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A Maximum Power Point Tracking Method Based on Perturb & Observe Algorithm for PV System.

KEYWORDS: Maximum power point (MPP), Maximum power point tracking (MPPT), Photovoltaic (PV), Perturbation and observation algorithm, Boost converter.

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ABSTRACT Maximum power point trackers (MPPTs) play very important role in photovoltaic (PV) power systems because according to the high cost and low efficiency of a PV system, it should be operated at the maximum power point (MPP) which changes with solar irradiances or load variations. So MPPT maximize the power output from a PV system for a given Atmospheric conditions i.e. irradiances and temperature, and therefore maximize the array efficiency. Thus, an MPPT can minimize the overall system cost. Maximum power point tracking (MPPT) is integrated with photovoltaic (PV) systems so that the photovoltaic arrays are able to deliver maximum available power. Maximum power point tracker (MPPT), can be used to maintain the PV array's operating point at the MPP. This paper presents an improved maximum power point tracking (MPPT) algorithm of a PV system under changing atmospherics conditions. The proposed MPPT is based on the perturbation and observation (P&O) strategy

I. INTRODUCTION

The MPPT has non linear characteristic of solar PV cell there exist one maximum power point (MPP) depending upon irradiation and temperature. So it is necessary to track continuously the MPP in order to maximize the power output from a PV system.

Maximize the output of photovoltaic system using different algorithm. There are different techniques used to track the maximum power point. Few of the most popular techniques are

(I) The perturbation and observation (P&O) algorithm is based on to give perturbation in PV operation points of a PV panel in order to force the direction of tracking toward an MPP.
(ii) The hill-climbing algorithm which directly makes a perturbation in a duty cycle of a DC-DC power converter.
(iii) The incremental conductance (INC) algorithm is implemented by periodically checking the slope of the P-V Curve of a PV panel. If the slope becomes zero or equal to a defined small value, the perturbation is stopped and the PV panel is forced to work at this operating point.

(iv) The constant voltage algorithm is based on keeping the ratio between the PV voltage at the maximum power (Vmp) and the open circuit voltage (Voc) as a constant value [3]. A group of solar cells are connected in series and parallel circuits to generate high power and this combination is a so-called PV module. A group of such modules can be electrically connected in series-parallel combinations to generate required currents and voltages as a PV array[3].

II. PHOTOVOLTAIC MODULES

Solar cells consist of a p-n junction fabricated in a thin wafer of semiconductor material. The I-V output characteristic of a solar cell has an exponential characteristic similar to that of a diode.

When exposed to light on solar cell, photons with energy greater than the bandgap energy of the semiconductor are absorbed and produce an electron-hole pair. These carriers are swept apart under the influence of the internal electric fields of the p-n junction and create a current proportional to the incident radiation. When the cell is short circuited, this current flows in the external circuit and when open circuited, this current is shunted internally by the intrinsic p-n junction diode. The characteristics of this diode therefore set the open circuit voltage characteristics of the cell [7].

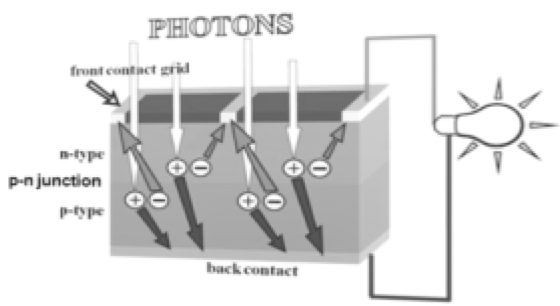

Fig. 1. Photovoltaic Solar Cell

III. MODELING THE SOLAR CELL

The simplest equivalent circuit of a solar cell is shown in Fig.2. The output of the current source is directly proportional to the light falling on the cell. The diode I-V characteristic is similar of the PV cell characteristics[7]. Fig.2 gives the equivalent circuit of a single solar cell, where Ipv and Vpv are the PV array's current and voltage, respectively, Ipv is the cell's photocurrent, Rj represents the nonlinear resistance of the p-n junction, and Rsh and Rs are the intrinsic shunt and series resistances of the cell[2].

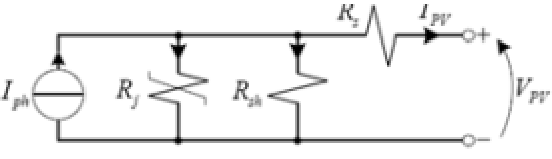

Fig. 2. Equivalent Circuit of PV Cell [2].

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Since Rsh is very large and Rs is very small, these terms can be neglected in order to simplify the electrical model. The following equation then describes the PV panel [2].

$$I_{pv} = n_p \cdot I_{ph} - n_p \cdot I_{rs}\left[exp\left(\frac{q}{k \cdot T \cdot A} \cdot \frac{V_{PV}}{n_S}\right) - 1\right]$$

Where ns and np are the number of cells connected in series and the in parallel, Iph is the cell's photocurrent (It depends on the atmospheric condition), Irs is the cell's reverse saturation current(It depends on temperature) [2].

TABLE I

Parameter	Values
Electron charge	$q=1.602.10^{-19}$ C
Boltzmann's constant	$k=1.3806.10^{-23}$ JK^{-1}
The p-n junction's ideality factor	A=2
The cell's temperature	T=25°C
Cell's photocurrent	Iph (it depends on the atmospheric condition)

In a maximum power point tracker (MPPT) a power electronic DC-DC converter inserted between the PV module and its load to achieve optimum matching of power. By using different algorithm, it ensures the PV module always operates at its maximum power point as the temperature, irradiation and load vary. A number of algorithms have been used and a number of DC-DC converter topologies are possible. The PSIM model is developed for achieving maximum power from the actual power using P&O algorithm.

IV. P-V & I-V CHARACTERISTICS FOR DIFFERENT TEMPERATURE AND RADIATION

Fig. 3 and Fig. 4 show the output characteristics of the PV panel as functions of irradiance and temperature, respectively. These curves are nonlinear and they are affected by solar radiation and temperature [2].

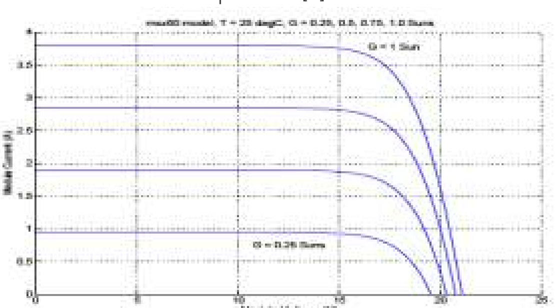

Fig. 3. The V-I curves for various irradiation levels[12].

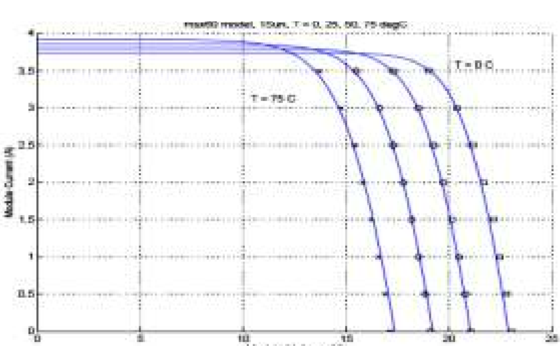

Fig. 4. V-I curves for various temperatures.[12].

V. MPPT USING P&O ALGORITHM

The perturbation and observation (P&O) algorithm is based on making perturbation in PV operation points of a PV panel in order to force the direction of tracking toward a MPP [3].

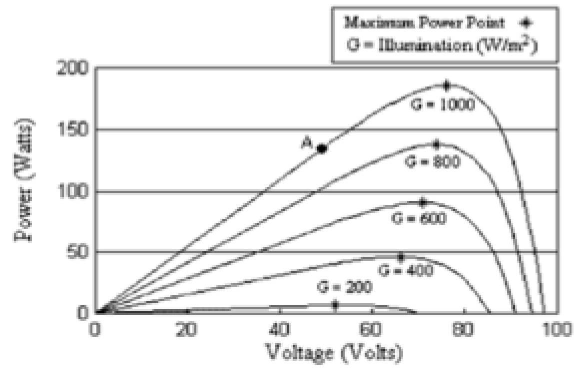

Fig. 5. Photovoltaic array power–voltage relationship[1].

The perturb and observe (P&O) algorithm is commonly used in practice because of its easy of implementation. Consider Figure 5 which shows a family of PV array power curves as a function of voltage, at different irradiance (G) levels, for different irradiance and constant temperature. Assume the PVarray to be operating at point A in Figure 5 which is far from the MPP. In the P&O algorithm, the operating voltage of the PV array is perturbed by a small increment, and the resulting change in power ΔP is measured. If ΔP is positive, then the perturbation of the operating voltage moved the PV array's operating point closer to the MPP. Thus, further voltage perturbations in the same direction should move the operating point toward the MPP. If ΔP is negative then the system operating point has moved away from the MPP, and the algebraic sign of the perturbation should be reversed to move back toward the MPP.

The advantages of this algorithm are simplicity and easy to implementation and P&O has limitations that reduce its MPPT efficiency, oscillates around the MPP and P&O methods can fail under rapidly changing atmospheric conditions [1].

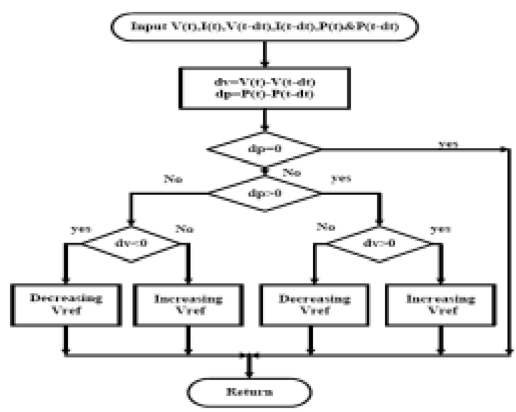

Fig. 6. Flow chart of P&O Algorithm

The flow chart for P&O algorithm first of all measures the actual voltage and current from that the product of voltage and current give the actual power of PV. Then it will check condition that whether dp=0 or not. If this condition is satisfied then operating point is at MPP. If it is not satisfy than check another condition that dp>0,if this condition is satisfied than checkout that dv>0, if it is satisfied than it indicate that operating point is at the left side of the MPP. If

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dv>0 condition is not satisfied than it indicate that operating point is at the right side of the MPP. This process is continuously repeated until it reaches at MPP.

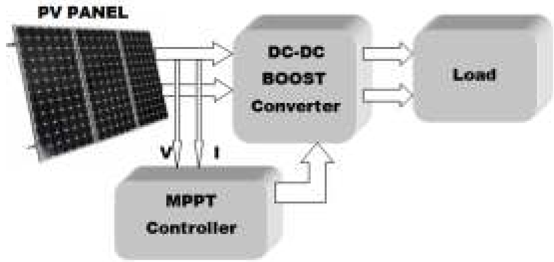

Fig. 7. The block diagram of solar system

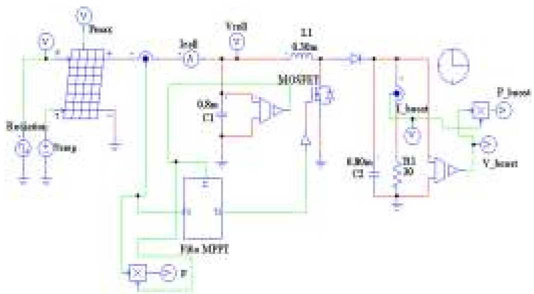

Fig. 8. Simulation of PV module with MPPT

TABLE II

Parameter of Circuit	Values
Load resister	R_1=30 Ω
Filter Capacitor	C_1=0.8 mF
Filter Capacitor of boost converter	C_2=0.80 mF
Inductor of boost converter	L_1=0.30 mH

TABLE III

Parameter of PV Module	Values
Number of cell (Ns)	36
Standard light intensity(So)	1000 W/m^2
Ref.Temperature(Tref)	25°C
Series Resistance(Rs)	0.008 Ω
Shunt Resistance(Rsh)	1000 Ω
Short circuit current (Iso)	2.16e^{-8}A
Band energy(Eg)	1.12 eV
Ideality factor(A)	1.2

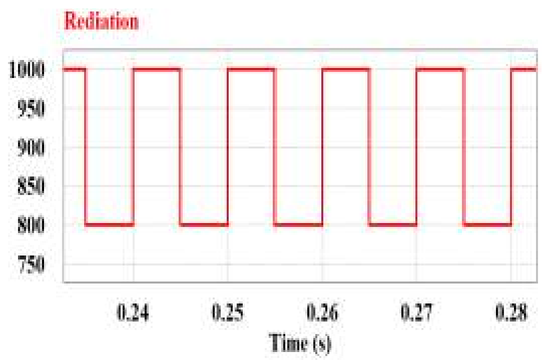

Fig. 9. (a) Radiation from 1000 W/m2 to 800 W/m2

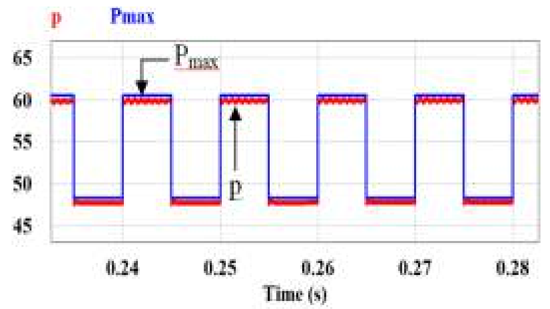

Fig. 9. (b) Maximum output power of solar module (Pmax=60.5346W) and actual output power of solar module (P=59.770W)

Radiation and temperature are the input of PV module. In the simulation radiation is change from 1000W/m2 to 800W/m2 and temperature is at 25 C.Due to this change in radiation the maximum power of PV module will changing from 48W to 60W. Figure 9(b) shows that due to P&O algorithm the actual power (P) of a PV module track the maximum power (Pmax).

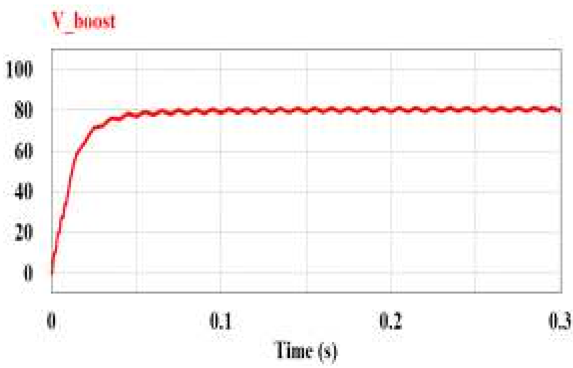

Fig. 10. (a)Voltage output of PV module (Vcell=17.7618V)

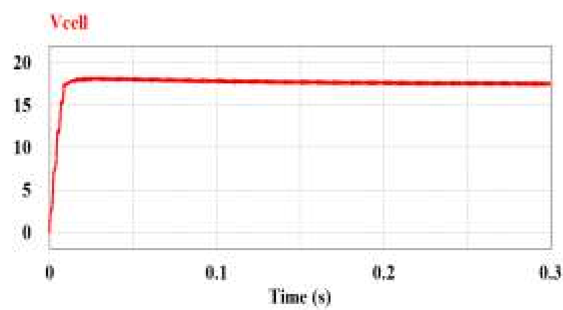

Fig. 10. (b)Voltage output of boost converter (V_boost=80.8784V)

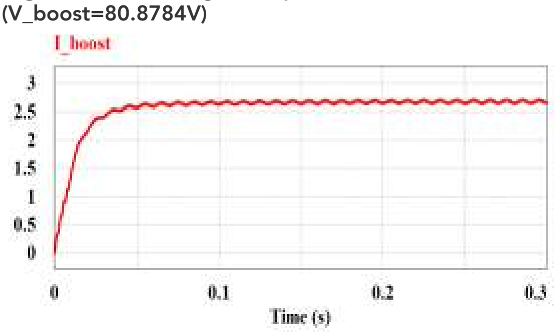

Fig. 10. (c)Current output of the boost converter (I_boost=2.6959A)

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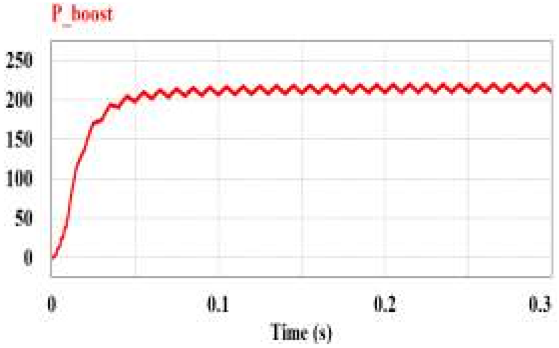

Fig. 10. (d)Power output of boost converter (P_boost=218.04431W)

Fig.-10(a),(b)shows output of PV module (Vcell)and output of boost converter(V_boost).The boost converter boost the output voltage of PV module by 78% .the actual power (P) is boost by 73%.

VI . CONCLUSION

This paper described the simulation and analysis of the P&O algorithm discussed in the literature. The results are give on the basis of maximum power point tracking. The simulation is done for a PV system to obtain maximum power with weather fluctuations. The result shows that the maximum power is track by actual power(P) using P&O algorithm.

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