An Efficient Method for Detection of Partial Shading and Maximum Power Point Tracking Algorithm

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***Abstract:* In this paper Maximum Power Point Tracking (MPPT) is applied to the Photovoltaic (PV) system to harvest the maximum power output. The output power of the PV effect changes according to external solar irradiation and ambient temperature conditions. In the existing MPPT strategies most of them only take variations in radiation level into account and rarely considering the impact of temperature changes. However the Temperature Coefficients (TC) plays an important role in the PV system especially in applications where ambient temperature changes are relatively large. In this work MPPT method is presented for a PV system that considers the temperature change by using Variable Universe Fuzzy Logic Control (VUFLC). By considering the ambient temperature change in PV modules the proposed control method can regulate the contraction and expansion factor of VUFLC which will eliminates the influence of temperature variability and improves the performance of MPPT. Therefore can achieve fast and accurate tracking control. The proposed method was evaluated for a PV module under different ambient conditions and its control performance is compared with other MPPT strategies by simulation and experimental results.**

***Keywords:* Maximum Power Point Tracking (MPPT); Photovoltaic (PV); Variable Universe Fuzzy Logic Control (VUFLC); Temperature Variability.**

I. INTRODUCTION

The "Photovoltaic (PV) impact". Inferable from the developing overall interest for power and expanding critical need to handle the worldwide difficulties of energy security, environmental change and reasonable turn of events, huge measure of exploration exertion has been made on creating PV cells, which are essentially semiconductors fit for changing over the energy of light straightforwardly into power by the PV impact. Since the output intensity of PV cells is restricted at high voltage levels, PV module, an associated get together of PV cells, is generally utilized as a rudimentary part in huge PV frameworks. The present PV advances are more modern than any other time in recent memory. An assortment of silicon (Si) materials have been investigated to build the energy change effectiveness and decrease creation cost. The industrially accessible PV advancements can be assembled into two classes: wafer-based Crystalline Silicon (C-Si) and Thin-Flim (TF). The change proficiency of C-Si made PV modules is around 13-20%, while the transformation productivity of TF made PV modules is around 6-12 %. TF innovations utilize modest quantities of dynamic materials and can be fabricated at a lower cost than the C-Si. As of late, many rising and novel PV advances, for example, Concentrating Photovoltaics (CPV), natural sun powered cells, progressed inorganic flimsy movies, Thermo-Photovoltaics (TPV), are as of now under scrutiny.

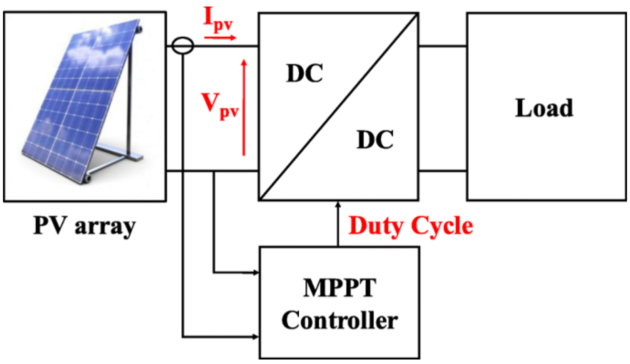

Figure1: Photo Voltaic system.

PV markets expand with advances of PV technologies. Considering the IEA-PVPS 1 report, the worldwide PV advertise developed to in any event 36.9 gigawatt (GW) in 2013. Notwithstanding legislative motivating forces and mechanical advances, flow PV sending cost can't contend with the underlying introduced cost of fossil wellsprings of electrical age much of the time [1-2]. This propels the exploration for augmenting conceivable force age from the PV plants over the whole time of activity just as creating execution estimation instruments.

Because of the high beginning expense of a PV-provided framework, prescient execution apparatuses are utilized widely by architects to enhance the framework execution. PV makers typically give constrained plain information estimated under the Standard Test Conditions (STCs), which compare to a phone temperature of 25°C and an irradiance of 1000 W/m2 at 1.5 air mass ghostly conveyances.

PV generators 26 consistently work under conditions a long way from the STCs. Inferable from this explanation, the information accessible in the datasheet for the most part neglect to satisfy the designing necessities. PV electrical model, with the capacity to anticipate I-V attributes of PV generators under a working situation other than the STCs, is a prescient presentation device that permits buyers to boost the cost viability of the framework before establishment. They are commonly diagnostic conditions dependent on physical depictions that detail PV created current I with the most urgent specialized qualities and the natural factors, for example, the working voltage V , the encompassing temperature T, and the irradiance G. Throughout the years, huge exploration endeavors have been adding to the advancement of the electrical models. Among various demonstrating approaches, the Single-Diode (SD) model is the most generally used PV model in the writing. So as to adjust PV model conduct to various working conditions, recommended to apply the system depicted in the International Standard IEC 891 that relates current and voltage of the PV attributes at given estimations of T and G with the comparing esteems at various working conditions. Boundary estimation is an instrument that gauges the estimations of these boundaries by utilizing the deliberate information. In this part, we talk about the Cuckoo Search (CS) calculation and its application to boundary estimation for the SD model and the De Soto's model. Reproduction and exploratory outcomes show unrivaled exactness and practicality of the proposed boundary estimation strategy.

II. LITERATURE REVIEW

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. [1] 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.

AbdkadirMahammad, et al. [3] 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.

A.Bouilouta, et al.[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.

KoraySenerParlak [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.

Jun Qi, Youbing Zhang [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.

A. Elnosh, et al.[8] 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.

Venkateswarlu, et al.[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. Kok Soon Tey et al. [10] has 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.

Mohammad Mehdi SeyedMahmoudian, et al.[1] 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. Nicola Femia, et al. [12] 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.

III. PROBLEM DEFINITION

1. Photovoltaic arrays are used in many applications such as water pumping, battery charging, hybrid vehicles, and grid connected PV systems. A power Voltage graph of a solar panel which was used in the previous work shows that there is an optimum operating point where the panel is able to deliver maximum possible power to the load at a particular voltage or current.
2. An increasing temperature for every individual panel depending mainly on the cell temperature, irradiance and insignificantly on some other factors. Therefore, on line tracking of the maximum power point of a PV array is an essential part of any successful PV system. A variety of maximum power point tracking (MPPT) methods are developed.
3. The methods vary in implementation complexity, sensed parameters, required number of sensors, convergence speed, and cost. The goal behind our implementation of the solar panel is to come up with a design to operate each panel to operate at its maximum power and to extract maximum power from the PV panels even in times of partial shading or minimum irradiance.

IV. PROPOSED METHODOLOGY

In this section an explanation of the proposed algorithm will done which is Maximum power point tracking algorithm.

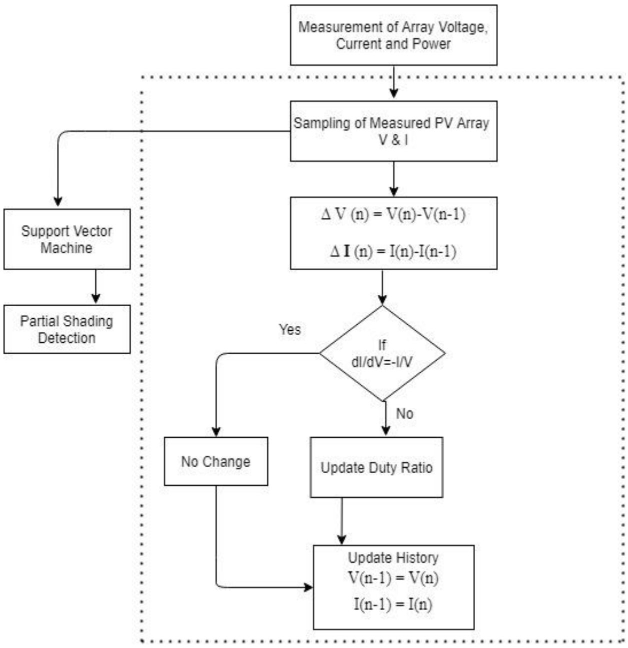

Figure 2: Flowchart of proposed method.

Description of Flowchart-

Step 1: photovoltaic solar panels are made up of individual photovoltaic cells connected together, then the Solar Photovoltaic Array, also known simply as a Solar Array is a system made up of a group of solar panels connected together. Most manufactures produce standard PV panels with an output voltage of 12V or 24V.

To measure amperage or Voltage of solar panel, need to set the function to DC amperage or DC Voltage. To test a 18V solar panel voltage output directly, put your solar panel in direct sunlight, set your multi-meter to the DC “volts” setting.

Incremental Conductance method

Step 3: Incremental method will be applied so to calculate the I and V-

1. The INC algorithm calculates the maximum power point by comparison of the incremental conductance (ΔI/ΔV) with the array conductance (I/V). When these two are the same (ΔI/ΔV= I/V), the output voltage is the MPP voltage. The controller maintains this voltage until the irradiation changes and the process is repeated.
2. The INC algorithm is based on the fact that at the maximum power point ΔP/ΔV = 0 and P = VI. Incremental conductance algorithm has only two sensors, voltage and current sensors, which are required in order to measure the PV device output voltage and current.

Step 4: update history ratio will done in this step using-

V (n-1) = V(n)

I (n-1) = I (n)

Step 5: Finish

V. SIMULATION SETUP

This section covers the simulation of the system parameters in MATLAB/SIMULINK. The mathematical modeling of the PV module is discussed. The direct duty ratio controlled MPPT algorithm principle and working flowchart was presented in the previous section. The solar insolation and temperature profile considered for analysis and the respective related parameters for analysis are cited in brief as well.

PARAMETERS USED

The maximum power point tracking (MPPT) is the control algorithm to adjust the power interface (dc converter) associated with the PV system such that greatest possible power yield is achieved, during moment to moment variations of insolation level, temperature, and loads connected with the system. It is important to note that the change in duty ratio has a corresponding changing effect on the converter performance parameters which include voltage gain, current gain, input impedance to the converter, boundary values of inductance and capacitance.

RESULT ANALYSIS

Table 1: Partial Shading Patterns.

Pattern	Irradiance (W/m^2)			
	Array 1	Array 2	Array 3	Array 4
Pattern 1	1000	300	850	250
Pattern 2	1000	600	250	700

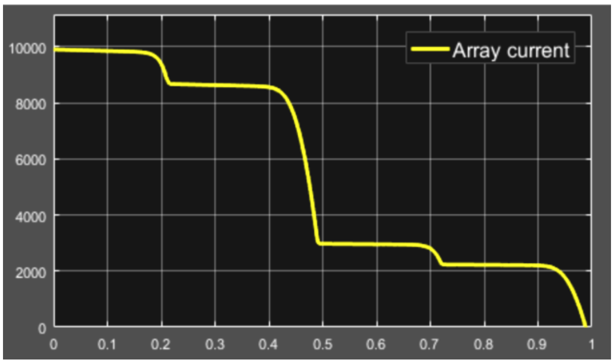

Figure 3 Array current for partial shading pattern 1 (as illustrated in Table 1)

In the above figure 3 the graph of Array current for partial shading pattern 1 is shown. The values goes from 10000 at 0-0.1 , 8500 at 0.2-0.4, 3000 at 0.5-0.7, 2000 at 0.7- 1.

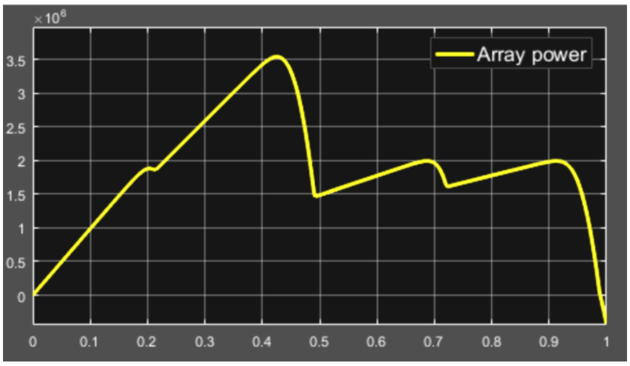

Figure 4 Array output power for partial shading pattern 1 (as illustrated in Table 1)

In the above figure 4 the graph of Array output power for partial shading pattern 1 is shown.

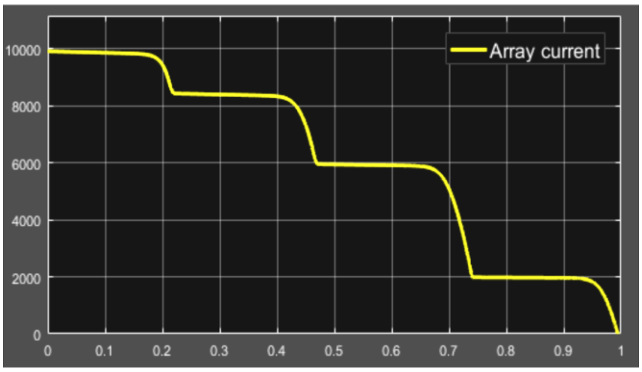

Figure 5 Array current for partial shading pattern 2 (as illustrated in Table 1)

In the above figure 5 the graph of Array current for partial shading pattern 2 is shown.The values goes from 10000 at 0-0.1 , 8300 at 0.2-0.4, 6000 at 0.5-0.7, 2000 at 0.7- 1.

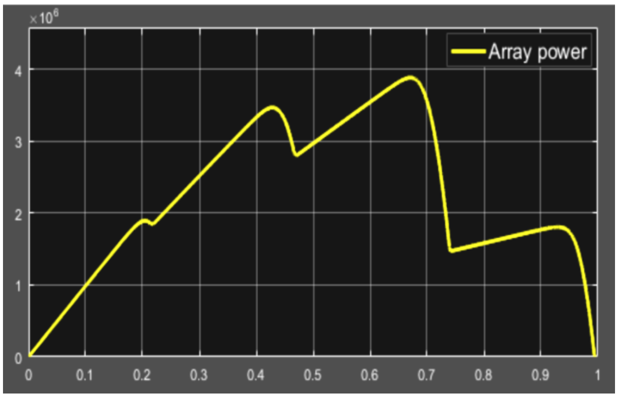

Figure 6 Array output power for partial shading pattern 2 (as illustrated in Table 1)

In the above figure 6 the graph of Array output power for partial shading pattern 2 is shown.

VI. CONCLUSION & FUTURE WORK

Photovoltaic (PV) innovation has been the focal point of enthusiasm because of its nonpolluting operation and great establishment flexibility. Light and temperature are the two primary components which impact the exhibition of the

PV framework. Likewise, when incomplete concealing from surroundings occurs, its occurrence shadow lessens the light and decreases the produced power. Since the conventional most extreme force point following strategies (MPPT) couldn't recognize the global maximum intensity of the force voltage (P-V) trademark bend, another following technique needs to be created. This paper proposes a worldwide greatest force point following technique utilizing shading detection and the pattern of inclines from each area of the bend. Full scientific equations and calculations are introduced. Recreations dependent on genuine climate information were performed both inshort-term and long haul examines. Additionally, this paper likewise presents the investigation utilizing the DC-DC coordinated and interleaved support converter. Results from the reenactment show an accurate tracking result and the framework can improve the all out vitality created by 8.55% contrasted with the conventional examining strategy. Besides, the trial additionally confirms the achievement of the proposedtracking calculation.

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