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Modified Efficient Perturb & Observe Mppt Technique for Isolated PV System

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ABSTRACT: The PV cells are used to convert incident solar energy into electrical energy. However, due to change in environmental conditions less power output is generated. The operating point shifts from the maximum power point (MPP) to some other point, which decreases the efficiency of solar panels. Till now, the maximum power is estimated or PV power output is considered from the present value of voltage and current or reference voltage is estimated by using the given irradiance and temperature values. But in the Modified algorithm of P&O MPPT presented in this paper uses the theoretical power values which is calculated by using the system model which can be generated by the given irradiance and temperature values. We compare the results of the Conventional P&O to the Modified P&O. For the comparison we have taken voltage ripple, current ripple, power ripple, and tracking efficiency as the parameters. The graphs and observations clearly showed that Modified P&O boosts the efficiency of the system.

KEYWORDS: PV cell, MPPT, P&O, Power controller, Solar energy, MATLAB/simulink.

I. INTRODUCTION

The suitable environment for solar panels is available in India because India receives good sunshine for over 300 days in a year. India launched its National Solar Mission in 2010 with a target of 20 GW for solar energy which further revises in 2015 to 100 GW by the end of 2022. In India various schemes are launched by the government to promote the use of solar panels like solar rooftop programme, solar parks, for farmers KUSUM scheme, etc.[1]

India is continuously increasing its solar capacity. As in just last 5.5 years the capacity increases from around 2.6 GW to more than 34 GW. India is now at the 5th position globally for overall installed renewable energy capacity.[1]

As the efficiency of solar panels is not much so to boost up it various MPPT algorithms are used with mechanical trackers [2]. In this paper P&O technique with modified algorithm is discussed, with its finding that it increases the efficiency of the PV tracking system by comparing it with the conventional P&O results.

II. MATHEMATICAL MODELING OF A PV CELL

A Photovoltaic (PV) cell transforms the incident solar radiations (or insolation) into electricity by a phenomenon called Photovoltaic effect. Several PV cells are joined together to get the desired power output. The semiconductor material is used for the manufacturing of solar cells. Solar cell's equivalent circuit model is shown in Figure 1. It consists of a current source, a diode connected in shunt and two resistors, resistor connected in series (Rs) and a resistor connected in shunt (Rsh), as it is shown in Figure 1. [3-14]

By using the Kirchoff's current law, that is KCL in the PV cell equivalent circuit, the PV cell generated current, that is Ip can be given as in Equation (1), [15]

$$Ip = Id + Ish + I \quad (1)$$

Where, I_P is Photo-generated current (A) and Id is Diode saturation current (A)

The current Ip is sum of the diode current (Id), the current through the shunt resistance Rsh and the terminal current, I.[16-17]

As the voltage across Rsh is equal to V + IR_S, the current through Rsh can be given by the Equation (2) [18].

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$$Ish = \left(\frac{(V + IRs)}{Rsh} \right) \tag{2}$$

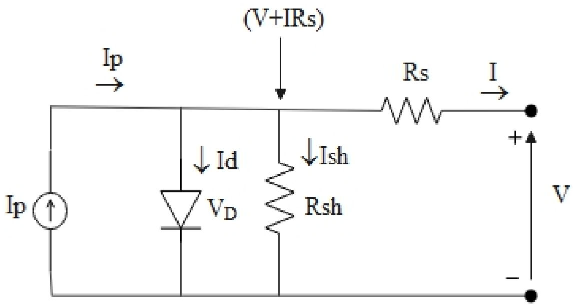

Figure 1: PV solar cell equivalent circuit

Where, [15]

$$I = Ip - Id - \left(\frac{(V + IRs)}{Rsh} \right) \tag{3}$$

From PN junction theory,

$$Id = NpI0\ (e^{(V+IRs)/nV_T} - 1) \tag{4}$$

So this is the current equation for the diode.

Where, I0 represents reverse saturation current of the diode, V_T is the voltage equivalent of temperature and n represents the diode ideality factor.

Equation (5) shows the characteristic curve of the PV module. [6], [9-10], [18-21]

$$I = Ip - I0\ (e^{\frac{(V+IRs)}{nV_T}} - 1) - \left(\frac{V + IRs}{Rsh} \right) \tag{5}$$

III. MPPT CONTROL TECHNIQUE

There are various MPPT algorithms provided in literature. As they are an essential part in the PV panel to get maximum power or maximum efficiency at any time. Let's discuss some of the MPPT algorithms one by one.

Conventional P&O method [4], [14], [22-26]

In conventional method the PV voltage output (V) and current output (I) are considered as the control inputs in the MPPT controller. The controller algorithm gives the control signal for the converter accordingly.

Lets understand how this method works. Let initially, the PV output voltage is increased by using the control signal for the converter. Then calculate the output power which is calculated by using V and I, then compare it with the previous power. At the start initial power is set at zero value.

If the power is increased then the algorithm is designed such that it continuously increasing the PV output voltage till the generated power starts decreasing. If the power starts decreasing then the voltage is reduced by the control signal to reach the MPP again.

If due to reduction in the output voltage value, the power is decreased from the previous iteration then the voltage is further increased to reach the MPP to generate maximum power.

The present power is matched up with the previous power and according to the P&O principle the algorithm works and reaches the maximum power point

.

Modified Algorithm P&O MPPT Flow chart

The P&O MPPT with Modified Algorithm is depicted as a flow chart in Figure 3. The present values of output voltage and current output of the PV system are measured and calculated the present power output that get from the PV system. Then the power difference is taken which is the difference of maximum theoretical power for the given conditions and the present power.

If the power difference is zero then the step size is no longer to change and operating point reach the maximum power point (MPP). If the error

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is not zero then by using the variable step sizes it performs the MPPT operation to fast reach the MPP and also reduce the steady state oscillation which is not desirable.

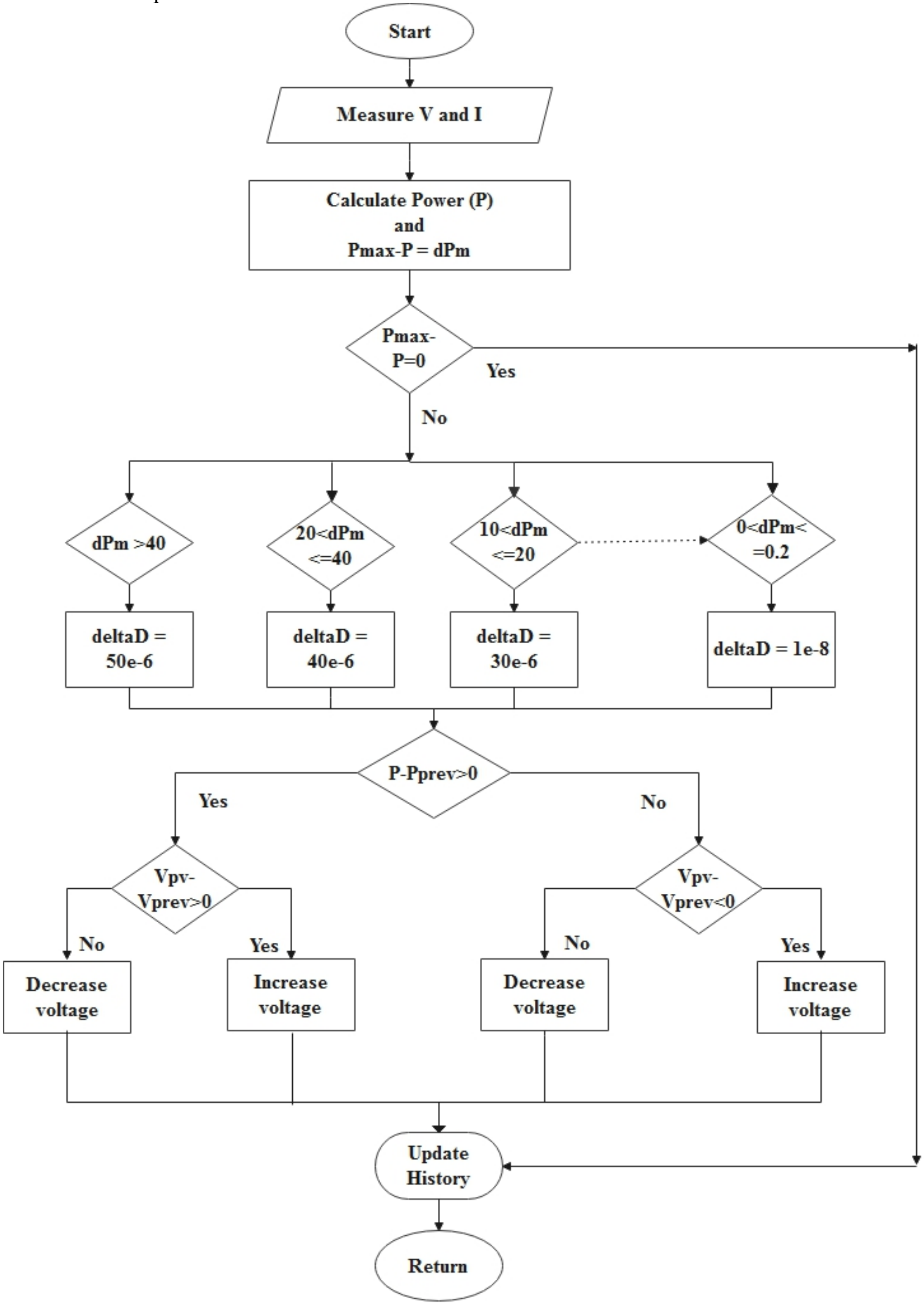

Figure 2: Modified P&O MPPT Algorithm Flow chart

IV. PV SIDE RESULTS

The input Solar irradiance profile, Ambient cell temperature profile, PV voltage output, PV current output and PV power output all are incorporated in the PV side results.

Figure 3 shows the Irradiance and temperature profile of the input data given to the PV array block in the MATLAB.

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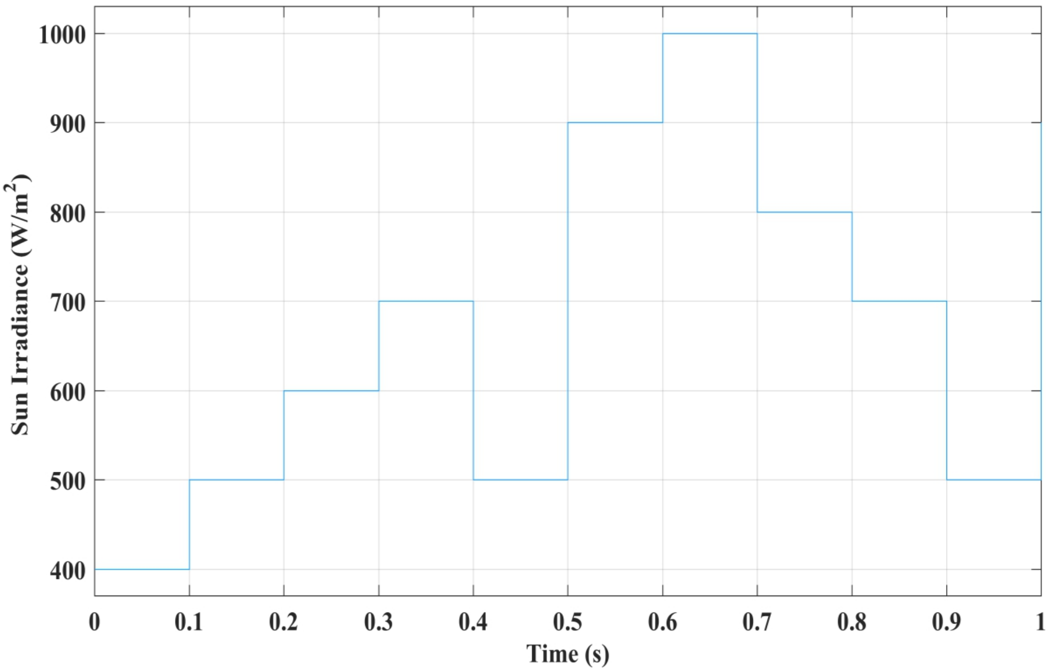

Figure 3.a: Profile for the Irradiance value in a step changed manner [16]

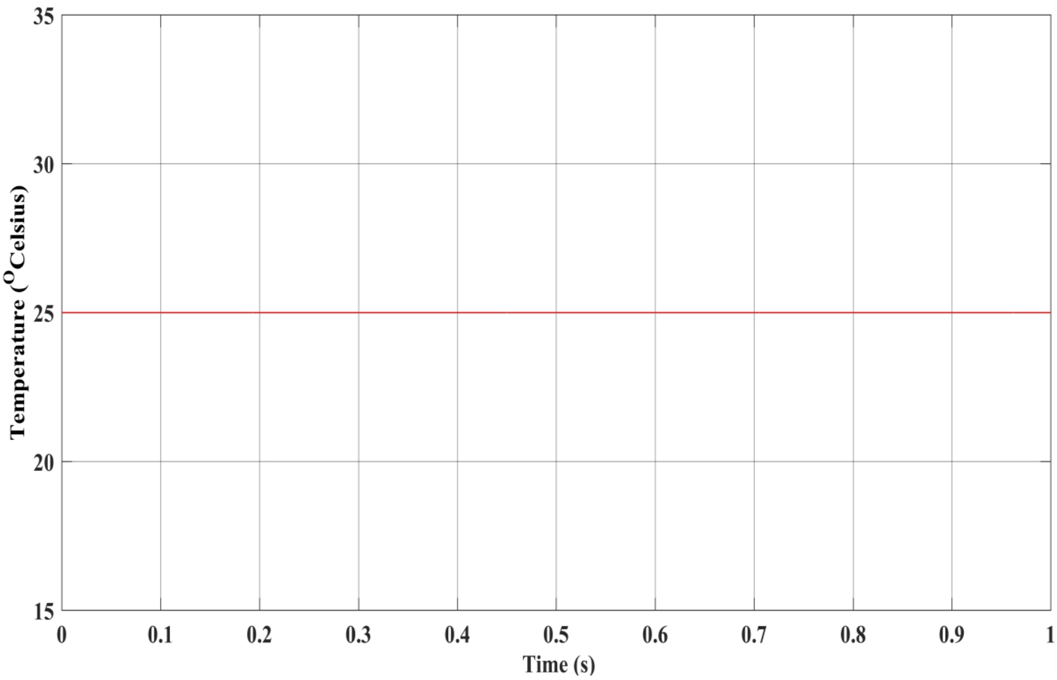

Figure 3.b: Constant Temperature profile (25 ºC)

Output voltage graph of the PV panel in case of Modified and Conventional MPPT with P&O technique is shown in Figure 5. We can easily see that the voltage ripple in steady state condition is highly reduced in Modified P&O algorithm.

Figure 6 shows the graph between the output current of the PV panel in case of Modified and Conventional P&O MPPT technique. We can easily see that in Modified P&O algorithm the current ripple in steady state condition is highly reduced.

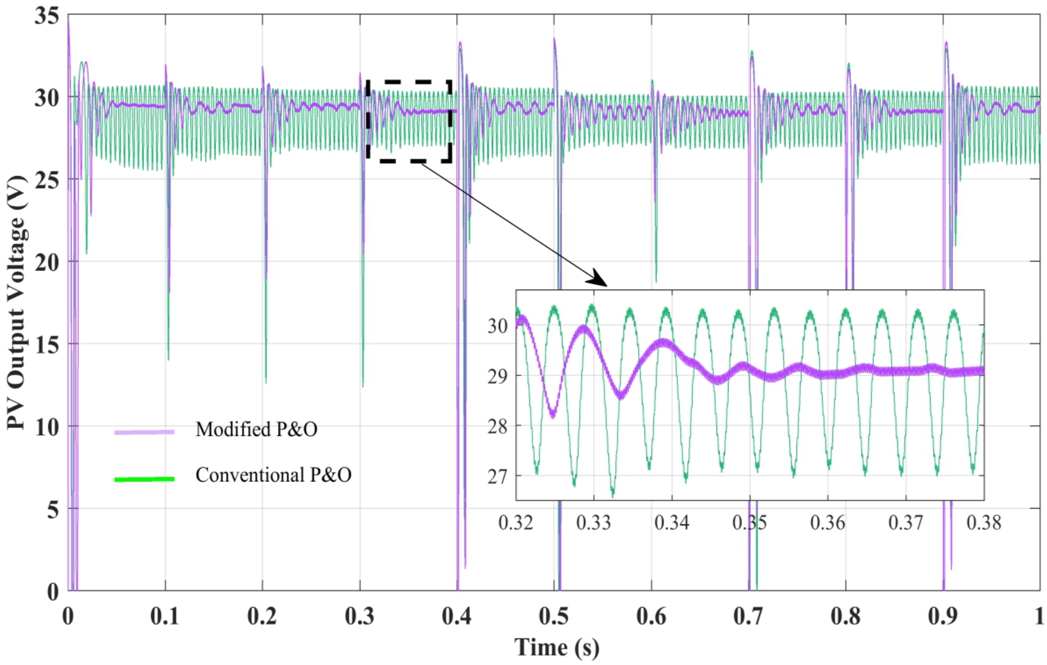

Figure 4: Graph of PV Output Voltage vs Time

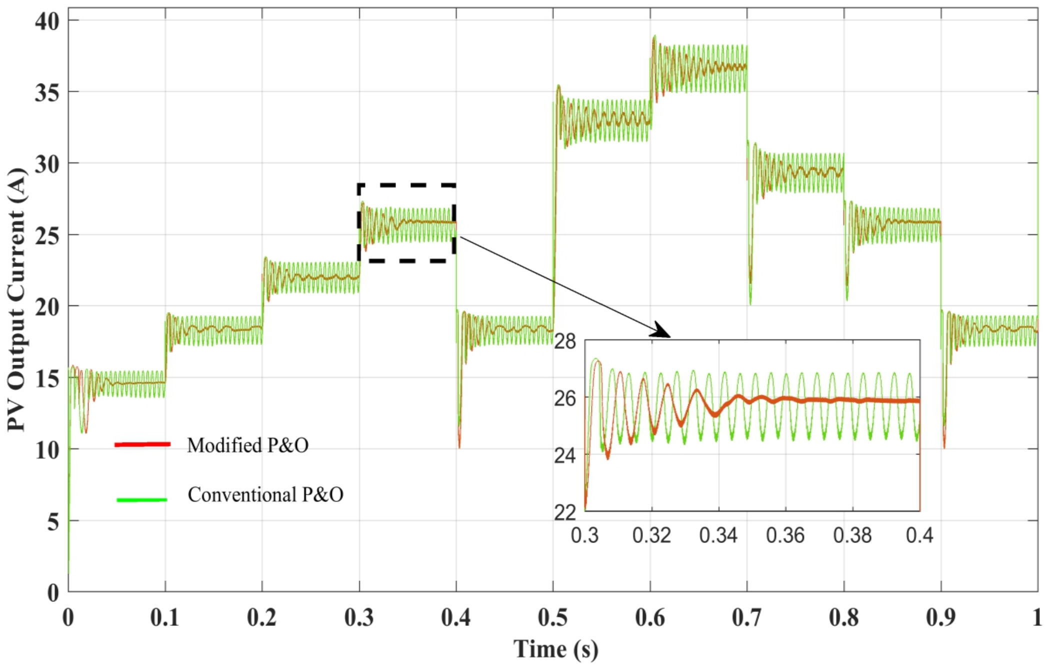

Figure 5: Graph of PV Output Current vs Time

The output power graph generated by the PV panel in case of Modified and Conventional technique is shown in Figure 6. It also incorporates the theoretical power calculated by using the system model.It is seen that the tracking of power is rapid following a change in the value of insolation and the steady state response is smooth in Modified algorithm as compared to the Conventional algorithm.

MPPT tracking efficiency defines the effectiveness of the Modified algorithm. How close the tracking power to the maximum power at any instant of time denotes the tracking efficiency. The following formula is used to compute the instantaneous MPPT tracking efficiency [2]:

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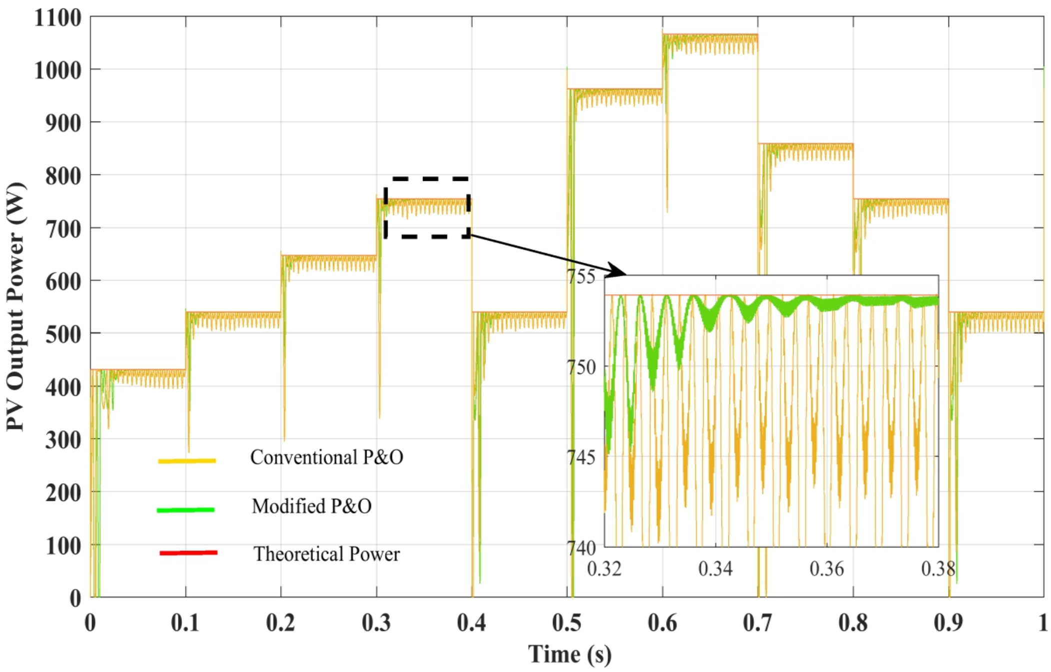

Figure 6: Graph of PV Output Power (W) vs Time

$$\eta_{MPPT} = \frac{P_{MPP}(t)}{P_{MPP*}(t)} X100 \quad (6)$$

The average tracking efficiency is given by [2],[16], [20], [27]

$$\eta_{MPPT(avg)} = \frac{\int P_{MPP}(t)dt}{\int P_{MPP*}(t)dt} X100 \quad (7)$$

In Equations (6) and (7), P_{MPP*} is the panel theoretical maximum power, which is try to reach by the MPPT algorithm. P_{MPP*} is calculated by using the PV system model. The P_{MPP} is actually the power which gets by utilising the MPPT. P_{MPP} is calculated by using the present values of V and I.

The graph between the tracking efficiency of PV panel in case of Modified and Conventional P&O MPPT technique by using the Equation (6) is given in Figure 7.

V. OBESERVATIONS FROM THE GRAPHS

From Table 1 we can observe that in Modified P&O algorithm the voltage ripple, current ripple and the power ripples are reduced as compared to the Conventional P&O MPPT algorithm.

Table 2 shows the average tracking efficiency which is calculated by using the Equation (7) in case of Modified and Conventional MPPT algorithm.

VI. CONCLUSION

In this paper, the variable change in voltage, that is ΔV MPPT algorithm is presented and simulated for isolated PV system. The various values of step sizes used are based on the error between the present extracted power to the theoretical maximum power the PV array can generate at the given input conditions. The modified algorithm is simple and provide higher efficiency, which is verified by comparing to the conventional method by using MATLAB/simulink R2016a software. The modified P&O algorithm boosts the tracking response.

The Modified P&O MPPT algorithm reduces the voltage ripples(peak-to-peak) from 3V to 0.5V, current ripples(peak-to-peak) from 2.5A to 0.5A, power ripples(peak-to-peak) from 15W to 1.5W and boosts the average tracking efficiency of the PV system from 97.51% to 98.73%, which increases the system overall efficiency.

Future scope

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The following points states the future scope of the research report:

1) The Modified MPPT technique with mechanical tracking can give additional overall efficiency, project may be extended in this direction.

2) By adding local area network module to the PV panel, we are able to record the input data, i.e. the irradiance and the temperature values within the system and optimize the information for better use.

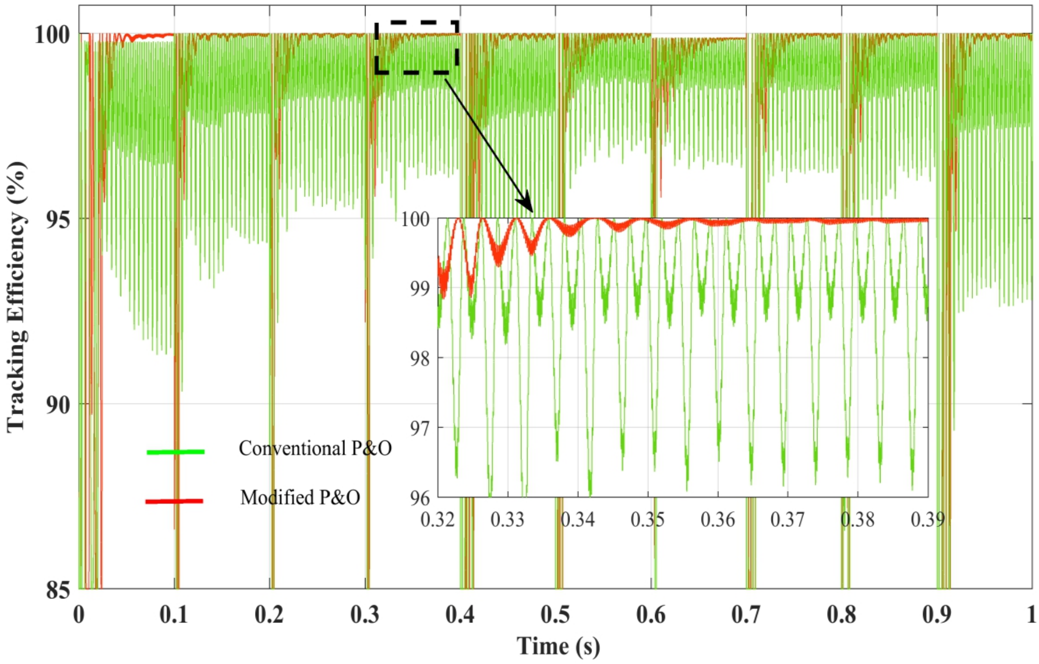

Figure 7: Graph of System tracking efficiency

Table 1: Conventional and Modified P&O MPPT algorithm comparison chart

MPPT Algorithm	Voltage Ripple (V) (Peak-to-peak)	Current Ripple (A) (Peak-to-peak)	Power Ripple (W) (Peak-to-peak)
Conventional P&O	3 V	2.5 A	15 W
Modified P&O	0.5 V	0.5 A	1.5 W

Table 2: Summary of MPPT Efficiency in Conventional and Modified MPPT Algorithms

MPPT Algorithm	Average Tracking Efficiency (%)
Conventional P&O	97.51%
Modified P&O	98.73%

REFERENCES

[1]. https://mnre.gov.in/

[2]. Jubaer Ahmed, and Zainal Salam, “An improved perturb and observe (P&O) maximum power point tracking (MPPT) algorithm for higher efficiency”, Applied Energy, vol. 150, pp. 97–108, 2015

[3]. F.Z. Hamidon et al., Photovoltaic Array Modelling with P&O MPPT Algorithm in MATLAB.

[4]. Muhammad Kamran et al., “Implementation of improved Perturb & Observe MPPT technique with confined search space for standalone photovoltaic system”, Journal of King Saud University – Engineering Sciences, vol. 32, pp. 432–441, 2020.

[5]. Ayman Alhejji, and Mohamed I. Mosaad, “Performance enhancement of grid-connected PV systems using adaptive reference PI controller”, Ain Shams Engineering Journal, vol. 12, pp. 541–554, 2021.

[6]. Abdelaziz Salah Saidi et al.,“A novel approach in stand-alone photovoltaic system using MPPT controllers & NNE”, Ain Shams Engineering Journal.

[7]. Jianpo Li, and Pengwei Dong, ”Global maximum power point tracking for solar power systems using the hybrid artificial fish swarm algorithm”, Global Energy Interconnection, vol. 2, no. 4, pp. 351-360, August 2019.

[8]. Hanane Yatimi et al., “Control of an Off-Grid PV System based on the Backstepping MPPT Controller”, Procedia Manufacturing, vol. 46, pp. 715–723, 2020.
[9]. Saad Motahhir et al.,“Photovoltaic system with quantitative comparative between an improved MPPT and existing INC and P&O methods under fast varying of solar irradiation”, Energy Reports, vol. 4, pp. 341–350, 2018.
[10]. Deepthi Pilakkat, and S. Kanthalakshmi, “Single phase PV system operating under Partially Shaded Conditions with ABC-PO as MPPT algorithm for grid connected applications”, Energy Reports, vol. 6, pp. 1910–1921, 2020.
[11]. Om Prakash Pahari and Bidyadhar Subudhi, “A New Approach to Suppress DC-link Voltage Oscillations for a Grid Connected Photovoltaic System”, International Federation of Automatic Control (IFAC), vol. 51, no.1, pp. 261–266, 2018.
[12]. H. Bounechba et al., “Comparison of perturb & observe and fuzzy logic in maximum power point tracker for PV systems”, Energy Procedia, vol. 50, pp. 677 – 684, 2014.
[13]. Abdelghani harrag, and Sabir Messalti, “IC-based Variable Step Size Neuro-Fuzzy MPPT Improving PV System Performances”, Energy Procedia, vol. 157, pp. 362–374, 2019.
[14]. Hanane Yatimi, and Elhassan Aroudam, “MPPT algorithms based modeling and control for photovoltaic system under variable climatic conditions”, Procedia Manufacturing, vol. 22, pp. 757-764, 2018.
[15]. Bharathy Priya D, and A.Sumathi, “Modeling and Simulation of Solar PV Energy Conversion Systems”, International Journal of Engineering and Advanced Technology (IJEAT), vol.8, Issue-6S3, September 2019.
[16]. Ahmed I.M. Ali et al., “Modified efficient perturb and observe maximum power point tracking technique for grid-tied PV system”, Electrical Power and Energy Systems, vol. 99, pp. 192–202, 2018.
[17]. Aranzazu D. Martin, and Jesus R. Vazquez, “MPPT Algorithms Comparison in PV Systems P&O, PI, Neuro-Fuzzy and Backstepping Controls”, IEEE, 2015.
[18]. Hyeon-Seok Lee, and Jae-Jung Yun, “Advanced MPPT Algorithm for Distributed Photovoltaic Systems”, Energies, 2019.
[19]. Marcelo G. Villalva, and Ernesto Ruppert F., “Analysis and Simulation of the P&O MPPT Algorithm Using a Linearized PV Array Model”, IEEE, 2019.
[20]. Muralidhar Nayak Bhukya, and Venkata Reddy Kota, “A quick and effective MPPT scheme for solar power generation during dynamic weather and partial shaded conditions”, Engineering Science and Technology, vol. 22, pp. 869–884, 2019.
[21]. Abdelhakim Belkaid et al., “Implementation of a modified P&O-MPPT algorithm adapted for varying solar radiation conditions”, Springer, September 2017.
[22]. Murari Lal Azad et al., “P&O algorithm based MPPT technique for solar PV System under different weather conditions”, International Conference on circuits Power and Computing Technologies [ICCPCT], 2017.
[23]. Mostafa R. Mostafa et al., “Tracking the maximum power point of PV array by sliding mode control method”, Ain Shams Engineering Journal, vol. 11, pp. 119–131, 2020.
[24]. Mohammed A. Elgendy et al., “Operating Characteristics of the P&O Algorithm at High Perturbation Frequencies for Standalone PV Systems”, IEEE Transactions on energy conversion, vol. 30, no. 1, March 2015.
[25]. Yong Yang, and FangPing Zhao, “Adaptive perturb and observe MPPT technique for Grid-connected Photovoltaic Inverters”, Procedia Engineering, vol. 23, pp. 468-473, 2011.
[26]. Atul Manmohan et al., “Up and Down Conversion of Photons with modified Perturb and Observe MPPT technique for Efficient Solar Energy Generation”, Energy Procedia, vol. 117, pp. 786–793, 2017.
[27]. Hafsa ABOUADANE et al., “Performance of a new MPPT method for Photovoltaic systems under dynamic solar irradiation profiles“, Energy Procedia, vol. 142, pp. 538–544, 2017.