

Reviewed Study on Maximum Power Point Tracker in PV System

Mohit Kumar Saxena^{1*} Dr. Sunil Kumar Choudhary²

¹ Department of Electrical Engineering, Sunrise University, Alwar, Rajasthan, India

² Department of Electrical Engineering, Sunrise University, Alwar, Rajasthan, India

Abstract – Fossil fuels used for electric power generation has created several problems on the environment including global warming and greenhouse effect. This has led to an era in which the increasing demand of power has to be met by Grid connected system that are based on renewable on sources such as wind, solar and hydro power that are renewable in nature. Generating electrical power from solar energy is very popular. The generation of electricity from photovoltaic (PV) arrays has been increasingly considered as a prominent alternative to fossil fuels. However, the conversion efficiency is typically low and the initial cost is still appreciable. A required feature of a PV system is the ability to track the maximum power point (MPP) of the PV array. Besides, MPP tracking (MPPT) is desirable in both grid-connected and stand-alone photovoltaic systems. There are many studies aiming at increasing the efficiency and designing simpler systems. Electrical power generated by PV cells depends on solar irradiances, ambient temperatures and electrical loads. To transfer maximum available power from PV cells to the grid, Maximum Power Point Tracker (MPPT) algorithms have been developed and implemented to make it better. In this Article, we studied the existing literature on Maximum Power Point Tracker in PV System.

Keywords: Maximum Power Point Tracker, photovoltaic, Fossil Fuels, Renewable Energy, etc.

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I. INTRODUCTION

Considering energy efficiency and power quality issues the generation of electrical energy from renewable sources is an important factor for meeting world energy requirement. The various renewable energy sources are like solar energy, wind energy, hydropower, biomass, geothermal, ocean energy etc. Among all these energies solar energy is more dominant as it is available free of cost, pollution free and distributed worldwide. Solar energy can be utilized in two ways i.e. one is the concentrated solar power and the other is solar photovoltaic. The present installed power generation capacity of India is 334.40 GW as on 31.01.2018. Generation from the thermal power plant is 2,18,960 MW, the hydroelectric power plant is 44,963 MW nuclear power plant is 6,780 MW and from renewable energy sources is 60,158 MW. Of the total installed capacity, 67.8% comprises of the conventional power plants and 32.2% comprise of nonconventional power plants. For the period 2016-17 the total electricity generation including both utilities and non-utilities was 1433.4TWh whereas the growing electricity consumption was 1,122 kWh per capita. In the world, India stands third largest producer and consumer of electricity. In order to supply continuous and uninterrupted electricity to all the people including households, industries, the commercial establishment

by March 2019 the government of India has launched a scheme called "Power for all". Of the total installed power capacity, renewable energy accounted for 18.37% excluding large hydropower. Solar energy Corporation of India is responsible for the development of solar energy industries in India. As of January 2018 installed solar power has reached over 20 GW including both solar parks and roof-top solar panels. India is ranked number one taking into consideration solar energy produced per Watt with an irradiance of 1700 to 1900 KW hours per kilowatt peak (kWh/kWp).

The asynchronous motor drive also needs the variable voltage because; its impedance minimizes the frequency and constantly regulates the current by varying the applied voltage. To obtain the variable supply voltage for the motor drive, it should be provided by the two level inverter that is controlled by the SVM controlling technique. To which the input is supplied by the DC-DC boost converter. For optimization of outputs in this research it is carried out with modified maximum power point tracking (MPPT), ANN based MPPT and ANFIS based MPPT incorporated with the DC-DC boost converter and inverter with SVM controlling technique.

II. RENEWABLE RESOURCES

Renewables (2011) stated that as Traditional fossil fuels are expected to run out in the near future, the world started to rely on renewable energy as a clean, cheap and permanent substitute. Renewable energy is the energy which is available in natural resources such as sun, wind, tides and earth's crust heat. These resources are renewable and naturally replenish. Unlike other conventional energy resources, they have almost zero carbon emissions which decrease the global warming problem and greenhouse effect phenomena. Apart from the harmful pollution that traditional energy resources do, fossil fuels reserves are decreasing rapidly, and that leads to the continuous increase in its price while renewable energy resources are permanent and free. In the past few years, renewable energy started to take serious steps on the way of replacing conventional fossil fuel energy production.

Silva et al (2011) stated that in the next few years, the world is supposed to face several problems related to the exhaustion of some energy sources, mainly those regarding fossil fuels. It is also well known that some aspects concerning the increase of oil price due to economic and political questions have been the cause of economic crisis in the last decades. The search for renewable energy sources then becomes more and more intense as a prominent alternative for the mitigation of the world energy crisis. Among the clean and green power sources, the photovoltaic (PV) solar energy comes up as an interesting alternative to supplement the generation of electricity. The significant cost reduction of PV modules in the last few years has made the use of solar energy particularly attractive, mainly in small single-phase residential systems connected to the utility grid and stand-alone applications. Electric energy can be obtained through direct conversion of light into electricity, which consists in the photovoltaic effect. Besides, solar energy is free for use, abundant in nature, and nonpolluting and has a fundamental role regarding the existence of all primary energy sources on Earth.

III. MAXIMUM POWER POINT TRACKER

Quamuzzam et al (2014) The Perturb and Observe MPPT algorithm is easy to implement, it works based on the PV array is perturbed of a radiation of direction. If the power drained from the array increases the operating point varies towards the MPP which in turn suits therefore the working voltage in the similar direction. if the power drained from the PV array decreases, the operating point varies away from the MPP, thus the direction of the working voltage perturbation have to be overturned.

Koad and Zobaa (2014) a disadvantage of P&O MPPT method is at steady state. The operating point oscillates in the region of the MPP give rise to the waste of energy. A number of improvements of the

P&O algorithm have been deliberate in order to decrease the oscillations in steady state, but this slows down the speed of response of the algorithm during the atmospheric changes. They discusses power oscillations in P&O algorithm is that the array terminal voltage is perturbed every MPPT cycle. They proposed to solve decoupling the PV power fluctuations caused by the hill climbing P&O process from the variations of the irradiance to solve the oscillation problem.

Hsiao and Chen (2016) present a MPPT algorithm which is called three-point comparison method. The ripple around the MPP is analyzed by comparing three points of the power curve. Since P&O uses only two points of the power curve to track the MPP, the work is based on a point by point analysis. Huang et al (2016) present an experimental comparison of techniques regarding the efficiency of some MPPT algorithms. It is shown that P&O is the most common algorithm used in commercial converters. IC has a performance level close to P&O, but in general the higher implementation cost compared to P&O would not be justified by an improvement in performance.

Esram and Chapman (2017) focus on various MPPT techniques from the analysis of more than 90 compiled papers. Methods such as P&O and hill climbing (HC) are found to be of simple implementation in either analog or digital forms. On the other hand, IC is slightly more complex and requires digital circuitry. However, the choice of a given method depends on engineers' and designers' knowledge and familiarity with analog and digital circuitry.

Xu et al (2013) the maximum power point tracking (MPPT) function plays a very important role as the voltage can have a wide range from 15V-40V with variable power capacities for a single PV panel. When the input voltage is of wide range, high efficiency is difficult to achieve in a single stage micro-inverter. Hence dual stage micro-inverter which combines a step up dc-dc converter and dc-ac inverter is implemented to obtain high efficiency as high as the conventional PV string type inverter. The controller for the inverter contains inner current loop and external voltage loop. The external voltage loop stabilizes the voltage of the dc link capacitor for the inverter and provides the magnitude of the reference current for the inner loop, while the inner loop controls the output current of the inverter to track reference current and meet the requirement of the grid.

Zhao Yang et al, (2012) presented the ANN based MPPT control to track the MPP at different weather, irradiance. This network is used to overcome slow tracking speed, more output oscillations and power oscillations. They discussed about the 3 layered ANN with back propagation algorithm based MPPT for boost converter for standalone PV system to minimize the long term system losses and to

increase the conversion efficiency. Even under variable temperature it gives optimum output voltage.

Huusari et al (2012) proposed the distributed maximum power point tracking in order to overcome the effect of shading which used to reduce the output power. Each PV module is connected by a DC-DC converter to extract maximum power where its output is connected to the grid connected inverter. It is also discussed about the terminal constraints, topological constraints and dynamic constraints to get maximum output voltage. They studied the MPPT with MCU control system in a grid connected photovoltaic generation system by introducing DCDC conversion techniques. They gives an analysis of the PV module characteristics and determination of short-circuit current to get converging maximum power point tracking control.

This method solves the time dependence and trade off as tracking time is very fast. Experimental valuation is carried out using dSPACE 1104. Jinbang Xu et al, (2011) has presented a new ANN based MPPT algorithm by using the traditional Incremental Conductance using sensors to get better performance. Compared with the Incremental Conductance & the P&O controller it is much faster to the sudden change of the weather combinations. To evaluate the effectiveness of the training network the mean square error is introduced to give the better performance and accuracy of the network. They implemented the 2-level neural network-genetic algorithm to estimate battery power influencing factors as light intensity, temperature, battery junction temperature.

IV. MAXIMUM POWER POINT TRACKER IN PV SYSTEM

Fakhfakh et al (2014) propose a control technique applied to a grid-connected PV system. The proposed approach includes a PV module, a dc-dc converter, and a dc-ac converter. MPPT is performed by the dc-dc converter, while hysteresis control technique is used to drive the dc-ac converter. Sahu et al (2014) present the estimation of the MPP in a PV array under different environmental conditions (i.e., temperature and solar irradiation) using Levenberg-Marquardt method. The estimation uses the single-diode-based model of the PV module and the related parameters are obtained from the datasheet provided by the manufacturer.

Wang and Shi (2011) on comparing with a typical P&O algorithm the efficiency of the MPPT is improved to 12.19% in the transient state. They proposed the PV model based mathematical models of photo-voltaic array on the basis of P&O method. In this the characteristics of photo voltaic arrays are analyzed. They presents the experimental works on a standalone solar system with P&O MPPT algorithm. They analyzed the equivalent model of PV cells based on Real Time Digital Simulation (RTDS) and studies the

output characteristics of PV cells. In this control of 3-phase PWM inverter controls the output active & reactive power with maintaining of DC bus voltage to a limited reference value.

Nordin and Omar (2011) validate generic and user-friendly PV array and MPPT models based on mathematical expressions and a circuit approach. The PV array model uses the irradiance and temperature as the input parameters and provides the corresponding characteristic curves. HC is also implemented to track the MPP. Rani et al (2013) study how the partial shading of PV modules affects the MPPT. The output power of PV arrays decreases significantly when one or more cells/modules are shaded. Partial shading can be caused by buildings, trees, and poles. In large PV systems, moving clouds may also lead to partial shading, which changes the PV characteristics with multiple peaks, apart from reducing the energy extraction from PV systems. The occurrence of such multiple peaks can mislead some MPPT algorithms to get trapped at local peaks.

This method is simple and achieves the good static and dynamic tracking. Yamauchi et al (2012) proposed the MPPT using a limited general regression neural network (LGRNN) for testing of two series connected solar panels if one of the panels is under shading condition. The LGRNN is used for learning the each panel output at instances with a limited memory capacity. They presented Artificial Neural Network based MPPT controller for the PV system in order to overcome the drawback of slow, wrong tracking and to operate it at maximum point, and reduce oscillations during rapidly changing weather conditions. In this with the help of boost converter, inverter are used to provide maximum output voltage to the load. Here back propagation feed forward trained networks are introduced to overcome the non-linearities of PV arrays.

V. CONCLUSION

The Photovoltaic cell is a semiconductor device that converts light energy into electrical energy by photoelectric effect. If the energy of photon of light is greater than the band gap then the electron is emitted and the flow of electrons generates electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells. The word 'photovoltaic' comes from 'photo' means light and 'voltaic' refers to producing the electricity. Therefore, the photovoltaic process is producing the electricity directly from sunlight, which is often referred to as PV. To overcome these non-linearities in the PV output voltage-current and voltage-power characteristics, the soft computing based MPPT techniques like ANN based MPPT and ANFIS based MPPT techniques are introduced.

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Corresponding Author

Mohit Kumar Saxena*

Department of Electrical Engineering, Sunrise
University, Alwar, Rajasthan, India