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№ 7745

A Comparison of Different MPPT Methods for Photovoltic System

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April 9, 2022

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Abstract: this paper encounters evaluation among various Maximum power point tracking (MPPT) approaches by comparing the amount of power extracted from a photovoltaic (PV) panel to the amount of power available.. Methods used for said comparison are namely, P&O (perturb & observe), I&C(incremental conductance) & linear regression technique.
Keywords: MPPT, P&O,I&C,Duty cycle

I. Introduction: The high surge in energy demand along with a future consisting reduce supply of conventional fuel forces us to look for an alternative way in order to sustain the need for technological advancement. In order to reduce reliability upon conventional non renewable energy sources, we look up to maximize energy output from present renewable energy sources.

Any association with renewable energy sources will automatically take solar & wind power into consideration & following this tradition, focus on solar power & maximizing power output from any solar array will be paramount. As a resource, solar power is clean & efficient and further researches are done in order to maximize the power output from any PV panel. Another great advantage of moving on to such renewable resource-based technology is reduced carbon footprint which in turn will be a great win in this ongoing fight against climate change. If all goes well .By 2030 inclusion of solar energy in main stream can reduce carbon emission by one gigaton per year which is comparable to India total emission in 2004.

Despite all the benefits associated with solar power, the efficiency of energy conversion is still adequate at best, combined with it is high initial cost of equipment making mass implementation of this technology a challenge. Due to such drawbacks, primary focus is now shifted upon extracting maximum power from any individual array thus the term MPPT (Maximum power point tracking) comes into being. Under uniform solar irradiation condition PV panels have a distinct operating point at which PV power is maximized. As per Fig.1, is can be observed that for any individual PV panel, the PV power characteristic is non-linear & it varies with different levels of temperature & irradiance respectively. This makes extracting maximum power from any system a complex task which is

further challenged by varied amount of load upon the system.

In order to overcome this challenge, certain methods are advised in the literature and a heedful comparison of proposed system can lead to the knowledge of important information that will affect the suggested systems' general design As a result, this research will use MATLAB/Simulink models to evaluate the key MPPT approach. via proper comparison between key output power & time.

This technique allows us to chose or design a soundly efficient form of MPPT technique which will further help in power extraction part of the overall project. Initially one of two present methods of PV panel assembly is chosen to carry out comparison with major emphasis on choosing the best initial method for tracking the maximum power point in a PV array.

II.PV panel modelling

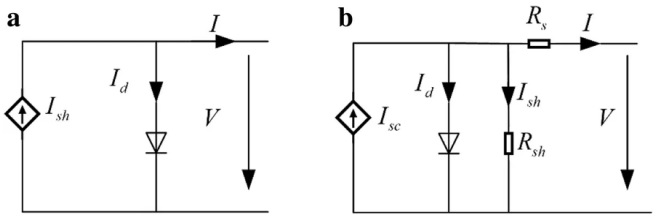

fig 1 pv equivalent circuit

Fig 1 Shows equivalent circuit of The Photovoltic panel and its mathematical equation is represented by

I = Ish − Ir [e^(q·(V +I·Rsh)/η·k·T) − 1]−
[(V + I · Rsh)/ Rph] ……(1)

V = output PV voltage of one PV panel

Ish = photocurrent

Ir = is the saturation current

q = is the electrical charge (1.6 × 10−19 C)

η = p-n junction quality factor, k is the Boltzmann constant (1.38 × 10−23 J/K),

T = temperature (in kelvins)

Keeping the above equation in mind, a single plate PV panel was used with block parameters given in fig.2 & maximum current & voltage value given in fig.3 respectively.

These are predefined values of a model used in MATLAB/Simulink which will be used test and track their maximum power point through various techniques.

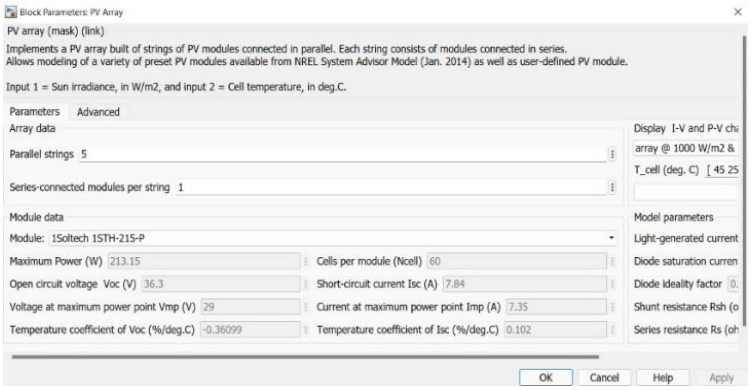

Fig.2 specifications of pv array

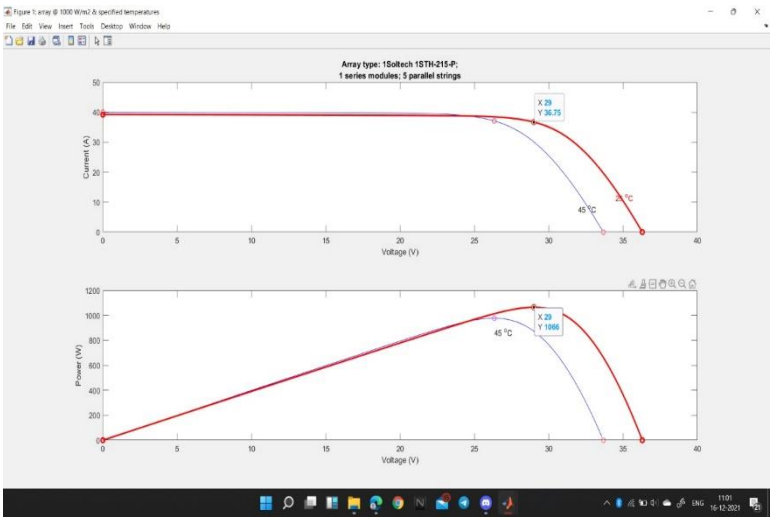

Fig 3. Maximum current & powe of selected pv array

III. Boost converter:

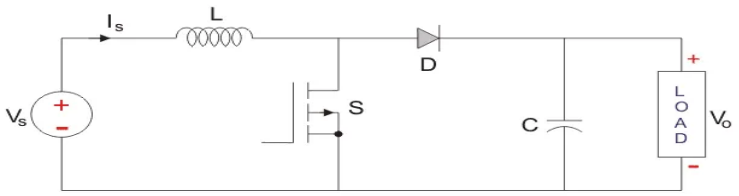

Fig.4 boost converter

A traditional boost converter is represented by circuit diagram shown in fig.4. It's a DC-DC power converting device that boosts voltage while lowering current from the input to the output. The transfer function is critical for an optimum boost converter.

Vi=(1-D)Vo ….(2)

Or

Vo/Vi=1/(1-D) …. (3)

Where

Vi= input voltage

Vo = output voltage
D = is duty cycle which for an ideal boost converter is where As a result, D can be anywhere between 0 (when S is turned off) and 1 (when S is turned on) (S is always on).

IV: Perturb & Observe based MPPT technique: -

This method is the most basic and inexpensive MPPT method and hence is commonly used.

The algorithm of Perturb and Observe works like a loop in which we track the maximum power point by comparing the new power by the older one and this whole iteration us called perturbation, in which we increase the value of PV array voltage by changing the value of duty cycle

If the next value of power is greater than the previous one the in next perturbation value of voltage is increased by increasing the value of duty cycle and then compared with the next iteration and if value of power comes less than the previous one, then it perturbs in opposite direction.

This process is done until we track the maximum power point

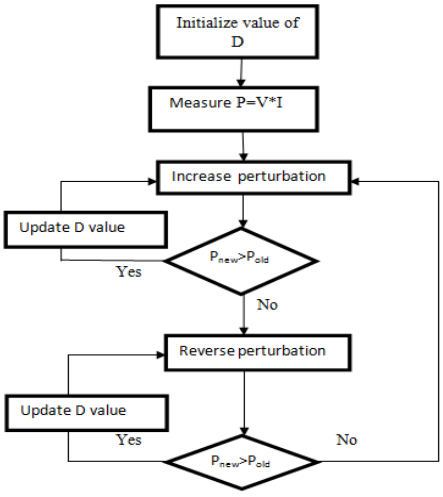

Fig 5: P&O algorithm

V. Incremental Conductance (I&C) based MPPT technique: -

The Incremental Conductance method is based on the idea that the slope of the power curve is zero at maximum power.

The IC algorithm compares the incremental conductance with the instantaneous conductance I/VThe Incremental Conductance approach is based on the assumption that the slope of the power curve is zero at maximum power.

The incremental conductance I/V is compared by the IC algorithm to the instantaneous conductance I/V..

IC requires fast calculation and higher sampling rate of the power slope.

This offers advantages i.e., good tracking efficiency and automatic adjustment of the module operation voltage with no oscillation.

The implementation of this algorithm is expensive but with recent development in microcontroller has become more cost efficient.

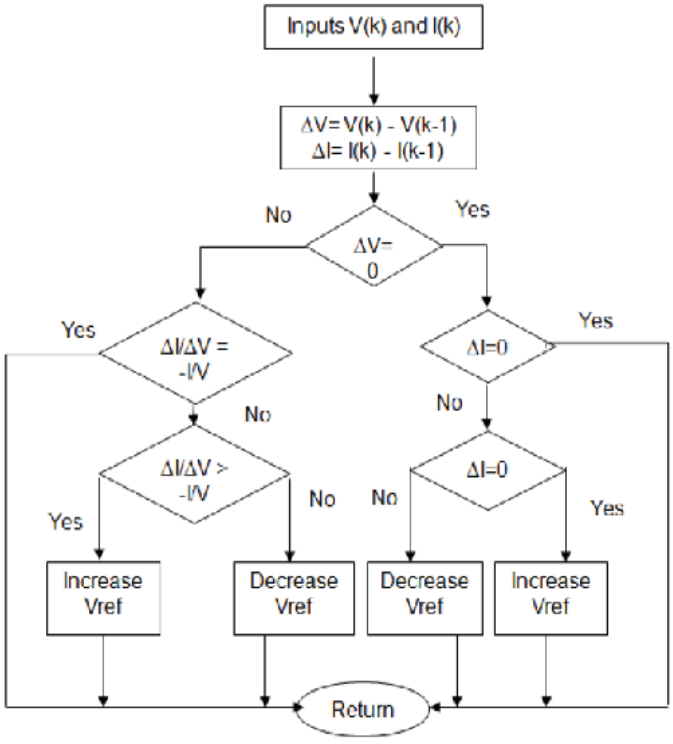

Fig 6: I&C algorithm

VI. Linear Regression based MPPT technique: -

In this method we use information by plotting the graph between current and irradiance. In the conclusion of the graph, we can see that that there is a linear curve by which we can find a linear function. That function depends on irradiance.

The graph formed between current, and irradiance have an optimal point by combining, all the optimal points function of that graph will be found in the form of y = m*x + c. Which is the standard equation of a linear curve.

The photovoltaic array output voltages depend on three parameters Irradiance(G), current(I) and temperature(T).

V=f (I, G, T) is output by combining all the parameters. The output voltages define an output power with the formula -:

P=VI =f (I, G, T) *I

If we keep the temperature constant and current is going to follow irradiance and that's because current is dependent upon irradiance and temperature.

Keywords Definitions: -
P: - Output Power of the PV panel
V: - Output Voltage of PV panel
I: - Output Current of PV panel
G: - Irradiance
T: - Temperature
f: - function of

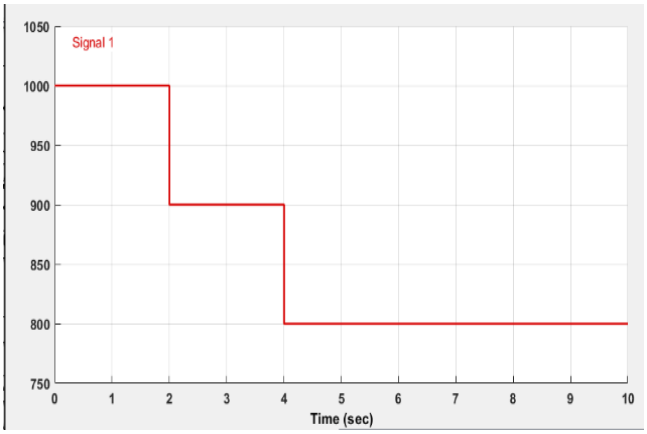

Fig.7 Graph of irradiance changing with respect to time.

The above graph is between time and irradiance.

On X-axis we have time, and

On Y-axis we have irradiance, which keeps changing with time as we are changing the irradiance to form the linear equation.

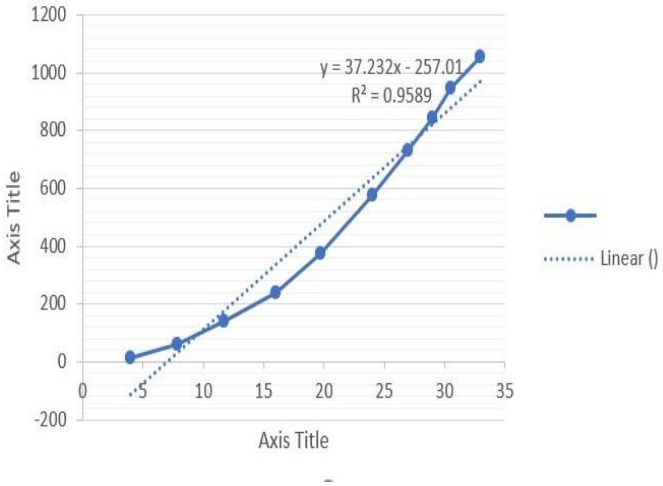

Fig.8 Graph Between Current and Power

After performing Linear Regression on optimal points, we got a graph and a linear equation satisfying it.
In Graph
On X-axis we have Current, and
On Y-axis we have Power
The Linear Equation we got is,
(P= 37.232*I - 257.01).
Where
P = power of the pv array
I = optimal current. with the help of this linear relation, we make the relation between the irradiance and power. removing the value of the optimal current

VII.PERFORMANCE COMPARISON

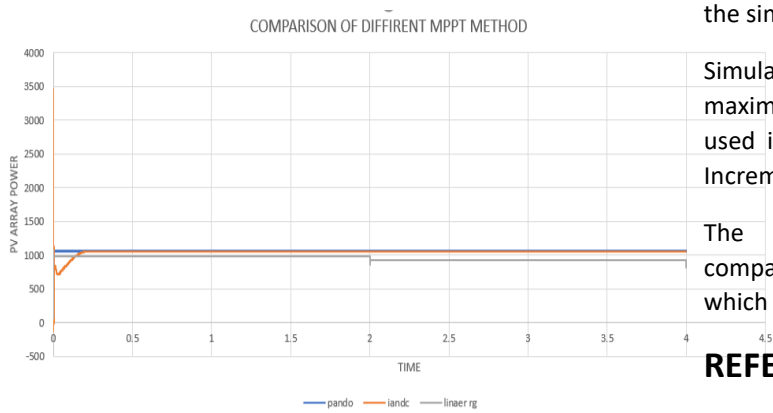

Fig 9 comparison of PV power of p&o incremental conductance Linear regression

The simulation uses a 100kw PV array which has the maximum voltage of (29) and the maximum current of (36.75) and the maximum open-circuit PV array power of (1066). The number of the parallel strings (5) and the number of the series-connected modules per string used is (1).

The above result shows that linear regression is the best most technique in the above three comparisons.

Linear regression has the maximum efficiency and takes less time to track the maximum PowerPoint. The above result also shows that perturb and observation method has the slow rate of tracking the MPPT and as far for the incremental conductance at the time for the (t=0+). To reach the maximum power point the time taken is less compared to the perturb and observation.

However, the study indicates that within the given range the accuracy and the efficiency of the P&O and the incremental conductance and the linear regression are almost the same. The simulation result also shows that the oscillation taken to reach the maximum power point using the incremental conductance is more compared to any other method.

The simulation result confirms that the result of the linear regression is better than the other two methods and the linear regression also works better for the different irradiance values. Simulation result also shows that the linear regression most technique has a high zone of efficiency and stay at the maximum power point for a long time.

VIII. CONCLUSION

A photovoltaic system not only consists of the PV modules but also involves the good deals of the power electronics as an interface between load and the PV array for the effective utilization of the PV array naturally available solar power. That type of PV model is easy to use for the implementation of the MATLAB /Simulink modelling and the simulation platform.

Simulation of PV module using the boost convertor to maximize the power using the different most techniques used in this paper are Perturb and Observation method, Incremental Conductance, and linear regression.

The proposed algorithms have demonstrated also comparative evaluation had carried them to obtain a result which verifies their performance.

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