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Review On MPPT Algorithms For PV System

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ABSTRACT:

Electricity is one the most essential needs for humans in the present. Conversion of solar energy into electricity not only improves generation of electricity but also reduces pollution due to fossil fuels. The output power of solar panel depends on solar irradiance, temperature and the load impedance. As the load impedance is depends on application, a dc-dc converter is used for improving the performance of solar panel. The solar irradiance and temperature are dynamic. Hence an online algorithm which dynamically computes the operating point of the solar panel is required. The efficient conversion of solar energy is possible with Maximum Power Point Tracking (MPPT) algorithm. There are various MPPT algorithms such as Perturb and Observe, Incremental Conductance etc. The various algorithms in MPPT and their topology is discussed in this paper.

1. INTRODUCTION:

Principle of Tracking the Maximum Power:

A solar panel converts 30-40% of energy incident on it to electrical energy. A Maximum Power Point Tracking algorithm is necessary to increase the efficiency of the solar panel. Photovoltaic (PV) systems have two main problems which are low efficiency of conversion, especially in low irradiance levels, and that the power produced by PV modules varries with weather conditions in a continuous manner. To maximize power generated by PV modules, a maximum power point tracking (MPPT) control system is used to track the maximum power point (MPP) of PV system. MPPT controller typically consists of a DC-DC converter and a controller driven by an MPPT algorithm.

In this Paper, a digital MPPT control algorithm is introduced and implemented using an inexpensive 8-bit microcontroller to improve the efficiency of solar energy conversion system. It is seen that the efficiency of the system also depends upon the converter. Typically it is maximum for a buck topology, then for buck-boost topology and minimum for a boost topology. When multiple solar modules are connected in parallel, another analog technique TEODI is also very effective which operates on the principle of equalization of output operating points in correspondence to force displacement of input operating points of the identical operating system. It is very simple to implement and has high efficiency both under stationary and time varying atmospheric conditions.

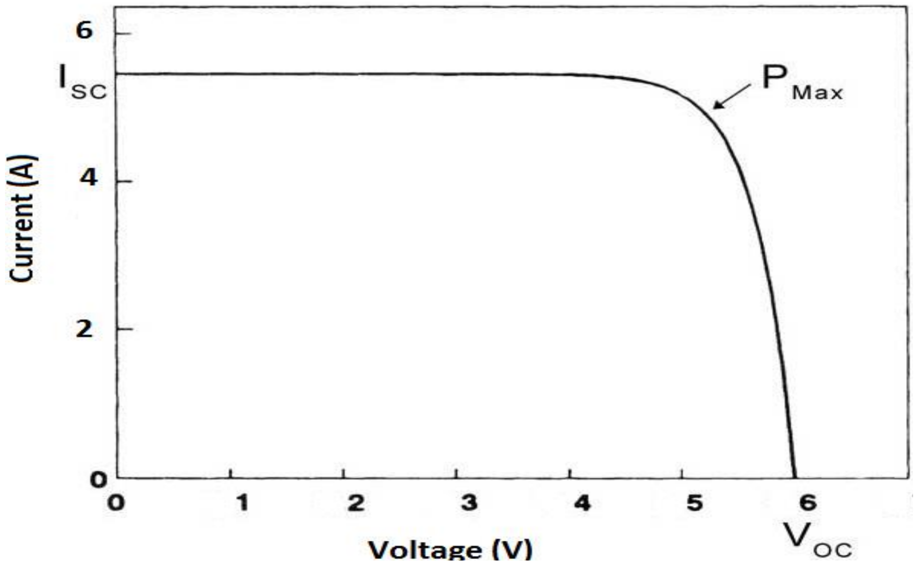

Fig. 1.1 Curves of power vs. voltage of PV module

The major principle of MPPT is to extract the maximum available power from PV module by making them operate at the most efficient voltage (maximum power point). [3], [6] .MPPT checks output of PV module, compares it to battery voltage then fixes what is the best power that PV module can produce to charge the battery and converts it to the best voltage to get maximum current into battery. A. Main Features of MPPT Charge Controllers MPPT solar charge controller is necessary for any solar power systems need to extract maximum power from PV module; it forces PV module to operate at voltage close to maximum power point to draw maximum power. MPPT solar charge controller reduces complexity of the system while output of system is high efficiency. MPPT solar charge controller can be applied to other renewable energy sources such as small water turbines, windpower turbines, etc. [3], [6] B. MPPT Algorithms Various algorithms may perform MPPT. Important factors to consider when choosing a technique to perform MPPT are the ability of an algorithm to detect multiple maxima, costs, and convergence speed. [2] The various algorithms available are perturb and observe method, Incremental conductance method, parasitic capacitance and constant voltage method. Out of all the available methods perturb and observe method is the most recognized because of its simplicity in design. A more complex but typically more accurate procedure is known as the incremental conductance method. The constant voltage method is also simplest one. The parasitic capacitance algorithm is similar to incremental conductance, except that the effect of the solar cells' parasitic junction capacitance CP, which models charge storage in the p–n junctions of the solar cells, is included

2. MAXIMUM POWER POINT TRACKING ALGORITHMS

2.1 Different MPPT techniques

There are different techniques used to track the maximum power point. Few of the most popular techniques are:

1) Perturb and Observe (hill climbing method)
2) Incremental Conductance method
3) Fractional short circuit current
4) Fractional open circuit voltage
5) Neural networks
6) Fuzzy logic

2.1.1 Perturb & 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. However the method does not take account of the rapid change of irradiation level (due to which MPPT changes) and considers it as a change in MPP due to perturbation and ends up calculating the wrong MPP. To avoid this problem we can use incremental conductance method.

2.1.2 Incremental Conductance

Incremental conductance method uses two voltage and current sensors to sense the output voltage and current of the PV array. At MPP the slope of the PV curve is 0.

(dP/dV)MPP=d(VI)/dV ………… **(2.1)**

0=I+VdI/dVMPP ………… **(2.2)**

dI/dVMPP = - I/V …………. **(2.3)**

The left hand side is the instantaneous conductance of the solar panel. When this instantaneous conductance equals the conductance of the solar then MPP is reached. Here we are sensing both the voltage and current simultaneously. Hence the error due to change in irradiance is eliminated. However the complexity and the cost of implementation increases. As we go down the list of algorithms the complexity and the cost of implementation goes on increasing which may be suitable for a highly complicated system. This is the reason that Perturb and Observe and Incremental Conductance method are the most widely used algorithms. Owing to its simplicity of implementation we have chosen the Perturb & Observe algorithm for our study among the two.

2.1.3 Fractional open circuit voltage

The near linear relationship between VMPP and VOC of the PV array, under varying irradiance and temperature levels, has given rise to the fractional VOC method.

VMPP = k1 Voc …………….. (2.4)

where k1 is a constant of proportionality. Since k1 is dependent on the characteristics of the PV array being used, it usually has to be computed beforehand by empirically determining VMPP and VOC for the specific PV array at different irradiance and temperature levels. The factor k1 has been reported to be between 0.71 and 0.78. Once k1 is known, VMPP can be computed with VOC measured periodically by momentarily shutting down the power converter. However, this incurs some disadvantages, including temporary loss of power.

2.1.4 Fractional short circuit current

Fractional ISC results from the fact that, under varying atmospheric conditions, IMPP is approximately linearly related to the ISC of the PV array.

IMPP =k2 Isc …………… (2.5)

where k2 is a proportionality constant. Just like in the fractional VOC technique, k2 has to be determined according to the PV array in use. The constant k2 is generally found to be between 0.78 and 0.92. Measuring ISC during operation is problematic. An additional switch usually has to be added to the power converter to periodically short the PV array so that ISC can be measured using a current sensor.

2.1.5 Fuzzy Logic Control

Microcontrollers have made using fuzzy logic control popular for MPPT over last decade. Fuzzy logic controllers have the advantages of working with imprecise inputs, not needing an accurate mathematical model, and handling nonlinearity.

2.1.6 Neural Network

Another technique of implementing MPPT which are also well adapted for microcontrollers is neural networks. Neural networks commonly have three layers: input, hidden, and output layers. The number nodes in each layer vary and are user-dependent. The input variables can be PV array parameters like VOC and ISC, atmospheric data like irradiance and temperature, or any combination of these. The output is usually one or several reference signals like a duty cycle signal used to drive the power converter to operate at or close to the MPPT.

Table 2.1: Characteristics of different MPPT techniques

MPPT technique	Convergence speed	Implementation complexity	Periodic tuning	Sensed parameters
Perturb & observe	Varies	Low	No	Voltage
Incremental conductance	Varies	Medium	No	Voltage, current
Fractional V_{oc}	Medium	Low	Yes	Voltage
Fractional I_{sc}	Medium	Medium	Yes	Current
Fuzzy logic control	Fast	High	Yes	Varies
Neural network	Fast	High	Yes	Varies

CONCLUSION:

Here discuss different MPPT algorithms. Mainly perturb and observation MPPT algorithm is used to obtain the maximum power point of solar array. Boost converter is used to obtain this maximum power point which helps in step down the array voltage to the maximum operating point voltage. So by using MPPT algorithm and boost converter solar array is operated at maximum power point irrespective of solar irradiance. Further we can also design the inverter circuit which converts the DC power into AC power. And this can be connected to grid with the help of inverter.

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