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# Maximum Power Point Tracking For Photovoltaic System Using Modified Perturb and Observe Method

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**ABSTRACT**: In the past decades, there has been a huge growth in the use of the renewable energy sources. Photovoltaic energy is one of these sources but, the high cost and low conversion efficiency have limited the use of such endless energy source. Also the output power of a photovoltaic system (PV) is nonlinear and it is affected by weather conditions, therefore the maximum power point tracking (MPPT) was invented to extract the maximum power from each PV array. In this paper two methods are critically reviewed; Perturb & Observe method (P&O) and a new technique of tracking the maximum power point based on P&O are introduced in this paper. In this technique, from the available P-V curve[8]-[10] the present value i.e, power and voltage,obtained is compared with the prior and post value which decreases the probability of error as observed in conventional P&O method. The performance of the the modified P&O method is evaluated and compared with the conventional MPPT method in MATLAB.

**KEYWORDS:** MPPT, PV System, P&O, MP&O

## I.INTRODUCTION

As one of the prominent renewable energy resources, photovoltaic (PV) generation has been increasingly gaining considerable attention among industry players all around the world . In most of the PV applications, the key function of PV system is to extract maximum power from PV array during the daytime. The power-voltage characteristics have nonlinear characteristics that depend on environmental conditions like irradiance and temperature . At each irradiance level, there exists a unique maximum power point of power - voltage curve of PV array. Maximum Power Point Tracking (MPPT) control algorithm of PV power converter is the function to maximize the power generation efficiency by regulating the PV array voltage, i.e. the input voltage of the converter. There have been many algorithms developed for MPPT, e.g. perturbation and observation (P&O) method, the fractional open circuit voltage, short circuit current, the fuzzy logic control among which P&O method is well preferred duo to its ease of implementation and low cost[1]-[4]. Instead of these advantages this method has the drawback of high time and low tracking speed. Therefore new proposed method eliminates these drawbacks by increasing the tracking speed and locating the exact maximum power point.

## II.PHOTOVOLTAIC MODULE

It is a non-linear device and can be represented as a current source in parallel with diode as shown in the Fig1.

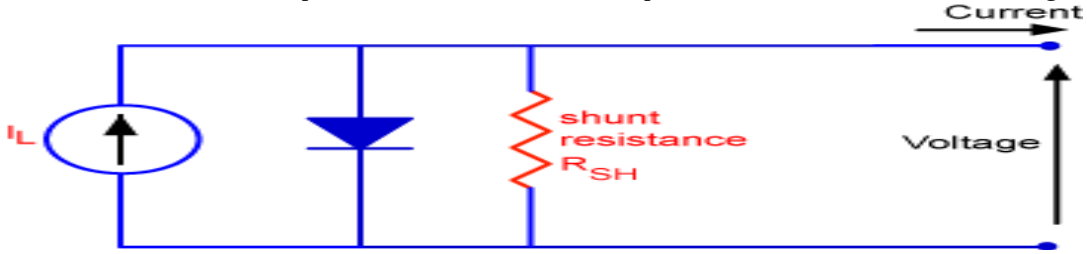


Fig1: Equivalent circuit of PV cell

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The current source $I_{ph}$ represents the cell photocurrent. $R_{sh}$ and $R_s$ are the intrinsic shunt and series resistances of the cell, respectively. Usually the value of $R_{sh}$ is very large and that of $R_s$ is very small, hence they may be neglected to simplify the analysis.

Module photo current,

$$I_{ph} = \left[I_{scr} + K_i(T - 298)\right]_{*\lambda/1000} \quad (1)$$

Modules reverse saturation current,

$$I_{rs} = I_{scr} / \left[\exp(qv_{oc} / N_s kAT) - 1\right] \quad (2)$$

The module saturation current $I^o$ vary with the cell temperature, which is given by,

$$I_0 = I_{rs}\left[\frac{T}{T_r}\right]^3 \exp\left[\frac{q * E_{go}}{Bk}\left\{\frac{1}{T_r} - \frac{1}{T}\right\}\right] \quad (3)$$

The current output of PV module is

$$I_{pv} = N_p * I_{ph} - N_p * I_o\left[\exp\{q * (V_{PV} + I_{PV} R_S) / N_s AkT\} - 1\right] \quad (4)$$

Where $V^{pv} = V^{OC}$, $N^p = 1$ and $N^s = 36$. And

The model of PV module is implemented in MATLAB using eq. (1-4) The model yields the PV current I, using the electrical parameter of the module ( $I^{sc}$ ,$V^{oc}$ ,n ) and the variables Voltage, Irradiation (G ) and Temperature (T) as the inputs to the model.

Solar make 36 W PV module is taken as the reference module for simulation and the name-plate details are given in Table 1.

Table1: electrical characteristics data of solar 36W PV module

| Rated power | 36W |
|---|---|
| Voltage at maximum power($V_{mp}$) | 16.56V |
| Current at maximum power($I_{mp}$) | 2.25A |
| Open circuit voltage($V_{oc}$) | 21.24V |
| Short circuit current($I_{sc}$) | 2.55A |
| Total number of cells in series($N_s$) | 36 |
| Total number of cells in parallel($N_p$) | 1 |

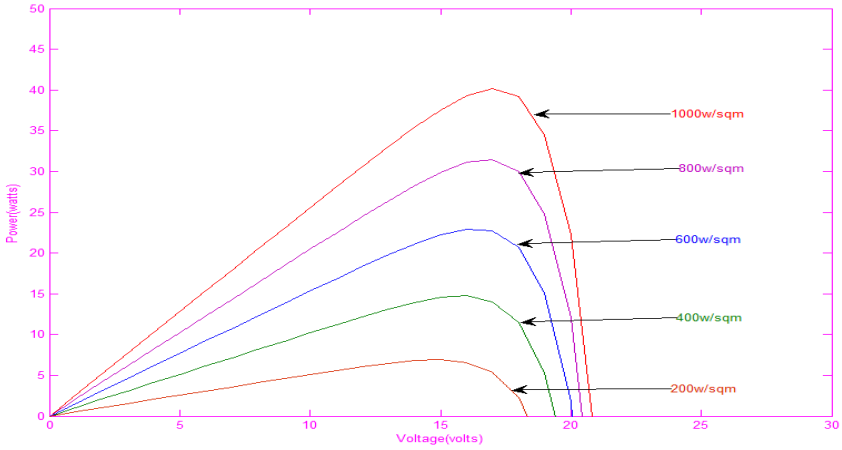


Fig (a): P-V characteristics for different irradiation levels at constant temperature of $25^0$ C .

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Higher is the solar irradiation, higher would be the solar input to the solar cell and hence power magnitude would increase for the same voltage value. With increase in the solar irradiation the open circuit voltage increases

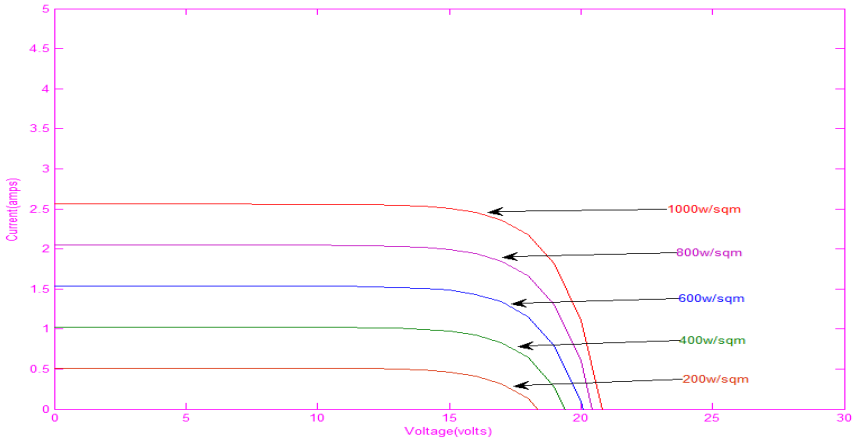


Fig (b): I-V characteristics for different irradiation levels at constant temperature of $25^{0}$C

. This is due to the fact that, when more sunlight incidents on to the solar cell, the electrons are supplied with higher excitation energy, thereby increasing the electron mobility and thus more power is generated

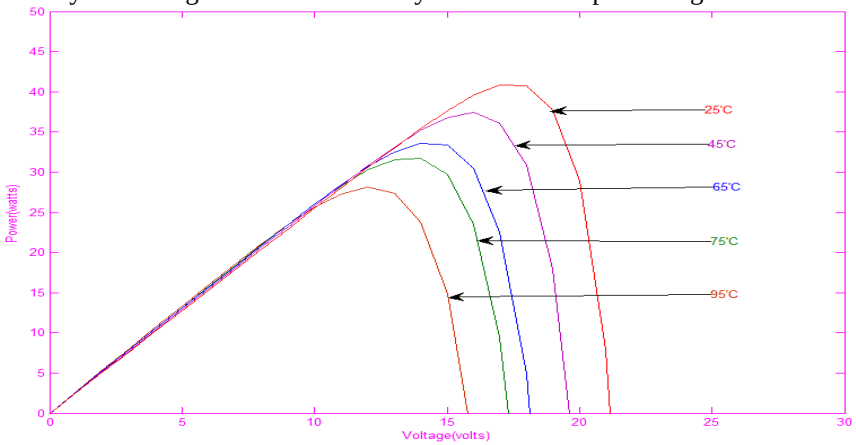


Fig (c): P-V characteristics for different temperatures at constant irradiation of 1000w/sqm

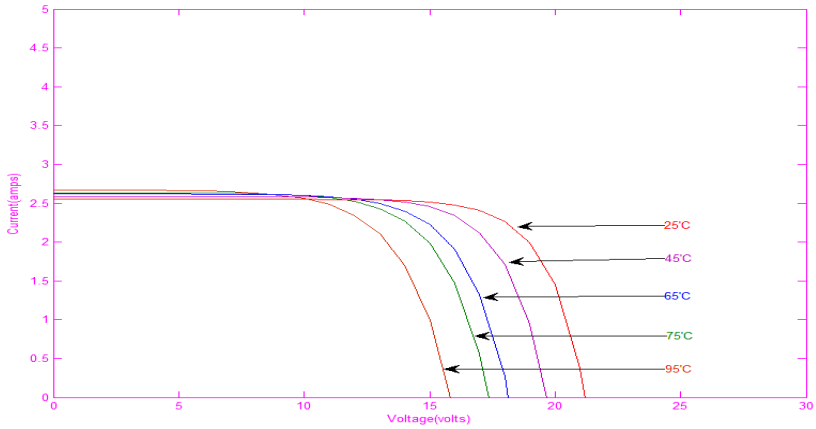


Fig (d): I-V characteristics for different temperatures at constant irradiation of 1000w/sqm

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On the contrary the temperature increase around the solar cell has a negative impact on the power generation capability. Increase in temperature is accompanied by a decrease in the open circuit voltage value. Increase in temperature causes increase in the band gap of the material and thus more energy is required to cross this barrier. Thus the efficiency of the solar cell is reduced.

## III.BOOST CONVERTER

A dc/dc converter is an integral part of any MPPT circuit system. When a direct connection is carried out between the source and the load, the output of the PV module is irregularly shifted away from the maximum power point. It is necessary to overcome this problem by adding an adaptation circuit between the source and the load. A MPPT controller circuit with a DC-DC converter circuit is used as an adaptive circuit.
The boost circuit consist a energy storing element inductor, a capacitor, a diode, a load and a switching device like Mosfet, BJT etc. Circuit diagram of boost converter is shown in figure 2 below.

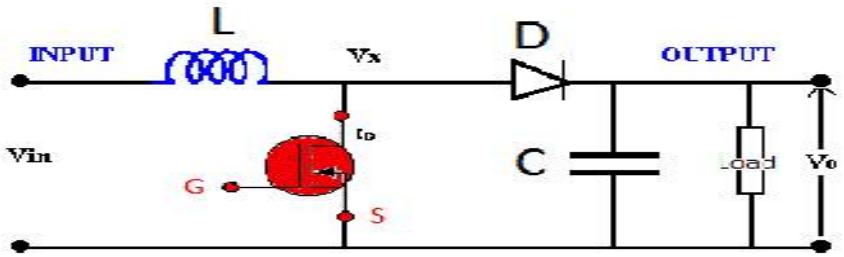


Fig.2. Boost Converter

The control strategy is based on manipulation the duty cycle of the Mosfet causes the voltage change in Boost converter.

## IV.MODIFIED PERTURB AND OBSERVE

Perturb & Observe (P&O) is the simplest method. In this we use only one sensor, that is the voltage sensor, to sense the PV array voltage and so the cost of implementation is less and hence easy to implement. The time complexity of this algorithm is very less but on reaching very close to the MPP it doesn't stop at the MPP and keeps on perturbing on both the directions. When this happens the algorithm has reached very close to the MPP and we can set an appropriate error limit or can use a wait function which ends up increasing the time complexity of the algorithm.The flowchart of P&O algorithm is shown below.

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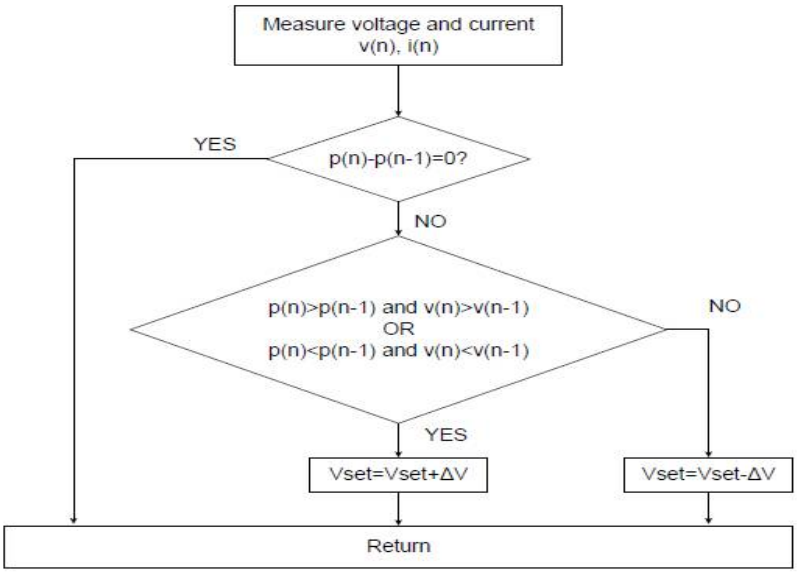


Fig.3. Flow chart of the P&O method

The Perturb & Observe algorithm states that when the operating voltage of the PV panel is perturbed by a small increment, if the resulting change in power ΔP is positive, then we are going in the direction of MPP and we keep on perturbing in the same direction. If ΔP is negative, we are going away from the direction of MPP and the sign of perturbation supplied has to be changed.

But, this method has the drawback of high time and low tracking speed. Therefore new proposed method eliminates these drawbacks by increasing the tracking speed and tracking the exact maximum power point

### A. Modified Perturb and Observe Method:

In this modified P&O method from the available P-V curve the voltage value is increased step-wise corresponding to which the power value is also obtained. Here, with each step-wise incremental, power value is compared with prior and post obtained value, i.e, each time, comparison of three values is done.Therefore,the overall comparison is used to track maximum power point.

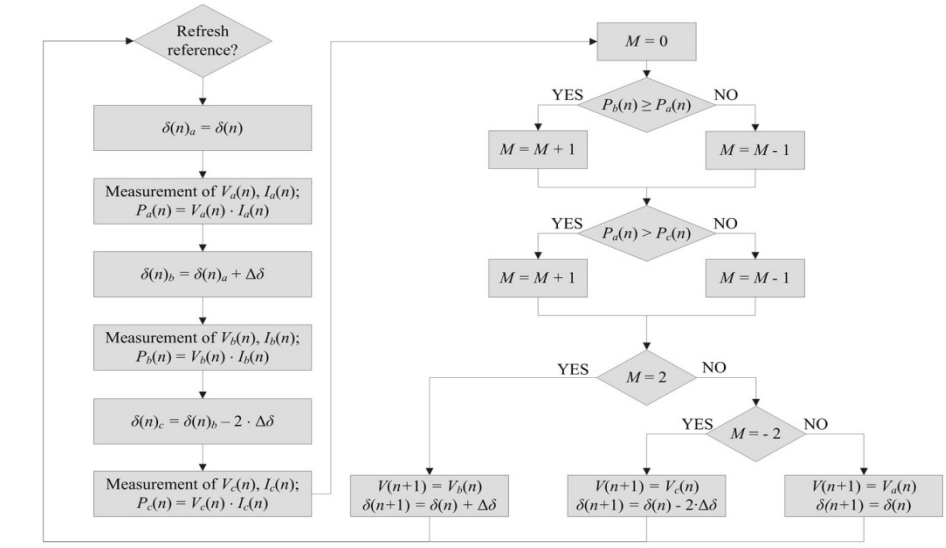


Fig.4 Flow chart of the Modified P&O method

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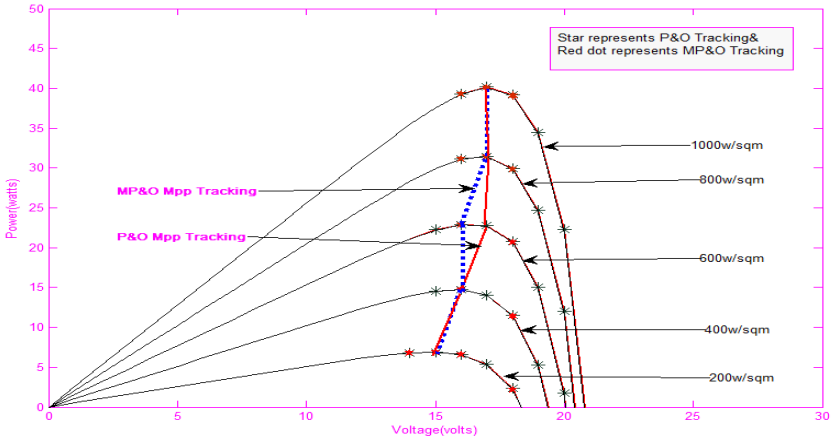
The major difference between the conventional P&O and MP&O is in the process of comparison. In P&O the post value obtained is compared with present value but not the prior value, hence MP&O compensates the drawback of conventional perturb and observe method, by increasing the tracking speed and decreasing the number of iterations

## V. RESULT AND DISCUSSION

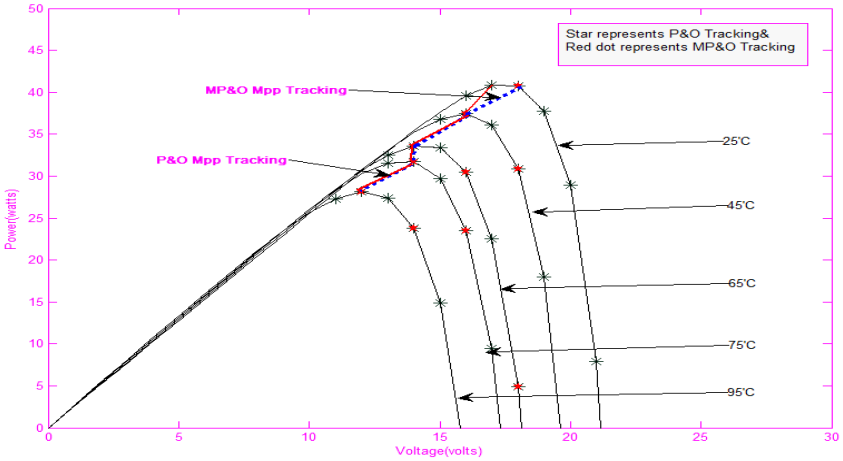
**Tracking of Maximum Power Point**

**P-V characteristics for different irradiation levels at constant temperature of $25^0$ C.**




Fig(e): Tracking of Maximum Power Point using P&O And MP&O Methods for different irradiation levels and constant temperature i.e,$25^0$ C

**P-V characteristics for different temperatures at constant irradiation of 1000w/sqm.**




Fig(f): Tracking of Maximum Power Point using P&O And MP&O methods for different temperature levels and constant irradiation i.e,1000w/sqm

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**Comparison of P&O and MP&O MPPT Techniques:**

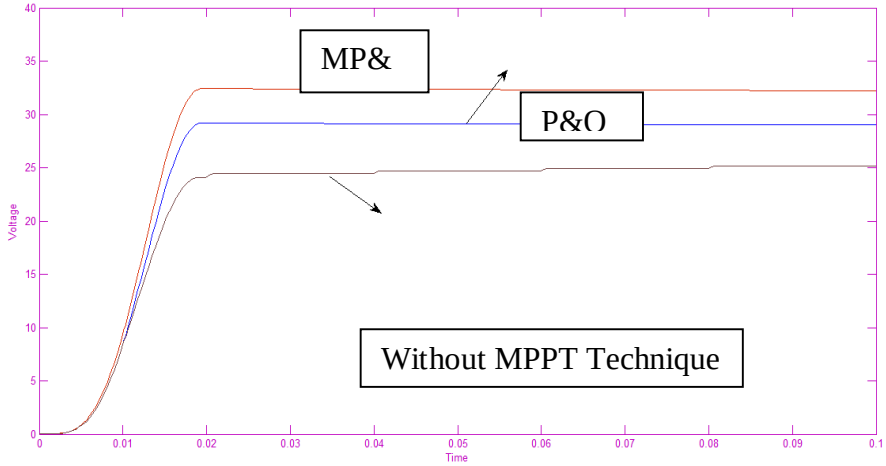


**Table2: Comparison of P&O and MP&O:**

| S.No. | Technique | Time to track MPP for different irradiations(sec) | Time to track MPP for different temperatures(sec) | Power | Conversion Efficiency (%) |
|---|---|---|---|---|---|
| 1 | With perturb and observe | 13.492 | 13.305 | 29 | 80.55 |
| 2 | With modified perturb and observe | 4.112 | 3.795 | 31 | 91.67 |

## VI.CONCLUSION

The comparison between the existing method perturb and observe and proposed method modified perturb and observe method has been done. Here,the results indicate that PV conversion system using modified perturb and observe method which has higher conversion efficiency and it tracks the exact maximum power point at less time with higher tracking speed than perturb and observe method.Therefore, the modified Perturb and Observe method was best preferred due to its higher tracking efficiency.

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