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Maximum Power Point Tracking Charge Controller Using Petrub And Observe Technique

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ABSTRACT: Solar cells convert sun light into electricity, but have the major drawbacks of high initial cost, low photo-conversion efficiency and intermittency. The current-voltage characteristics of the solar cells depend on solar insolation level and temperature, which lead to the variation of the maximum power point (MPP). Herein, to improve photovoltaic (PV) system efficiency, and increase the lifetime of the battery, a microcontroller-based battery charge controller with maximum power point tracker (MPPT) is designed for harvesting the maximum power available from the PV system under given insolation and temperature conditions. Among different MPPT techniques, perturb and observe (P&O) technique gives excellent results and thus is used. This work involves the design of MPPT charge controller using DC/DC buck converter and microcontroller. A prototype MPPT charge controller is tested with a 200 W PV panel and lead acid battery. The results show that the designed MPPT controller improves the efficiency of the PV panel when compared to conventional charge controllers.

I. INTRODUCTION

The usage of modern efficient photovoltaic solar cells (PVSCs) has featured as a masterminding alternative of energy conservation, renewable power and demand-side management. Due to their initial high expensive, PVSCs have not yet been an exactly a tempting alternative for electrical usage who are able to purchase less expensive electrical energy from the utility grid. However, they have been used widely for air conditioning in remote , water pumping and isolated or remote areas where utility power is not available or is high costly to transport. Although PVSC prices have decreased considerably during the last years due to new developments in the film technology and manufacturing process. The harnessing of solar energy using PV modules comes with its own problems that arise from the change in insulation conditions. Those changes in insulation conditions strongly influence the efficiency and output power of the PV modules. A great deal of research has been accomplished to improve the efficiency of the photovoltaic system. Several methods to track the maximum power point of a PV module have been suggested to solve the problem of efficiency and products using these methods have been made and now commercially available for consumers.

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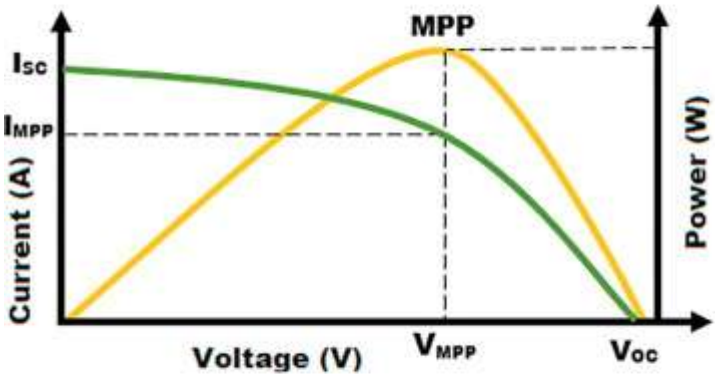

Fig. 1. I-V and P-V characteristics of solar PV cell.

This paper proposes a bound hunt space based improved P&O calculation coordinated with a sun powered tracker. Sunlight based tracker ensures the most extreme coupling of the irradiance with the sun oriented board by keeping the board consistently ordinary to the sun. The proposed calculation first partitions the force bend into three districts: Area 1 and region 3 are the left and right locales to the MPP separately. Region 2 is the moderate district of the force bend containing 10% space of the force bend and MPP lies in this space 2. This decrease in the pursuit space lessens the progression reaction time to arrive at the most extreme force and the consistent state motions at the greatest force point.

II. METHODOLOGY

2.1. Modeling of photovoltaic cell

The sun based photovoltaic cell is created of the semiconductor materials with back side positive and sun confronting side as negative. At whatever point the daylight falls on the PV materials, it creates electrons streaming in the outer circuit known as photocurrent (Meskani et al., 2015) or cut off and is determined by condition (I). In demonstrating of the PV cell, it is demonstrated by a current source as demonstrated in Fig. 2. There seems a voltage at the yield terminal in the event that it is open circuited and called open circuit voltage (Voc) determined by condition (ii). This voltage causes a current through the P-N intersection very much like a diode. This diode and the current source (Iph) are placed in equal as portrayed in Fig. 2. As the photograph created current beginnings streaming, a portion of the electron-opening recombination happens that diminishes the initially produced electrons; this deficiency of current is introduced by a shunt obstruction (Rsh). Arrangement obstruction (Rs) shows the opposition looked by the current as it moves through the mass material, outer metal contacts and to the heap. Makers consistently figure out how to keep the impacts of both these protections as low as conceivable to improve the working of the PV module. Fig. 2 demonstrates the single diode model of the sun based photovoltaic cell

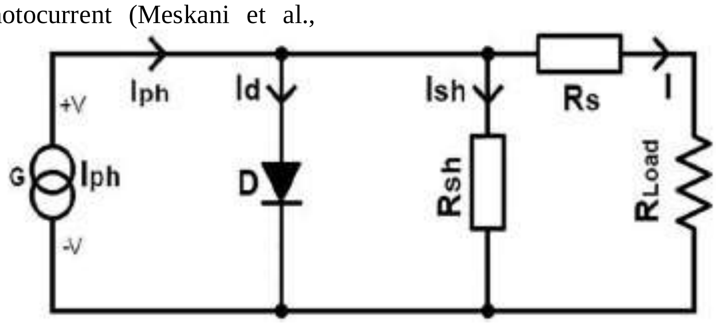

Fig. 2. Single diode model of solar PV cell.

The photocurrent, otherwise called cut off is produced when the sun based beams strike the sun powered module and is determined by Eq. (1)(1)Isc=G1000 [Iscr+Ki(Tc-Tr)] where G sun oriented irradiance, Isc photocurrent, Iscr turn around immersion current, Ki temperature coefficient, Tc cell temperature, Tr reference temperature.

The open circuit voltage as created at the yield of the single diode model of the sunlight based photovoltaic cell is determined by Eq. (2)Voc=lnIscIo+1nkTcqwhere Voc open circuit voltage, Isc photograph current, I0 immersion current, n ideality factor, k Boltzmann consistent, Tc cell temperature, q Electron charge Eq. (3) gives the connection between the voltage and current of the sun powered cell.(3)I=IsexpqVkT-1-Iphwhere Is immersion current, q Electron charge, V voltage across the diode, k Boltzman steady, T outright temperature (K), Iph light produced current

Test confirmation of the proposed calculation was approved on a low voltage sun based module. Particulars of sun powered module TTB12W are introduced in Table 1. The sun powered module gives 12 W VMPP 17.8 V and IMPP 0.68A at standard test conditions (250C and 1 kW/m2). Fig. 3 shows the attributes bends of the module utilized in the test arrangement. Attributes bend of the PV module specifies an unmistakable point where the module gives most extreme force and most elevated effectiveness as demonstrated in Fig. 1; this greatest force point is consistently inclined to two significant components: sun oriented irradiance and the temperature. It is important to keep the sun based module vertical to the sun for most extreme sun powered coupling. Fig. 4 shows the impact of fluctuating sun based irradiance on the P-V bend of the sunlight based board.

Table 1. Specification of solar module TTB12W.

Characteristic	Value
Rated Power (P_{max})	12 W
Tolerance	0 ± 3%
Voltage Maximum Power (V_{max})	17.8 V
current at Maximum power (I_{max})	0.68A
voltage at Open circuit (V_{OC})	21.6 V
Photo Current (I_{SC})	0.81A

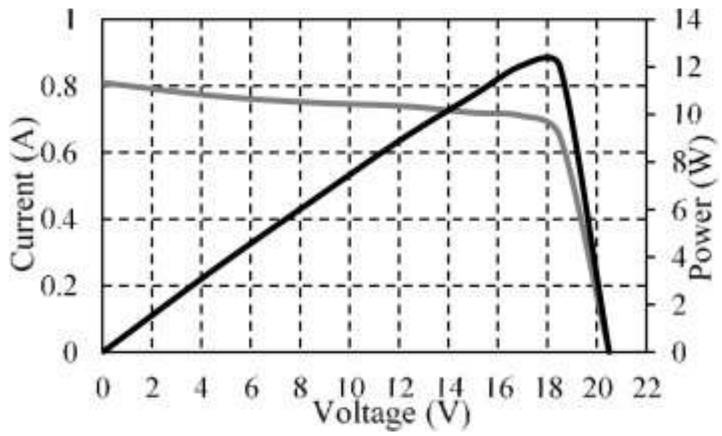

Fig. 3. Characteristic curves of the TTB12W solar module.

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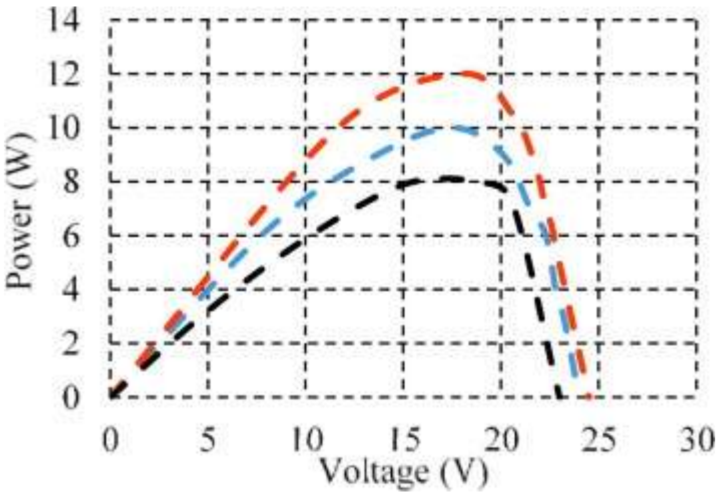

Fig. 4. PV curves under varying solar irradiance.

2.2. Solar tracker

The sun powered beams acquired by the sun oriented module subject to a constant variety. A sun powered tracker is utilized to follow the sun to upgrade the sunlight based irradiance coupling. In PV frameworks, PV modules are mounted on sun powered trackers so PV modules are constantly coordinated ordinary toward the sun. As the sun goes from east to west for the duration of the day, the sun oriented trackers ensure the steady and most extreme creation of power that equally charges the batteries and subsequently expands their lifetime. In indoor lighting frameworks, sun based trackers are accustomed to centering the daylight at Fresnel focal point's central length to be gathered by the optical fiber. In the proposed close planetary system, the twin hub tracker is executed that tracks the sun and creates greatest power. In the carried out sun based tracker, light sensors were utilized to gauge the light force. An obscure deterrent was put between those light sensors to stay away from the light coming from different bearings to precisely and rapidly track the sun.

Light Dependent Resistors (LDRs) were utilized as light sensors: Two for the East-West and two for the North-South direction. Light power was estimated by utilizing a resistor in arrangement with each LDR making a voltage partitioning circuit as demonstrated in Fig. 6. At whatever point the power of light on LDR changes, its obstruction and subsequently the yield voltage are changed; change in force is converted into an adjustment of voltage. Tracker under the shadow and in a following mode is appeared in Fig. 5. Under the accompanying four conditions, tracker chooses the heading to be moved.

- If light intensity on both LDRs is same, it means their resistance would be equal (RE=RW) and hence the same voltage to the controller; solar tracker will maintain its present position.
- If intensity on LDR_E is larger than intensity on LDR_W, the resistance of LDR_E will be lower than the resistance of LDR_W resulting in VE>VW; solar tracker will move toward the east.
- If intensity on LDR_W is larger than intensity on LDR_E, the resistance of LDR_W will be lower than the resistance of LDR_E resulting in VW>VE; solar tracker will move toward the west.

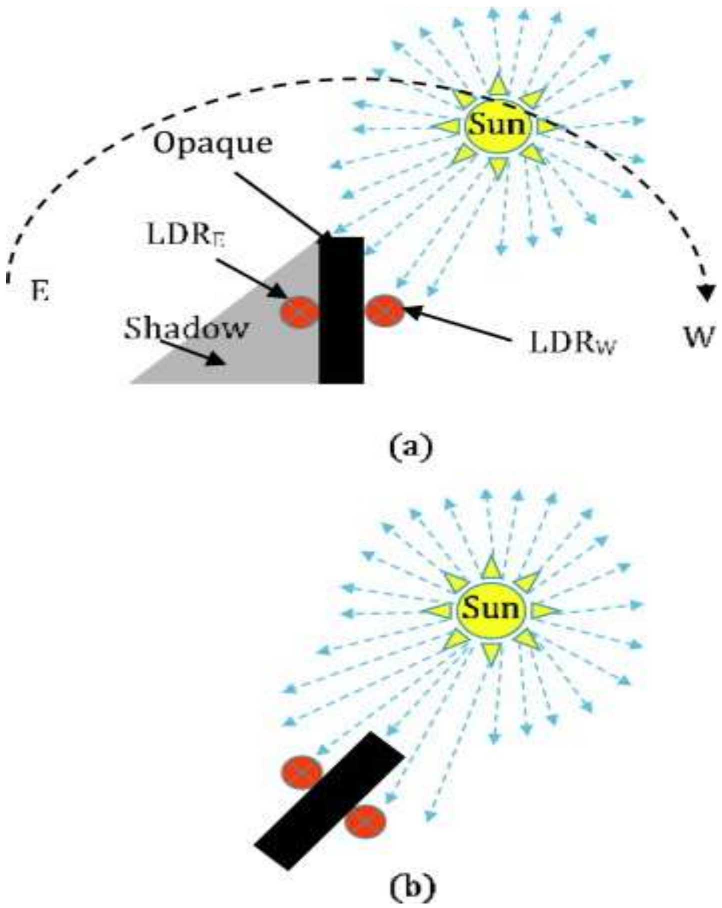

Fig. 5. (a) Solar tracker in shadow mode. (b) Solar tracker in tracking mode.

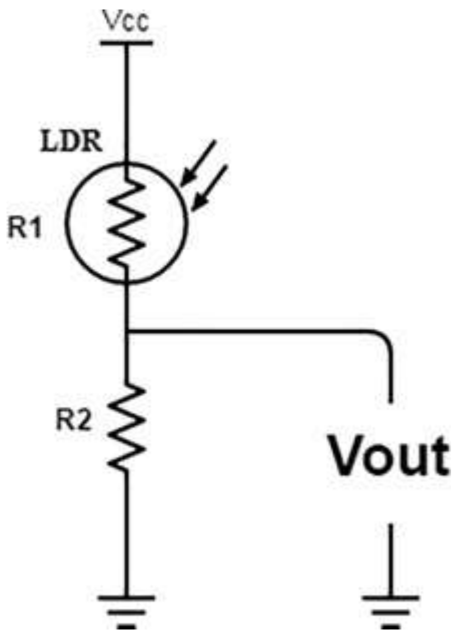

Fig. 6. Light intensity measurement by LDR.

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In view of the above-expressed conditions, sun oriented tracker flowchart is appeared in Fig. 7. The light power of east and west LDRs are looked at and as needs be choice is made whether to move the board east or west way. After appropriate direction the east–west way, south-north direction is checked and executed. Each time the situation of the sun is changed; the regulator rehashes a similar flowchart calculation and arranges the board the sun's way

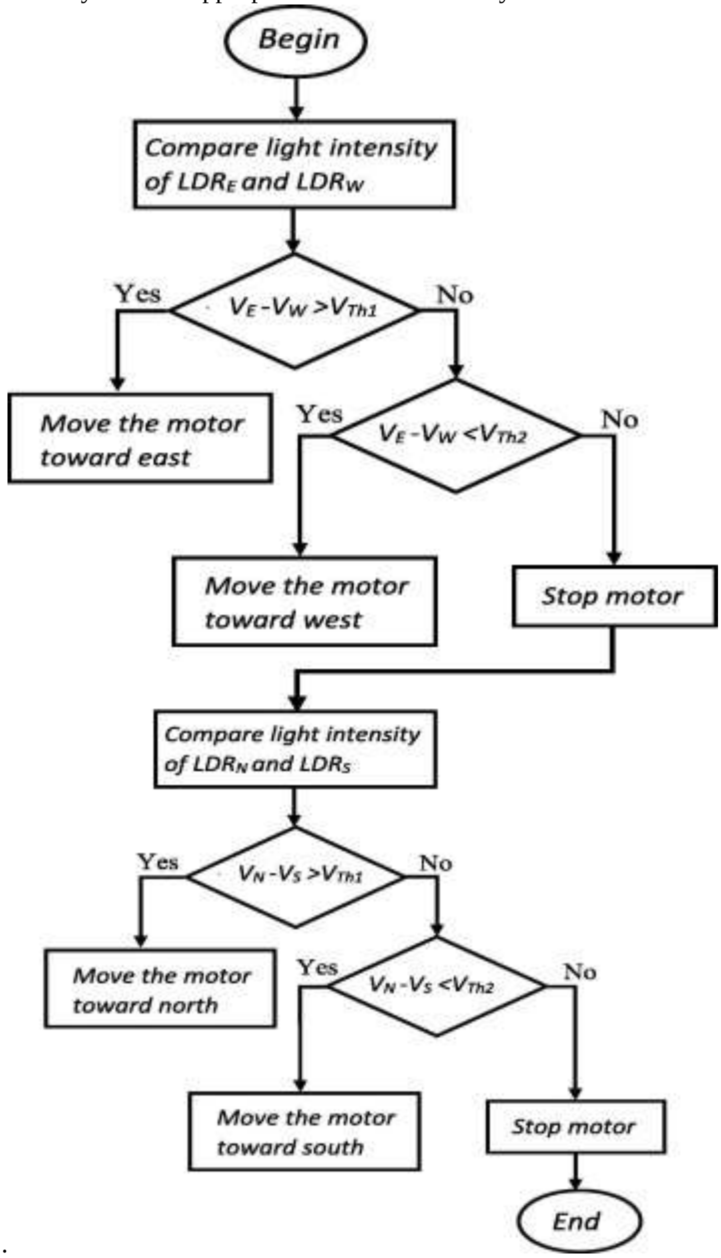

Fig. 7. Flowchart of dual axis solar tracker.

2.3. Conventional P&O algorithm

Conventional Perturb & Observe algorithm has been extensively used due to ease of implementation as explained in the flowchart in Fig. 8. This is a continuous process of observation and perturbation till the operating point converges at the MPP. The algorithm compares the power and voltages of time (K) with the sample at a time (K-1) and predicts the time to approach to MPP. A small voltage perturbation changes the power of the solar panel if the power alteration is positive, voltage perturbation is continued in the same track. But if delta power is negative, it indicates that the MPP is far away and the perturbation is decreased to reach the MPP. Table 2 shows the summary of the P&O algorithm. Thus,

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in this way the whole PV curve is checked by small perturbations to find the MPP that increases the response time of the algorithm. Conversely, if the perturbation size is enlarged, it generates steady state oscillations about the MPP. Many researchers have proposed modifications in the P&O algorithm to overcome the response time problem and steady state oscillations.

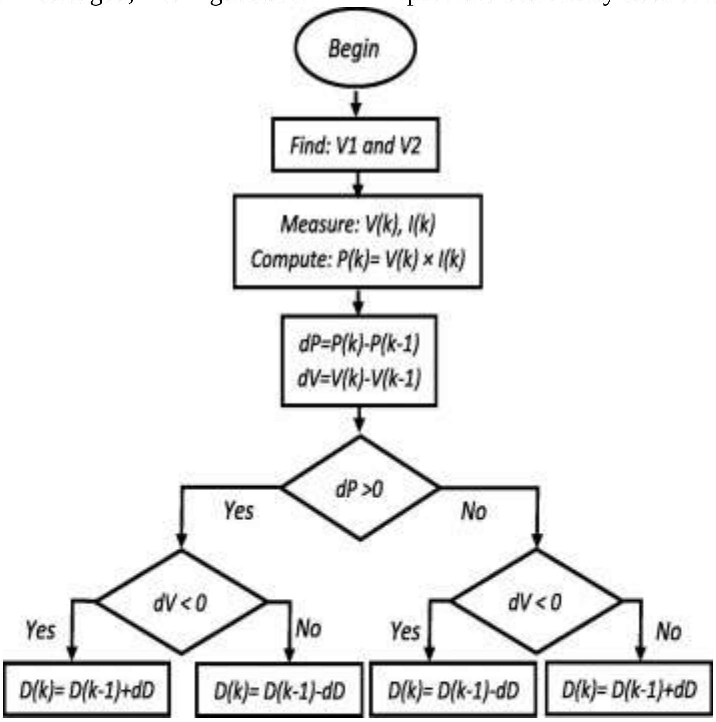

Fig. 8. Conventional flowchart of the P&O algorithm.

Table 2. Scheme of the P&O algorithm.

Perturbation	Delta P	Resulting Perturbation
+ve	+ve	+ve
+ve	−ve	−ve
−ve	+ve	−ve
−ve	−ve	+ve

2.4. Modified P&O algorithm

The issues faced in the regular calculation as distinguished above can be dispensed with by the proposed changes. The proposed calculation restricts the pursuit space to just 10% space of the force bend that diminishes the reaction time as well as decreases the consistent state motions. Enslin et al., 1997, Huynh and Dunnigan, 2016 states that the VMPP is about 76% of the open circuit voltage (VMPP = 76% of VOC). In this way, the P-V bend has been isolated into three areas named Area1, Area 2, and Area 3 as demonstrated in Fig. 10.

Details of every one of these spaces are given in Table 3. Area1 and region 3 contain 90% space of the force bend that has been barred from the inquiry space. Region 2 is the MPP containing district confining to just 10% of the PV bend and improved calculation needs to look through the most extreme force point just in region 2 that lessens the progression reaction season of the calculation and wipes out the consistent state motions about the MPP.

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Table 3. Area distribution of power curve.

	Starting (% of Voc)	Ending (% of Voc)	Total area (% of Voc)
Area 1	0	70	70
Area 2	70	80	10
Area 3	80	100	20

Flowchart of the adjusted bound pursuit separated Perturb and Observe calculation is appeared in Fig. 9. It first estimates the voltages V1 and V2 to discover the MPP containing district to limit the working place of the sun oriented board into region 2 areas which is just 10% of the force bend and afterward begins bother and perception. In couple of irritations, MPP is accomplished and kept up. Under uniform climate conditions, it adheres to the most extreme force point while as the irradiance transforms it discovers new neighborhood maxima similarly as depicted for the steady irradiance and afterward looks after it.

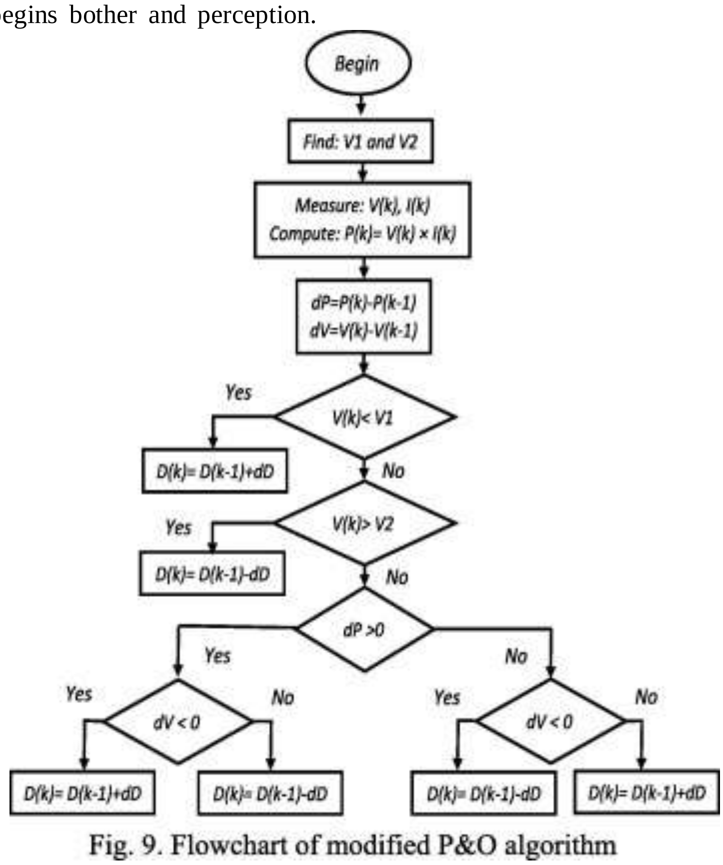

Fig. 9. Flowchart of modified P&O algorithm.

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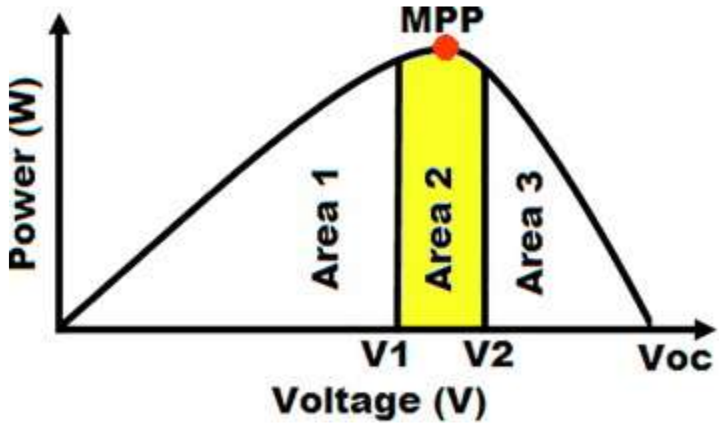

Fig. 10. Search space limitation of the power curve.

III. RESULTS AND DISCUSSION

3.1. Simulation results

To validate the sanctioning of the suggested calculation, a MATLAB/Simulink model was created as portrayed in Fig. 11. PV module mimicked in this examination depended on the trademark conditions of the sun based cell as clarified in Section 2. The MPPT calculation was executed by utilizing coding of the flowchart that made it straightforward and carry out the changes in the regular calculation. The IGBT based DC-DC help converter was constrained by the door signal which was chosen by the proposed P&O calculation. The exchanging recurrence of the entryway signal was 30 kHz and the lift converter comprised of 23 µH of the inductor and 120 µF of the capacitor.

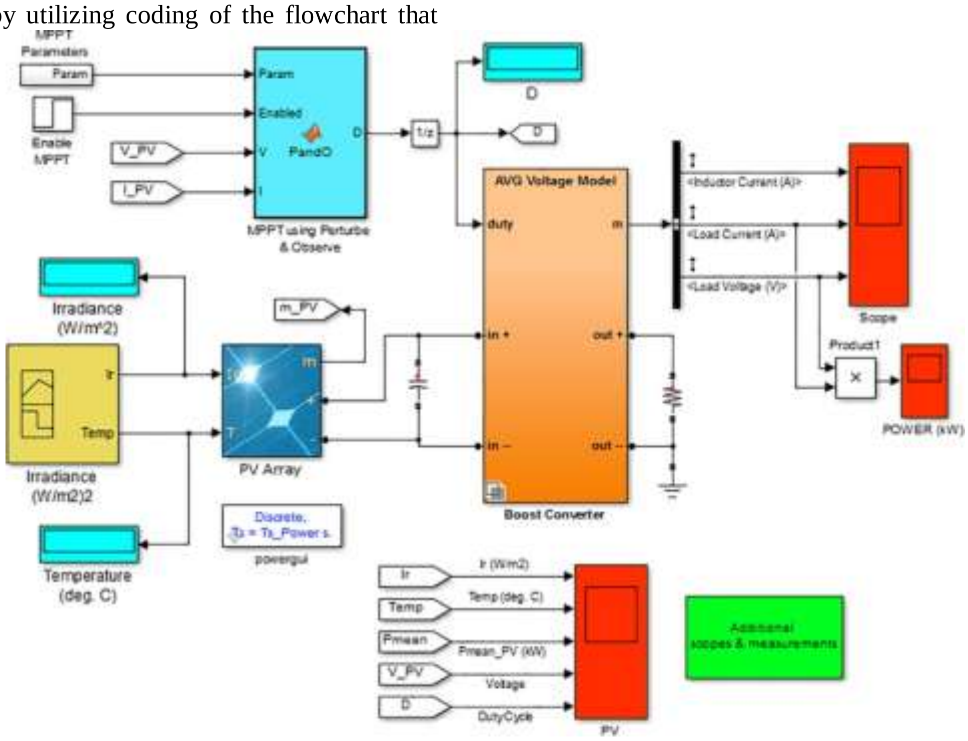

Fig. 11. Simulation model of the whole system.

The following daily practice of the traditional and the proposed bother and notice MPPT calculation in steady sun oriented irradiance can be broke down by Figs. 12 and 13 individually. The regular P&O created such countless motions at the greatest force point with such a sufficiency that it might lose the locus point under changing barometrical conditions. In the proposed P&O calculation, it followed the most extreme force point with the end of the consistent state motions about the MPP giving a smooth PV yield as demonstrated in Fig. 13. The amplified perspective

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on the force of both the calculations is likewise appeared.

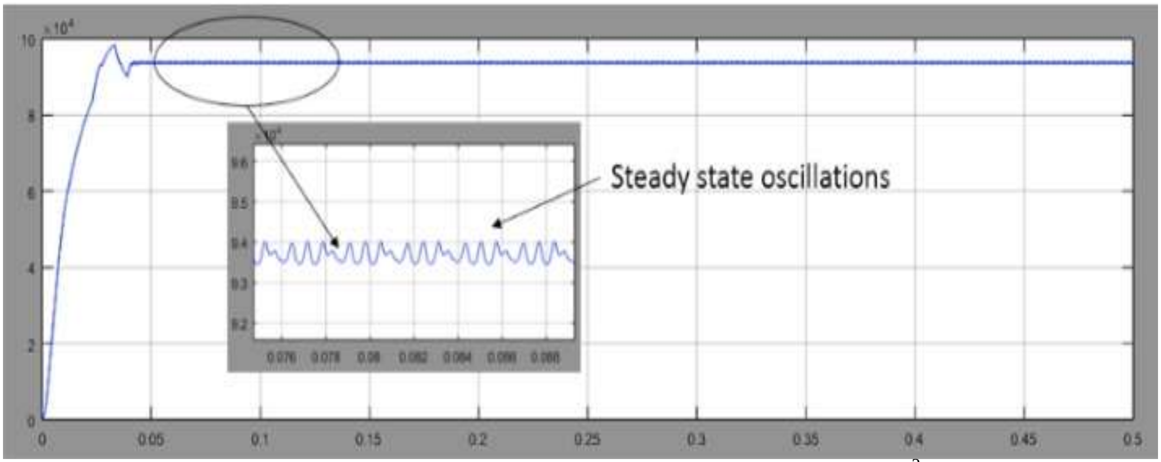

Fig. 12. PV power for conventional P&O algorithm under STC (1000 W/m^2 and 25 °C).

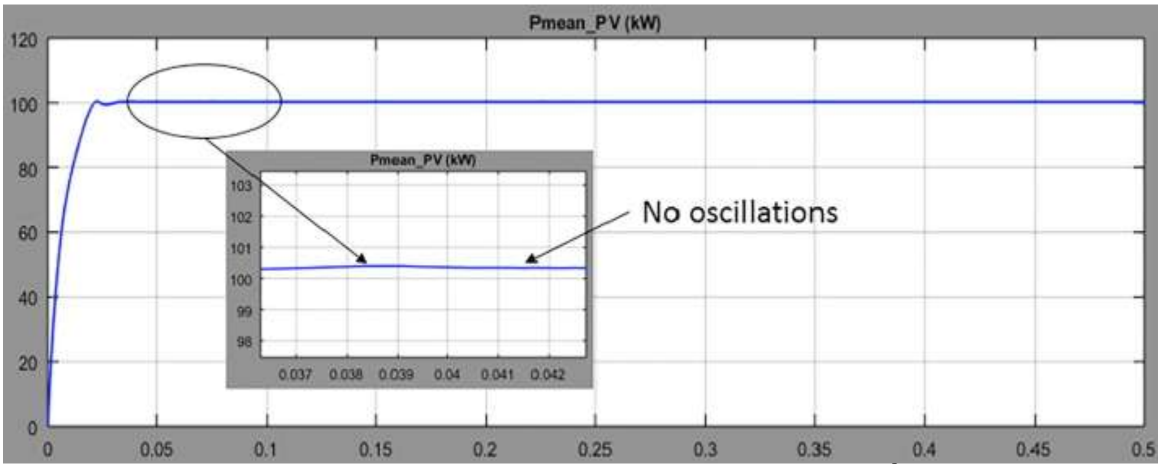

Fig. 13. PV power for proposed P&O algorithm under STC (1000 W/m^2 and 25 °C).

To confirm the enactment of the proposed Perturb and Observe algorithm, it was simulated under varying atmospheric conditions like irradiance and temperature. Fig. 14 shows the outputs under fluctuating solar irradiance and temperature. Solar irradiance was varied from 1 kW/m^2 to 0.25 kW/m^2 in various stages and the temperature was varied from 0 °C to 50 °C. Power, voltage and duty cycle profile exhibited the same pattern as the irradiance profile. Reduction in oscillations as the irradiance changed can be viewed in the power profile. A sudden variation in temperature created disturbance in the power and voltage profile. Duty cycle abruptly decreased as the irradiance and PV cell temperature increased. The results established the fact that under uniform atmospheric conditions all the algorithms tracked the MPP accurately but the conventional algorithm carried the problem of steady-state oscillations under abruptly changing weather conditions. The proposed algorithm accurately tracked the MPP under both uniform and varying atmospheric situations without any steady state oscillation at the maximum power point. A comparison of the proposed confined search spaced P&O algorithm with the conventional MPPT techniques.

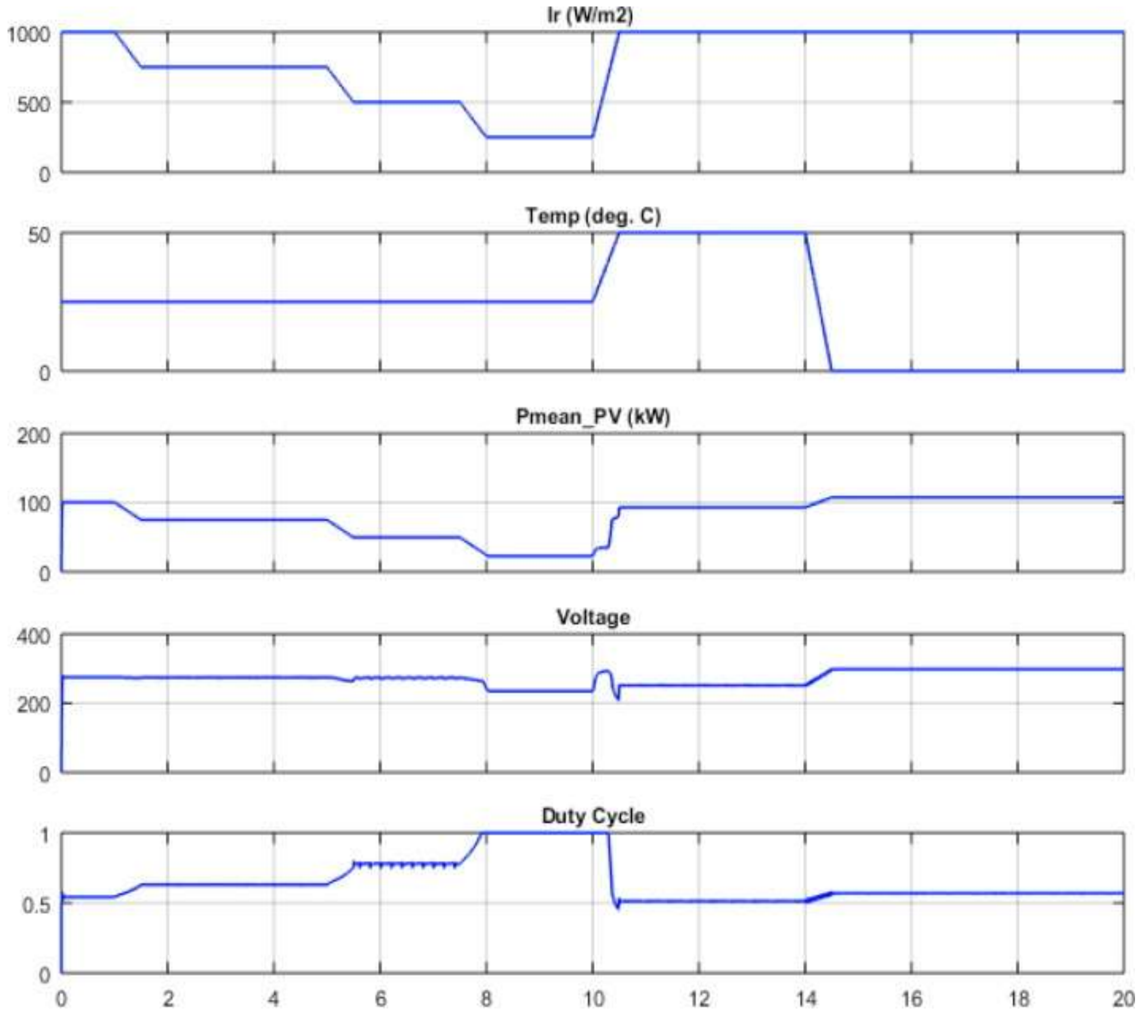

Fig. 14. PV Power, voltage and duty cycle under varying atmospheric weather conditions.

IV.

V. CONCLUSIONS

Sun oriented photovoltaic innovation has been embraced by different worldwide PV markets with 227 GW aggregate universally introduced PV limit in 2015 supplanting the traditional petroleum product energy assets. Nonetheless, productivity and adapted yield power is as yet a major test for analysts and PV industry. Force improvement procedure assumes a dynamic part in the presentation of the sun oriented photovoltaic frameworks. This technique is the mix of the sun based tracker and the MPPT to outfit the greatest sunlight based force as it travels through the sky from east to west in an entire day. Double hub sun powered tracker ensures the most extreme coupling of the sun with the sun oriented module that augments the sunlight based usefulness. The proposed Perturb and Observe calculation is the change in the regular calculation that limits the pursuit space of the calculation lessening the intricacy and improving the exhibition of the ordinary calculation under uniform and differing climate conditions. Evacuation of the consistent state motions about most extreme force point and decrease in sync reaction confirmed the upgrades in the traditional Perturb and Observe calculation for independent sun based photovoltaic frameworks.

REFERENCES

[1]. Seyedmahmoudian, M.; Horan, B.; Soon, T. Kok; Rahmani, R.; Than Oo, A. Muang; Mekhilef, S.; Stojcevski, A. (2016-10-01). "State of the art artificial intelligence-based MPPT techniques for mitigating partial shading effects on PV systems – A review". Renewable and Sustainable Energy Reviews. **64**: 435–455. doi:10.1016/j.rser.2016.06.053.

[2]. Seyedmahmoudian, Mehdi; Horan, Ben; Rahmani, Rasoul; MaungThanOo, Aman; Stojcevski, Alex (2016-03-02). "Efficient Photovoltaic System Maximum Power Point Tracking Using a New Technique". Energies. **9** (3): 147. doi:10.3390/en9030147.
[3]. "What is Maximum Power Point Tracking (MPPT)".
[4]. Ali, Ali Nasr Allah; Saied, Mohamed H.; Mostafa, M. Z.; Abdel- Moneim, T. M. (2012). "A survey of maximum PPT techniques of PV systems". A Survey of Maximum PPT technique of PV Systems - IEEE Xplore. pp. 1–17. doi:10.1109/EnergyTech.2012.6304652. ISBN 978-1-4673-1835-8. S2CID 10207856.
[5]. Seyedmahmoudian, M.; Rahmani, R.; Mekhilef, S.; MaungThanOo, A.; Stojcevski, A.; Soon, TeyKok; Ghandhari, A. S. (2015-07-01). "Simulation and Hardware Implementation of New Maximum Power Point Tracking Technique for Partially Shaded PV System Using Hybrid DEPSO Method". IEEE Transactions on Sustainable Energy. **6** (3):850862. Bibcode:2015ITSE....6..850S. doi:10.1109/TSTE.2015.2413359. ISSN 1949-3029. S2CID 34245477.
[6]. Jump up to:[a b] Seyedmahmoudian, Mohammadmehdi; Mohamadi, Arash; Kumary, Swarna (2014). "A Comparative Study on Procedure and State of the Art of Conventional Maximum Power Point Tracking Techniques for Photovoltaic System". International Journal of Computer and Electrical Engineering. **6** (5): 402–414. doi:10.17706/ijcee.2014.v6.859.
[7]. Seyedmahmoudian, Mohammadmehdi; Mekhilef, Saad; Rahmani, Rasoul; Yusof, Rubiyah; Renani, EhsanTaslimi (2013-01-04). "Analytical Modeling of Partially Shaded Photovoltaic Systems". Energies. **6** (1): 128–144. doi:10.3390/en6010128.
[8]. Surawdhaniwar, Sonali; Diwan, Ritesh (July 2012). "Study of Maximum Power Point Tracking Using Perturb and Observe Method". International Journal of Advanced Research in Computer Engineering & Technology. **1** (5): 106–110.
[9]. Seyedmahmoudian, Mohammadmehdi; Mekhilef, Saad; Rahmani, Rasoul; Yusof, Rubiyah; Shojaei, Ali Asghar (2014-03-01). "Maximum power point tracking of partial shaded photovoltaic array using an evolutionary algorithm: A particle swarm optimization technique". Journal of Renewable and Sustainable Energy. **6** (2): 023102. doi:10.1063/1.4868025. hdl:1959.3/440382. ISSN 1941-7012.
[10]. "University of Chicago GEOS24705 Solar Photovoltaics EJM May 2011" .