

Effect of Complex Shading Patterns on Photovoltaic Array & Global Power Point(GPP)

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Abstract: Energy from the sun is the best option for electricity generation as it is available everywhere and is free to harmless. Single solar cells can produce 1w to 3 w of power from the incident solar insolation. Therefore PV (Photovoltaic) array is constructed to get the required voltage. In normal condition, the PV array will show the single maxima on the P_V characteristic i.e. nothing but Maximum Power Point (MPP) and this point is unique. But at the shaded condition the Photovoltaic (PV) array will show the multiple maximum points on the PV characteristic. So from that multiple maxima it is necessary to track the Global Power Point (GPP). This paper discusses the different shading pattern and its effect on the position of the Global Power Point (GPP). Tracking the GPPT at the non uniform insolation condition will increase the efficiency of the Photovoltaic System.

Keywords: Photovoltaic (PV), P_V (Power_Voltage) characteristic, Maximum Power Point Tracker (MPPT), Global Power Point (GPP).

I. INTRODUCTION

Solar energy is one the most effective, less expensive, harmless and less environmental pollution effect of renewable energy sources. This energy can be converted into electrical energy through the implementation of photovoltaic array [1] [3].

Unfortunately, PV system has its own drawbacks, which are mainly due to high fabrication cost and low energy conversion. It is caused by their nonlinear, isolation level and temperature-dependent on current-voltage (I-V) and power voltage (P-V) characteristics, which result in the displacement of the Maximum Power Point (MPP)

To obtain the maximum power from the PV array, a maximum power point tracker (MPPT) is applied. Thus, there are some techniques used to track the maximum power point, which are known as "look-up table" methods; "perturbation and observation (P%O)", "Incremental Conductance" method, "Modified P & O" & "Estimate perturb-perturb" methods [4].

II. PHOTOVOLTIC ARRAY

Due to the low voltage generated in a PV cell (around 0.5V), several PV cells are connected in series (for high voltage) and in parallel (for high current) to form a PV module for desired output.

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 [3].

III. EFFECT OF SHADING ON THE PV ARRAY

Two important factors that affect the displacement of the MPP are the insolation and the temperature. The MPP must constantly be tracked. In uniform solar insolation, the output power of the array is equal the total output power of all solar cells. But in non uniform insolation condition shadow on the solar panel, the shaded solar module starts working as a load, which can be avoided by using the bypass and blocking diode. The cause of nonuniform insolation may be from trees, a be separated as soft and hard sources, depending upon the distance of the source of the shadow and the PV_array.

If a tree branch, roof vent, chimney or other item is shading from a distance, the shadow is diffuse or dispersed. These soft sources significantly reduce the amount of light reaching the cell(s) of a module [7].

Hard sources are defined as those that stop light from reaching the cell(s), such as a blanket, tree branch, bird dropping or the like, sitting directly on top of the glass.

IV. ALGORITHM STEPS FOR THE P_V CHARACTERISTIC OF THE PV_ARRAY

The input used for algorithms is the shading pattern on the array, which includes a number of the different shading pattern and the temperature, insolation and number of shaded parts in the PV_array. This data will be for the particular array. By

giving the proper insolation pattern to the array, we can decide the shading pattern on the array. Solar cell are grouped together to form the module and such module are connected together to form the array. We have grouped the array with the same insolation as a sub assembly and such a group of the assemble form the group. The algorithm used to find the PV characteristic of the array is as follows-

Step 1: Taking the parameter for the each PV_modes.

Step 2: Inialising of Current (I) and Voltage (V) to zero. Current is increased by small step size ie 0.001 and then the voltage is calculated.

Step 3: The value of the I will be increased and V is calculated for the first subassembly.

Step 4: This will give the I_V characteristics of the Sub-assemblies.

Step 5: By using steps from 2 to 4, the voltage for the other subassembly is calculated. The current will be same for the assembly as the Sub-assemblies are connected in series.

Step 6: The voltage of the assembly is the addition of the voltages of the Subassemblies.

Step 7: The power is calculated using the current and voltage.

Step 8: The values of the current, voltage and power are stored in the matrix.

Step 9: Step 2 to Step 8 will be repeated for each PV_array.

Step10: For the PV characteristics of the array the maximum value of the voltage is found out and it is compared with the voltage matrix and new matrix is formed for the PV_array.

Step 11: As the assemblies are connected in series, the group's current will be the addition of the current flows through the assemblies.

A) Result For the simple but complex shading pattern

The shading pattern which is considered is due to the dust or may be due to the tree leaves or any paper which causes the shading on some part of the PV_array. This type of shading is shown in the fig. 1. This type of shading can be categorized as a complex type of shading as some of the part is not at all shaded and the other part is shaded.

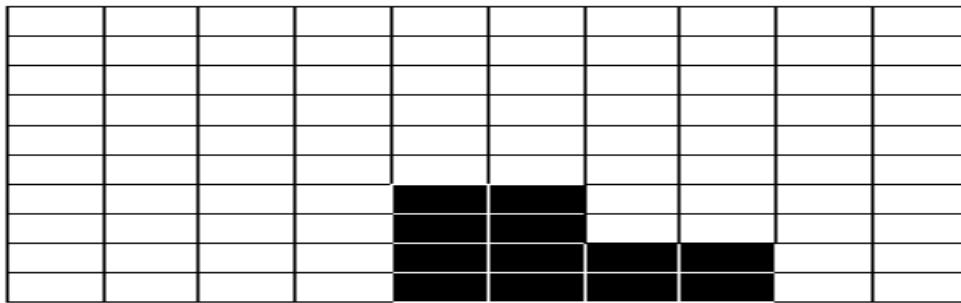


Fig.1: Complex Random Shading pattern on PV_Array

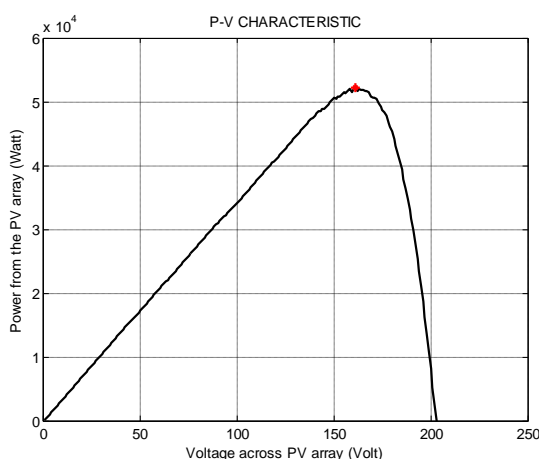


Fig.2:P_V characteristics of the Complex Shading GPP at Vref= 161

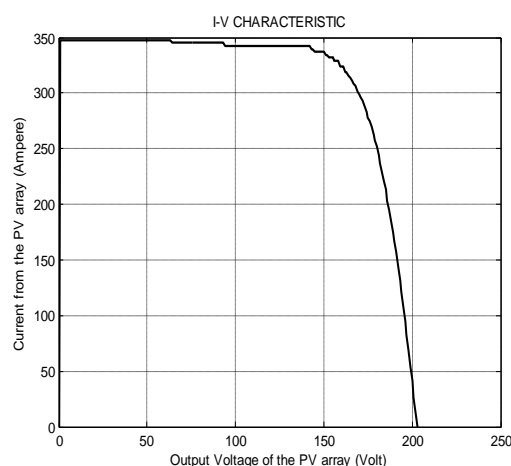


Fig.3: P_V characteristics of the Complex Shading

B) Results for the Complex & Random Shading Pattern

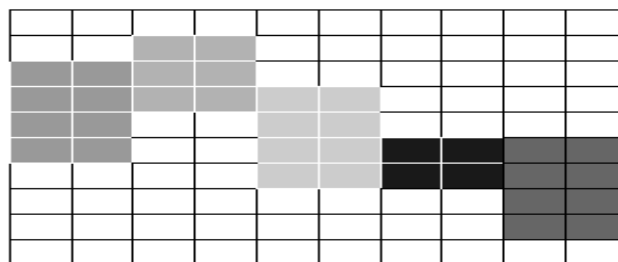
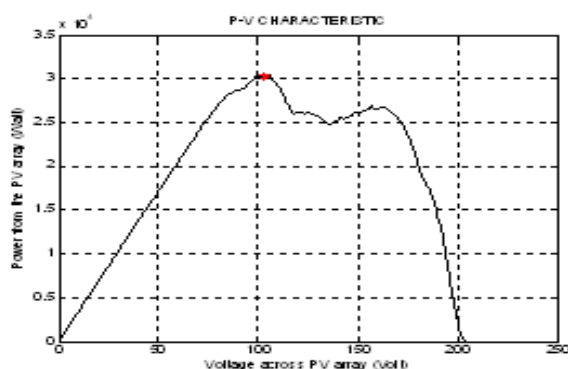
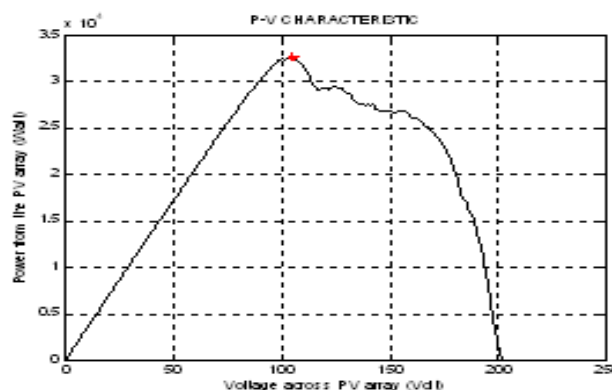


Fig.4: Complex Random Shading pattern on PV_Array

The shading pattern which is considered in this section is not possible. As the PV_array is of some feet in size and it cannot have such a different insolation at the each part of the PV array which is considered in this section. The insolation on the array is 0.4,0.3,0.2,0.9 and 0.6 kW/m² ie the first group will receive the 0.4 kW/m² of insolation.The P_Vcharacteristics of this shaded array is shown in fig.6. The insolation on the array is 0.2,0.3,0.4,0.6 and 0.6 kW/m² ie the first group will receive the 0.2 kW/m² of insolation.The P_V characteristics of this shaded array is shown in fig.6.



**Fig.5: PV characteristics
GPP at Vref= 103**



**Fig.6: PV characteristics
GPP at Vref= 105**

C Steps Used To Track the GPPT

The complex shading pattern on the PV_array is shown in the fig.5.We have applied different isolation level on this shading pattern. From the fig. 5 and fig.6, the location of the Global Power Point(GPP) varies. Therefore we need a different approach to track this GPP. This algorithm steps are given below-

- Step1:** Set the Verf at 85% of Voc
- Step2:** Call the P&O routine to search for first Local Maxima.
- Step3:** Store the value Pmpp and Vmpp and set the flag=1, it will search to the left of MPP.
- Step4:** Calculate ΔP.
- Step5:** If ΔP > ΔPcrit then call the GPP tracking subroutine (ΔPcrit=0. 01), to note the change of power and existence of another local maxima.
- Step6:** Check the flag, if flag= =1, then left side of the curve is traced fro local maxima else the right side.
- Step7:** Call the p & O subroutine to track the next local maxima.
- Step8:** Store the value Pmpp and Vmpp and compare it with the last value.
- Step9:** If the value is less, than the last maxima is at a higher level than the current, store the last value and set the flag=1.
- Step10:**If the difference is large, then this will be considered as the new maxima and flag=-1 is set, to search the right hand side [12].

V. IMPLEMENTATION OF GPPT

The Simulink model implemented using the above GPPT algorithm. Instead of giving the insolation directly timer is applied. Till the 9 seconds the insolation is uniform ie 1 kW/m² and after the 9 second the insolation applied is 0.3 kW/m².The output waveform is shown below.

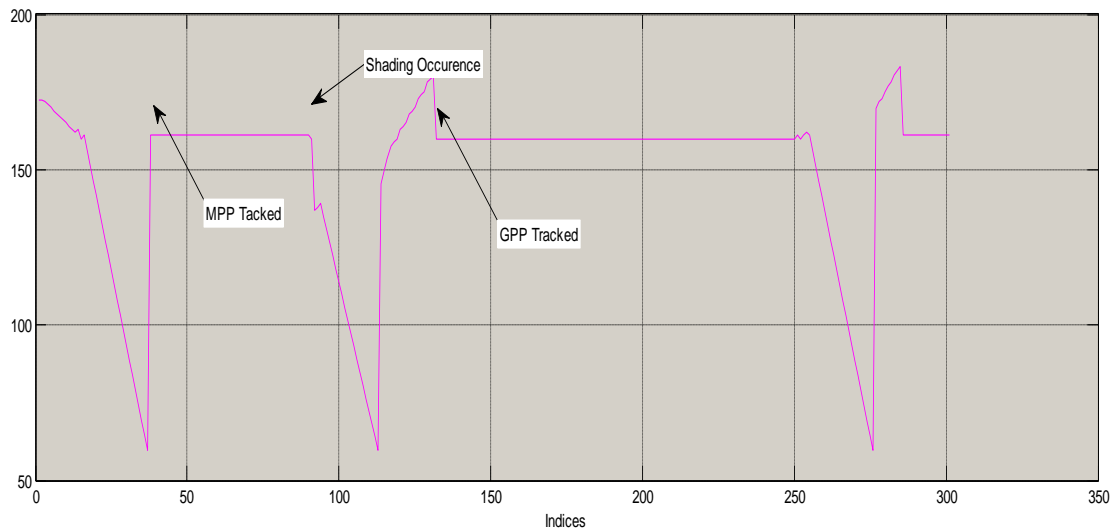


Fig.7: Output of the GPPT algorithm ie Vref volatge

From the Fig.7, the GPPT algorithm is activated at the 9 second, as the shading occurred at that time. Some tracking time is required. According to this value the output is tracked.

VI. CONCLUSION

This paper discussed the modeling of the PV array and different shading pattern, which may occur on the array. The Power_Voltage characteristic algorithm for the shaded array is discussed and its output is shown. From the output it is concluded that the PV characteristics show the multiple maxima points. To track the Global Power Point, from the multiple maxima different algorithm is needed. From these step algorithms are developed using SIMULINK and its output is also shown.

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