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MPP Detection Based On Genetic Algorithm for PV System in Partial Shading Condition

Bhavesh G Tandel[1] , Darshan R Vora [2]

[1]M.Tech power system , Electrical Engineering Department ,CGPIT, Bardoli, Surat, India

[2] Assistant Professor, Electrical Engineering Department, CGPIT ,Bardoli,Surat, India

Abstract— This thesis presents power versus voltage curve of PV (photovoltaic) array when only one maximum power point (MPP) with uniform shaded of the array or several local MPPs and there exists only one global MPP with non-uniform (partial shading) shaded of the array. Detect the MPP of PV array commonly used the Perturb and observe (P&O) algorithm when uniformly shaded of the Array. However when partial shading condition curve of PV is multiple peaks so maximum power point track by perturb and observe algorithm is an only local point not a global point or first point. In this paper, using a genetic algorithm (GA) is adopting in detect the global maximum power point of a partial shading of PV array. It is observed that performance of genetic algorithm (GA) is better than perturb and observe method find for global maximum point in different shading condition.

Index Terms—PV System, Partial Shading Condition, Maximum power point tracking, Genetic Algorithm.

INTRODUCTION

A rise in the global population has resulted in a consequent increase in demand for oil and gas. These fuels have become an integral part of our daily lives and they play a critical role in the functioning of the world. Besides the intermittent nature of the solar radiation and reliability concerns, the PV output power is significantly affected by changes in insulation level and temperature. Therefore, for applications demanding a constant output it is required to interface power electronic converters with PV systems. Photovoltaic (PV) strings under partially shaded conditions (PSCs) is presented with Parallel and series configurations of PV strings with different patterns of isolation have been investigated [1].

The solar cell and of its equivalent circuit [2] with Power electronic converter works as a regulator thereby helping the PV system in meeting the constant load demand. Since the current-voltage characteristic of a PV cell is non-linear, for a particular insulation and temperature, there is a unique point on the power-voltage characteristic at which the photovoltaic power is Maximum. This point is termed as the **M**aximum **P**ower **P**oint (MPP) [3]. In order to efficiently utilize the PV system it is always desirable to make the PV system operate at MPP. This is made possible interfacing the PV system with the power electronic converter working as a **M**aximum **P**ower **P**oint **T**racker (MPPT) incorporating one of the MPPT schemes. Various MPPT schemes for PV systems have been reported in literature with respect to their tracking speed and accuracy. It is not only the size (i.e., the total number of modules) of the PV array but also its configuration (i.e., the number of modules in series and parallel, respectively) that significantly affects its power output, and therefore, the performance of the system under partially shaded conditions [8]. To improve the rate and optimize this source it is very interesting to make PV systems working with their optimal efficiency so with their maximum power, this is the objective of Maximum Point Tracking MPPT in the partial shading condition [10].

There are many methods of MPPT but here we make comparison between the two conventional methods Perturb and Observe (P&O) and Genetic algorithm (GA)[3],[13] with proportional integral technique. The two algorithms use the P-V curve to give the MPPT search direction by incrementing/decrementing the array voltage in which genetic algorithm give a best value instead of P&O. They use different techniques observe if the operating point is left or right of the

MPP [4]-[5] . The proposed MPPT controller is based on genetic algorithm (GA) optimized artificial neural network (ANN) [6]. The coupled the PV array with the boost converter in such a way that with variation in load, the varying input current and voltage to the converter follows the open circuit characteristic of the PV array closely [7,9].

The amount of electric power generated by PV panels is always changing with weather conditions. In fact, the performance of a PV array is affected by temperature and solar irradiance. Thus, a major challenge in using a PV source is to tackle its nonlinear characteristic of power versus voltage, which results in a unique MPP which needs to be tracked when weather conditions change. The characteristics get more complicated if the array does not receive uniform irradiance, which results in multiple peaks. So aim of the project when partial shading occurring [12], on the PV array output result with multiple peaks (global or local point) on that condition maximum power point tracking by perturb and observe method would be difficult. That is tracking only the local point so for multiple tracking of MPP here using the genetic algorithm [11].To improve the rate and optimize this source it is very interesting to make PV systems working with their optimal efficiency so with their maximum power, this is the objective of Maximum Point Tracking MPPT. There are many methods of MPPT but here comparison between the two conventional methods Perturb and Observe (P&O) [14] and genetic algorithm [15].

The two algorithms use the P –V curve to give the MPPT search direction by incrementing/decrementing the array voltage. They use different techniques observe if the operating point is left or right of the MPP. These algorithms give good results and are widely used in MPPT, but they present the drawback of oscillating around the MPP and difficulty to adjust the search step for the Perturb and Observe technique and that is only track the local point [13]. Here using the MPP technique of genetic algorithm method for maximum power tracking point with tracking of local and global point and also describe which the best method of two [13].

BLOCK DIAGRAM OF THE SYSTEM

The DC power generated from PV systems can either be used for feeding a standalone load or can be interfaced with the grid feeding power into the utility grid. Stand-alone systems are self sufficient systems and are not connected with the utility power lines. These systems can be designed with storage or without storage. Figure 3.8 show a PV system without storage feeding a stand-alone load. These systems work in the day-time using the available solar energy and providing it to the load directly. Systems with storage have a battery which is charged when the sun is available and is used to supply the load when the sun is not available. Figs. 3.8 show the block diagrams of a PV system with battery storage feeding only DC loads.

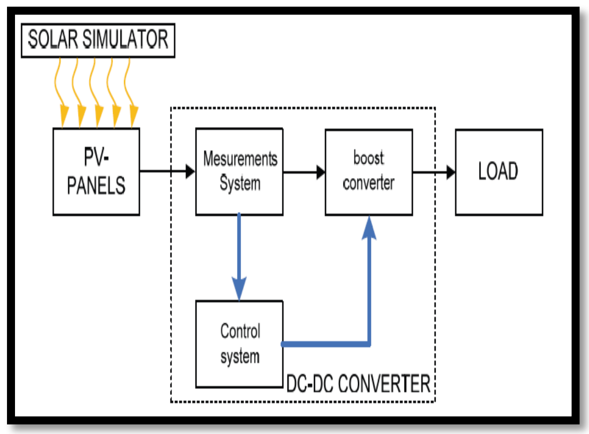

Figure 1 Block Diagram of the system

If the using of AC load then consisting process of the PV system usually consists of a PV source, batteries for storage, charge controller to prevent overcharging of the batteries and an inverter to convert DC power of PV system into AC power in case of grid and grid connected loads [10]-[12].

PHOTOVOLTAIC CELL

The power that one module can produce is not sufficient to meet the requirements of home or business. Most PV arrays use an inverter to convert the DC power into alternating current that can power the motors, loads, lights etc. The modules in a PV array are usually first connected in series to obtain the desired voltages; the individual modules are then connected in parallel to allow the system to produce more current [7].

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Equivalent Circuit of a Solar PV cell

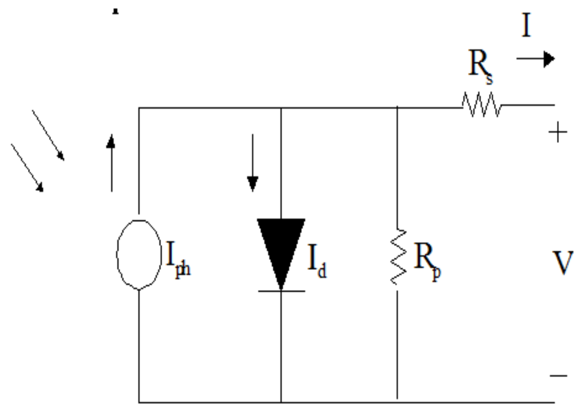

Figure 2 Equivalent circuit of PV cell

The I-V characteristics of PV cell can be determined by the following equations [5]. Solar cell output current is given as,

$$I = I_{ph} - I_d - I_{sh}$$

Diode Current is given as,

$$I_d = I_0[\exp^{\frac{q(V+I\cdot R_s)}{N_s\cdot A\cdot k\cdot T_c}} - 1]$$

Photo current is given as,

$$I_{ph} = I_{sc} + k(T_c - T_{ref})\frac{G}{1000}$$

Current through shunt resistor is given as,

$$I_{sh} = \frac{V + I\cdot R_s}{R_p}$$

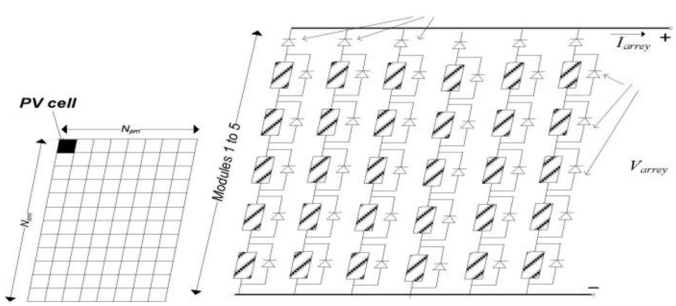

Figure 3 PV modules with bypass and blocking diode

Table 1 system parameter of PV cell

Peak power (P max)	200.143 watt
Short circuit current (I sc)	8.21 Amp
Open circuit voltage (Voc)	32.9 Volt
Maximum power current (I mpp)	7.61 Amp
Maximum power voltage (V mpp)	26.3 Volt
Number of series cell	54
Energy gap	1.3
Parallel resistance	415.405 ohm
Series resistance	0.221ohm

Partial shading condition

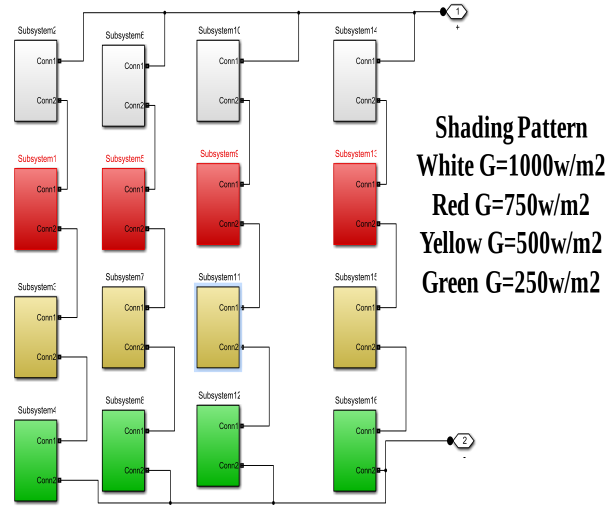

Figure 4 different irradiation level of PV module

Multiple local points will be appearing on the P-V characteristic because here using different irradiation level. The bypass diodes can replace with MPPT converters was improve the energy extraction from the solar panels. Placing a power optimizer on each panel eliminates the local point from the P-V characteristic of the overall system. In the literature,' it is stated that the global point systems can harvest up to 25% more energy than the systems with bypass diodes'. The disadvantage of power optimizers is their high price and that condition cannot use the method of perturb and observe because they do not detect the global point. So we have required method of genetic algorithm for detection of the global point [13]. Refer fig.14.

MAXIMUM POWER POINT TRACKING

The energy extracted from sunlight by solar PV cells is dependent mainly on sunlight intensity and cell temperature which are in turn affected by many factors such as geo-graphical location, collector site location, collector orientation, time of the day, time of the year, atmospheric condition and collector design etc. Maximum Power Point Tracking, frequently referred to as MPPT is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that physically moves the modules to make them point more directly at the

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sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different. PV cells have a single operating point where the values of the current (I) and Voltage (V) of the cell result in a maximum power output.

These values correspond to a particular resistance, which is equal to V/I as specified by Ohm's Law. The current voltage characteristics of the PV cell and hence the PV array are highly non-linear. It can be seen from the power-voltage characteristics, that there is a unique point on the characteristics at which the photovoltaic power is maximum.

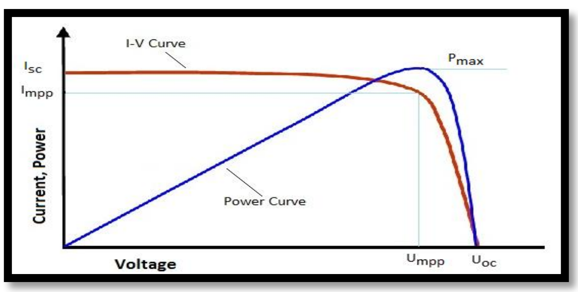

Figure 5 Basic graphs of P-V and I-V characteristic

This point is termed as the maximum power point (MPP). The power, voltage and current corresponding to this point are referred to as PMPP (power at maximum power point), VMPP (voltage at maximum power point) and IMPP (current at maximum power point) respectively. As the irradiation level Current Voltage MPPs Irradiation level changes, the power output of the PV system changes, which in turn, changes the MPP Figure 6. Shows how the MPP points changes under different levels.

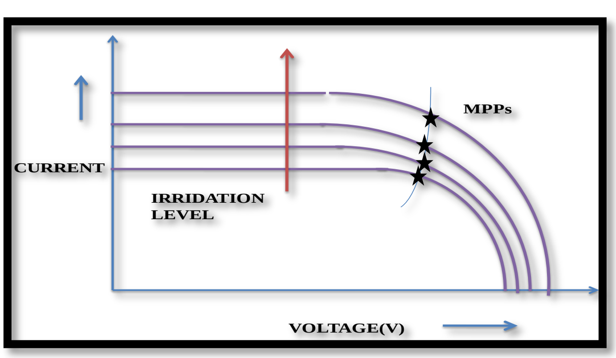

Figure 6 I-V characteristic at different irradiation level

It is desirable to make the PV system operate at MPP so that the source is utilized efficiently at all the times. Maximum power point trackers utilize some type of control circuit or logic to search for this point and thus to allow the converter circuit to extract the maximum power available from a cell. Various tracking methods like curve-fitting technique, open circuit voltage method, short circuit method, incremental conductance technique, perturb & observation method[9].

PERTURB AND OBSERVE TECHNIQUE

There have been extensive applications of the P&O MPPT algorithm in various types of PV system. This is because P&O algorithm has a simple control structure and few measured parameters are required for the power tracking. Moreover, it has an advantage of not relying on the PV module characteristics in the MPPT process and so can be easily applied to any PV panel**.** The name of algorithm itself reveals that it operates by periodically perturbing the control variable and comparing the instantaneous PV output power after perturbation with that before. The outcome of the PV power comparison together with the PV voltage condition determines the direction of the next perturbation that should be used.

The algorithm has been shown as shown in Figure 5.3. If the PV output power is increasing, the perturbation will continue with the same direction in the next cycle, otherwise the perturbation direction will be reversed [5].

We can write:

$\Delta P>0$ → Continues changing with the original direction

$\Delta P<0$ → Changes to the opposite direction

$\Delta P=0$ → doesn't change (theoretical case)

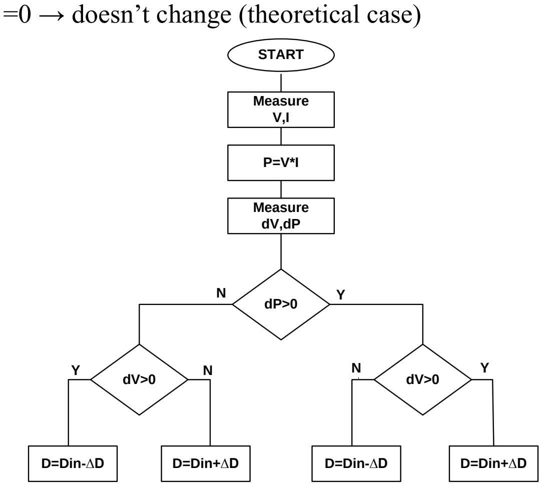

Figure 7 Flow Chart of Perturb & Observe technique

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The P&O perturbation step-size used in any MPPT technique plays a significant role in determining the accuracy and speed with which the operating point moves towards the MPP. The larger the perturbation step the faster the operating point can be driven to the MPP. However, the intrinsic oscillations around the MPP are larger in steady-state Maximum power point tracking.

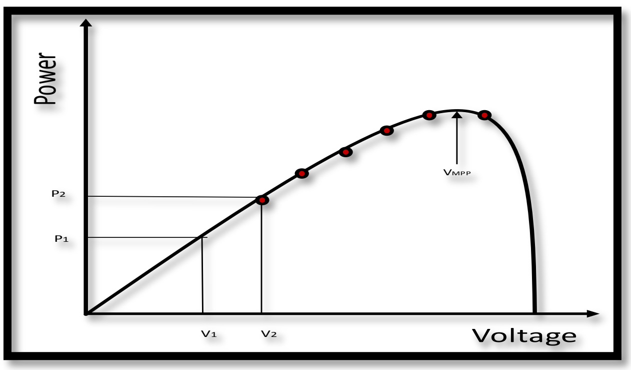

Figure 8 MPP detection by perturb and observe method

These oscillations would reduce the effectiveness of the PV power conversion. A smaller perturbation step size reduces the magnitude of oscillation around the MPP and increases the energy conversion effectiveness once the MPP has been achieved. This would solve the problem at steady-state but would lead to a slow response under rapidly changing environmental conditions [6]-[9].

GENETIC ALGORITHM

Genetic algorithms (GAs) are gradient-free, parallel optimization algorithms that use a performance criterion for evaluation and a population of possible solutions to the search for a global optimum. GAs is capable of handling complex and irregular solution spaces, and they have been applied to various difficult optimization problems**.**

Main operators of GA:

1. Selection
2. Crossover
3. Mutation

Objective function

Fitness function= (Output power of PV array) = V * I

chromosome = initial_pop(pop_size,nbit);

x1 =b2d(chromosome,bit1,x1_Min,x1_Max);

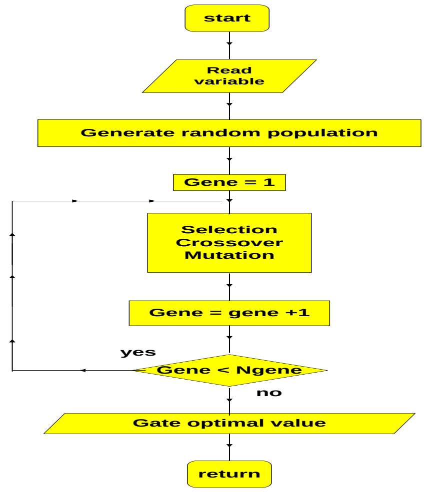

Figure 9 flow chart of Genetic Algorithm

Outline of genetic algorithm

Step 1 Generates random population of chromosome.

Step 2 Evaluate the fitness f(x) for each chromosome x in the population.

Step 3 Creates new populations by repeating following steps until the new population is complete.

- ✓ [selection] select the two parent chromosome from a population according to their fitness (better fitness, bigger the chance to be selected)
- ✓ [crossover] With crossover probability, crossover the parents to form new offspring. If no crossover performed, offspring is the exact copy of parents.
- ✓ [Mutation] with a mutation probability, mutate new offspring at each locus (position in chromosome).
- ✓ [Accepting] Place new offspring in the new population.

Step 4 [Replace] use new generate population for a further run of the algorithm.

Step 5 [Test] if the end condition is satisfied, stop, and return the best solution in current population.

Step 6 [Loop] Go to step 2.

Crossover

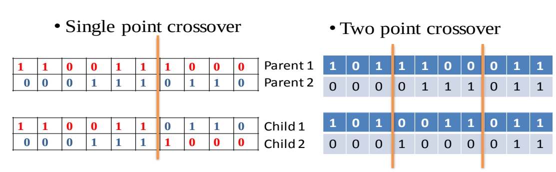

Figure 10 crossover technique

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Mutation

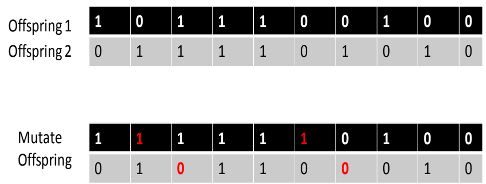

Figure 11 mutation technique

System parameter of GA

Dimension of Problem	1(Variable V)
Population Size	100
Maximum number of iteration	100
Mutation Rate	0.08
Crossover Probability	0.25
Initial Population	Uniformly distributed interval [Xmin, Xmax]
Mating	Single point crossover

PI Controller

The system also employs a PI controller. The task of the MPPT algorithm is just to calculate the reference voltage V ref towards which the PV operating voltage should move next for obtaining maximum power output. This process is repeated periodically with a slower rate of around 1-10 samples per second. The external control loop is the PI controller, which controls the input voltage of the converter. The pulse width modulation is carried in the PWM block at a considerably faster switching frequency of 5 KHz. In our simulation, KP is taken to be 1 and KI is taken to be 0.001. A relatively high KI value ensures that the system stabilizes at a faster rate.

The PI controller works towards minimizing the error between V ref and the measured voltage by varying the duty cycle through the switch. The switch is physically realized by using a MOSFET with the gate voltage controlled by the duty cycle [16].

simulation and result

Simulation

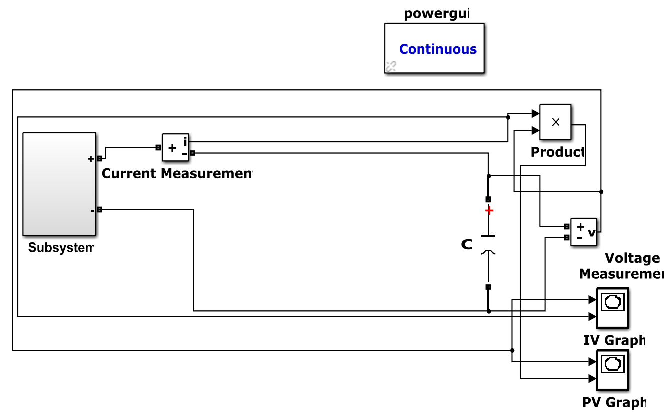

Figure 12 simulation of PV array

Result of PV Module (54 cell in series)

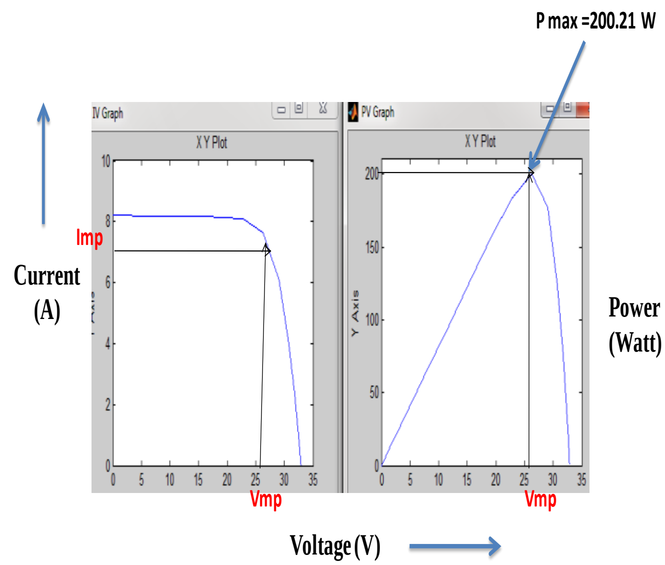

Figure 13 I-V & P-V char. Of PV module

Result of PV module in Partial shading condition

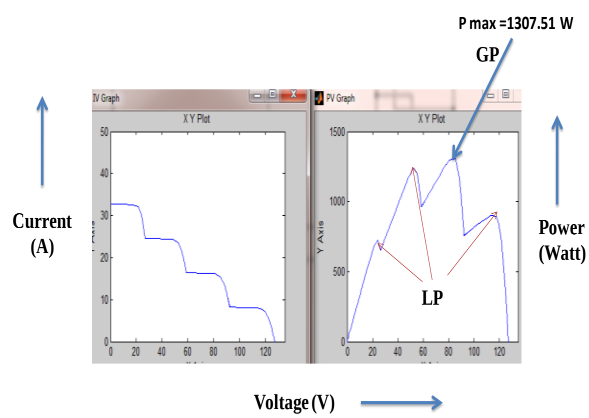

Figure 14 I-V & P-V char. Of PV array in PSC

Here using 16 PV module show in fig.4 with 54 solar cell in series with different irradiation level so at a different level created multiple peak that peak show in fig 14. It should be difficult to track by perturb and observe method.

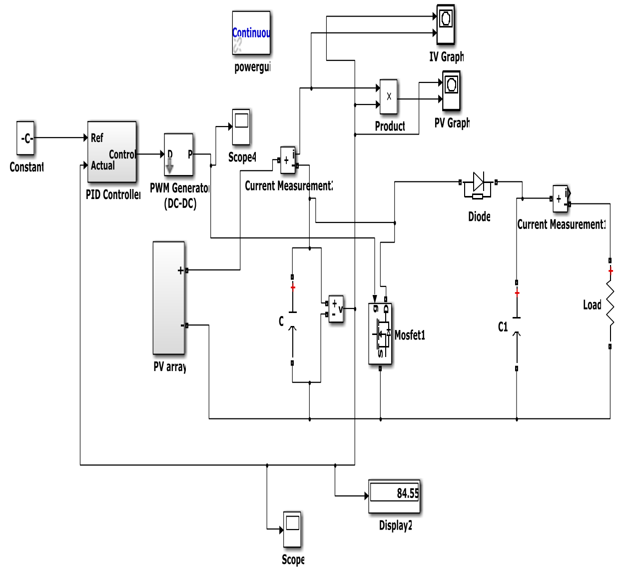

Figure 15 simulation of MPP track by PI controller with GA

Result

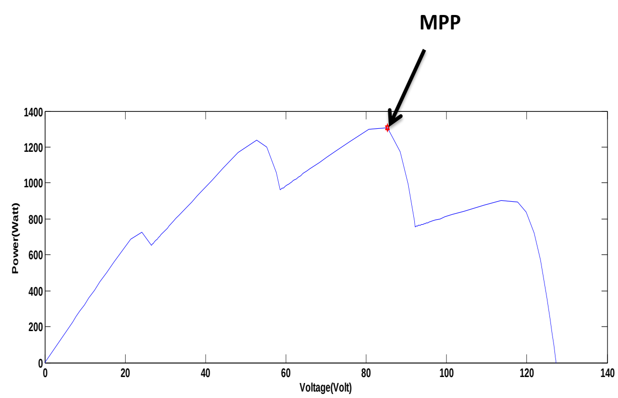

Figure 16 GP MPP detect by genetic algorithm.

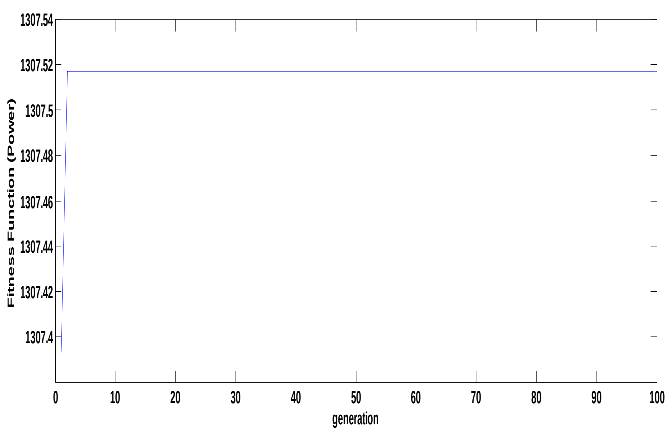

Figure 17 fitness functions vs. generation

Result compare between two method

The results yielded by this algorithm are presented in column 3 of Table 3. In column 2 of the same table, the actual simulated results yielded by MATLAB model for the studied PV array are presented. Performance of the P&O algorithm in detecting the peak point is presented in Fig. 17. It is clear from Table 3 as well as from Fig. 17 that though the P&O algorithm is formidably fast yet it is not very much effective. The global MPP is not being detected. Instead of detecting the global MPP, the P&O method settles the operating point of the PV array at a local MPP which may not be the actual MPP. Thus, the PV array might be under-utilized and less economical.

The results yielded by the GA for the detection of global MPP in case of partially shaded PV array are presented in column 4 of Table 3. Fig. 17 shows how genetically optimized power points start clustering around the global MPP with increasing number of iterations. It is clear from Fig. 17 that the GA is successful in tracking global MPP unlike the P&O method. Thus, the PV array does not remain severely under-utilized as compared to the earlier case.

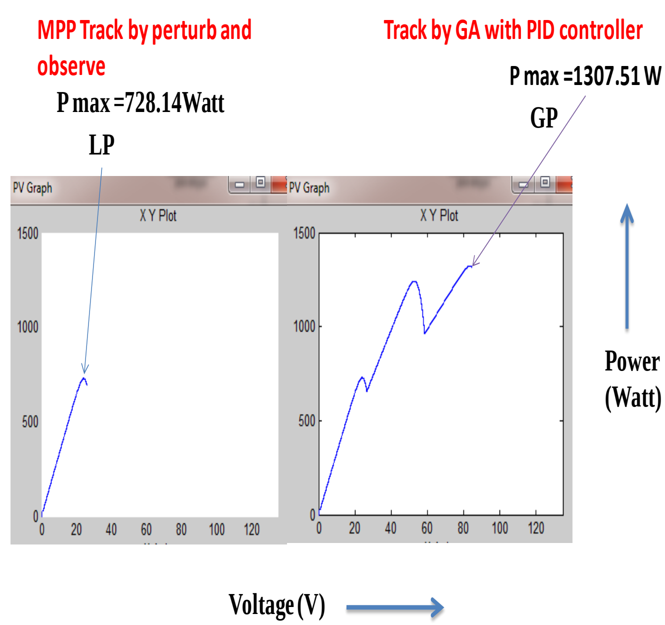

Figure 18 result of MPP tracking by P&O and GA

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3 Actual results vs. results obtained using P&O algorithm and GA for MPP detection of partially shaded PV array.

Variable	Actual Result	By P&O	By GA
Peak Power, Pm(W)	1319.12	728.14	1319.12
Voltage at Peak power Vm(V)	85.27	24.41	85.27
Current at Peak Power Im (A)	15.62	29.81	15.62

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CONCLUSION

A PV array is modeled in MATLAB environment. GA technique is applied for detecting the MPP of a partially shaded PV array. The results obtained by using GA are compared to a standard conventional MPPT algorithm such as P&O algorithm. It is reported in the literature that the performance of the P&O algorithm in detecting the MPP is very efficient for a uniformly shaded PV array system. But it is observed in the present work that the same fails to achieve global point in case of a partially shaded PV array. It is observed from the results that the GA overcomes this problem associated with conventional P&O algorithm in detecting the MPP under the condition of partially shading of the PV array and also observe that GA is easily detect the MPP of global point in PSC.

REFERENCES

[1]. Habbati Bellia a, Ramdani Youcef , Moulay Fatima ,"A detailed modeling of photovoltaic module using MATLAB", NRIAG Journal of Astronomy and Geophysics (2014) 3, 53–61.

[2]. Atsushi Kajihara, Tetsumi harakawa, "Model of Photovoltaic Cell Circuits under Partial Shading", IEEE transaction on, 2005.

[3]. Slimane Hadji, Krim Fateh, " Development of an Algorithm of Maximum Power point tracking for photovoltaic systems using Genetic Algorithms" ,EFEEA'10 November 2010, Ghardaïa, Algeria..

[4]. S. Hadji, J.-P. Gaubert, F. Krim, "Maximum Power Point Tracking (MPPT) for Photovoltaic systems using open circuit voltage [and short circuit current",IEEE, October 29-31, 2013.

5]. Slimane HADJI , Jean-Paul GAUBERT, Fateh KRIM, " Experimental analysis of genetic algorithms based MPPT for PV systems", IEEE 2014.

[6]. R. Ramaprabha , V.Gothandaraman, K.Kanimozhi, R.Divya ,B.L.Mathur , "Maximum Power Point Tracking using GA Optimized Artificial Neural Network for Solar PV System", IEEE transaction on, 2011.

[7]. Shishir kumar, Pradhan, Debashis das, "modeling and simulation of PV array with boost converter: an open loop study", 2011.

[8]. Masoud Etezadi Nezhad, Behzad Asaei, Shahrokh Farhangi, "Modified Analytical Solution for Tracking Photovoltaic Module Maximum Power Point under Partial Shading Condition" ,IEEE transaction on 2013.

[9]. Muthuramalingam, P. S. Manoharan, " Energy comparative analysis of MPPT techniques for PV system using interleaved soft-switching boost converter", World Journal of Modelling and Simulation, Vol. 11 (2015) No. 2.

[10]. Hiren Patel and Vivek Agarwal , "MATLAB-Based Modelling to Study the Effects of Partial Shading on PV Array Characteristics", IEEE transactions on energy conversion, vol. 23, no. 1, march 2008.

[11]. Hamid Reza Mohajeri, Mohsen Parsa Moghaddam, Mahdi Shahparasti, Mostafa Mohamadian , "Development a New Algorithm for Maximum Power Point Tracking of Partially Shaded Photovoltaic Arrays", IEEE transaction, May 15-17,2012, Tehran, Iran.

[12]. R.Ramaprabha, Badrilal Mathur, MadhuriMurthy, S.Madhumitha, “New configuration of solar photo voltaic array to address partial shaded conditions” IEEE transaction on, 2010.

[13] G. Shankar, V. Mukherjee,“MPP detection of a partially shaded PV array by continuous GA and hybrid PSO”, Ain Shams Engineering Journal (2015) 6, 471–479.

[14] Stefan Daraban , Dorin Petreus , Cristina Morel , “A novel MPPT (maximum power point tracking) algorithm based on a modified genetic algorithm specialized on tracking the global maximum power point in photovoltaic systems affected by partial shading”, Energy 74 (2014) 374e388.

[15]. S.Rajasekaran, G.A. Vijayalakshmi Pai, “Neural networks, Fuzzy logic, genetic algorithms” book page 225-234.

[16] Arjav Harjai, Abhishek Bhardwaj, Mrutyunjaya Sandhibigraha**, “**study of maximum power point Tracking (mppt) techniques in a solar photovoltaic array”.