

Study & Analysis of Incremental Conductance Method of Maximum Power Point Tracking System

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Abstract

Solar energy is one of the most important source of energy but due to a large amount of transmission losses these devices are not used generally. So to transmit a large amount of power, various techniques are used. The incremental conductance method is one of the best methods to deliver maximum power from photovoltaic module to load due to its simple implementation and fast tracking accuracy. This paper presents the analysis of incremental conductance method. To find out the maximum power point by power voltage (P-V) and current-voltage (I-V) graph are drawn by using MATLAB.

Keywords: Solar Energy, Photovoltaic cell, Incremental Conductance, Maximum Power Point (MPP).

1. Introduction

As we know, after a long period of time all conventional sources of energy like petrol, diesel, LPG etc. will finish from the earth surface. But the conventional source will never be finished from earth surface so; it means that the life of human being will completely depend on non-conventional source of energy. To use the conventional source for a long time we are concentrating towards the renewable sources.

The consumption of different energy sources and overall generation as on 31.12.2016 shown below;

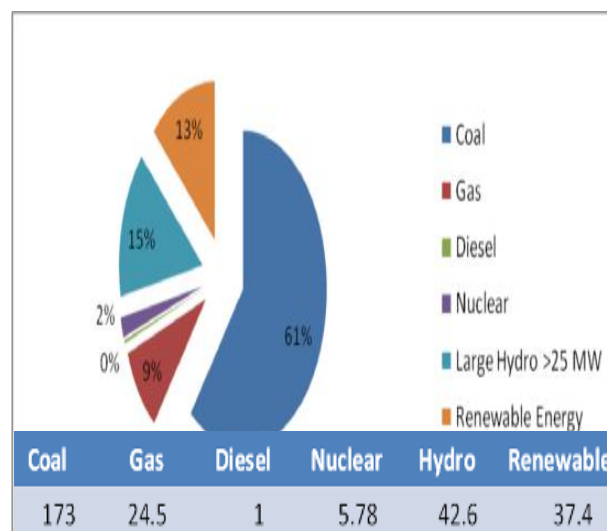
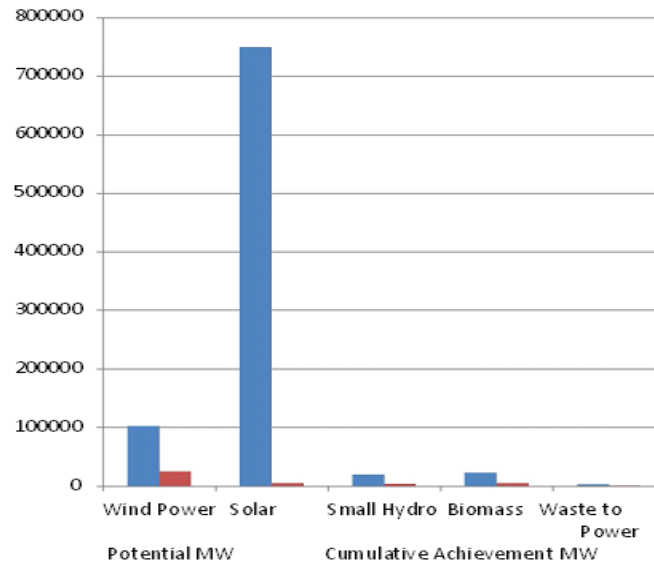


Figure.1: Source Central Electricity Authority (CEA), 2015[6]

Renewable is now established around the world as main- stream sources of energy. Rapid growth, particularly in the power sector, is driven by several factors, including the improving cost-competitiveness of renewable technologies, dedicated policy initiatives, better access to financing, energy security and environmental concerns, growing demand for energy in developing and emerging economies, and the need for access to modern energy.”[1].

The solar energy is playing a vital role in generation of electricity. The main application of solar energy is to generate the electrical power by using photovoltaic cell.

From the following figure we can observe that solar energy is the best source out of various renewable energy sources which is showing the Potential & Achievement of renewable energy sources in India as on 31.12.2015.



Sector	Potential MW	Cumulative Achievements MW
Wind Power	1,02,772	25,088
Solar Power	7,48,990	4,879
Small Hydro Power	19,749	4,177
Bio-Power	22,536	4,551
Waste to Power	2,554	127
Total	8,96,602	38,822

Figure.2: Ministry of Renewable Energy Sources[6]

2. Working of Solar Cell

The photovoltaic cell works on the principle of Photo-Electric effect. Under this effect when photons are incident on the photovoltaic cell then an energy generated this is formulated as below;

$$E = hf + \frac{1}{2}mv^2 \dots\dots\dots (i)$$

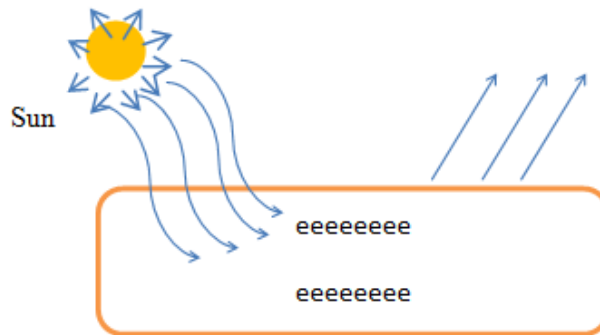


Figure 3: Photo-Electric Effect

The I-V and P-V characteristic of photovoltaic cell is shown in following figure;

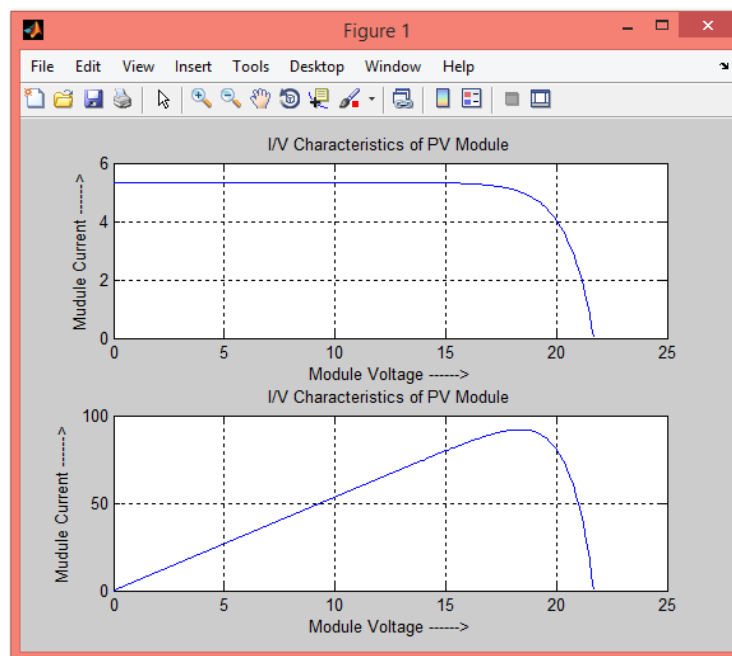


Figure 5: I-V & P-V Curve of Photovoltaic Module

The generated electrical energy by the PV cell is in very less amount and their large amount of generated energy is wasted during the transmission to the load. To deliver the maximum power to the load various techniques are used. Still total seventeen techniques are going to use in the field out of them incremental conductance method is the most preferable method due to its accuracy and fast tracking properties.

In a case of Electrical method, by varying the electric parameters like voltage, current we can generate the maximum power through the photovoltaic cell. There are several techniques to generate the maximum power from the photovoltaic cell. These techniques are called maximum power point tracking techniques.

Block diagram of Incremental Conductance Method:

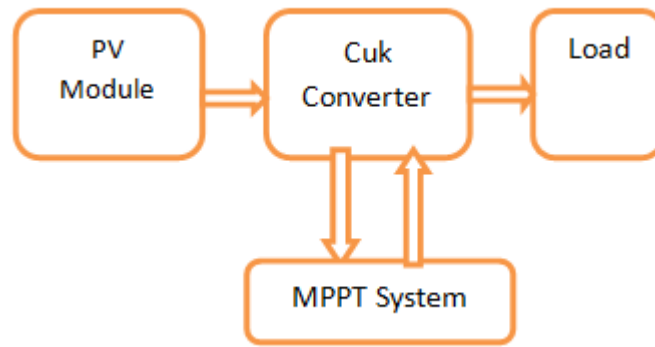


Figure 4: Block Diagram of Optimization of PV Module using MPPT Algorithm

From above figure, it is clear that when solar radiations are incident over solar arrays the generated d.c power is not uniform. So to make it uniform we will use MPPT algorithm over their after applying MPPT algorithm we will compare tracked output voltage and current with the reference voltage and current. If tracked parameters are not like the same as reference parameters then, we track the parameters again and get the maximum power point.

MPPT stands for maximum power point tracking. This topic is very needful for PV system and this also brings various applications of power electronics for a photovoltaic system. MPPT is equally valid for cells, modules and arrays but MPPT system is used at PV array level.

To get maximum power delivered by the PV module we should operate the system in such a manner that the operating point should be corresponding to the maximum power and that point is known as the maximum power point.

This point is present at the peak of PV curve and at the knee of I-V curve. When a radiations or temperature varies then maximum power point (MPP) also varies so to get again maximum power point we have to change in I-V curve. This process is called MPPT.

3. Different Methods for MPP

Generally there are two types of MPPT techniques that are given below:

1. Indirect Techniques:

- i) Fixed voltage method,
- ii) Fractional open circuit

2. Direct Techniques:

- i) Perturb and observe method
- ii) Incremental conductance

Incremental Conductance Method:

This method has been proven as one of the best method of optimizing the power derived from PV module. The shortcomings of the P&O method are improved in incremental conductance method [2].

Before explaining the incremental conductance method we should know the relation between incremental conductances instant an eon's conductance. Conductance is the ratio of current to resistance. We can say conductance is reciprocal to the resistance.

The necessary condition of incremental conductance method to deliver the maximum power from PV module to the load is determined as below;

As we know;

$$P = I * V \dots\dots\dots (i)$$

For maximum power condition,

$$\frac{dP}{dV} = 0 \dots\dots\dots (ii)$$

$$\text{or } \frac{dI * V}{dV} = V * \frac{dI}{dV} + I * \frac{dV}{dV} = 0$$

$$\text{or } = V * \frac{dI}{dV} + I \frac{dI}{dV}$$

$$\text{or } = -\frac{I}{V}$$

$$\frac{dI}{dV} = -\frac{I}{V}$$

Above is the required expression.

The above condition can be explained through the P-V characteristics of PV array as shown below:

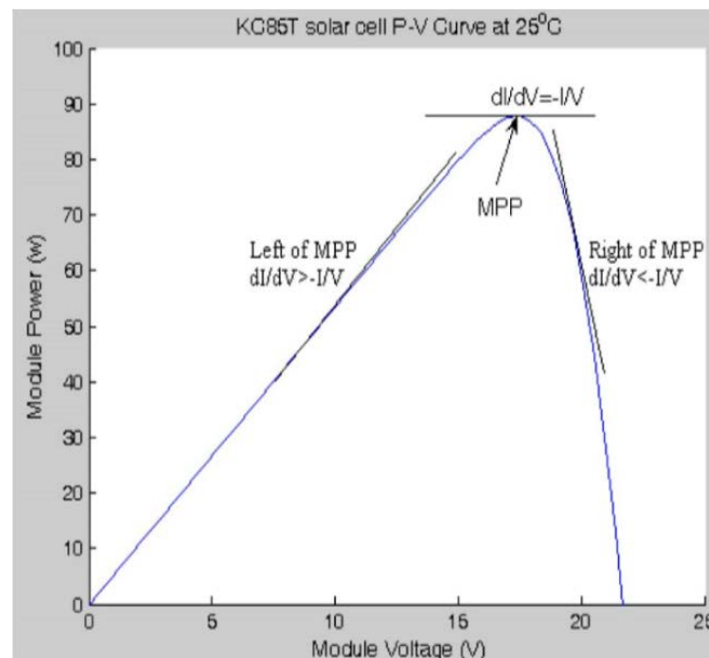


Figure 6: Power Vs Voltage Characteristics of PV Module [9]

4. Algorithm of Incremental Conductance Method

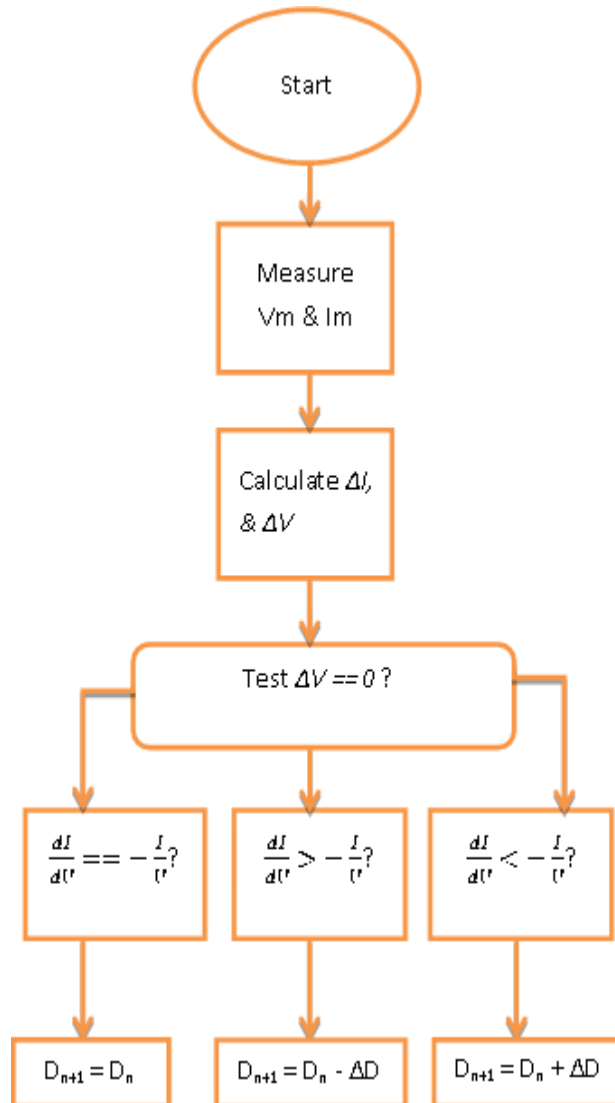


Figure 7: Algorithm of Incremental Conductance Method

For the algorithm of this method, we will compare the incremental conductance of the PV array to the instantaneous conductance for each I_n above flow chart it is shown that first of all we will measure the output voltage and current from solar panels and determine the If incremental conductance is curve to instantaneous conductance then maximum will generate this point.

$$dI/dV = -I/V \text{ at MPP} \quad (1)$$

If incremental conductance is less than instantaneous conductance then we will lie at the left of MPP.

$$dI/dV > -I/V \text{ Left of MPP} \quad (2)$$

If incremental conductance is more than instantaneous conductance then we will lie at the right of MPP.

$$dI/dV < -I/V \text{ Right of MPP} \quad (3)$$

In above flow chart it is shown that first of all we will measure the output voltage and current from solar panels and determine the instantaneous conductance (I/v). Now we will vary the duty cycle and determine the variable value of voltage and current and thus, determine the incremental conductance (di/dv).

The Incremental Conductance successfully determines that the MPPT has reached the MPP and stop perturbing the operating point. If this condition is not met, the direction in which the MPPT operating point must be perturbed can be calculated using the differential equation of the VI characteristic of PV module [3].

5. Conclusion

From the above observations, we concluded that incremental conductance is a simple MPPT method that determines the maximum power point by comparing incremental conductance with instantaneous conductance at variations in temperature. The result of the paper indicates that by using incremental conductance method on maximum power point tracking system improves the applications of solar power by the solar array and thus efficiency of the PV system also increased. This method also has the other benefits like fast breaking, simplicity, low power loss.

6. References

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