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A STUDY ON SOLAR PV SYSTEMS

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Abstract *The light, which comes from the Sun, is a renewable source of energy. It can easily reimburse the energy drawn from the non-renewable sources of energy such as petroleum and fossil fuels residues inside the planet. It's free from environment pollution and noise. The construction of solar cells has passed through a large number of stages from one to other generation. In this article, we have reviewed about MPPT Techniques and discussed about their future trends and aspects. MPPT are significant to get an energy resourceful solar PV system. The difference between these techniques depends upon their speed, cost, design, sensor requirement. This paper presents concise analysis of few important MMP techniques and tries to highlight the various practices and methods to support the benefits of solar energy.*

Keywords: Solar cell, MPPT System, efficiency, PV Systems

I. INTRODUCTION

Energy sources with capacity to renew are need of time to fulfill ever-increasing demand of energy. To meet this increasing energy demand, researchers in world community have focused on production of energy from renewable energy sources. There are so many renewable energy sources such as solar, wind, bio-mass, thermal energy etc. Solar power is one in all the foremost popular energy, which is employed to provide power. Solar energy is an limitless source of energy, which is unfilled. Solar energy becomes more popular in last few years because of its own advantage like noise free, pollution free etc.

Solar photovoltaic system has a non-linear relationship between voltage & current and its output is function of solar irradiance and operating temperature. Therefore, maximum power point also dependent on these operating parameters and it put the requirement of automatic maximum power point trackers. MPP trackers continuously track maximum power point to deliver it to connected load [1]. There are many MPPT techniques by which maximum power point can be achieved to get more efficient solar system. These MPP trackers are essential part of unconnected and grid connected solar PV systems [11].

In this paper, we have discussed commonly used MPPT techniques like observe and perturb technique (P&O)/ hill-climbing, adaptive hill-climbing, incremental conductance, fractional open circuit voltage, fractional short circuit current, ripple correction, fuzzy logic and artificial neural network (ANN) techniques.

II. VARIOUS MPPT METHODS

There are so many MMPT techniques are available. Suitable MPPT techniques can be selected according to the suitability of technique for that particular application based on different parameters. These parameters include hardware and software implementation, voltage and current sensor, convergence speed of solar panel, multiple local maximum points, cost, and other array parameters. Ability to identify maximum local points when system is under different irradiance and temperature level is significant parameter.

The MPPT system can be dependent or independent on array limitations. PV current and voltage measurement use direct method. Thus operating points is independences of temperature, temperature degradation levels and irradiance. The indirect values is created on data base factors that include data of typical PV curves of PV system for different irradiance.

A. Perturb and Observe (P& O) / Hill – climbing technique:

This algorithm(P&O) [2-4], operates by increasing and decreasing array terminal current and voltage at regular intervals and compare it with array output powers with that of pervious values. Maximum power is achieved at dP/dV=0. If operating voltage changes and power increase dP/dV > 0, then controller moves the operating voltage to the same direction as before otherwise operating points moves in opposite direction.

The advantage of this technique is low cost and simplicity. The major drawbacks of perturb and observe method is that the maximum power is not achieved when rapidly change environmental condition i.e. this techniques fails when there is change in environmental condition. To solve this problems modified adaptive P&O methods is used [2-4].

B. Adaptive Hill-climbing method

In the P&O method, it fails in rapidly changing environment. We can use adaptive Hill-climbing with variable perturbation step size, where an automatic tuning controller is used to vary perturbation step size to a large value. when the power change due to rapidly change in environment condition, If power changes is less or equal to lowest value then the system reaches steady state condition. In adaptive MPPT, P&O method duty cycle is decreased that linearly reduce with increase power flow from PV panel.

Incremental conductance

Incremental conductance algorithm overcomes the limitation of P&O method. It is capable of tracking MPP more accurately in rapidly change in environmental condition. Incremental conductance computes the sign of dP/dV without perturbation. Advantage of this is through the variation of step size it improve speed and accuracy. Disadvantage of this technique is its increased complexity in comparison to the P&O method along with increased computation time. Under low level of isolation, the differentiation process is difficult and prone to measure noise and result can be unsatisfactory.

$$\frac{dP}{dV} = \frac{d(IV)}{dV} = I + V\frac{dI}{dV} = I + V\frac{\Delta I}{\Delta V}$$

$$\frac{\Delta I}{\Delta V} = -\frac{I}{V}\ at\ MPP$$

$$\frac{\Delta I}{\Delta V} > -\frac{I}{V} at\ left\ of\ MPP$$

$$\frac{\Delta I}{\Delta V} < -\frac{I}{V} at\ right\ of\ MPP$$

Thus MPPT can be tracked by comparing the instantaneous conductance(I/V) to the incremental conductance $(\Delta I/\Delta V)$[3],[4]. It is the same efficient as P&O, good yield under rapidly changing environmental condition. Here, also the same perturbation size problem as the P&O exist and an attempt has been to solve by taking variable step size [5].

D. Constant voltage method (fractional open circuit voltage)

This is one of the simplest MPPT algorithms. In this method maximum power of PV panel voltage change with irradiation. To measure open circuit voltage set the PV panel current to zero. The operating voltage is set to fixed percentage of open circuit voltage. The panel parameter which having,

$$V_{MPP} \approx K_{oc}.V_{oc}$$

where value of K varies from 0.78 to 0.92 [6, 7]

K_{OC} can be calculated by varying solar temperature and irradiance. The constant voltage is to achieve performance close to MPP, for this reason, in practice; the constant voltage algorithm may never exactly locate MPP.

E. Fraction Short Circuit Current Technique

In FSCI technique, the non-linear characteristic of PV system is modeled using mathematical equation . Based on those V-I characteristic the mathematical relationship between I_{mpp} and I_{sc} is constructed as I_{mpp} linearly depend on I_{sc}.

$$I_{mpp} \approx K_{sc}.I_{sc}$$

K_{SC} generally varies between 0.64 and 8.85 [6].

F. Ripple correction technique (RCC)

In PV system, the switching action imposes voltage and current ripple. In RCC, this ripple utilize is utilize by PV system to perform MPPT. No artificial perturbation is required. RCC correlated dP/dT with either di/dt or dv/dt. RCC force this ripple to zero and achieve MPP. PV panel voltage and current that of MPP

$$\frac{dv}{dt} > 0\ or\ \frac{di}{dt} > 0\ and\ \frac{dp}{dt} > 0 \Longrightarrow V < V_{mpp}\ or\ I < I_{mpp}$$

$$\frac{dv}{dt} > 0\ or\ \frac{di}{dt} > 0\ and\ \frac{dp}{dt} < 0 \Longrightarrow V > V_{mpp}\ or\ I < I_{mpp}$$

The above equation is applied to any switching power converter topology.

G. Fuzzy logic

It convert numeric input variable to linguistic variable. In this, two input error signal and one output signal [8].The human description of a system reaction or command strategy is used to produce the best performance and insure high flexibility during the conception of controller. Fuzzy logic is only possible if there is human know to how to be interpreted as fuzzy rules, for which exact functioning of the system must be known. In a fuzzy logic, system composed three steps

a. Fuzzification
b. Interface
c. Defuzzification

a. Fuzzification

According to membership function, numerical input variable convert linguistic variable. The simplest from in many types of function is triangular, in which for a given time, two function are active for each input. The technique confines the calculation periods of given parameters, and simplifies it.

b. Interface

After the fuzzification the second process is interface. In this, fuzzy interface formulate the mapping from a given input signal.

c. Defuzzification

After fuzzification and interface process the value again moves from fuzzy to real domain.

The main advantage of fuzzy logic is that it doesn't need a correct mathematical standard of system and it is efficient of supervision system non-linearity. It can work efficiently in different weather conditions. Disadvantage of this system is effective dependence on user's knowledge and complexity in choosing the correct error.

III. Artificial neural network (ANN)

ANN is one in every of the machine learning technique which has been developed over the decades as generalization of mathematical models of biological systema nervosum sort of a physical body systema nervosum. There are different MMMPT supported artificial neural network [9,101].

First method is using neural network as a controller, it is used to control duty cycle of pulse width generator block and therefore the output resistance match with the load resistance to produce axiom power.

Second method is using neural network as a respect to the maximum voltage (Vm) and current (Im). This method uses another Fuzzy logic controller to track MPP.

ANN based trackers are fast and respond quickly under sudden change in solar irradiation.

CONCLUSION

This article offers a broad review of MPPT techniques, which are used in solar PV system. This paper also delivers advantages and disadvantages associated with each technique.

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