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Performance Comparison of Perturb and Observe MPPT Algorithm

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Abstract:
This paper is an attempt to develop the modified perturbs and observes (MPO) based Maximum Power Point Transfer (MPPT) on the Pholtovoltaic (PV) array. In quest of a better performance in the renewable energy based systems it is always been researched obtaining better algorithm in power processing. The simulation is carried out using Matlab Simulink for a comparative analysis of the MPO and the Perturb and Observe algorithm. The performance comparison between the ordinary Perturb and Observe (P and O) and MPO algorithm is carried out. Power from PV array with variable irradiation is supplied to the Boost converter and the maximum power point is obtained for all the irradiation levels. The capability to maintain the MPPT condition by both the methods is compared and results are tabulated.

Keywords: MPPT; Perturb and Observe;Modified Perturb and Observe; Photovoltaic array

I. INTRODUCTION

It is extremely essential for photovoltaic generation to operate the system at high power efficiency by ensuring that, the system is always working at the peak power point regardless of changes in load and weather conditions. In other words, transfer the maximum power to the load by matching the source with the load impedance. To confirm that, an MPPT system has been implemented which enables the maximum power to be delivered during the operation of the solar array and which trail the deviation in maximum power caused by the variations in the atmospheric conditions. The MPPT system is basically an electronic device inserted between the PV array and the load. This device comprises two essential components, as illustrated in Fig. 1. A DC-DC switching power converter along with an MPPT control algorithm to operate the PV system in such way it can transfer the maximum capable power to the load.

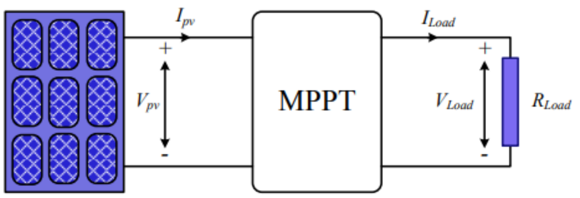

Figure.1. MPPT Tracking Using Converter

As the solar panel outputs power, its maximum generated power changes with the atmospheric conditions (solar radiation and temperature) and the electrical characteristic of the load may also vary. Thus, the PV array internal impedance rarely matches the load impedance. It is critical to manage the photovoltaic generation system at the MPP or near to it to ensure the optimal use of the available solar energy. The foremost purpose of the MPPT is to match these two parameters by adjusting the duty ratio of the power converter. As the location of the MPP on the I-V curve varies in an unpredictable manner it cannot be defined beforehand owed to changes of radiation and PV panel temperature. Accordingly, the use of MPPT algorithm or calculating model is necessary to locate this point [1]. There are quite a few methods to track the MPP of the photovoltaic system that have been carefully studied, developed and published over the last decades. The authors in [2, 3-7] have presented many MPPT control algorithms, some of which are addressed in the following sections. There are variations between these techniques in terms of, simplicity, sensor requirements, cost, range of efficiency, convergence speed and hardware implementation. Some MPPT algorithms do better than the others under the same operating conditions. A review and analysis of several MPPT techniques have been conceded in [8] to enumerate the performance of each control algorithm compared to the others. This paper deals with the relative analysis of the performance between the P & O and the M P&O algorithm to obtain the MPPT in an 80W PV array. The paper is organized in the following manner, the section –II having the details about the P & O and MPO algorithm. Section-III has the result and discussion section followed by conclusion and references.

II. MODIFIED PERTURB AND OBSERVE ALGORITHM

A. Performance specifications of MPPT control algorithm

As noted earlier, the dynamic response, steady-state error and tracking efficiency should be considered for a successful design when assessing the performance of a new or modified MPPT control algorithms [9].

Dynamic response: The response of a MPPT control algorithm needs be fast to track the MPP during the rapid changes in the atmospheric conditions (solar irradiation and temperature). The higher the tracking speed of the MPPT algorithm, the lower the loss in solar energy in the system.

Steady-state error: The MPPT control algorithm should stop tracking, once the MPP is located and should force the system to maintain operation at this optimal operating point as long as possible. However, this is unfeasible to achieve practically in an actual MPPT system because of the active perturbation process in MPPT algorithms with fixed tracking step-size and the continuous variation in solar insolation and temperature. This phenomenon has a harmful impact on the PV system efficiency.

B. Perturb and observe (P&O) algorithm:

The perturb and observe algorithm is considered to be the most commonly used MPPT algorithm among the other techniques because of its simple structure and simplicity of execution. It is based on the concept that on the power-voltage curve, the change in the PV array output power is equal to zero (ΔPPV = 0) on the top of the curve as illustrated in [3]. The P&O operates by periodically perturbing (incrementing or decrementing) the PV array terminal voltage or current and comparing the corresponding output power of PV array P(n +1) with that of the previous perturbation P(n) . The perturbation cycle is repeated until reaching the maximum power at (ΔPPV = 0). The control flow chart of P&O is shown in Fig. 3. There are two different ways to implement the P&O algorithm. In the conventional way a indication voltage is used as a perturbation parameter; therefore a PI controller is desirable to alter the duty ratio [8, 9]. The other way is that, the duty ratio is directly perturbed and the power is measured every PWM cycle [11]. However, the P&O will not stop perturbing when the MPP is reached and will oscillate around it resulting in some unnecessary power loss.

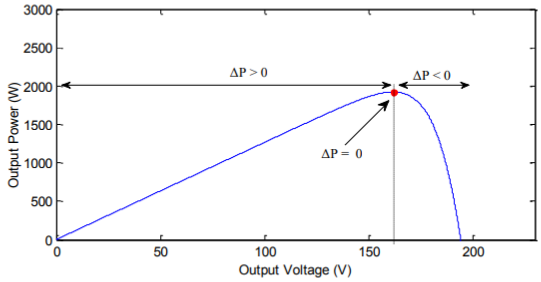

Figure.2. Sign of the dP/dV at diverse point on the power profile

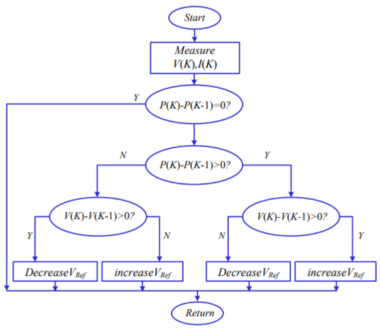

Figure. 3. Flowchart of the P&O algorithm.

C. *Modified Perturb and observe (P&O) algorithm*

This method was proposed to in order to reduce the oscillation around the MPP caused by conventional P&O algorithm [12, 13]. The MOP&O operates by adding an irradiance-changing estimate process in every perturb process to measure the amount of power change caused by the change of atmospheric condition. It was verified by simulations and experimental tests that evidenced the overall performance of the MOP&O is better than the P&O. However, it slows down the tracing speed to the half of conventional P&O [13].

III. RESULTS AND DISCUSSION

A PV array with 80 W MPP is used for the implementation and the results are obtained for both the P and O and MPO algorithm. The Figure 3 depicts the amount of irradiation the solar array is supplying to the power conversion system.

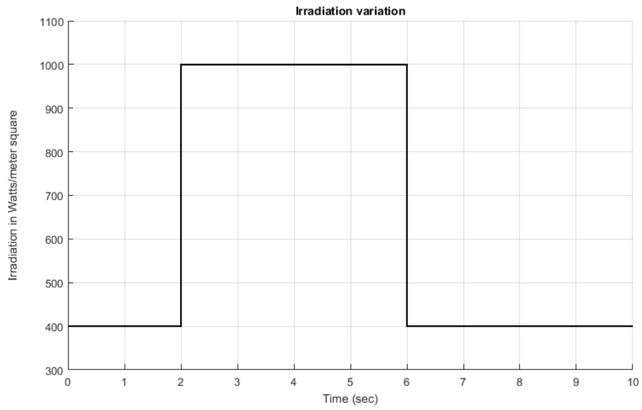

Figure 3. Irradiation Curve in Watts/m^2

It can be observed that the voltage output of the PV array is higher at the higher irradiation . The voltage of rated 21 V is observed from the PV array.It can be seen in figure 4.

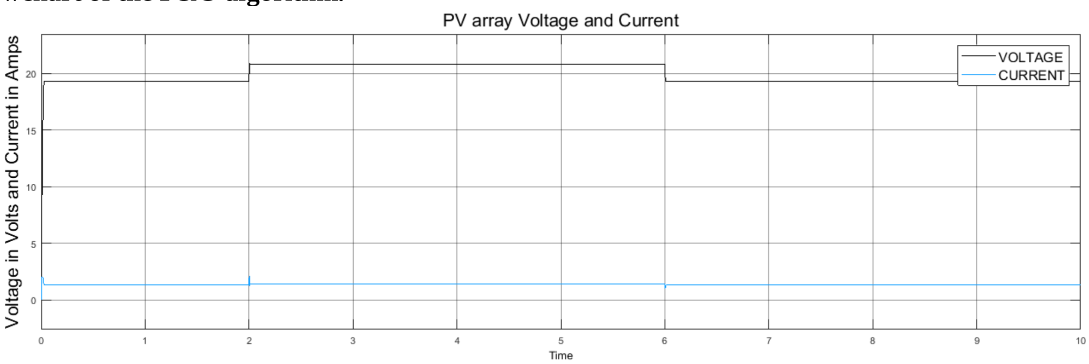

Figure .4. The voltage and current curve of the PV array

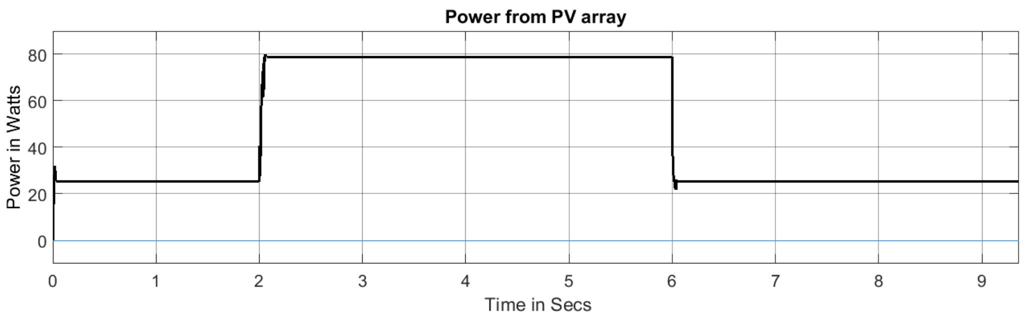

Figure .4. Power from PV array with MPO algorithm

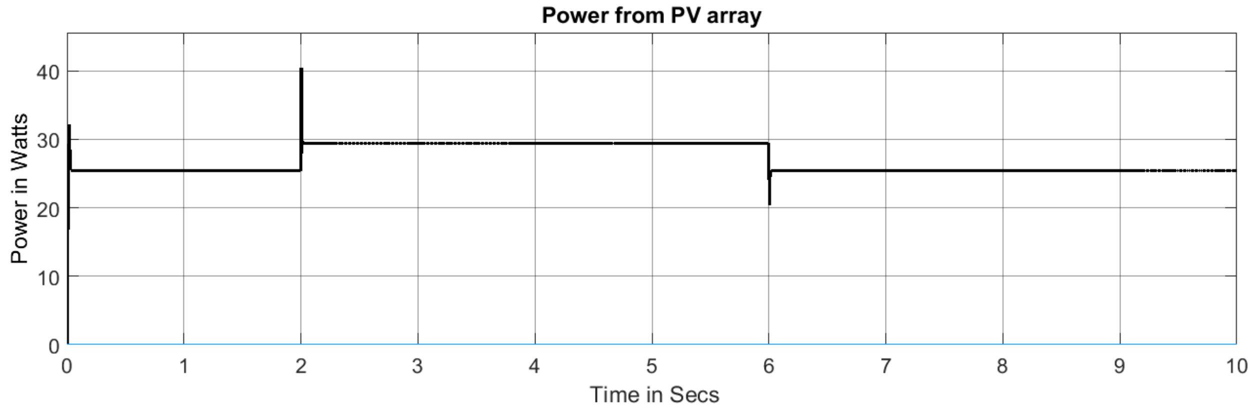

Figure .5. Power from PV array with PO algorithm

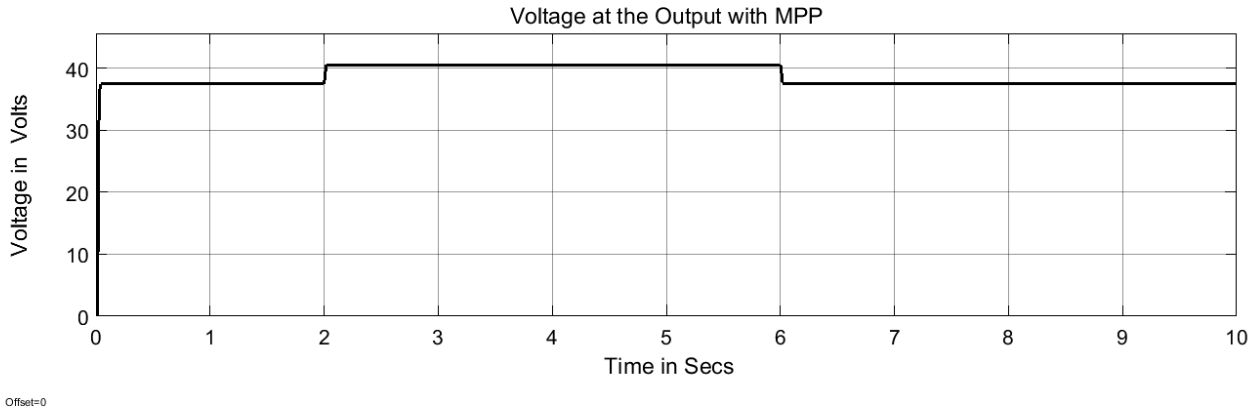

Figure .6. Voltage at output with P and O algorithm

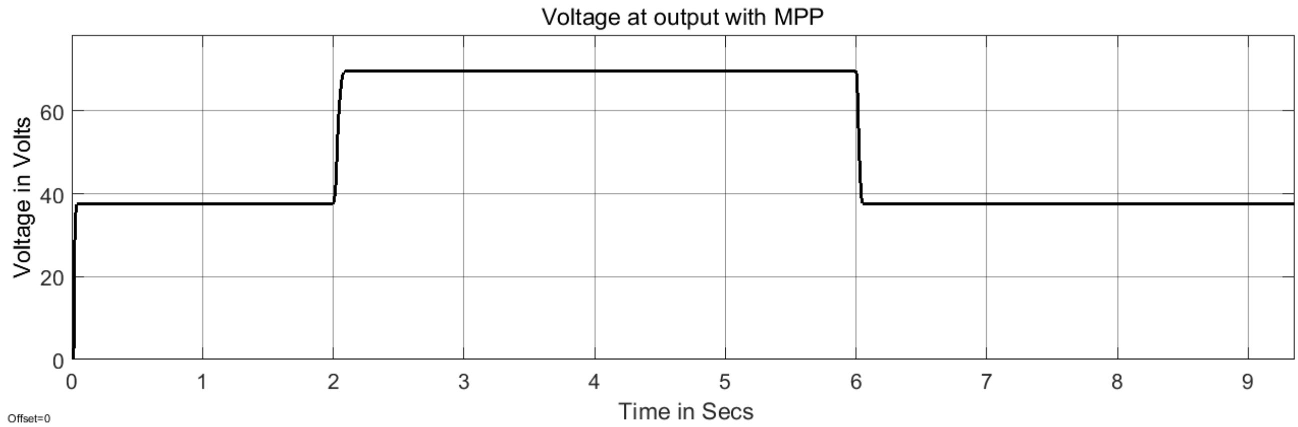

Figure .7. Voltage at output with M P and O algorithm

It is observed from the Figure 4 and 5 which shows the power delivery while P and O method and MPO method, that the power delivery while MPO is used would provide higher power compared to that applied with P and O method. And similarly the voltage is observed in the Figure 6 and 7. It can be inferred that the voltage is better while MPO is used.

IV. CONCLUSION

Matlab Simulation of the implementation is carried out on both the P and O and the MPO algorithm for a PV array with 80 watt capacity for a output voltage of 40V and input voltage of 21 V. The Power capability and the voltage of the MPO algorithm has outperformed compared to the P and O algorithm.

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