

REVIEW ON MPPT TECHNIQUES IN SOLAR PHOTOVOLTAIC SYSTEM

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ABSTRACT

The non conventional energy sources overcomes the drawback of Conventional energy sources, drawbacks like depletion, increasing cost, global warming etc. Among the all non conventional sources , solar energy is widely used as it can directly convert solar energy solar energy into electrical form with solar photovoltaic cell (PV Cell). Energy produced by PV cell is varying with partially shading conditions, temperature and environmental condition. To trace the maximum power at different condition Various Maximum Power Point Tracking (MPPT) methods have been developed by researchers. This review paper focuses the light on the state of art of MPPT suggested by researchers in photovoltaic system.

Keywords: Maximum Power Point Tracking (MPPT), Photovoltaic cell (PV cell)

I. INTRODUCTION

The utilization of energy is increasing day by day and it is mainly supplied by conventional sources of energy. The conventional sources are limited and will be exhausted by the time, so they are becoming more and more expensive and also a reason for global warming. This is the main reason to growth the different technology based on non conventional sources of energy. Solar is ever lasting, clean energy sources, no potential damage to environmental. It can be converting to solar form of energy to electrical form directly with photovoltaic (PV) cell. Different types of connection of these PV cells from different modules.

PV arrays have a non linear voltage and current characteristic which depends on the temperature and irradiance on the panel. Array can stand alone or it can also be connected to the grid. PV array has a unique point where the maximum power can be produced. Temperature and irradiance changes during the day and it also changes in different seasons of the year. It is very important to trace the MPP accurately under all possible conditions so that maximum available power is always obtained. As efficiency of PV cell lies between 10-19% only, its cost of production is very high. Main reason to trace MPP is to increase efficiency and to reduce the cost of production of generation power.

Several methods and algorithms have been reported for MPPT. Different MPPT algorithms are Hill climbing method Perturbation and Observation (P&O) and Incremental conductance method, Fractional open circuit voltage, Fractional short circuit current, Fuzzy logic control ,Differential Evaluation (DE) algorithm, Genetic algorithm

(GA), Particle Swarm Optimization (PSO), Neural Network and Hybrid method, Combination of two or modified of any one method. The topic, MPPT techniques has been well-researched by some scholarly researchers and in this review paper I have focused light on the work these researchers have done.

II. BASIC EQUATION OF PV ARRAY MODEL

Simplified equivalent circuit for the cell is shown in figure 1. Current delivered to load is given by equation

$$I = I_{PV} - I_0 \left[\left(e^{\frac{V + IR_s}{V_T}} - 1 \right) - \frac{V + IR_s}{R_{sh}} \right]$$

$$V_T = \frac{KT}{q}$$

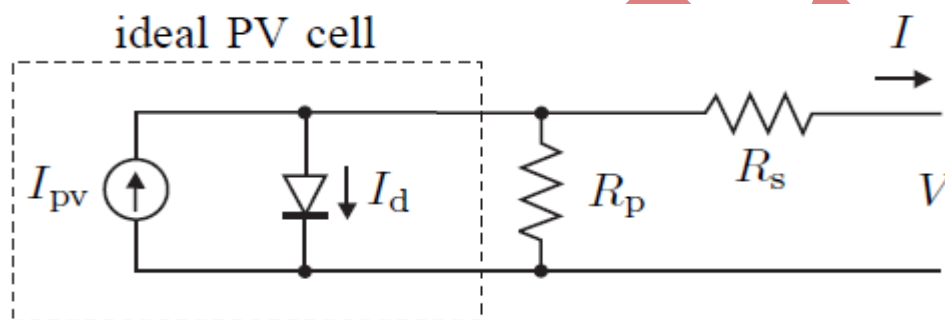


Figure 1. Simplified Equivalent Circuit for PV Cell

I_{pv} Light generated current

I_d Diode current

I_0 is the reverse saturation current

$V_T = V$ the thermal voltage

R_s is the series resistance

R_{sh} is the shunt resistance

K Boltzman Constant = $1.3806488 \times 10^{-23}$

T PN Junction absolute temperature

q Electronic charge

I_{sc} Short circuit current

V_{oc} Open circuit voltage

I_{mp} Max power current

V_{mp} Max power voltage

P_{max} Maximum Power

the I-V curve and power output of a solar panel is illustrated in fig (2) If no load is connected with solar panel which is sitting under the sun, an open circuit voltage V_{oc} will be produced but no current flows. If the terminals of the solar panel are shorted together, the short-circuit current I_{sc} will flow but the output voltage will be zero. In both cases, no power is delivered by the solar panel. When a load is connected, we need to consider the I-V curve of the panel and the I-V curve of the load to figure out how much power can be delivered to the load. The maximum power point (MPP) is the spot near the knee of the I-V curve, and the voltage and current at the MPP are designated as V_{mp} and I_{mp} . For a particular load, the maximum point is changing as the I-V curve varies with the temperature, isolation, and shading. Because solar power is relatively expensive, it is important to operate panels at their maximum power conditions.

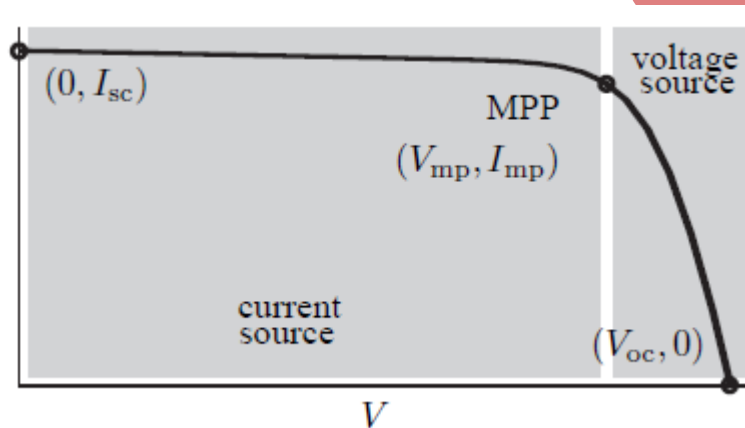


Fig.2 Characteristic I-V curve of photovoltaic device & three remarkable points.

III. LITERATURE REVIEW

MPPT has been a challenge for researchers. Many researchers have addressed various techniques for MPPT and published this work. Reviews of few of them are presented below:

Mohammad Faridun Naim Tajuddin et al [1] has presented the modified differential evaluation (DE) algorithm for maximum power tracking (MPPT). DE is applied under large and rapid fluctuation of irradiance and result of this algorithm is compared with hill climbing technique with mat lab and simulation. The modified DE algorithm has simple and straight forward implementation with the ability to search global maximum point regardless of initial parameter value. Result comparison of DE and HC method shows that DE has fast convergence and requires only few control parameter and better tracking performance in most environmental condition.

Kashif Ishaque and Zainal Salam [2] have suggested improved PSO algorithm which is called Deterministic Particle Swarm Optimization (DPSO). This method applies direct control scheme to track global Peak (GP) in which duty cycle is computed directly in MPP algorithm. DPSO is implemented in two modes: local mode under normal condition and global mode under partial shading condition. Under local mode this method maintains existing GP and under global mode once when GP is located algorithm again works on local mode, which consists of Hill climbing

perturbation for GP search. DPSO method has a simple control structure as it does not consist random number and accelerates coefficient factor. This method has high accuracy and more speed compared to conventional method.

Weidong Xiao et al. [3] has proposed the parallel test bench system for evaluating MPPT algorithm which overcomes the drawback of testing approaches like simulators, artificial sunlight and natural sunlight. Test bench system consists of two PV modules. Two identical dc-dc boost converters, battery bank and digital controller. Both modules are equipped with different MPPT algorithm. First module is equipped with Perturbation and observation (P&O) method while second is equipped with centered differential and steepest descent (C&S) method and allows testing of two modules simultaneously under the same environmental condition for 8 hours in a day and lasts for 15 days. Energy harvest of two modules is affected by weather condition and MPPT algorithm, so it is very difficult to quantify which MPPT is more effective. To get statically significant outcomes paired difference test is done on data collected by C&S and P&O observation. In this paper new pair wise difference comparison methodology is used and this can be compared with any two types of MPPT technology. Result of comparison reveals that module 2 with C&S method is more effective than P&O method.

M. Dahmane et al. [4] has suggested the algorithm based on the selecting short circuit (I_{sc}) current to generate current at maximum power for MPPT. The short circuit current has been estimated using Genetic Algorithm for MPP and result is compared with robust control using Linear Matrix Inequality (LMI) tool. For Irradiance value near 1000 w/m² at given data sheet both method show similar result but at unfavorable weather condition GA gives better energy production.

Mohammed A Elgendy et al. [5] has proposed incremental conductance (INC) algorithm. If solar irradiance and cell temperature level is constant than module has single MPP is the base of this algorithm. At this MPP sum of instantaneous conductance and incremental conductance equal to zero. INC algorithm consists of two techniques, that is reference voltage perturbation and direct duty ratio perturbation. Step size is important factor for INC method and in this method a constant step size scheme is used. Perturbation rate is slow enough so that steady state condition reaches before next perturbation and step size must be high so that noise should not affect control parameter to change output. Perturbation period should select slightly higher than settling of system and perturbation period can be varied by step size. To reduce the transient time initial duty cycle is selected at 50 % for direct duty ratio perturbation and for reference voltage perturbation initial reference voltage must be equal to standard test condition (STC) value of array. The result is compared for P&O and INC algorithm for voltage reference control and direct duty algorithm. INC algorithm has less confusion due to noise and system dynamics but has high confusion in rapid changing weather condition than P&O algorithm. Reference voltage perturbation has fast transient response but has instability at high perturbation rate and use of low pass filter to reject noise from voltage and current. Direct duty ratio perturbation shows better stability but at slower transient response, if irradiance is changing its performance reduces.

Liqun Liu and Chunxia Lia [6] has introduced Genetic algorithm adaptive particle swarm optimization (GAAPSO) method for real time MPPT control for multiple photovoltaic arrays at partial shading. This method combines

adaptive particle swarm optimization (APSO) and genetic algorithm (GA) together to get global peak among the local peak. GAAPSO method has high tracking speed and also has more efficiency than P&O method. Author results prove that under random partial shading condition where P&O method is unable to trace MPP GAAPSO method trace MPP very fast.

Eflichos Koutrouli and Frede Bababjerg [7] have introduced a method which overcome the difficulties of iteratively control method which has complexity and high cost. This method assures convergence of global MPP under any partial shading condition and without knowledge of electrical characteristics of PV module and their configuration within PV array. In this method dc/dc power converter is connected to PV array. Output is controlled in such a way that it behaves as constant input power load. The main advantage of proposed method is that it can track global MPP of PV array of standalone as well as grid connected PV system. It can also be incorporated into any existing MPPT control system.

R.Ramaprabha and B.L. Mathur [8] have used Artificial Neural Network (ANN) and the result of this MPPT is optimized using Genetic Algorithm. ANN has ability to trace MPP under non linearity, uncertainties and parameter variation. In the proposed method ANN is trained by set of input and data which are optimized using GA and if the trained input is increases the output power will be more and efficiency also increases.

Chian-Song Chiu [9] has proposed Takagi Sugeno (T-S) Fuzzy model based MPPT method. This method is applied on standalone solar photovoltaic system. In this method the solar system is represented by T-S fuzzy model and T-S fuzzy observer is designed and then a fuzzy direct MPPT controller is employed. The result of observer and controller is calculated separately using two set of linear matrix inequalities to trace the MPP. The main advantages of this method are strict stability and performance analysis of model and it also draw more power than traditional methods as power chattering phenomena is absent.

C. Larbes, et-al [10] have reported an intelligent control technology using Fuzzy Logic Control and then Genetic Algorithm is applied to increase the efficiency. Fuzzy controller has two inputs: error and change in error, and controller output is used to trace the MPP. To optimize the result Genetic algorithm is applied.

IV. CONCLUSION

In this describe paper several MPPT methods have been surveyed. Different MPPT methods are discussed based on simulation, dynamic response, and efficiency and implementation consideration. There are number of hybrid MPPT methods are included with their benefits. Further MPPT is discussed for partial shading and non uniformity of PV panel temperature.

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