Power comparison of MPPT techniques for solar system

Sushant Kumar
M.Tech (PE& D)
VIVA Institute Of Technology Virar

Mukesh Kumar Mishra
M.Tech (PE& D)
VIVA Institute Of Technology Virar

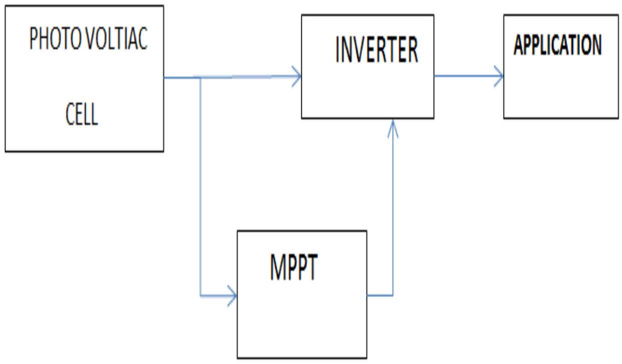
Anoj Yadav
M.Tech (PE& D)
VIVA Institute Of Technology Virar

VinodKumar Pal
M.Tech (PE& D)
VIVA Institute Of Technology Virar

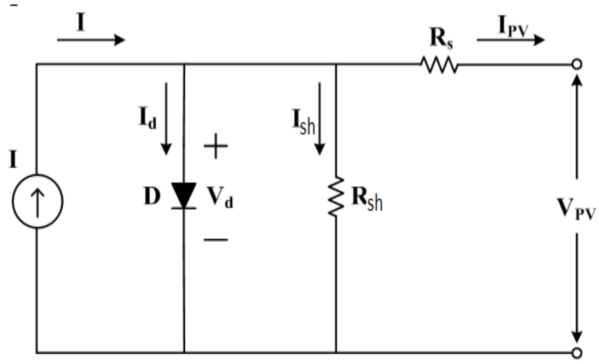
ABSTRACT
This theorem is helpful to produce the maximum power from the solar cell and there are number of technique to do the same but we are discriminating between them. Many maximum power point tracking techniques for photovoltaic systems have been developed to maximize the produced energy and a lot of these are well established in the literature. These techniques vary in many aspects as: simplicity, convergence speed, digital or analogical implementation, sensors required, cost, range of effectiveness, and in other aspects. This paper presents a comparative study of widely-adopted MPPT algorithms; their performance is evaluated on the energy point of view, considering different solar irradiance variations.

Keywords
Maximum power point (MPP), maximum power point tracking (MPPT), photovoltaic (PV), comparative study, PV Converter.

1. INTRODUCTION
Renewable energy is very useful energy source in this world. As there are so many energy in opposition to the renewable energy like coal, gas, nuclear, etcetera. But solar energy is free from population and impossible to use up completely and free of cost or easily available everywhere. And if talk about application it can be used in water pump lighting, vehicles, charging battery army and air.[1] And along with this the most important by solar energy which can feed power to the grid but power delivered from the Photo voltaic cell depend upon the illumination, temperature and current of the cell. This theorem (MPPT) is useful to get maximum power from the system. To attain maximum power converter is used for that simple and complex voltage relation need to develop by the designer. Now mainly need to focus on efficiency because of the weather condition means irradiation changes according to the weather condition. So the VI characteristics of the PV cell vary according to the irradiant and temperature of the cell and we need to find the maximum power point to produce the maximum power. There are so many theorems to produce the maximum power according to the technique used and the can be chosen by considering simplicity, speed and implementation.



2. MODELING PV CELL
A PV array comprises the arrangement of several PV panels. The PV panel constitutes number of series connected PV modules. A photovoltaic module is formed by connecting many solar cells in series since the output of each solar cell is 0.7V. Considering only single solar cell which can be modelled by utilizing a current source, a diode and a resistor as shown in Fig. This model is known as a single diode model of solar cell. The equivalent circuit for solar cell considering all the elements mentioned.[2]



Rs is contact resistance .

R_{sh} is cell resistance.

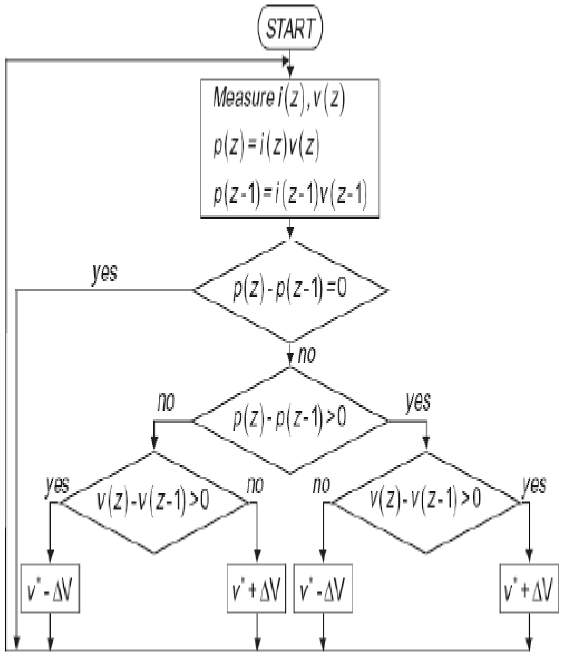
I_{PV} & V_{PV} are PV module current & voltage.

Ish leakage current

3. HILL CLIMBING ALGORITHM/ P&O METHOD
As the output power characteristics of the PV system as functions of illumination and temperature curves are nonlinear and influenced by solar illumination and temperature. Need to fetch the maximum power by using some iteration in which we adjust the voltage and measure the power and try to balance the required power and if power is less than need to increase and if the power is more than need to decrease the

power[4] .This method also called the perturb and observe method and is most used, It is referred to as a *hill climbing* method, because it depends on the rise of the curve of power against voltage below the maximum power point, and the fall above that point. Perturb and observe is the most commonly used MPPT method due to its easy implementation. Perturb and observe method may result in top-level efficiency, provided that a proper predictive and adaptive hill climbing strategy is adopted. It may possible to have multiple maxima, but overall there is only one true maximum power point.

The algorithm will first measure the current and voltage than calculate the power and along with this calculate the previous power. Then if the difference of power to the previous power is zero it goes to the start button and if difference is not zero than it compare with the zero. If the difference is greater than zero then it compares the present and previous voltage and if greater than zero than some voltage will add to the present voltage otherwise subtract. And if the power difference is less than the zero it compare the present and previous voltage and if the voltage difference is greater than the zero some voltage need to subtract from the present voltage otherwise add.



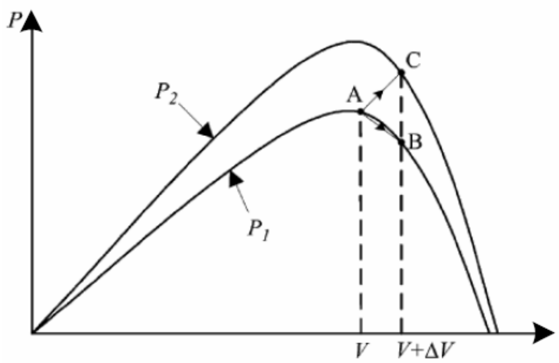
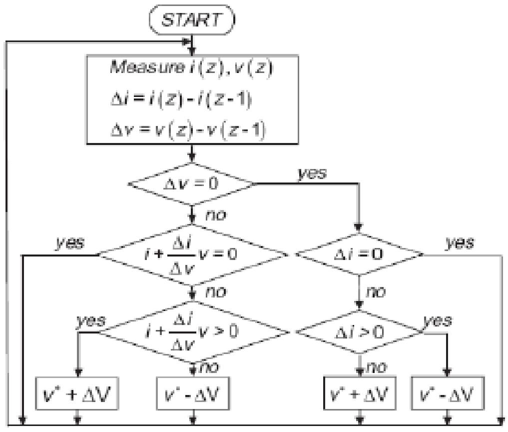


Fig. Divergence of P&O from MPP

4. INCREMENTAL CONDUCTANCE

This method mainly deals with the slope of the PV curve. At maximum power point the slope of the curve will be zero, negative on right side of maximum power point and positive on the left of the maximum power point. Now we need to find the conductance by using I/V [5]. In this method first we measure the current and voltage and find the change in current (ΔI) and voltage (ΔV) by subtracting the previous value from present values. Now if the ΔV is equal to zero we compare ΔI with zero and if coming zero than we need to go at start button and if ΔI is greater to zero than reduce the voltage by ΔV and if not add the voltage in ΔV[6]. Now if the ΔV is not equal to the zero the find addition of current and index factor and compare it with zero, if equal to zero than again go at start otherwise after getting it greater than zero, add ΔV in voltage otherwise subtract ΔV from voltage.[7]

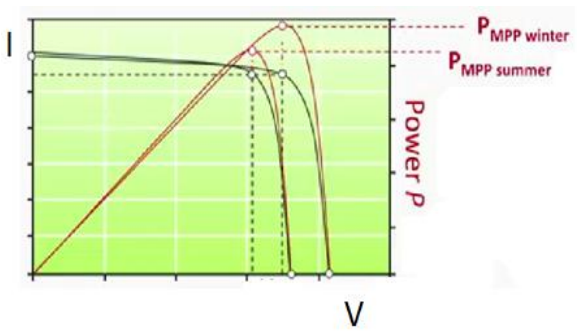


5. CONSTANT VOLTAGE

In this method output voltage is regulated to a fixed value under all conditions and one in which on a constant ratio the output voltage is regulated to the measured open circuit voltage (V_{OC}). If the output voltage is found to be constant, there is no way to track the maximum power point. We need to adjust the operating voltage only on seasonable basis we assuming lower MPP voltage in summer and higher MPP voltage during winter. Where in a particular day the irradiance change is very less the method is not so much accurate. The power delivered to the load is time to time interrupted and with zero current the open-circuit voltage is measured.

V_{MP} in some cases is programmed by an external resistor connected to a current source pin

of the control IC. The method will give around 80% of the available maximum power. The actual performance we can determine by taking average of irradiance.



6. SHORT CIRCUIT CURRENT METHOD

This method achieves the Maximum power point by calculating the operating current Io by current-controlled power converter. And the optimum operating current Io for maximum power output is proportional to the short-circuit current I_{SC} under different conditions of irradiance level.

$Io = k \cdot I_{SC}$

where k=proportional constant.

Now by using this relation Io can be determined by finding I_{SC}. So we are getting the relation of Io and Isc along with the temperature change from 0°C to 60°C. So this method need to mainly find the short circuit current which is somewhat difficult and make other problem related to the voltage calculation of PV because to calculate the short circuit current we need to place one parallel static switch with PV module. And the major problem during this is we can not deliver the power to the load

7. FRACTIONAL OPEN CIRCUIT VOLTAGE

In this method we use the a relationship between the M_{PP} voltage (V_{MPP})

and the open circuit voltage (*VOC*), which varies with the illumination and temperature[4]

$V_{MPP} = K.V_{OC}$

where *k* is a constant

Now the V_{PP} and V_{MPP} we can find by finding V_{OC} . So now we face the difficulties in finding V_{OC} because we need to remove the load by shut down the converter and another problem is M_{PP} because whenever the illumination change we have to find it again and again. And there are some approximation so real M_{PP} is not possible to calculate. So by choosing pilot cells V_{OC} can be obtain but cost of the system will increases. If the V_{OC} is measured the V_{MPP} can be easily estimated. This technique is easier compare to the other complicated technique

8. COMPARISON OF METHODS

P&O and incremental conductance both can find the local maximum of the power under the operating condition of PV cell and provide a maximum power point. P&O produce oscillations even in steady state condition of the cell while incremental conductance method is not having the oscillation even in varying illumination condition. But incremental conductance method takes more computational time because of slowing down of the sampling frequency and the complexity of the algorithm increased compared to the P&O method.

In the constant voltage method, assume the voltage value according to the seasonable basis for finding the MPP but in the fractional open circuit voltage, current from the photovoltaic array must be set to zero momentarily to measure the voltage and then afterwards set to a predetermined percentage of the measured voltage. Energy may be wasted during the time the current is set to zero. Although simple and low-cost to implement, the interruptions reduce array efficiency and do not ensure finding the actual maximum power point.

Technique	Array dependent	True MPPT?	Analog or Digital	Periodic Tuning	Convergence Speed	Implementation Complexity	Sensed parameters
P&O	NO	YES	Both	NO	Varies	Low	V,I
INC	NO	YES	Digital	NO	Varies	Medium	V,I
Frac V_{OC}	YES	NO	Both	Yes	Medium	Low	V
Frac I_{SC}	YES	NO	Both	Yes	Medium	Medium	I
RCC	NO	YES	Analog	NO	Fast	Low	V,I
dp/dv or dp/di	NO	YES	Digital	NO	Fast	Medium	V,I
I_{mpp} and V_{mpp}	YES	YES	Digital	Yes	N/A	Medium	Irradiance, temperature
OCC	Yes	No	Both	Yes	Fast	Medium	Current
Current Sweep	Yes	Yes	Digital	Yes	Slow	High	V,I

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