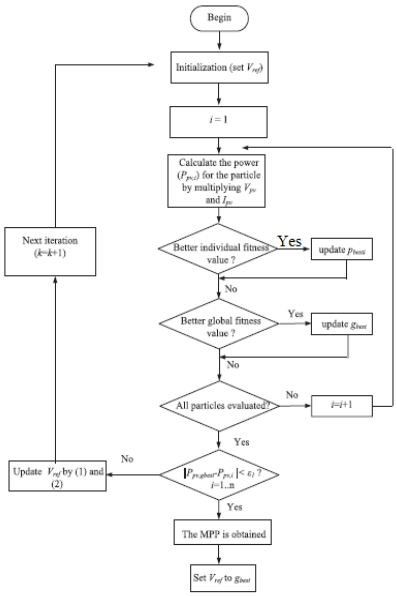

Fig.4. flow chart for the PSO

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PSO based MPPT flow chart

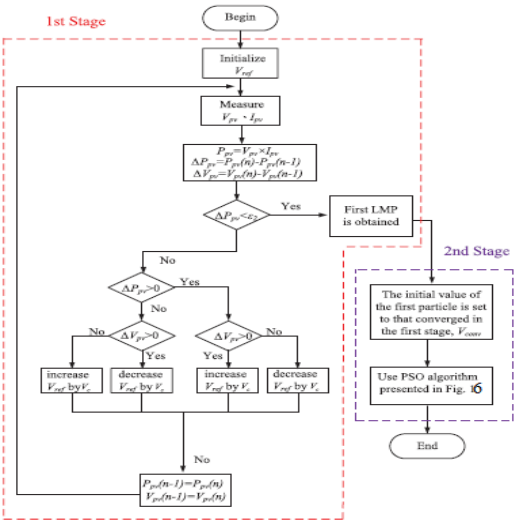

Fig.5. Flowchart for the PSO based MPPT (P&O)

Fig.5 illustrates the PSO based MPPT algorithm as a flowchart. The method consists of two stages. In first stage the P&O method is employed to quickly search for the first local maximum. The operating voltage is perturbed by small amount (Vc) [17],[18] every control cycle to determine whether the algorithm is traveling up or down in the P-V curve. Note that convergence criterion needs to be introduced in the first stage of the proposed system to locate the first LMP and to pass it to the second stage.

In the second stage the PSO is activated to search for the GMP. The initial condition for the first particle is set to the converged value from the first stage Vconv. The initial conditions of the other particles are set to value ranging from Vconv to the upper bound of the search space. Because the number of particles remains the same but the search space is smaller, the hybrid method is expected to find the GMP in a shorter time than that taken by PSO method alone.

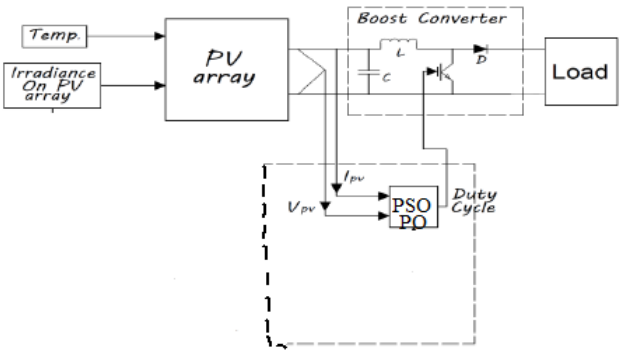

Fig.6. Schematic diagram of the PV system using PSOPO

Table1 lists the parameters of the PV module employed in each array. To emulate the effect of partial shading, the irradiances of the four PV arrays are set to different values. The mathematical model described in section II is model educing MATLAB/Simulink (R2011a), and it is utilized to obtain the characteristics of the four series PV arrays under PSC.

TABLE 1
PHOTO VOLTAIC (PV) PANEL PARAMETER

Parameter	Value
Maximum power	200W

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Number of cells in each module	54
Open circuit voltage(V_{oc})	32.9V
Optimum voltage(V_{mp})	26.3V
Short circuit current(I_{sc})	8.21A
Optimum voltage(I_{mp})	7.61
Temp.coefficient of I_{sc} (K_I)	0.00318A/^{0}C
Temp.coefficient of V_{oc} (K_V)	-0.123V/^{0}C
Parallel resistance	601.3368 ohm
Series resistance	0.23 ohm

2.SIMULATION RESULTS

PSO based MPPT technique is verified by various simulations under different partial shading patterns using MATLAB/Simulink (R2011a). In this three different shading patterns (SP1, SP2, and SP3) are considered for PV array under partial shading, while one SP under uniform irradiance (SP4) is considered, as listed in table. the case of uniform irradiance single peak , which leads to a simple detection for the MPP by directly utilizing any conventional method .however, in the other three cases of partial shading, there is a challenge in defining the global peak, as the PV curve changes from a single peak to multiple peaks.

TABLE 2
SHADING PATTERNS (SPS) FOR TEST SCENERIOS

SHADING PARAMETER NO	IRRADIANCE ON THE ARRAY in W/m^2			
	A_1	A_2	A_3	A_4
SP1	200	400	600	1000
SP2	400	500	800	800
SP3	600	600	1000	1000
SP4	1000	1000	1000	1000

To verify the proposed technique the system shown in fig.6 was modelled and simulated under different SPs. Each PV array consists of two parallel strings, each of which comprised 15 series modules. Therefore, the maximum power of each array at nominal conditions (250C and 1000W/m2) was 6125W (6.125KW). Fig.10 displays the MATLAB/Simulink (R2011a) model for the system Fig.10.

First simulation was run to obtain the PV characteristics for the four SPs described in Table2. Fig.8. illustrates the PV characteristics under SP1 and SP4. Fig.9. illustrates the PV characteristics under SP2, SP3 and SP4.

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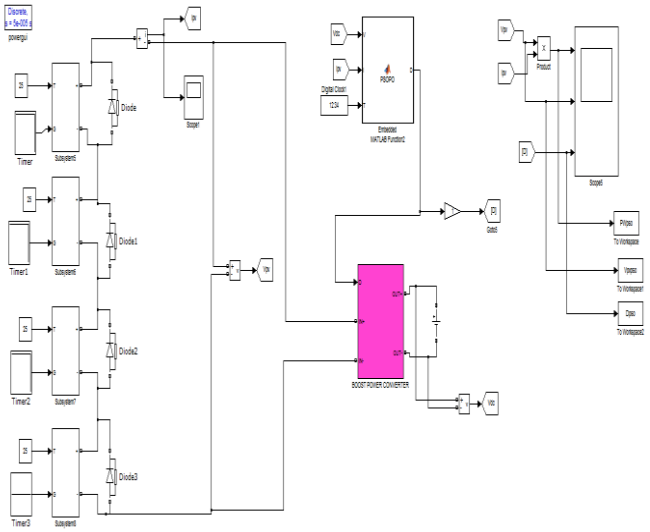

Fig.7 MATLAB/simulink model

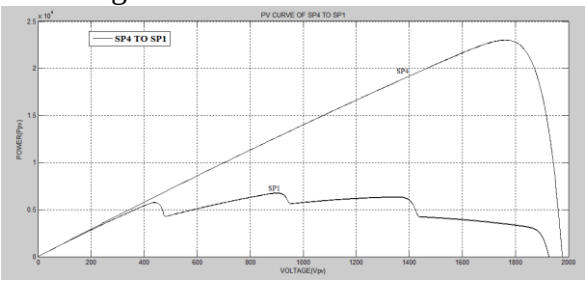

Fig.8.PV Characteristics under shading patterns SP4 to SP1

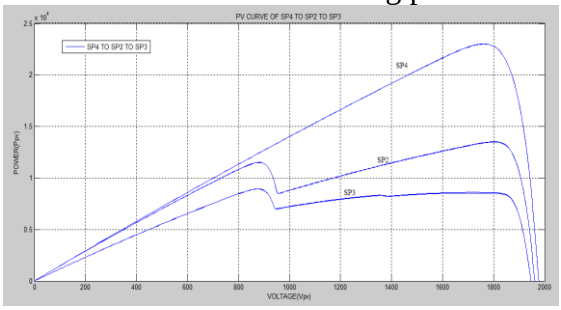

Fig.9. PV Characteristics under shading pattern SP2 to SP3 to SP4

Second the simulation was to obtain the Steady state and Dynamic behaviour of the system Fig.13. Illustrates for the changes of irradiances shading patterns from SP4 to SP1.

These are observed by the MPPT technique

TABLE 3
Shading patterns change from SP4 to SP1

SHADING PATTERNS	POWER (W)	VOLATGE(V)	DUTYCYCLE
SP4 to SP1 (at t=0s to t=5s)	24500 to 8200	1665 to 1350	0.232 to 0.392

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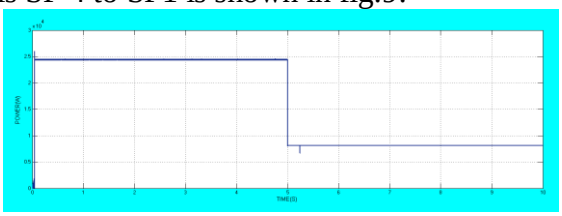
The PV characteristics of this SP 4 to SP1 is shown in fig.9.



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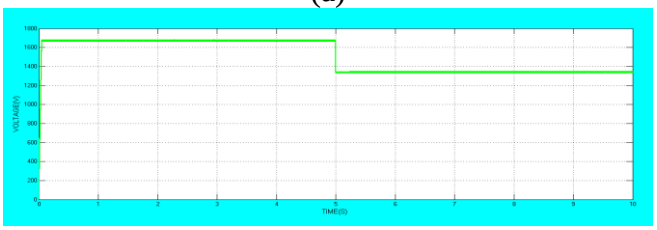

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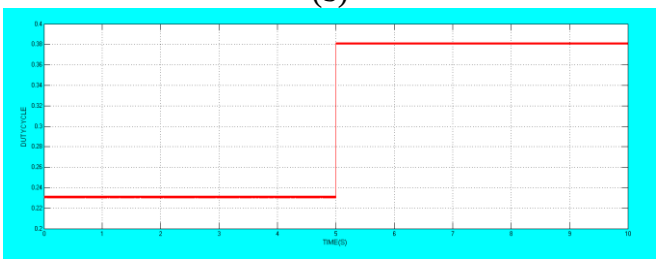
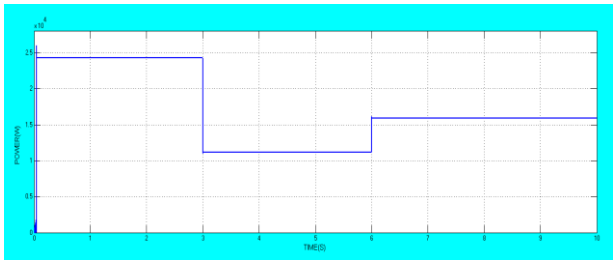


(c)

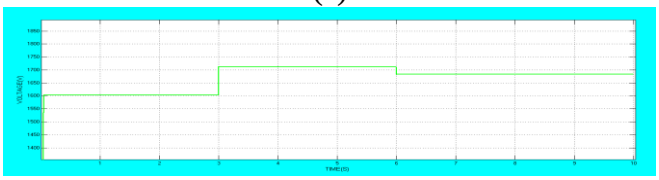
Fig.10. the simulation results of the changes from SP4 to SP1 ((a) power vs time, (b) voltage vs time, and (c) duty cycle vs time)

TABLE 4
Shading patterns change from SP4 to SP2 to SP3

SHADING PATTERNS	POWER(W)	VOLTAGE(V)	DUTYCYCLE
SP4 to SP2(at t=o to t=3s)	24500 to 11168	1602 to 1712	0.232 to 0.1752
SP2 to SP3(at t= 3s to t=6s)	11168 to 15891	1712 to 1683	0.1753 to 0.1853



(a)



(b)

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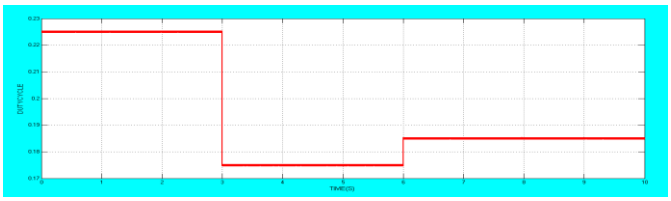


(c)

Fig.11. the simulation results of the changes from SP4 to SP2 to SP3((a) power vs time, (b) voltage vs time, and (c) duty cycle vs time)

3.COMPARISION STUDY OF THE PSO based MPPT and ANN based MPPT

In order to clarify the performance improvement of the PSO based MPPT technique, a comparative study between it and the ANN based MPPT technique which presents in [1] is carried out in this section. Consider two shading patterns (SP5 and SP6) as listed in TABLE 5.

TABLE 5

Shading patterns for test scenarios

SHADING PARAMETER NO	IRRADIANCE ON THE ARRAY in W/m^2			
	A1	A2	A3	A4
SP5	120	240	600	700
SP6	220	460	680	1000

The same Simulink model is described in this test scenarios but here change the shading patterns in different ways to compare ANN based MPPT and PSO based MPPT here ANN based MPPT is previous technique PSO based MPPT is newest technique here also compare with only ANN.

Knowing the optimum voltage leads to predict the desired duty cycle of the boost converter. The PV track during change of irradiance from SP5 to SP6.

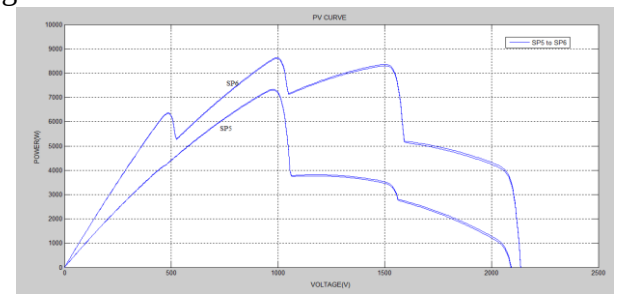
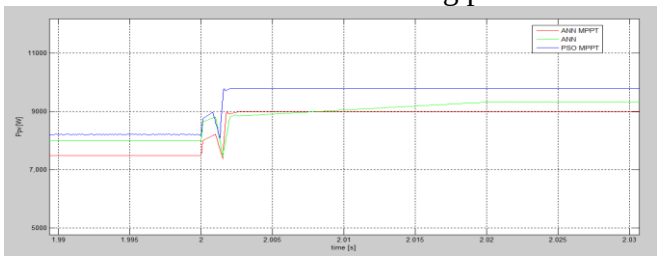


Fig.12. PV characteristics under shading patterns SP5 to SP6



(a)

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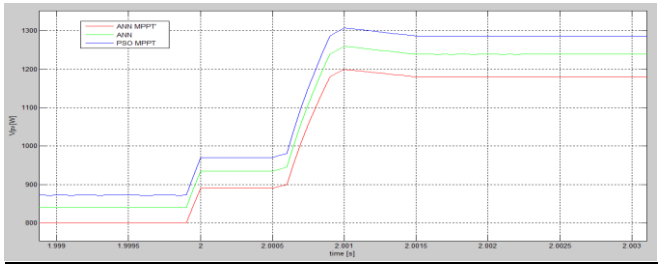

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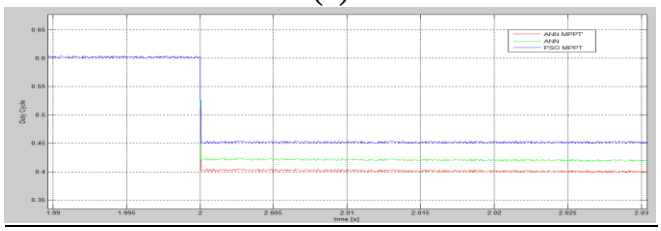

(c)

Fig.13. simulation results when changing from SP5 to SP6 considering the ANN, ANN based MPPT and PSO based MPPT techniques (a) output power of PV arrays (b) terminal voltage of the PV array (c) duty cycle of the boost converter.

4 CONCLUSIONS

Traditional MPPT algorithms such as Perturbed and observed, Incremental Conductance, Hill climbing so many Traditional MPPTs are not succeeded while tracking MPP under different Partial Shading Conditions (PSCs) they are track instead of MPP, LMP is tracked to track MPP here additionally combined With traditional MPPT to other swarm (or) artificial intelligent is used to obtain the MPP. Here PSO based MPPT is used to track global MPP here MPPT (i.e. P & O) technique is firstly track the LMP is the first stage for the next stage it is PSO is activated and get the MPP. That's why it is simple and give more accurate MPP when compare to others for different partial shading conditions (PSCs) these are observed by simulation (MATLAB Simulink) steady state and dynamic, compare this PSO based MPPT with ANN based MPPT and ANN and observed that PSO based MPPT is better performance.

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