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Research Paper

Design and Performance of P&O and PSO Methods based MPPT Algorithms for Photovoltaic System

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ABSTRACT
MPPT is a photovoltaic inverter algorithm used to adjust the impedance perceived by the solar array continuously to maintain the PV system at or close to its peak power point, like changing solar irradiances, temperature and load. This is the only solution that allows PV in a photovoltaic system to operate at different times. This paper presents a comparative performance between P&O and PSO techniques based MPPT algorithms for photovoltaic system. The proposed PSO tracking technique will be compared with the P&O technique in the MATLAB/SIMULINK. The simulation results shows the stability of maximum peak point without oscillations with in less time to stable.
KEYWORDS: *MPPT, P&O, PSO, PV System, Stability.*

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I. INTRODUCTION

The electronic DC to DC converter is the maximum power point tracker, which optimizes the match between the solar panels, and battery bank or utilities grid. In simple terms, the solar panels (and a few wind generators) convert higher voltage DC power into the battery-charging voltage needed. In fact, every MPPT has its own advantage and disadvantage, therefore, every MPPT is so numerous.
However, the most common problem with each MPPT is
1) high transient time
2) steady state oscillation is high
3) less tracking efficiency

All MPPT techniques are always affected by the trade- off between all of these three problems. Some are one or more full- filled, but not all three. Therefore, any other option to improve on all of these three problems must pragmatically be searched, then Hybrid MPPT was found. Actually I tell you the exact meaning of hybrid MPPT, the hybrid MPPT technique is basically a more than one-stage algorithm. (Basically, conventional MPPT has a specific individual algorithm). However, in hybrid MPPT we mixed two or three algorithms.
Now I will share the techniques of the MPPT with the problems. The offline MPPT techniques are discussed below as,
i) Fractional Open Circuit Voltage(FOCV)
ii) Fractional Short Circuit Current(FSCC)

By using offline MPPT techniques, we are facing problems are discuss below as,
1) It is obvious that the temperature and irradiation (sunlight) vary during full-day operation, hence it is required to intermittent monitoring of the open circuit voltage / short circuit current. This intermittent measurement results in a loss of power.
2) Nevertheless, these techniques work on real MPP and are therefore not suitable to the effective system.

The online MPPT techniques are discussed below as,
i) Perturb & Observe(P&O) MPPT technique
ii) Incremental Conductance(INC) MPPT technique

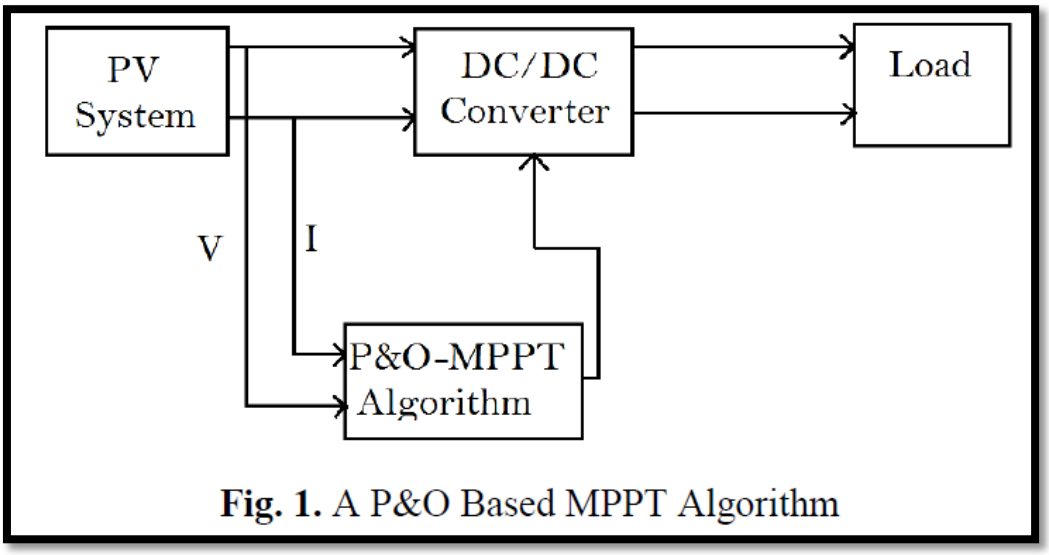

Fig. 1. A P&O Based MPPT Algorithm

By using online MPPT techniques, we are facing problems are discuss below as,
1) During changing weather conditions, P&O always struggles to find the Maximum power point (MPP). Thus, the PV cell is damaged and a hot spot is created.
2) The INC MPPT technique has a difficult and complex problem to implement.

We discuss about some other soft computing MPPT techniques are,
1) Fuzzy Logic(FL)
2) Artificial Neural Network(ANN)

3) Evolutionary Algorithm (EA)
4) Genetic Algorithm(GA)
5) Particle Swarm Optimization(PSO)
Hybrid MPPT techniques have several benefits compared to other MPPT techniques are,
1) less transient time
2) less steady state oscillation
3) high tracking speed

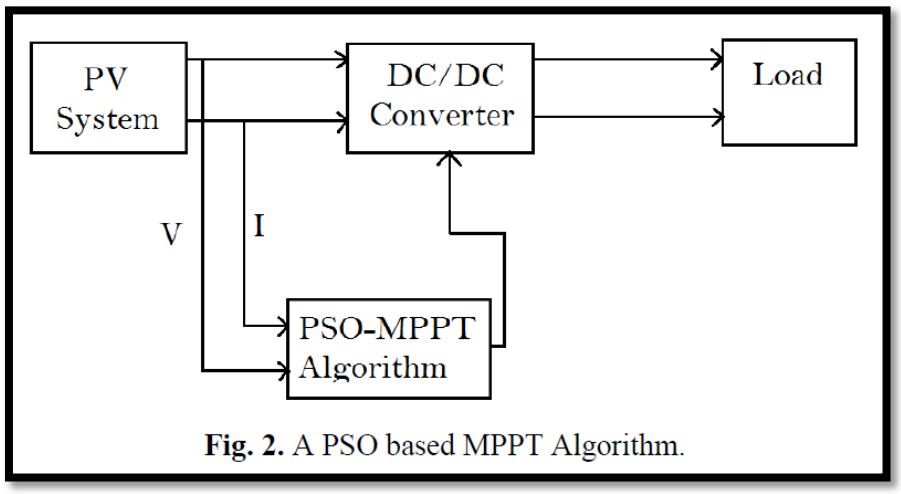

Fig. 2. A PSO based MPPT Algorithm.

In this paper, we discuss about the comparison of the P&O technique and PSO technique for the tracking system. We do not get the optimized values when checking the system performance with the P&O based MPPT algorithm has less tracking speed with the fixed PI values. So that, the problem can be reduced by using the PSO based MPPT algorithm, to get the optimized values when we place the values are tune-up and every fraction value incremental checking the loops. The PSO is a constraint based algorithm with the limits and percentage increment decides within the loops.

II. SOLAR CELL

Photovoltaic panels are the core components of solar cells. Although other materials are also used, the majority are made from silicon. The photoelectric effect is used by solar cells: some semiconductors ability to convert electromagnetic radiation directly into electric currents. The charged particles generated through the radiation incident are conveniently separated to produce an electrical current through a suitable structure design of the solar cell, as described shortly below.

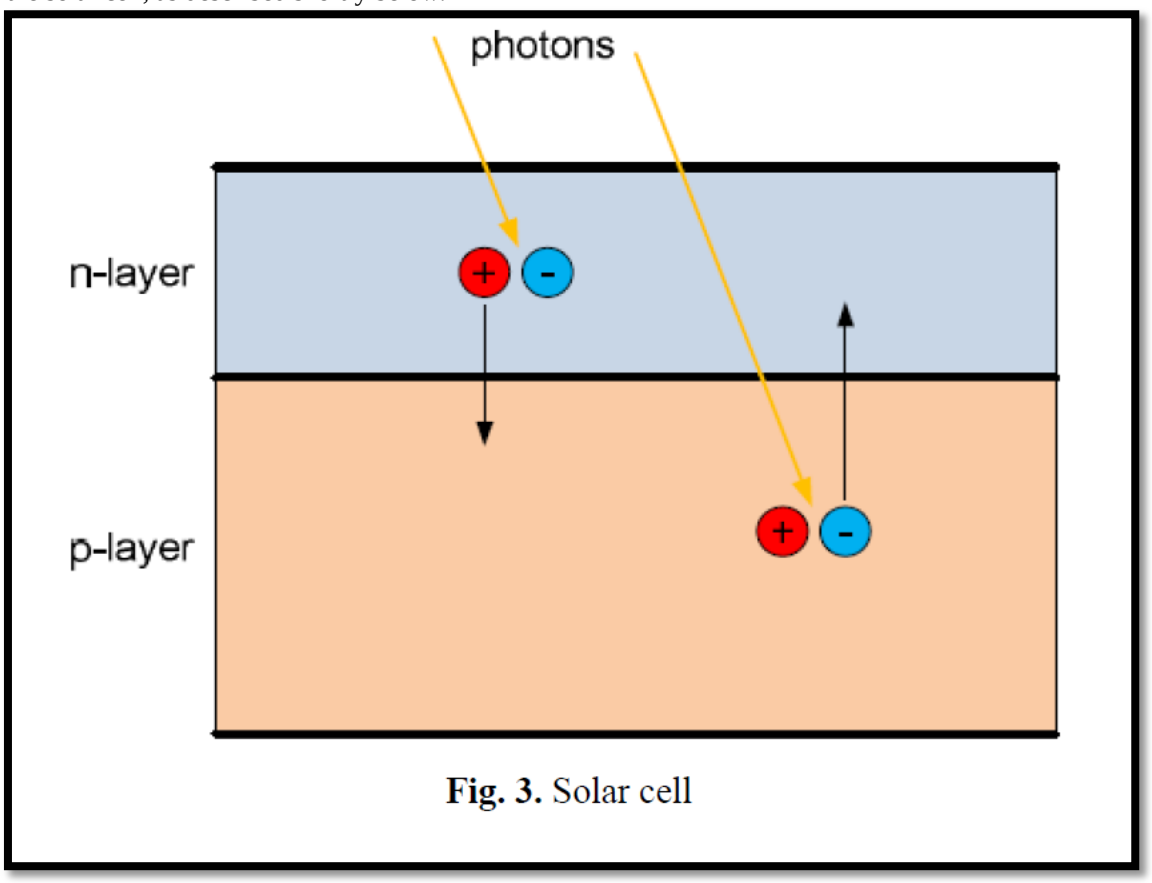

Fig. 3. Solar cell

In the case of the N-layer, atoms with one more valence electron, called the donors, and the p-layer, known as the receiver, with one less valence electron. A solar cell is essentially a p-n intersection, made up of two different silicon layers and is doped with small amounts of impurity. When the two layers are combined, free electrons of the n layer are spread on the p-side near the interface, leaving the donors positively charged behind. Similarly, the free holes in the p-layer are spread to the n side and the recipients load negative behind a region. It creates an electrical field that is possible to prevent further flow between the two sides.

The balance is reached at the intersection when electrons and holes cannot overcome this potential barrier and therefore cannot move. This electrical field pulls the electrons and the hole to the other side, so that the current flows in one way only: from the p side, electrons may flow to the n side and the holes in the other. In order to collect the electrons and the holes the current can flow, metal contacts are added on both sides. For the n-layer, which faces the Solar radiation, several metallic strips are used to make it possible for light, which is known as fingers, to pass over to the Solar Cell.

The solar cell can be represented by the electrical model shown in Fig.2. Its current voltage characteristic is expressed by the following Equation.

$$I = I_L - I_O\left(e^{\frac{q(v-IR_S)}{AKT}} - 1\right) - \frac{V - IR_S}{R_{SH}}$$

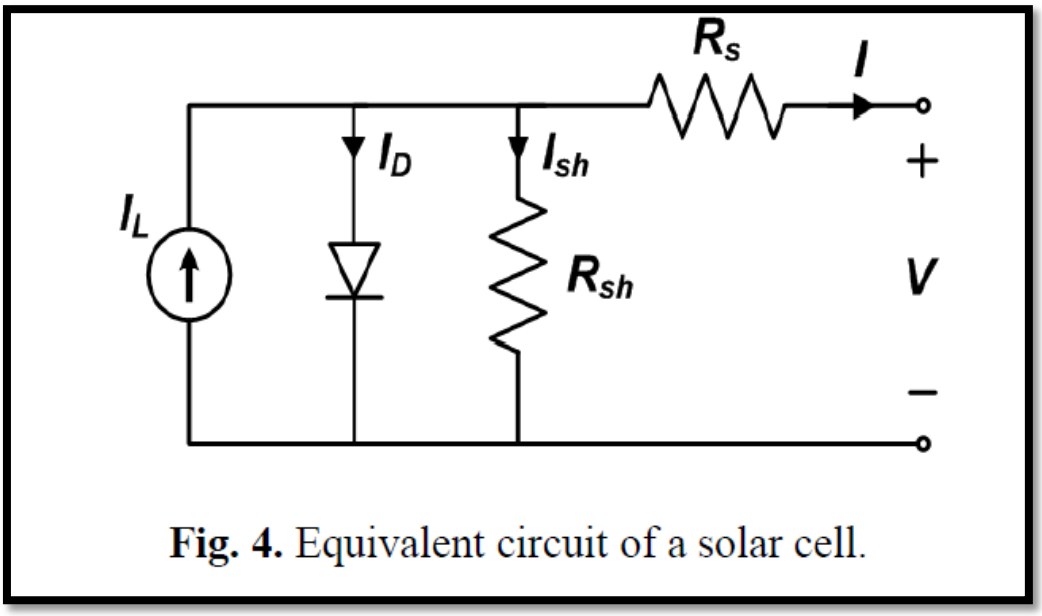

Fig. 4. Equivalent circuit of a solar cell.

Taking into description the overview mentioned above, the output current-voltage characteristic of a PV panel is expressed by Equation, where np and ns are the number of solar cells in parallel and series respectively.

$$I = n_p I_L - n_p I_O \left(e^{\frac{q(v - IR_S)}{AKTn_s}} - 1 \right)$$

III. MPPT ALGORITHMS

MPPT algorithms are necessary as PV arrays are non-linear in voltage current features with a single point where maximum power is produced. The panel temperature and the conditions of irradiance are dependent on this point. During the day, both conditions change and vary according to the season of the year. In addition, radiation can quickly change as conditions like clouds change in the atmosphere. Under all possible conditions, it is important to monitor the MPP accurately to achieve maximum available power.

The efficiency of a PV plant is mainly influenced by 3 factors: the efficiency of the PV panel, which is between 8-15% in the commercial panel, the effectiveness of the inverter, which is 95-98%, and the efficiency of the algorithm of maximum power point (MPPT) tracking, which exceeds 98%.

It's not easy to increase the efficiency of the PV panels and the inverter, because dependent on the available technology, better components may be needed that could dramatically increase installation costs. Rather, it's easier, not expensive, to improve tracking of the maximal power point (MPP) with new control algorithms. Even in plants that are already used, it can be done by updating their control algorithms, leading to a direct increase in PV generation and thus a decrease in their price.

The goal is to examine various MPPT algorithms first of all. In addition, the most popular P&O and Particle Swarm Optimization (PSO) perturbations are thoroughly analyzed and tested in accordance with the standard referred to above. Maximum Power Point Tracking is a photovoltaic (PV) inversion-based algorithm that continuously adjusts the impedance of a solar array so that the PV system can maintain its operation at or close to the panel's peak power point, such as changing sun irradiation, temperature and load, under various circumstances.

A. PERTURB & OBSERVE(P&O) MPPT TECHNIQUE

This algorithm perturbs the voltage of operation to maximize power. A fundamental P&O MPPT algorithm is shown below, although there are several more advanced and better optimized variants.

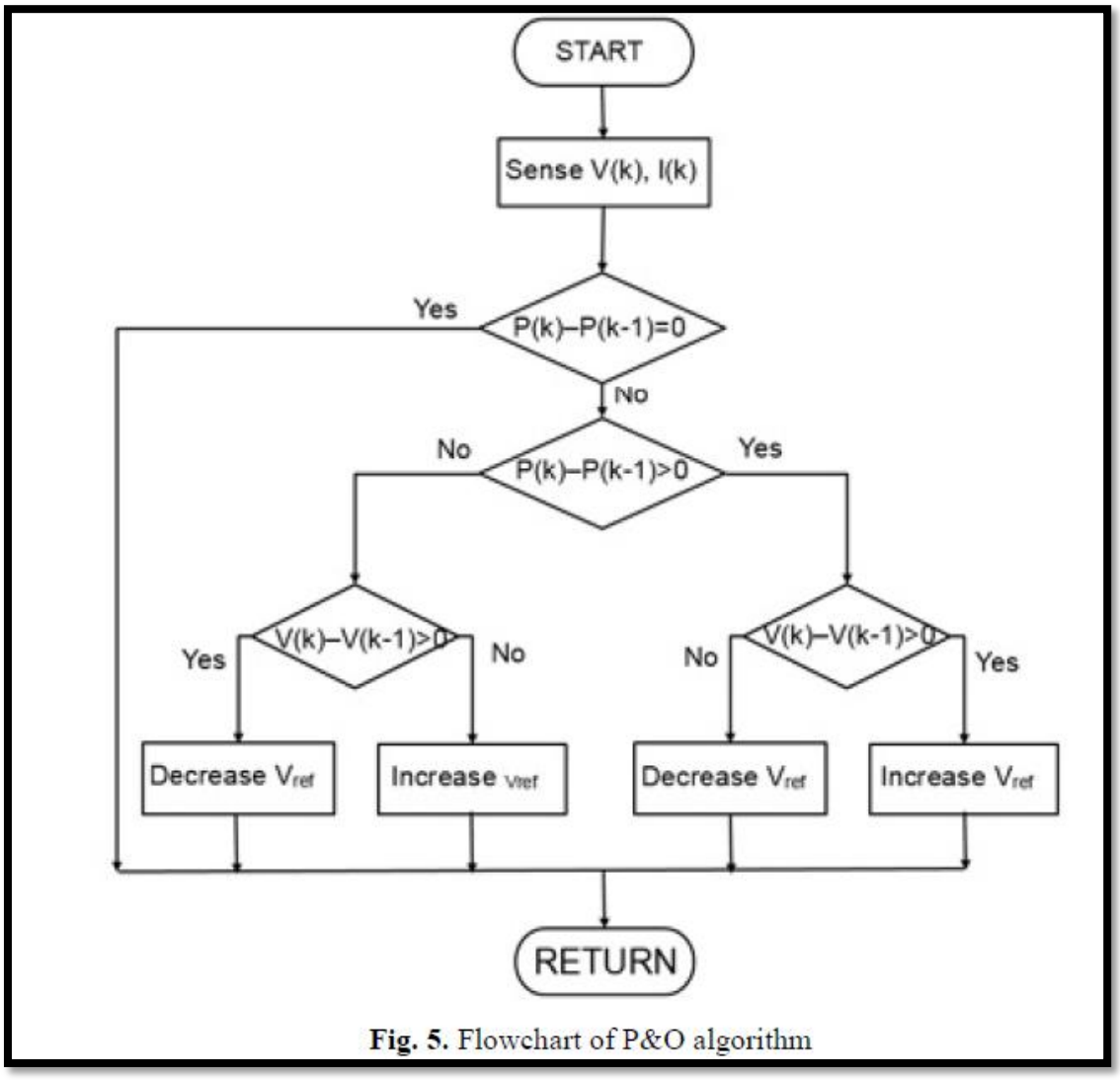

Fig. 5. Flowchart of P&O algorithm

The hill climbing algorithm is also named, but according to their implementation, both names refer to the same algorithm. Hill-climbing involves a disruption to the power converter duty cycle and P&O a disruption of the DC operating voltage between the PV array and the power converter. In the case of Hill climbing, disrupting the duty cycle implies modifying the voltage of the DC connection between the PV array and the power converter.

The algorithm is developed so that the modules reference voltage corresponds to the modules peak voltage. The operating point of the module at this specific voltage level is transported using a PI control. The loss of power due to the disorder is noticed, and the power cannot be tracked under quickly changing conditions in the atmosphere. However, because of its simplicity this algorithm is still very popular.

B. PARTICLE SWARM OPTIMIZATION(PSO) MPPT TECHNIQUE

Previously some traditional MPPT techniques, such as the perturbation and observation technique, the behavioral increase technique and the optimal gradient procedure. All these techniques work well in uniform lighting and constant temperature conditions. Mainly Particle Swarm Optimization (PSO) are currently used the main MPPT algorithm for complex lighting conditions. The Particle Swarm optimization is most commonly used thanks to its simple and fast solving.

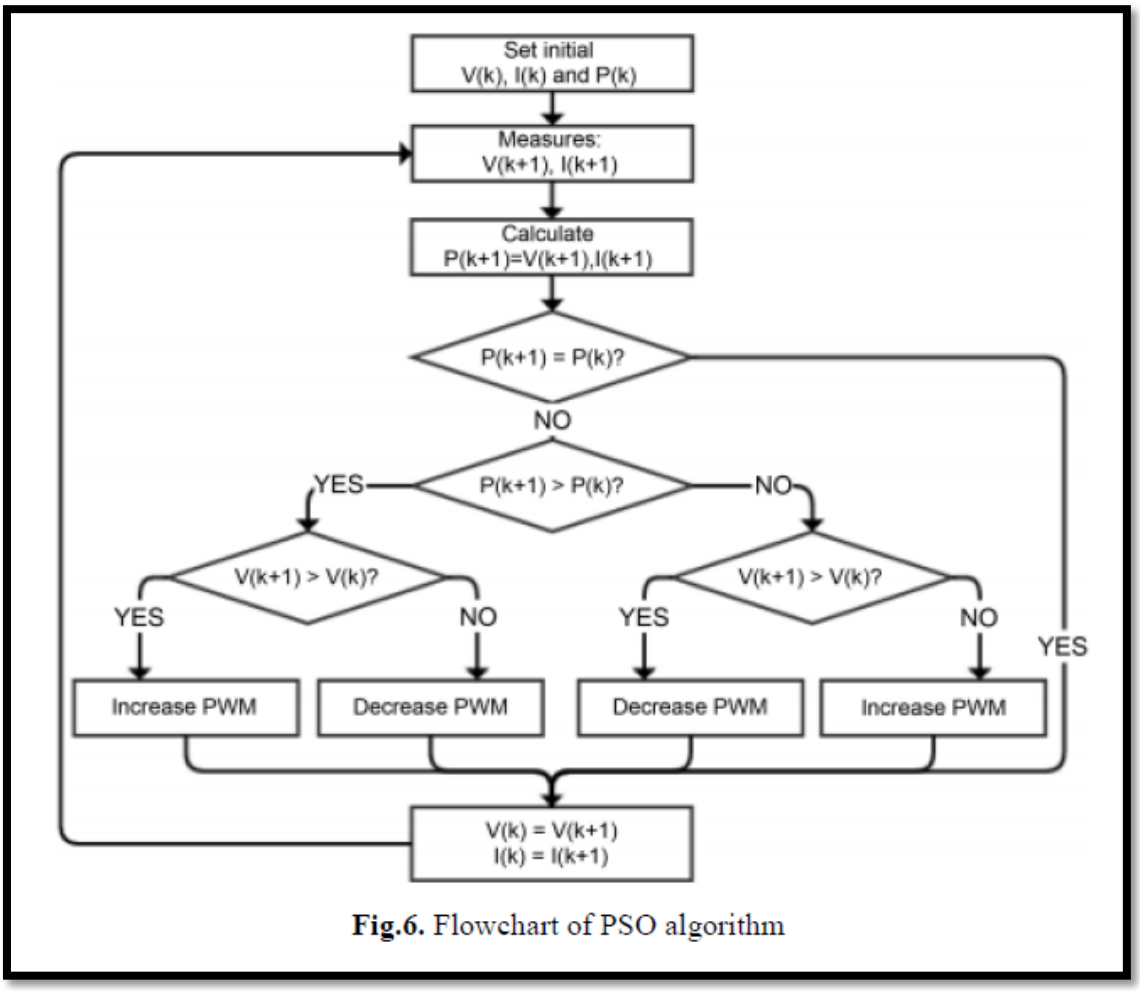

Fig.6. Flowchart of PSO algorithm

The proposed new technique combine the natural and the traditional MPPT selection mechanism to improve the particle swarm to find the optimal solution to replace the half particles fitness and location, the worst of which is the best for each iteration. Every N dimensional search area particle I has a function in the PSO algorithm, to be optimized with a determined fitness and vector adjustment value which can determine the direction and distance of their flight. Meanwhile, all particles know their best position (the best person) and their best position (the optimal solution for the world) for currently grouped particles.

IV. SIMULATION RESULTS

The models of P&O and PSO techniques are implemented in MATLAB/SIMULINK. The voltage, current and output power is the main points of comparison to take into account.

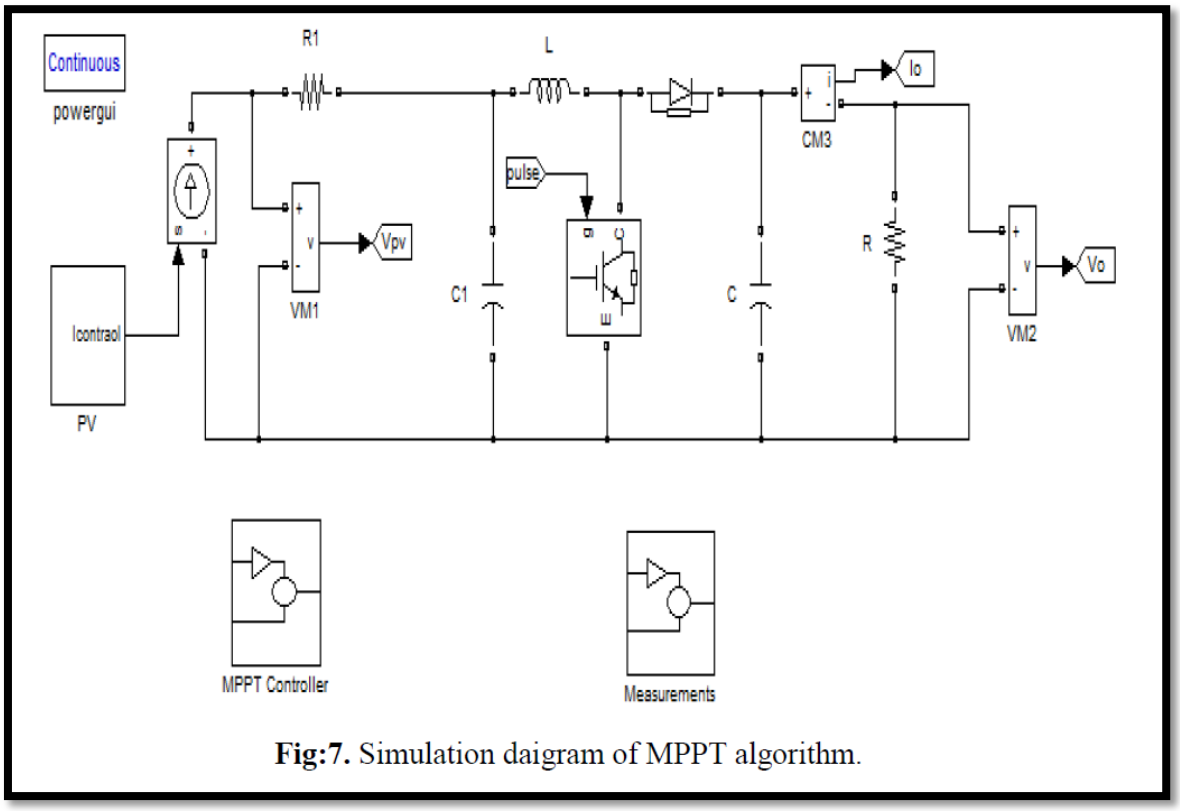

Fig:7. Simulation daigram of MPPT algorithm.

The below figures shows the voltage and current and power waveforms for the P&O and PSO based techniques. The waveforms shows the difference between the P&O(red indicate waveform) and PSO(blue indicate waveform) based techniques with constraint based algorithms for every fraction values incremental checking the loops.

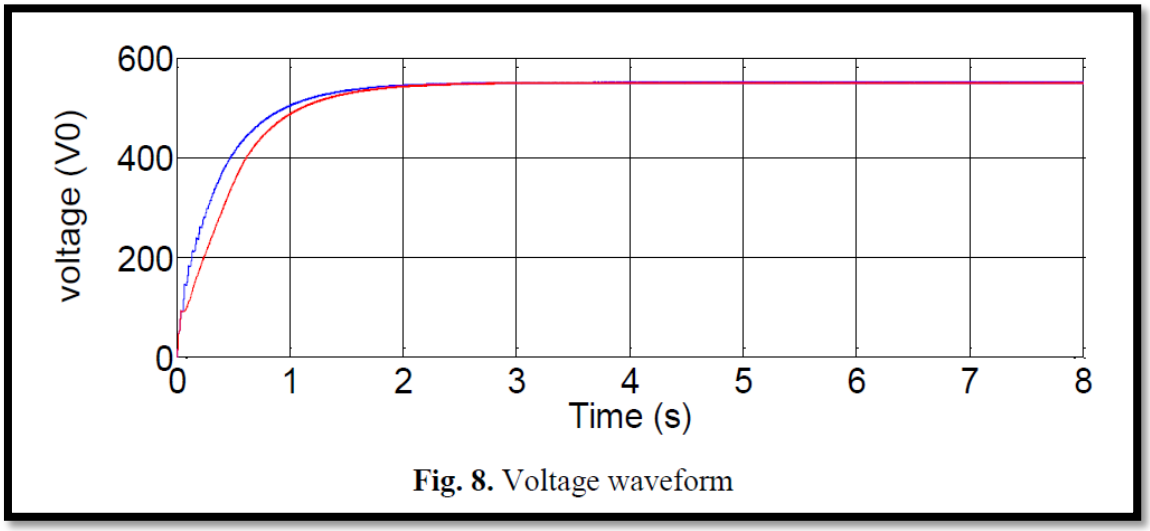

Fig. 8. Voltage waveform

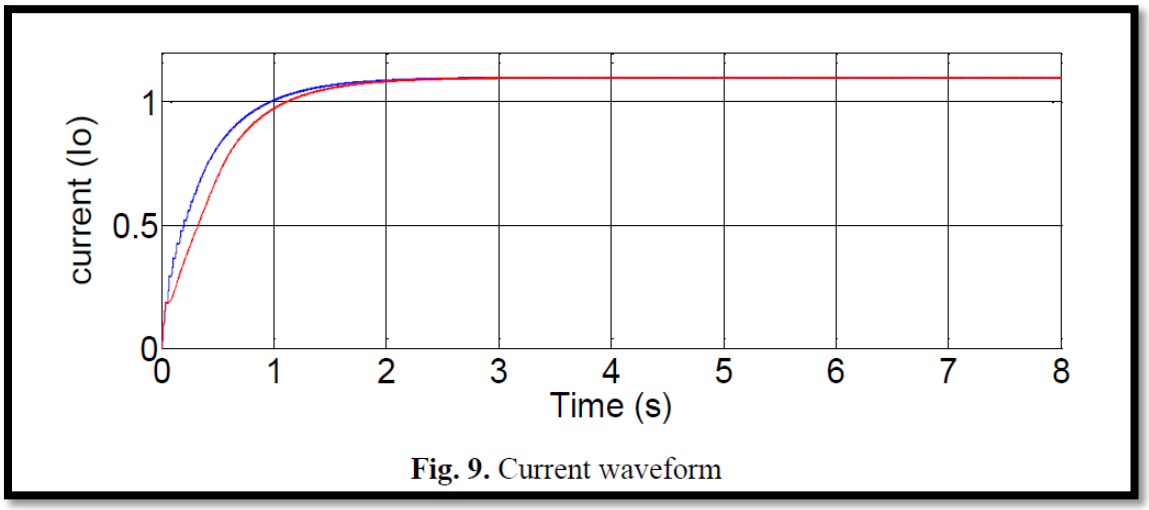

Fig. 9. Current waveform

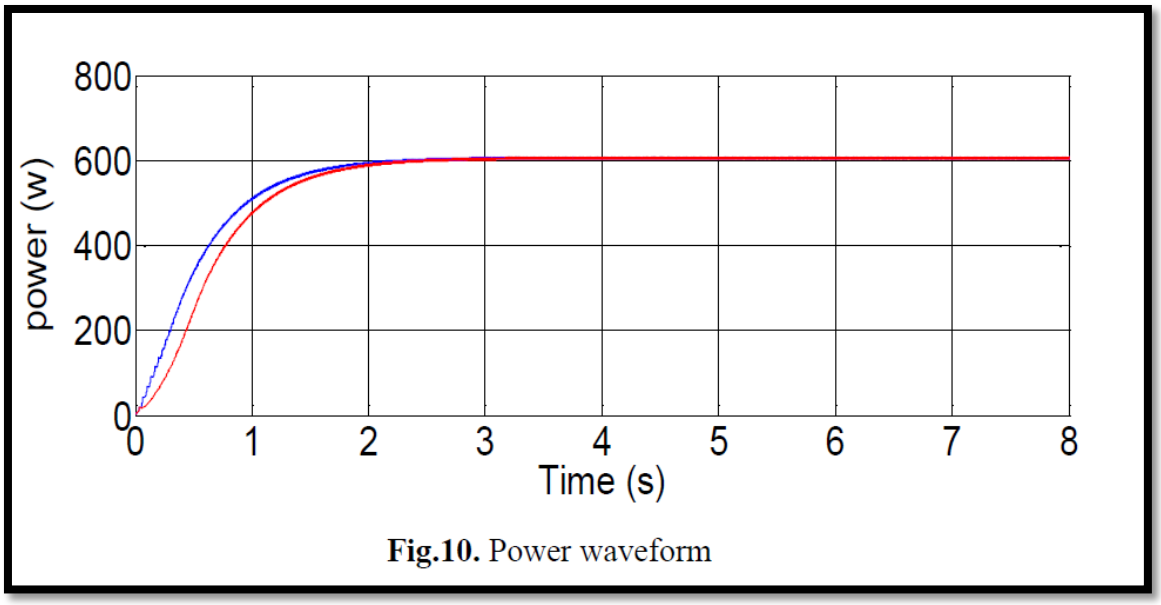

Fig.10. Power waveform

V. CONCLUSION

This study compares in terms of tracking efficiency, convergence speed and performance between two different MPPT photovoltaic system techniques using photovoltaic algorithm PSO and P&O. The problem can be reduced by using the PSO based MPPT algorithm, to get the optimized values when we place the values are tune-up and every fraction value incremental checking the loops. The PSO is a constraint based algorithm with the limits and percentage increment decides within the loops. The PSO technique has managed to monitor MPP under all circumstances and benefits compared to other techniques including very high monitoring efficiency, simple structure, simple implementation, and rapid convergence with the required solution, according to simulation results.

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