INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING & APPLIED SCIENCES
ISSN: 2322-0821(O)
ISSN: 2394-9910(P)
VOLUME 8 ISSUE 3
Jul 2020 - Sep 2020
www.irjeas.org

A REVIEW ON EFFICIENT METHOD FOR DETECTION OF PARTIAL SHADING AND MAXIMUM POWER POINT TRACKING ALGORITHM OF PV SYSTEM

[1]Raja Kumar, [2]Santosh Kumar
[12]Department of Electrical and Electronics Engineering,
Millennium Institute of Technology and Science, Bhopal (M.P), India

Abstract-In this study Maximum Power Point Tracking (MPPT) is applied to the Photovoltaic (PV) system to harvest the maximum power output. Maximum Power Point Tracker in a Photovoltaic system allows to maximize the energy drawn from the connected photovoltaic modules. In the partial shade conditions there can be more than one maximum point in photovoltaic output power curve. The solution for this situation is a maximum power point tracker algorithm, which finds the global maximum. In literature, there is a large number of studies on maximum power point trackers. Therefore designers are drowning in a sea of knowledge. This study eliminates similar studies and classified them into groups, and at the end of the study a comparison table is given to guide the designers in the performance information of the selected studies. This study aims to guide the designers to make a sensible selection of a maximum power point tracker algorithm for partial shade conditions. The proposed method was evaluated for a PV module under different ambient conditions and its control performance is compared with other MPPT strategies by experimental results.

Keywords: Maximum Power Point Tracking (MPPT); Photovoltaic (PV) System; Global Point(GP)

I. INTRODUCTION

Despite the relatively high cost of solar modules, PV power systems have been commercialized in many countries. One critical component of any PV is the effectiveness of its Maximum Power Point Tracker (MPPT). This area has been and is still attracting immense interest from PV research communities. Conceptually, MPPT is a simple problem-it is basically an operating point matching between PV array and power converter. However, because of non-linear I-V characteristics of PV curve and under condition known as partial condition, tracking of MPP becomes more challenging task. Conventional MPPT algorithms such as P&O, IC(to name a few) is likely to be trapped at one of the local peaks because it could not differentiate between local with Global point(GP). Numerous, MPPT techniques have been proposed by different authors published in different journals. In a short span of time, the body of knowledge related to this subject has grown tremendously.

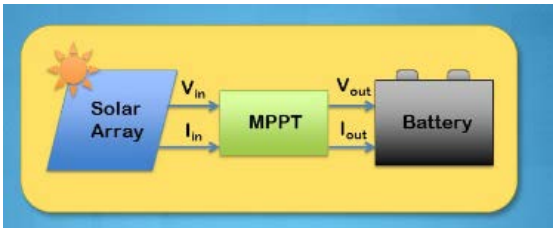

Figure 1: Maximum Power Point Tracking (MPPT).

Clearly, it is difficult to keep track with literature unless a single reference with concise and accurate summaries of various MPPT schemes made available [1-15]. This paper presents brief of different latest research papers on MPPT operating under partial shading condition, it is envisaged that some background knowledge would be helpful for certain group of readers. However, since the number of papers related to one particular method is quite large, it is imperative that only works with significant contributions are cited. Papers that refer to previous works with minor modifications or improvements may not be included in the reference list. In that regard, apologies are offered to the respective authors.

PARTIAL SHADING PROBLEM

Considering a PV array in a series parallel configuration where the modules are connected in strings, with three modules per string. When one of the modules in the string experiences [1] less illumination due to shading it's voltage drops; thus it behaves as a load instead of a generator. A hot spot ensued and typically a bypass diode is connected in parallel with each PV module to protect the shaded module from being damaged. Additionally, a blocking diode is connected at the end of each string (combination of series modules in one current path) to provide the protection against reverse current caused by the parallel connected strings. In normal condition, i.e., when the solar insolation on the entire PV array is uniform, the P-V curve exhibits the unique MPP. During partial shading, when any part of PV

International Research Journal of Engineering & Applied Sciences, IRJEAS
www.irjeas.org, ISSN(O): 2322-0821, ISSN(P): 2394-9910, Volume 8 Issue 3, July-September 2020, Page 12-16

module being less illuminated, the difference in insolation between two modules activates the bypass diode of that module.

As a result, two stairs current waveform is created on the I-V curve. Consequently, the corresponding P-V curve is characterized by several local peaks and one global peak (GP). Furthermore, if the bypass diode is removed, the PV array exhibits only a single peak; but this is achieved at the expense of a significant reduction in power. Therefore, in general, the bypass diode is always installed to improve the power throughput of the P-V array, despite the complication that arises during partial shading [15-30].

II. LITERATURE SURVEY

In this section the comparison of the techniques which are proposed by several authors in order to perform fault detection as well as the classification is performed.

K. Punitha et al. [10] has proposed a neural network (NN) based modified IC algorithm for MPPT in PV system. IC algorithm comes under the category of model-free algorithm. The idea behind the IC method is to increase or decrease Vref value based on the comparison of instantaneous conductance to incremental conductance. The advantage of this method is that it offers an effective solution under rapidly changing atmospheric condition. Under the variation in atmospheric condition this algorithm tracks the MPP by applying increments or decrements to Vref. The disadvantage of IC algorithm is that size of increment or decrement value is crucial. If the size is large, the algorithm finds MPP quickly but results in oscillation around the MPP. If size is small, the oscillation around the MPP is reduced but the convergence will decrease. Future scope of this algorithm is that it provides higher percentage of maximum power with less response time.

Yeong-Chau K[1] has compared conventional Proportional Integral Derivative(PID) and Fuzzy Logic(FL) under four different conditions which are : constant irradiation and temperature, constant irradiation and variable temperature, constant temperature and variable irradiation. After simulation results PID controller has shown better performance than FL controller under partially shaded conditions. PID controller has greater maximum power and average power compared to FL controller.

W Wenkai, N Pongratananukul, Q Weihong[4] has introduced a new method to track the global maximum power point (GMPP) under partially shaded condition for standalone PV systems. Advantages are that PV systems have fast response and good stabilization at the real MPP, efficiency is high. The disadvantage is that under rapid changes in isolation (or under dynamic loads) it takes small amount of time to reach MPP and has small overshoots. Further work is being conducted on the overall system design and experimental implementation.

Qiang M, Mingwei S, Liying L [5] has offered a new novel method of Global MPPT operating under partially shaded conditions. A capacitor is connected to the array as load, and, its current and voltage parameters are sensed while charging from PV array. Advantages are ability to find GMPP in partial shading configuration, no need of multiple MPPT devices, very short computation time. In future challenges of application for the proposed MPPT method will be investigated since there may occur some technical difficulties in widely ranging irradiance level and for large scale system.

Wu L, Zhao Z, Liu J [7] has proposed AMPPT algorithm based on conventional MPPT method by introducing two more steps. They are change detection for partial shade and search for GPA. The proposed method is satisfactory in real global MPP tracking under a large number of different partial shade conditions; less number of sensors is needed. If implemented generation efficiency for PV power system will improve.

Kobayashi K, Takano I[11] has proposed Extremu-Seeking Control(ESC) to track the global power peak under non uniform irradiance conditions. It relies on the measurements of power and estimation of the power gradient to iteratively determine the segment of the PV characteristics in which the global peak lies, without converging at the local maxima. The proposed method can reach the global peak with a faster convergence rate and higher tracking efficiency than conventional approaches.

D Menniti, A Burgio[9] has presented a method to quickly draw the characteristics and recording the result using an electronic load. Also a method to add the characteristics of individual panels to obtain the combined characteristics has also been presented. Author also proposed a Differential Evolution (DE) based optimization algorithm to provide the globalized search space to track the GMPP. The direction of mutation in the DE algorithm is modified to ensure that mutation always converges to best solution among all the particles in the generation. The proposed algorithm has benefits of rapid convergence to GMPP and higher efficiency than conventional approaches.

Sahnoun MA et al [19] has presented MATLAB-programmed modeling and simulation of PV systems, by focusing on the effects of partial shading on the output of the PV systems. The proposed model simulates the behavior of different ranges of PV systems from a single PV module through the multidimensional PV structure. It has shown that negative effects of drawbacks of P&O can be limited by customizing P&O MPPT parameters to the dynamic behavior of the specific converter adopted. Also, theoretical analysis has been provided.

Jain S, Agarwal V[15] has presented a MATLABbased modeling and simulation scheme suitable for studying the I-V and P-V characteristics of a PV array under partial shading, also , it can be used for developing new MPPT techniques. It can also be used as a tool to study the effects of shading patterns on PV panels with different configurations. has proposed a new algorithm to track the GMPP under partially shaded conditions. The algorithm works in conjunction with a dc-dc converter to track GP. Also, to accelerate the tracking speed, a feedforward control scheme for operating the

International Research Journal of Engineering & Applied Sciences, IRJEAS
www.irjeas.org, ISSN(O): 2322-0821, ISSN(P): 2394-9910, Volume 8 Issue 3, July-September 2020, Page 12-16

dc-dc converter is proposed, it uses the reference voltage information from the tracking algorithm to shift the operation toward the MPP. As compared to conventional controller, tracking time is reduced to one-tenth. Also entire P-V curve is not scanned.

Young-Hyok J, Doo-Yong J [12] has presented detailed analysis of impact of irradiance and temperature variations caused by partial shading condition. Also, an innovative MPPT scheme has been proposed which employs the Fractional Open-Circuit Voltage technique. Also, variable perturbation size concept is introduced. The proposed algorithm along with variable size control results in reduction of energy loss due to the fluctuation of tracker near MPP.

Table 1: Comparative study of Methods.

Authors	Methods	Purposes	Tasks
K. Punitha et al. [10]	IC algorithm	Under the variation in atmospheric condition this algorithm tracks the MPP by applying increments or decrements to Vref.	The disadvantage of IC algorithm is that size of increment or decrement value is crucial.
Yeong-Chau K[1]	Proportional Integral Derivative(PID) and Fuzzy Logic(FL)	Control value	After simulation results PID controller has shown better performance than FL controller under partially shaded conditions.
D Menniti, A Burgio [9]	Global Maximum Power Point (GMPP)	Dynamic loads	It takes small amount of time to reach MPP and has small overshoots.
Kobayashi K, Takano I[11]	Extremu-Seeking Control(ESC)	Diagnosis Strategy	The proposed method can reach the global peak with a faster convergence rate and higher tracking efficiency than conventional approaches.
D Menniti, A Burgio [9]	Differential Evolution (DE)	Detection algorithm	The proposed algorithm has benefits of rapid convergence to GMPP and higher efficiency than conventional approaches.

In the above table 1 the comparative analysis over previously used algorithms is given.

III. CLASSIFICATION OF PHOTO VOLTAIC MODULE

A Photo Voltaic module is constructed by series connected large number of Photo Voltaic cells. After that the Photo Voltaic modules can be again connected it may be series or parallel by the requirement of customer need it means that maximum voltage range with respect to type of application like water pumping.

Figure 2 Demonstrates the current versus voltage (I–V) characteristic for the Photo Voltaic modules. The arrangement associated left side segment of the photograph voltaic modules is non shaded. Then series-connected right side portion of the photo voltaic module is lightly shaded. In the event that the arrangement associated Photo Voltaic modules are working at level of Ia, then the non-shaded portion of the photo voltaic module will work in the region forward bias condition , while the shaded portion of the photo voltaic module will be work in the reverse bias region. Subsequently, the shaded portion of the photo voltaic module will absorb electrical energy rather than providing it, and then it will be dissipated in terms of heat energy for all time harm the module it will lead to failure of photo voltaic cells.

IV. PROBLEM DEFINITION

1. It is apparent that we cannot control the two aforementioned parameters; therefore, the problem of “PV mismatch” can occur.
2. These intelligence methods have been used to solve the maximum power point (MPP) tracking problem under the shading situation.

V. CONCLUSIONS

Going by the amount of research work, it can be concluded that the MPPT is continuously being

researched. This area has been and is still attracting immense interest from PV research communities. Conceptually MPPT is a simple problem which is basically an operating point matching between PV array and power converter. However because of non-linear I-V characteristics of PV curve and under condition known as partial condition. The tracking of MPP becomes more challenging task. This implies that improvements and new techniques are destined to happen in near future. In uniform isolations conditions there is no as such problems and only efficiency is being increased by improving or combining existing technique. But the real concern is for partial shading condition where still new techniques are being developed. In new techniques PSO shows the greatest viability. But research will continue to get the maximum power from PV system.

REFERENCES

[1] Yeong-Chau K, Tsorng-Juu L, Jiann-Fuh C, Novel maximumpower-point- tracking controller for photovoltaic energy conversion system, Industrial Electronics. IEEE Transactions on 2001;48:594–601. 6

[2] GJ Yu, YS Jung, JY Choi, I Choy, JH Song, GS Kim, A novel two-mode MPPT control algorithm based on comparative study of existing algorithms, In: photovoltaic specialists conference, 2002. Conference record of the twenty- ninth IEEE, 2002, p. 1531–1534.

[3] H Koizumi, K Kurokawa, A Novel Maximum power point tracking method for PV module integrated converter, In: power electronics specialists conference, 2005. PESC '05. IEEE 36th, 2005, p. 2081–2086.

[4] W Wenkai, N Pongratananukul, Q Weihong, K Rustom, T Kasparis, I Batarseh, DSP-based multiple peak power tracking for expandable power system, In: applied power electronics conference and exposition, 2003. APEC '03.Eighteenth annual IEEE, 2003, p. 525–530 vol. 521.

[5] Qiang M, Mingwei S, Liying L, Guerrero JM. A. Novel improved variable step- size incremental-resistance MPPT method for PV systems, industrial electronics. IEEE Transactions on 2011;58:2427–34.

[6] L Jiyong, W Honghua, A novel stand-alone PV generation system based on variable step size INC MPPT and SVPWM control, In: power electronics and motion control conference, 2009. IPEMC '09.IEEE 6th international, 2009, p. 2155–2160.

[7] Wu L, Zhao Z, Liu J. A. single-stage three-phase grid-connected photovoltaic system with modified MPPT method and reactive power compensation, energy conversion. IEEE Transactions on 2007;22:881–6.

[8] L Jae , B HyunSu, C Bo Hyung, Advanced incremental conductance MPPT algorithm with a variable step size, In: power electronics and motion control conference, 2006EPEPEMC 2006. 12thinternational, 2006, p. 603–607.

[9] D Menniti, A Burgio, N Sorrentino, A Pinnarelli, G Brusco, An incremental conductance method with variable step size for MPPT: design and implementation, In: electrical power quality and utilisation, 2009. EPQU 2009.10th international conference on, 2009, p. 1–5.

[10] Punitha K.; Devaraj D. ; Sakthivel S., Artificial neural network based modified incremental conductance algorithm for maximum power point tracking in photovoltaic system under partial shading conditions,In: Energy Vol. 62, December 2013, Page(s): 330–340.

[11] Kobayashi K, Takano I, Sawada Y. A study of a two stage maximum power point tracking control of a photovoltaic system under partially shaded insolation conditions. Solar Energy Materials and Solar Cells 2006;90:2975–88.

[12] Young-Hyok J, Doo-Yong J, Jun-Gu K, Jae-Hyung K, Tae-Won L, Chung-Yuen W. A. real maximum power point tracking method for mismatching compensation in PV array under partially shaded conditions, power elec- tronics. IEEE Transactions on 2011;26:1001–9.

[13] Koutroulis E, Kalaitzakis K, Voulgaris NC. Development of a microcontroller- based, photovoltaic maximum power point tracking control system, power electronics. IEEE Transactions on 2001;16:46–54.

[14] Kasa N, Iida T, Chen L. Flyback inverter controlled by sensorless current MPPT for photovoltaic power system, industrial electronics. IEEE Transactions on 2005;52:1145–52.

[15] Jain S, Agarwal V, Single-Stage Grid A. Connected inverter topology for solar PV systems with maximum power point tracking, power electronics. IEEE Transactions on 2007;22:1928–40.

[16] Hairul N, Saad M (2010) Comparison study of maximum power point tracker techniques for PV systems. In: Proceedings of the 14th international middle east power systems conference (MEPCON'10), Cairo University, Egypt, December 19–21, 2010

[17] Attou A, Massoum A, Saidi M (2014) Photovoltaic power control using MPPT and boost converter. Balkan Journal of Electrical & Computer Engineering 2(1):23–27

[18] Elgendy M, Zahawi B, Atkinson D (2012) Assessment of perturb and observe MPPT algorithm implementation techniques for PV pumping applications. IEEE Trans Sustain Energy 3(1):21–33

[19] Sahnoun MA et al (2013) Maximum power point tracking using P&O control optimized by a neural network approach: a good compromise between accuracy and complexity. Energy Procedia 42:650–659

[20] Patel G, Patel DB, Paghdal KM (2016) Analysis of P&O MPPT algorithm for PV system. Int J Electr Electron Eng (IJEEE) 5(6):1–10

[21] El-Sayed M, Leeb S (2014) Evaluation of maximum power point tracking algorithms for photovoltaic electricity generation in Kuwait. Renew Energy Power Qual J (RE&PQJ) 1(12):44–50
[22] Lamnad M et al (2016) Comparative study of IC, P&O and FLC method of MPPT algorithm for grid connected PV module. J TheorApplInfTechnol 89(1):242–253
[23] Tofoli FL, Pereira DC, Paula WJ (2015) Comparative study of maximum power point tracking techniques for photovoltaic systems. Int J Photo-energy 3:1–10
[24] Haripriya T, Alivelu M, Rao UM (2016) Performance evaluation of DC grid connected solar PV system for hybrid control of DC–DC boost converter. In: 10th international conference on intelligent systems and control (ISCO), 7–8 Jan 2016, pp 1–6
[25] Ozcelik MA, Yilmaz AS (2016) Effect of improving perturb and observe MPPT algorithm on AC grid connected PV systems. IU-JEEE 16(2):3025–3032.
[26] Wang, Y.J.; Hsu, P.C. Analytical modelling of partial shading and different orientation of photovoltaic modules. Renew. Power Gener. IET 2010, 4, 272–282.
[27] Pandiarajan, N.; Muthu, R. Mathematical modeling of photovoltaic module with simulink. In Proceedings of the 1st International Conference on Electrical Energy Systems (ICEES), Newport Beach, CA, USA, 3–5 January 2011; pp. 258–263.
[28] Maki, A.; Valkealahti, S. Power losses in long string and parallel-connected short strings of series-connected silicon-based photovoltaic modules due to partial shading conditions. IEEE Trans. Energy Convers. 2012, 27, 173–183.
[29] Paraskevadaki, E.V.; Papathanassiou, S.A. Evaluation of MPP voltage and power of mc-Si PV modules in partial shading conditions. IEEE Trans. Energy Convers. 2011, 26, 923–932.
[30] Silvestre, S.; Boronat, A.; Chouder, A. Study of bypass diodes configuration on PV modules. Appl. Energy 2009, 86, 1632–1640.