International Journal for Modern Trends in Science and Technology
Volume: 03, Issue No: 06, June 2017
ISSN: 2455-3778
http://www.ijmtst.com

Drift Avoidance Mechanism in Maximum Power Point Tracking Using Artificial Neural Network

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To Cite this Article
Pushpendra Kumar and Ritesh Diwan, "Drift Avoidance Mechanism in Maximum Power Point Tracking Using Artificial Neural Network", *International Journal for Modern Trends in Science and Technology*, Vol. 03, Issue 06, June 2017, pp. 150-155.

ABSTRACT

As the requirement of Photovoltaic System escalates since it uses the solar energy which is one of the renewable energies for the electrical energy it's production has an enormous potential. The development of PV system is very rapid as compared to its counterparts of the renewable energies like wind energy. The DC voltage which is generated by the Photovoltaic system will be boosted by the DC-DC Boost converter. The utility grid is incorporated with the PV Solar Power Generator through the 3-ɩ PWM DC-AC inverter, whose control is provided by a constant current controller which employs MOSFET Switch. This controller will use a 3-ɩ phase locked loop (PLL) for tracking the phase angle of the utility grid and reacts very fast enough to the changes in load or grid connection states , as a result, it seems to be very efficient in supplying to load the constant voltage without phase jump. An artificial neural network which consist of device with having many inputs and one output. By using artificial neuron networks, the control algorithm implemented in the SEPIC converter enhances by reducing the response time and hence, transient response for this drift settling time is improved.

Keyword: *- Photovoltaic system, DC-DC Converter, SEPIC converter, artificial neural networks.*

I. INTRODUCTION

Renewable energy is usually outlined as energy that comes from resources that area unit naturally replenished on a person's duration like daylight, wind, rain, tides, waves and geothermic heat. Renewable energy replaces conventional fuels in four distinct areas: electricity generation, hot water/space heating, motor fuels, and rural (off-grid) energy services. electrical phenomenon (PV) technology converts one kind of energy (sunlight) into another kind of energy (electricity) exploitation no moving elements, overwhelming no typical fossil fuels, making no pollution, and lasting for decades with little or no maintenance

PV panels tend to figure far better in weather than in hot climates (except for amorphous atomic number 14 panels). Add a reflective snow surface and therefore the output will typically exceed the rating for the panel. Array currents up to 20% larger than the required output are reportable. In general, PV materials ar classified as either crystalline or skinny film, and that they ar judged on 2 basic factors: potency and economic science. For remote installations where the particular house accessible for PV panels is usually quite restricted, the larger conversion potency of crystalline technology appears to own the advantage. It's additionally value noting that the conversion potency of thin-film panels tends to drop off rather chop-chop within the 1st few years of operation. Decreases of quite twenty fifth have been reported. This performance deterioration should be taken into consideration once size the array for a multi-year project Operating mutely and with none moving components or environmental emissions, PV systems have developed from being niche market applications into a mature technology used for thought electricity generation. A roof-top system recoups the endowed energy for its producing and installation among zero.7 to two years and produces concerning ninety five Percent of internet clean renewable over a 30-year service life.Conventional c-Si star cells, usually wired serial, square measure encapsulated in an exceedingly star module to safeguard them from the weather. The module consists of a tempered glass as cowl, a soft and versatile encapsulate, a rear back sheet made of a weathering Associate in Nursing d non combustible material and an metallic element frame round the outer reaches. Electrically connected and mounted on a structure, star modules build a string of modules, typically referred to as solar battery. A electrical device consists of 1 or several such panels. An electrical phenomenon array, or electrical device, could be a joined assortment of star panels. The Power that one module will manufacture is rarely enough to satisfy necessities of a home or a business, that the modules square measure linked along to make Associate in Nursing array

1.1 SEPIC CONVERTER

The single-ended primary-inductor convertor (SEPIC) is a type of DC/DC convertor permitting the voltage at its output to be bigger than, less than, or adequate that at its input. The SEPIC convertor combines the most effective qualities of each the boost convertor and fly back convertor. A SEPIC is actually a lift convertor followed by a buck-boost convertor, thus it's almost like a traditional buck-boost convertor, however has benefits of having non-inverted output (the output has a similar voltage polarity because the input). This convertor can scale back current ripples at the input for low level DC outputs, thus eliminating the requirement for a high frequency filter at the AC aspect, and therefore the voltage stresses on the switches reduced. Whereas this convertor is incredibly smart for prime voltage applications once operated in CCM, it's higher for low voltage choices only if operated in DCM mode.

The schematic diagram for a basic SEPIC is shown in Figure 2. SEPIC exchanges energy between the capacitors and inductors in order to convert from one voltage to another. The amount of energy exchanged is controlled by switch S1, which is typically a transistor such as a MOSFET. MOSFETs offer much higher input impedance and lower voltage drop and do not require biasing resistors as MOSFET switching is controlled by differences in voltage.During a SEPIC's steady-state operation, the average voltage across capacitor C1 (VC1) is equal to the input voltage (Vin). Because capacitor C1 blocks direct current (DC), the average current through it (IC1) is zero, making inductor L2 the only source of DC load current. Therefore, the average current through inductor L2 (IL2) is the same as the average load current. When switch S1 is turned on, current IL1 increases and the current IL2goes more negative, voltage VC1is approximately VIN, the voltage VL2 is approximately −VI. Therefore, the Capacitor C1 supplies the energy to increase the magnitude of the current in IL2 and thus increase the energy stored in L2. When switch S1 is turned off, the current IC1becomes the same as the current IL1,since inductors do not allow instantaneous changes in current.

The current IL2 will continue in the negative direction, in fact it never reverses direction. It can be seen from the diagram that a negative IL2 will add to the current IL1 to increase the current delivered to the load. Thus it can be concluded, that while S1 is off, power is delivered to the load from both L2 and L1. C1, however is being charged by L1 during off cycle, and will in turn recharge L2 during the on cycle.

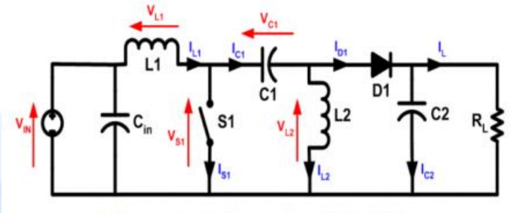


Fig 1.1 Schematic Diag of Sepic Converter

II. MAXIMUM POWER POINT TRACKING ALGORITHMS

MPPT algorithms are important in PV applications because the MPP of the solar panel directly varies with the irradiation and temperature, so the use of MPPT algorithms is always required in order to obtain the maximum power from the solar array. Among all the algorithms which are available P & O and Inc Con algorithms are most common as they have the advantage of an easy implementation. In very normal conditions the P-V curve have only one maximum point, so it will be not a problem. However, if the PV array is partially shaded, there will be multiple maxima in these curves.

2.1 Curve Fitting method

The curve-fitting method is the method where PV module characteristics and all data and manufacturing details which are required, for mathematical modelling and equations describing the output characteristics are pre-decided. PV module characteristic is given by eq. (1), where a, b, c and d are coefficients which are determined by sampling m values of PV voltage V_{PV}, PV current I_{PV} and output power P_{PV} [Salas, 2006]. Once these coefficients are calculated, the voltage at which power become maximum is obtained by eq. (2).

$$P_{PV} = a V_{PV}^3 + b V_{PV}^2 + c V_{PV} + d \quad (1)$$

At maximum power point, $dP_{PV}/dV_{PV} = 0$.

$$V_{MPP} = \frac{-b \pm \sqrt{b^2 - 3ac}}{3a}$$

The advantage of this method is its very simplicity. Disadvantage is that it requires prior and accurate knowledge of physical parameters. It requires large memory as number of calculation is more and the Speed is less.

2.2 Differential Method

In this method, eq. (3) must be solved very fast in order to provide the accurate operating point.

$$\frac{dP_{PV}}{dt} = V_{PV,}\frac{dI_{PV}}{dt} + I_{PV}\frac{dV_{PV}}{dt} = 0 \quad (3)$$

Disadvantage of this method is that it requires extensive calculation time as after calculating eq. (3) parameters, sum + is calculated and a comparison of these sum to an equal perturbation on the opposite side of the operating point or the operating point power. This will be done till final sum becomes zero and if not than more calculations are required [Salas, 2006].

2.3 Open-Circuit Voltage method

In this method the ratio of PV array's maximum power voltage (VMPP) to its open-circuit voltage (VOC) is approximately constant as given by eq. (4).

$$V\_MPP/V\_OC \cong K\_1 < 1 \quad (4)$$

The Open-Circuit method will be implemented using the flowchart as shown in fig. 1. The PV array is transitory isolated using from MPPT then VOC is measured. After that VMPP is calculated according to eq. (4), finally the operation voltage is set for the maximum voltage point. This process is repeated periodically

The core Advantage of this method is that it is simple and very cheap. Disadvantage is that it is quite difficult to choose an optimal value of constant K1.

The literature [Salas, 2006 & Eltawil, 2013], reports K1 values ranging from 0.73 to 0.80 for Polycrystalline PV modules.

2.4 Short-Circuit Method

This method is very similar to Open-Circuit Voltage method, in this the current in MPP (IMPP) and it is linearly proportional to Short-Circuit current (ISC) given by eq. (5). The value of K2 is considered to be around 0.85 [Salas, 2006].

$$I\_MPP/I\_SC \cong K\_2 < 1 \quad (5)$$

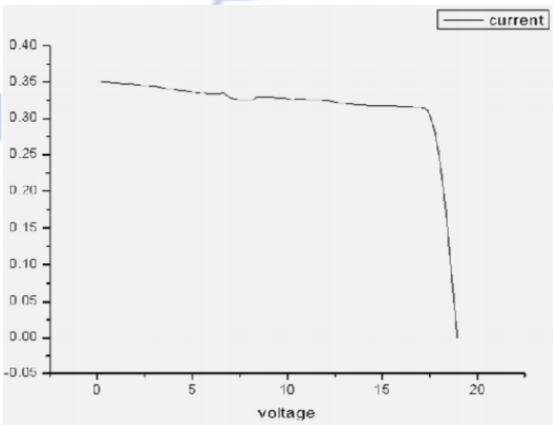
The way of evaluating K2 is quite more complicated than any of fixed value. The flowchart, advantages and disadvantages are similar to that of Open-Circuit Voltage method.

2.5 Hill Climbing Techniques

P & O and Inc Con algorithms operate on Hill Climbing Principle, in which operating point of the PV module moves in the increasing direction of power [Morales, 2010].

2.5.1 Perturb and Observe (P&O) method

P&O is an iterative repetitive method. It senses the panel operating voltage repeatedly and will compares the PV output power with that of the previous power; the resulting change in power (ΔPPV) is measured. If ΔPPV is positive, the perturbation of the operating voltage be in the same direction of the step incremental. However, if it will be negative, the system operating point obtained moves away from the MPPT and the operating voltage should be in the opposite direction of the increment [Salas, 2006], perturbation should be reversed to move back towards the MPP. This process will continues till $dP_{PV}/Dv_{PV}=0$ regardless of the and PV module's terminal voltage. Fig. 1 shows the P -V characteristics of PV module.



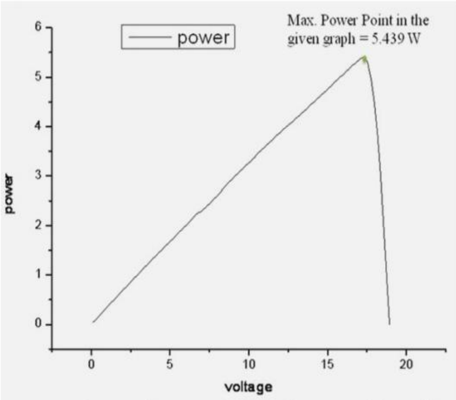


Fig. 1: I-V and P-V characteristics of PV module with MPP

A scheme of the algorithm is shown in Fig. 2, according to which PV module output voltage VPV and output currents IPV are sense. Then the power is calculated P (n) and will compared with the power measured at the previous sample P(n -1) in order to calculate ΔP. Then according to the sign of ΔP and ΔV, MPP is tracked which is summarized in Table I, calculations are done according to I-V characteristics in Fig. 1

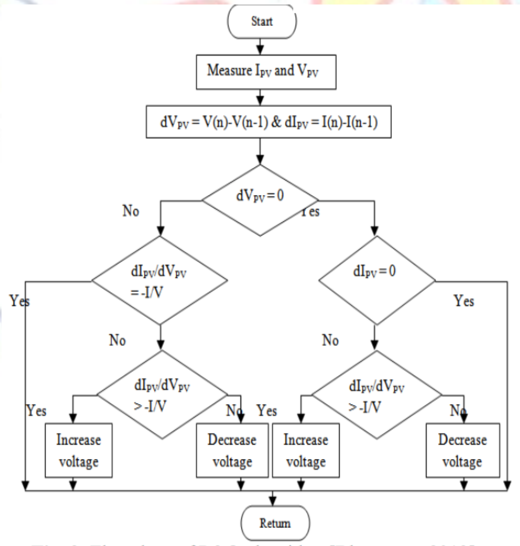


Fig. 2: Flowchart of P&O algorithm [Bhatnagar, 2013].

The advantages of this algorithm, as stated above, are its simplicity and ease of implementation. However, P&O hve its limitations that reduce its MPPT efficiency and One such limitation is that as the amount of sunlight decreases, the P–V curve saturates out. Another limitation of P&O is that it will oscillates around the MPP, as this method will becomes unstable with rapid change in atmospheric conditions such as irradiance and temperature. The oscillation will be minimized by reducing the perturbation step size. However, with a smaller perturbation size slows down the MPPT. A solution to this conflicting situation is to have a variable perturbation size that gets smaller towards the MPP [Esram, 2007].

2.5.**2 Incremental Conductance (Inc Con) Method**.

The disadvantage of P&O algorithm will be of oscillating the operating point around MPP is removed by Inc Con method by that comparing the instantaneous panel conductance (IPV/VPV) with the incremental step by step panel conductance (dIPV/dVPV). The voltage of MPP is tracked to satisfy dPPV/dVPV=0, which is MPP [Bhatnagar, 2013]

Output power of PV module PPV Is given by eq. (6).

$$P_{PV} = I_{PV} V_{PV} \quad (6)$$

Differentiating eq. (6) with respect to VPV gives the basis of Inc Con algorithm

$$dP_{PV}/dV_{PV} = I_{PV} + V_{PV}\, dI_{PV}/dV_{PV} \quad (7)$$

The advantage of this incremental conductance method, which is superior to those of the other MPPT algorithms, is that it will calculate and find the exact perturbation direction for the operating voltage of PV modules and Also it is very easy to implement and has high tracking speed and highly efficient [Bhatnagar, 2013]. Disadvantage is that itrequires complex control circuits [Salas, 2006].

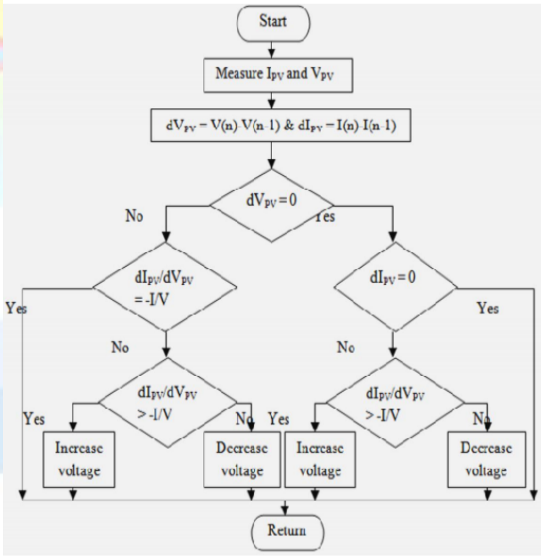


Fig. 3: Flowchart of Inc Con algorithm [Salas, 2006].

III. EXISTING SYSTEM

In this technique the controller adjusts the voltage by a little quantity from the array and measures power; if the facility increases, more changes in this direction area unit tried till power now not will increase. This is often known as the perturb and observe method and is commonest, though this technique may end up in oscillations of power output. it's noted as a hill rise method, as a result of it depends on the increase of the curve of power against voltage below the utmost PowerPoint, and also the fall on top of that purpose. Perturb and observe is that the most typically used MPPT technique as a result of its easy implementation. Perturb and observe method could end in superior potency, providing a correct prognostic and accommodative hill rise strategy is adopted. The operative purpose on the characteristics of the PV module primarily depends on the electrical resistance matching of the PV module with reference to the connected load. A DC-DC device between the PV module and cargo acts as AN interface to work at MPP by dynamical the duty cycle of the device generated by the MPPT controller and a general diagram of PV system methods for tracking of MPP to the PV generator. Finally, it has been shown that other methods also exist by which the MPP of PV module can be tracked.

3.1Drawbacks of existing systems

1. Drift problem will occurs for an increase in insolation and it will be severe for a rapid increase in the insolation and generally it occurs in cloudy days.

2. Drift problem is due to the lack of knowledge in knowing whether the increase in power is due to perturbation or due to increase in insolation.

3.2 Proposed System

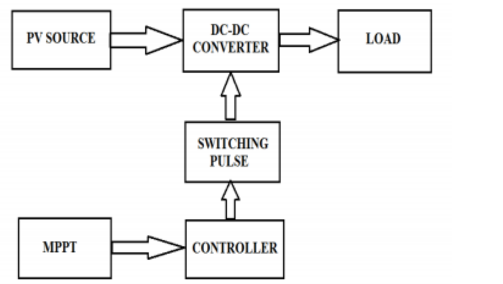


FIG 3.2 Proposed Systems.

The operating point of the characteristics on the PV module primarily depends upon the impedance matching of the PV module basically with respect to the connected load. A DC-DC converter especially SEPIC converter between the PV module and load acts as an interface to operate at Maximum Power Point by changing the duty cycle of the SEPIC converter generated by the MPPT controller and a general block diagram of PV system.

3.2.1 DESCRIPTION OF BLOCK DIAGRAM:

Perturb and Observe (P&O) maximum power point tracking (MPPT) algorithm is a simple and efficient tracking technique. However, P&O tracking method suffers from drift in case of an increase in insolation (G) and this drift effect is severe in case of a rapid increase in insolation. Drift occurs due to the incorrect decision taken by the conventional P&O algorithm at the first step change in duty cycle during increase in insolation. A modified P&O technique is proposed to avoid the drift problem by incorporating the information of change in current (I) in the decision process in addition to change in power (P) and change in voltage (V). The drift phenomena and its effects are clearly demonstrated in this paper for conventional P&O algorithm with both fixed and adaptive step size technique.

SEPIC converter is considered to validate the proposed drift free P&O MPPT using direct duty ratio control technique. The two vital parameters in any MPPT algorithm are perturbation time and perturbation step size and the criteria for choosing these two parameters are described.

IV. SIMULATION AND RESULTS MATLAB

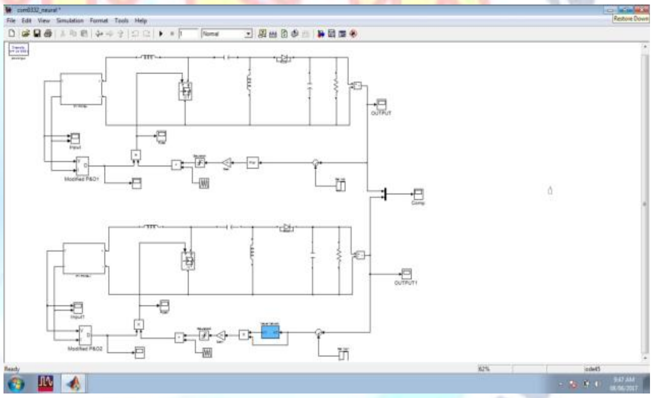


Fig 4.1 Simulation for proposed system

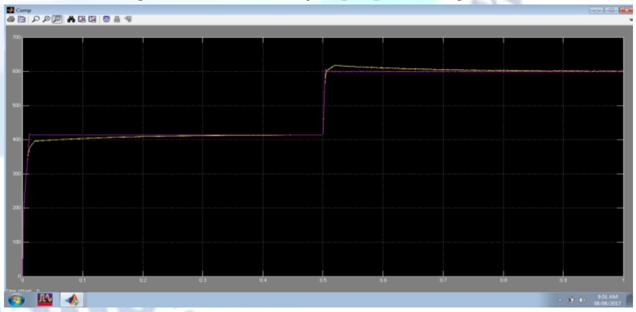


Fig 4.2 Simulation result for proposed system.

References

[1] V. Salas, E. Olıas, A. Barrado, A. Lazaro (2006), “Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems”, ELSEVIER Solar Energy Materials & Solar Cells, Vol. 90, pp. 1555– 1578.

[2] David Sanz Morales (2010), "Maximum Power Point Tracking Algorithms for Photovoltaic Applications", Thesis submitted for examination for the degree of Master of Science in Technology, Aalto University.
[3] Mohamed A.Eltawil, ZhengmingZhao (2013), "MPPT techniques for photovoltaic applications", ELSEVIER Renewable and Sustainable Energy Reviews, vol. 25, pp. 793-813.
[4] Pallavee Bhatnagar, R.K.Nema (2013), "Maximum power point tracking control techniques: State-of-the-art in photovoltaic applications", ELSEVIER Renewable and Sustainable Energy Reviews, vol. 23, pp. 224-241.
[5] Trishan Esram and Patrick L. Chapman (2007), "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques", IEEE Transactions On Energy Conversion, vol. 22, No. 2.
[6] C. R. Sullivan and M. J. Powers, "High-efficiency maximum power point tracker for photovoltaic arrays in a solar-powered race vehicle," in Proceedings of the IEEE 24th Annual Power Electronics Specialist Conference, pp. 574–580, June 1993.
[7] C. Hua and C. Shen, "Control of DC/DC converters for solar energy system with maximum power tracking," in Proceedings of the 23rd Annual International Conference on Industrial Electronics, Control, and Instrumentation (IECON '97), pp. 827–832, November 1997.
[8] T.J.Liang J.F.Chen, T.C.Mi, Y.C.Kuo and C.A Cheng "Study and Implemention of DSP- based Photovoltaic Energy Conversion System"2001 IEEE
[9] Chihchiang Hua, Jongrong lin and Chihming Shen "Implemention of a DSP-Controlled Photovoltaic System with Peak Power Tracking" IEEE Transactions on Industrial Electronics.Vol.45, No.1, February.
[10] Won C-Y, Kim D-H, Kim S-C, Kim W-S, Kim H-S. New maximum power point tracker of photovoltaic arrays using fuzzy controller. Proceedings of the 1994 25th Annual IEEE Power Electronics Specialists Conference 1994; 2: 396–403.
[11] Nafaa Jeddi , Lilia El Amraoui Ouni, "Comparative Study of MPPT techniques for PV Control Systems",IEEE Transactions 2014
[12] Ehsan Jamshidpour et.al , "MPPT and Output Voltage Control of Photovoltaic Systems Using a Single-Switch DC-DC Converter", IEEE Transactions 2016
[13] Mourad Mordjaoui et. Al , "Contribution to the Performance of GPV Systems by an Efficient MPPT Control", IEEE Transaction, 2015