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A Comparative Study on Different MPPT Techniques Applied On Photovoltaic System

Sagar Savaliya[1], Soumyadeep Ray[2]

M.Tech Student [EPS], Dept. of ELE, R.K. University, Rajkot, India[1]

Assistant Professor, Dept. of Electrical Engineering, R.K. University, Rajkot, India [2]

ABSTRACT:This paper represents a review of a comparative study of widely-adopted MPPT techniques applied to photovoltaic (PV) power system. But, confusion lies while selecting a MPPT as every technique has its own advantages and disadvantages. Also some technique has more complexity than other system and cost also plays big role in selection procedure of MPPT technique for particular application like domestic, industrial etc.

KEYWORDS: Photovoltaic, Maximum Power Point Tracking,Petrub &observe, Incremental Conductance.

I.INTRODUCTION

The predictable exhaustion of the fossil fuels, the necessity of fighting against the global warming, the awareness for the protection of the environment and the consideration of the sustainable development in energy policies put the renewable energies in the heart of a strategic stake for the future of our planet. Among the options of the renewable energies, there is an inexhaustible energy and still underexploited in our days: the solar energy. Indeed, the photovoltaic panels remain a real promise for the future. The main hindrance of solar energy going widespread is the initial high capital cost of solar modules. The disadvantage of solar energy production is that the power generation is not constant throughout the day, as it changes with weather conditions. Furthermore, the efficiency of solar energy conversion to electrical energy is very low. This means that a fairly vast amount of surface area is required to produce high power. Therefore, maximum power point tracking (MPPT) is an essential part of the photovoltaic (PV) system to ensure that the power converters operate at the maximum power point (MPP) of the solar array. Various MPPT algorithms have been developed in [1]-[3].

In the P&O method, the voltage is being increased or decreased with a fixed step size in the direction of reaching the MPP. The process is repeated periodically until the MPP is reached. At steady state, the operating point oscillates around the MPP. [4]- [9]

II. COMPARISON OF DIFFERENT MPPT METHODS

These algorithms differ from each other in terms of number of the sensors used, complexity, and cost to implement the algorithm. The main objectives of all these MPPT algorithms are to achieve faster and accurate tracking performance and reduce the oscillations around MPP.

	Algorithm	**Efficiency**	**Sensors**	**Remarks**
1	Fixed duty cycle	Poor	Nil	Open-loop control very, limited utility
2	Constant voltage method	Average	Voltage	Poor scalability due to wide variations in solar cell characteristics
3	Perturb & observe	Excellent	Voltage, current	Standard method for MPPT

Table. No-1 Comparison of Various MPPT Algorithms For Cost Reduction

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Each algorithm can be categorized based on the type of the control variable it uses:1) Voltage; 2) current; or 3) duty cycle. Among different algorithms, much focus has been on perturb and observe (P&O) and hill climbing (HC) methods. The P&O method involves a perturbation in the operating voltage of the solar array. And in table no-1 comparison is done of three methods fixed duty cycle, Constant Voltage method & Petrub and observe method for purpose of cost reduction. Among all methods P&O method has excellent efficiency.

2.1 Artificial Neural Networks (ANN) Method

An ANN is a collection of electrical neurons connected based on various topologies. The most common application of an ANN involves identification and modelling of the system using nonlinear and complex functions.

2.2Fuzzy Logic Method (FL)

This system implements the fuzzy logic control in three stages: fuzzification, decision-making and defuzzification. During fuzzification, crisp input variables are converted into linguistic variables based on a membership function In the decision-making stage, the rules which are specified by a set of IF-THEN statements define the controller behaviour.
In the defuzzification stage, the fuzzy logic controller output is converted from a linguistic variable to a numerical variable still using a membership function.

2.3 Online Methods

In online methods, also known as model-free methods, usually the instantaneous values of the PV output voltage or current are used to generate the control signals. The online methods Perturbation and observation method (P&O), as well as the incremental conductance method (IncCond) will be reviewed [3].

2.3.1 Perturbation and Observation Method (P&O)

This method is one of the simplest online methods which, has been considered by a number of researches. P&O can be implemented by applying perturbations to the reference voltage or the reference current signal of the solar panel.The P And O method is a widely used approach to MPPT. It employs amicroprocessor with the values for panel voltage V and panelcurrent I as its input values and the desired operating voltageVref. as its output value. Another possible configuration is to have the microprocessor directly controlling the dc-to-dcconverter's PWM input variable d. This makes the extra voltagecontrol feedback loop dispensable. Withalgorithm of microprocessor the operatingvoltage V is perturbed with every MPPT cycle. As soon as theMPP is reached, V will oscillate around the ideal operatingvoltage Vmp. This causes a power loss, which depends on thestep width of a single perturbation. If the step width is large, theMPPT algorithm will be responding quickly to sudden changesin operating conditions with the trade-off of increased lossesunder stable or slowly changing conditions. If the step width isvery small the losses under stable or slowly changing conditionswill be reduced, but the system will be only able to respond very slowly to rapid changes in temperature or insolation. The valuefor the ideal step width is system dependent and needs to bedetermined experimentally.Assuming that the system has been oscillating around the MPP,it can be seen in figure that a continuous perturbation in onedirection will lead to an operating point far away from the actualMPP. This process continues until the increase in insolationslows down or ends. [1]

2.3.2 Incremental Conductance Method (IncCond)

The incremental conductance (IncCond) method employs the slope of the PV array power characteristics to track MPP. This method is based on the fact that the slope of the PV array power curve is zero at the MPP, positive for values of output power smaller than MPP, and negative for values of the output power greater than MPP.

$dP/dV = 0$ for $V = Vmp$, (1)
$dP/dV > 0$ for $V < Vmp$, (2)
$dP/dV < 0$ for $V > Vmp$. (3)
The fact that $P = V I$ and the chain rule for the derivative of products yields
$dP/dV = d(V I)/dV = I\, dV/dV + V\, dI/dV = I + V\, dI/dV$ (4)
Combining equations (1) and (4) leads to the MPP condition ($V = Vmp$) in terms of array voltage V and array current I:
$dI/dV = - I/V$. ------ (5) [1]

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Now as we seen in table no-1 there only the comparison about in terms of algorithms, no of sensors, efficiency, in table no-2 now we compare only these methods that have more efficiency so only comparison is done which methods has higher efficiency than previous methods.

MPPT methods	**Sensed parameters**	**Efficiency**
Open circuit voltage	Voltage	Low (=86%)
Short circuit current	Current	Low (=89%)
Artificial neural networks	Depends	High (=98%)
Fuzzy logic	Depends	High
P&O(fixed perturbation size)	Voltage& current	Low
P&O (variable perturbation size)	Voltage& current	High (=96%)
IncCond	Voltage& current	High

Table No-2 Comparison of other characteristics of MPPT method

2.4 Hybrid Methods

The hybrid methods are expected to track MPP more efficiently. In these methods, the control signal associated with the algorithm consists of two parts.

Each part is generated based on a separate algorithmic loop. The first part is determined according to one of the simplified offline methods as a constant value, which depends on the given atmospheric conditions of the PV panel and represents the fixed steady state value. This part of the control signal is intended to follow the MPP approximately and is only required to present a fast response to the environmental variations. This part can be generated using one of the previous offline methods or simplification thereof based on the relationship between output power characteristics and ambient.

The second part of the control signal, which could be obtained based on one of the online methods involving steady state searches, represents attempts to track MPP exactly.

In contrast to the first part of the control signal this part attempts to minimize the steady state error and does not require a fast response to the environmental variations. In a hybrid method is proposed that uses an offline method to bring the operating point of the PV array close to the MPP and then uses the online IncCond approach to track the MPP with high accuracy. Other hybrid methods are reported elsewhere, a linear function is used to detect the location of the operating point relative to the MPP so that a perturbation of appropriate sign can be applied.

III. CONCLUSION

In this review paper, MPPT techniques have been classified into two categories: online and hybrid methods. This classification depends upon the PV system behavior around the steady state conditions. The result shows that the efficiency of Hybrid technique is 98% which is better than all other techniques available, although ANN method has the same efficiency as Hybrid method but its complexity is very high so we do not consider it. So finally P&O and Incremental conductance has very good characteristics than others in terms of cost, complexity and implementation.

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