# Enhanced P&O Technique for Multi Stage Grid Interfaced Solar Cell

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**Article Info**
**Page Number: 253-260**
**Publication Issue:**
**Vol. 71 No. 1 (2022)**

**Article History**
**Article Received: 02** February 2022
**Revised: 10** March 2022
**Accepted: 25** March 2022
**Publication: 15** April 2022

**Abstract:**
This paper presents an adaptive perturbation and observation algorithm for Maximum power point tracking of solar photo voltaic cell. The solar cell interfaced with grid network in double stage mode using 3-phase converter. The 3-phase converter is used to reduce the harmonics in the system. It is used voltage source inverter to maintain the power quality norms with fewer harmonic as per IEEE-519 standard. The Matlab Simulink is used for simulation. The algorithm performance is observed in different environmental condition using experiment prototype in the laboratory. The PV cell obey different characteristics at different environmental conditions. The P&O algorithm is adopting by many industries due to its simplicity.

**Keywords-** P&O Algorithm, Maximum power point, Voltage source inverter. Solar PV Cell

## I. INTRODUCTION.

The solar photovoltaic cell not always gives maximum power due to its pros and cons. To abstract maximum power from the cell , efficient algorithm is required to work in simple and proper manner.So many algorithms are available like hill climbing, incremental conductance, neural network, Particle swarm optimization, sliding mode, incremental resistance ,etc along with P &O algorithm. But The P & O algorithm is simple and efficient compared to other algorithms. The real time implementation is possible in both analog and digital environment. The P& O algorithm will observe the slope of power versus voltage. There are two schemes are available for P& O technique implementation . The reference voltage setting by PI control or duty ratio control.The perturbation size is very important for optimization. If step size is low then output response is slow. When step size is large then there is large oscillations and steady state error. The cons of P&O algorithm is when sudden climate change it deviate from its maximum operating power point.The proper step size of P & O will overcome the above problem. An energy storage system or Grid interfaced system is also one of the solutions for above problem. The perturbation and operating voltage is decided by the sign of the track of the slope. In this method the perturbation is introduced to cause the power variation. The power measured at every instant is compared with previous instant . If the output power increases , same process will

continue otherwise The perturbation is reversed. The PV array is the combination of solar cells in series and parallel. The output of PV array is DC and it is converted in to AC using inverter. The VI characteristics of PV array is non linear. MPPT will check the load that will match with maximum power from PV solar array. The P&O algorithm will verify the matching of load and maximum power.

## II. PROPOSED SCHEME

In this paper, based on the proposed scheme, The SPVECS ( solar photo voltaic energy conversion system ) is connected to the 3-phase distribution network. The boost converter and voltage source inverter is cascaded . The boost converter duty ratio is varied with MPPT control .

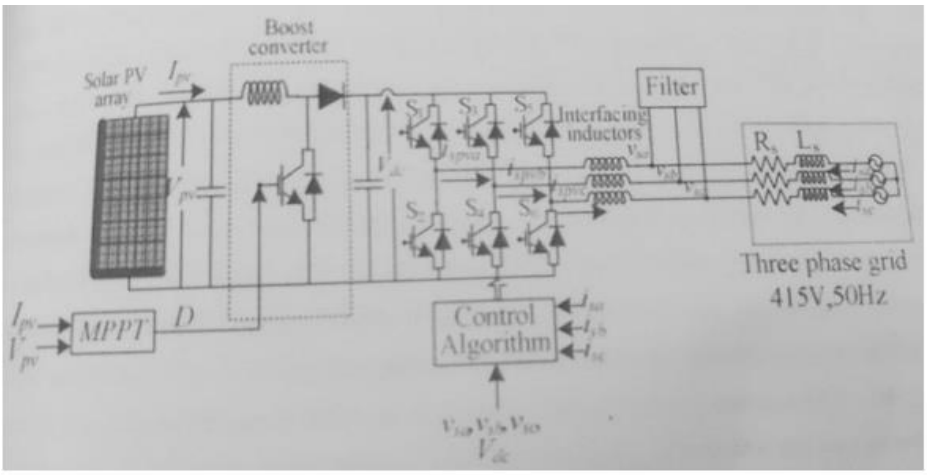


Figure 1. Cascaded connection of booster and inverter

The Fig. 1 shows the cascaded connection of booster and inverter. The difference between traditional and adaptive P & O method is ,in traditional the output is compared with saw tooth wave . In adaptive method The PV voltage and PV current is observed in each iteration . If power is more than previous iteration then the PV voltage is increased otherwise pv voltage is decreased. The perturbation size is important for speedy convergence. Due to weather conditions solar irradiation will change. In this situation the adaptive P & O will count the weather conditions also. The information of solar current variation is also used along with solar voltage variation. Large step size is considered for large power mismatches which uses short span of time. To minimize the oscillations adaptive P&O technique is used with small step size.

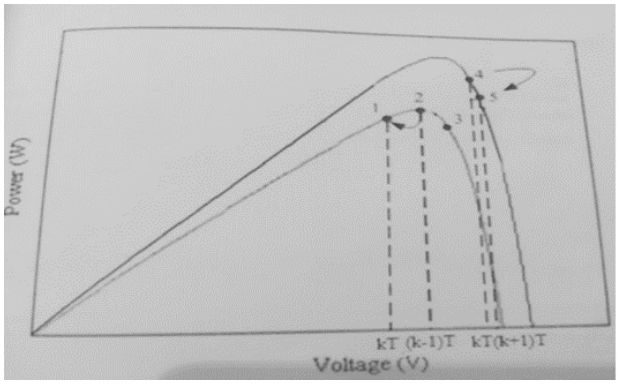


Figure 2.: P versus VI Graph

Figure 2 shows the power P versus V,I graph variation for one module.

Voltage source Inverter control :

The voltage source inverter uses the MOSFET device for switching between DC to AC

Due to 3-phase converter it reduces the harmonics.The band pass filter is used to avoid the ripples and harmonics. The photo voltaic generation is one of the important natural source now a days.

The Fig.3a, Fig 3b shows the solar cell characteristics for various irradiations and at various temperatures. The maintaining the Maximum power point is really required algorithm control .

There is need to track constantly the power curve and keep the solar panel operating voltage

At maximum operating power point. Integration of irradiation over the period of time is called the radiation. The solar cell is facing southern hemisphere for northern latitudes and vice versa . The PV cell voltage decreases with increasing temperature and vice versa. The solar cell is modelled with diode . The electron hole mobility is high with increasing irradiation and decreasing temperature.

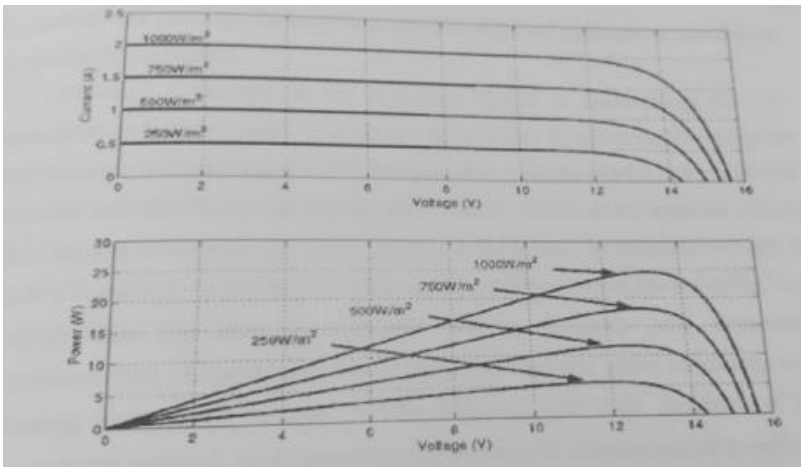


Figure 3a. PV characteristics at various irradiations

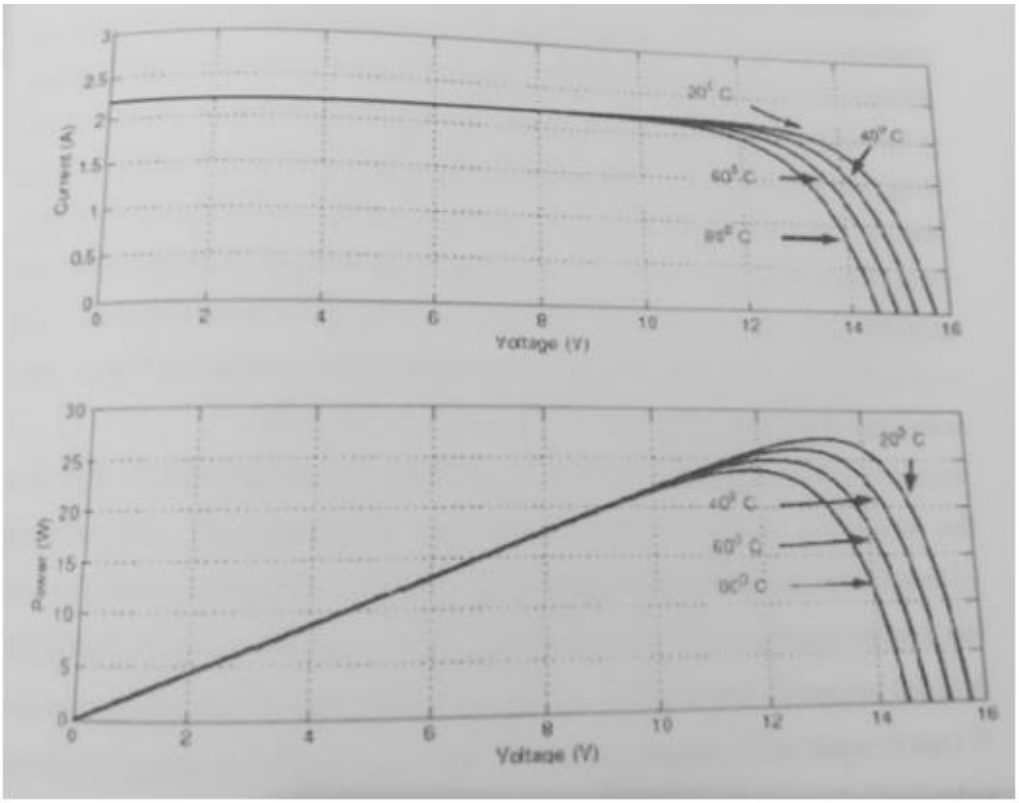


Figure 3b PV characteristics at various temperatures

The MPPT is perform for whole array of solar cells. Different panels have different IV characteristics, Some modules may perform below their MPP, resulting in the loss of energy.

The MPP are also can use for each individual modules to operate at maximum efficiency depite uneven shading ,partial cell damage ,etc.The power tracker also change its position according to the load demand. There should be match between load demand and solar current generation.The MPPT algorithm uses abc / dq transformation control.

## III. SIMULATION RESULTS

In fig 4 shows the simulation circuit for MPPT control with P&O algorithm for two stage SPVECS.

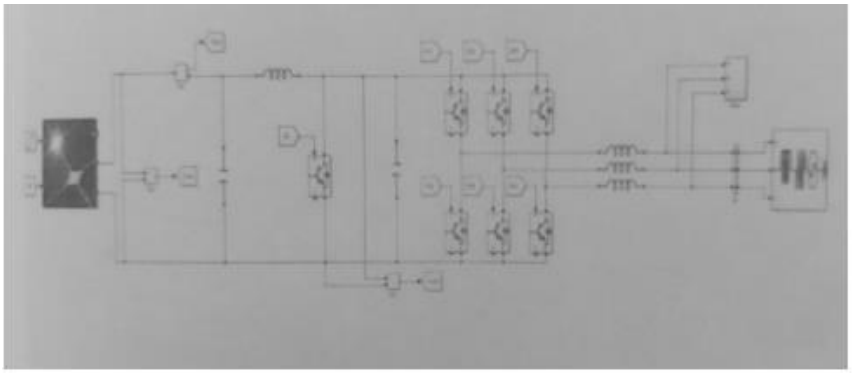

Figure 4. Simulation circuit

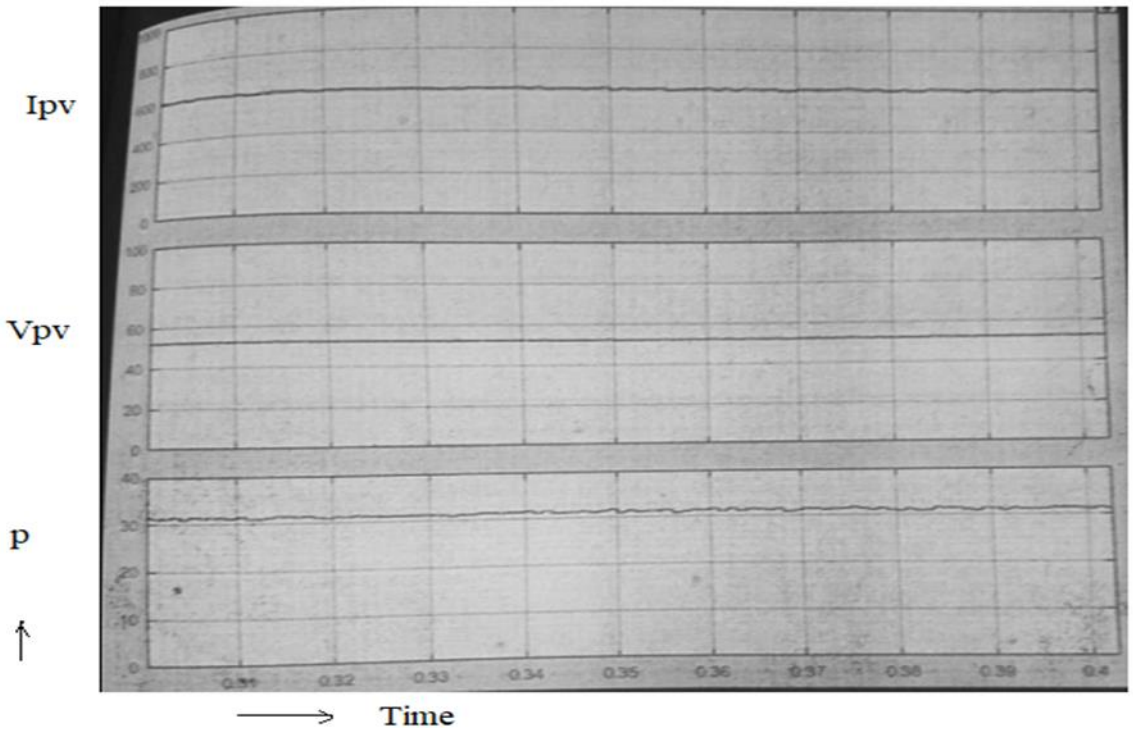


Fig. 5 shows the DC Output steady values of P ,Vpv of Ipv under nonlinear conditions.

Figure 5.Steady Values

Fig. 6 shows the steady values of the V dc and Vabc and Iabc on AC side. With non linear loads

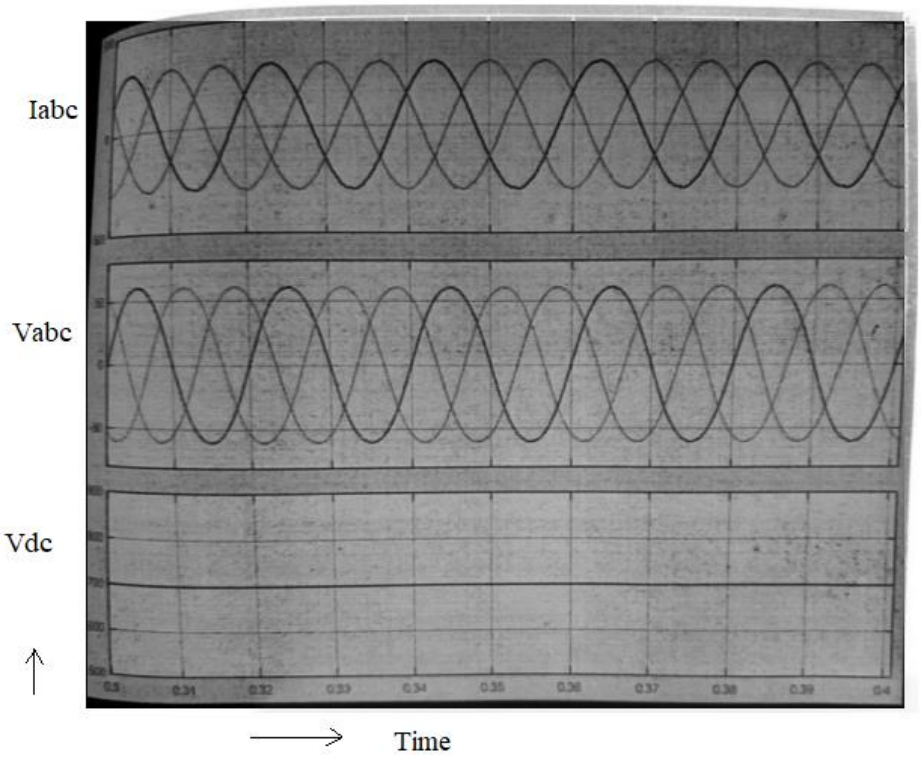


Figure 6.Steady DC and AC Values

Fig 7 shows the P, Ipv , Vpv dynamic behaviour.

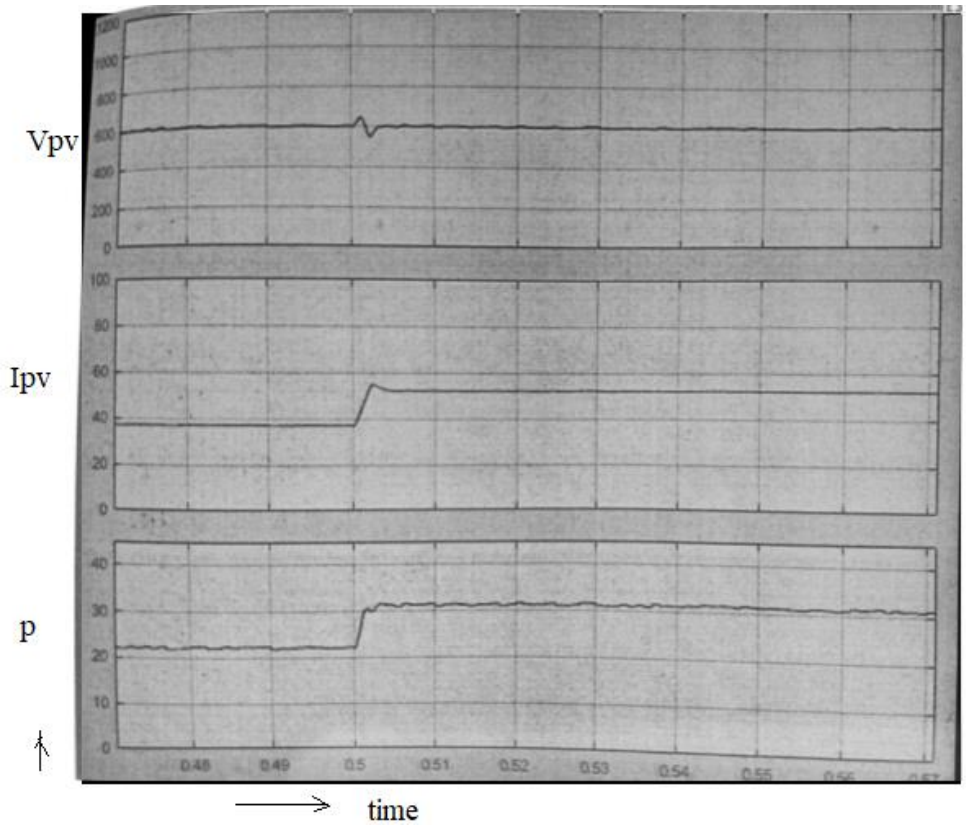


Figure 7.Dynamic behaviour values

The Fig 8 shows the dynamic behaviour of Vdc , Iabc , Vabc

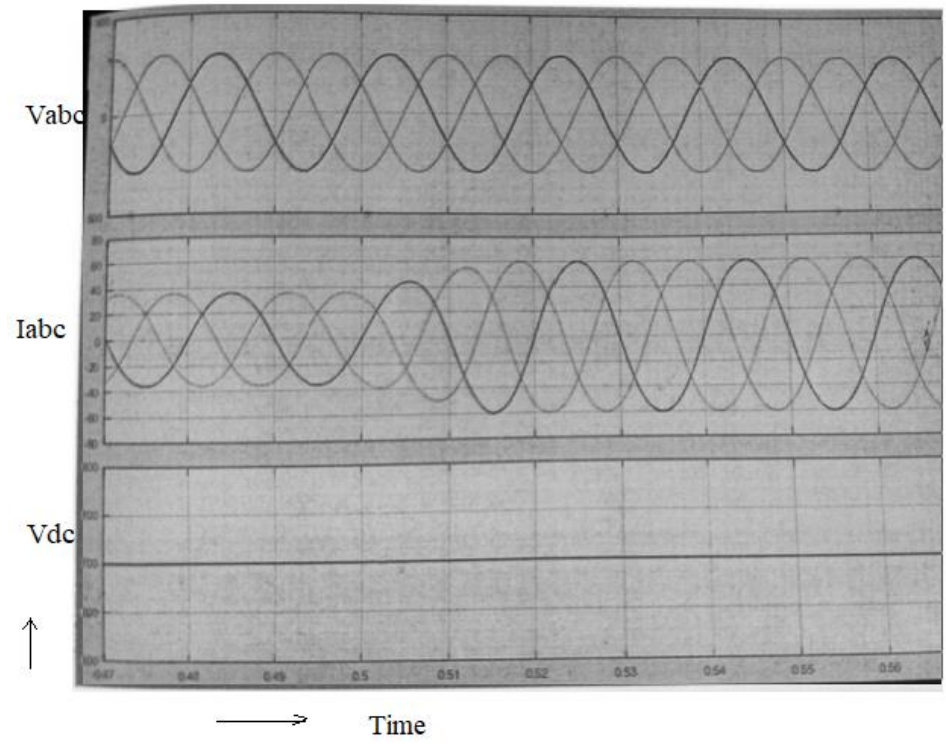


Figure 8. Output reactive power of STATCOM

## IV. CONCLUTION

The MPPT with P & O algorithm has been used and implemented successfully on the established laboratory prototype. It extracts the optimum power from SPVECS and wheels that power in to 3 phase grid. The THD is within the acceptable range. The voltage and current values shows that P& O algorithm is better than other traditional algorithms.

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## VI. APPENDIX

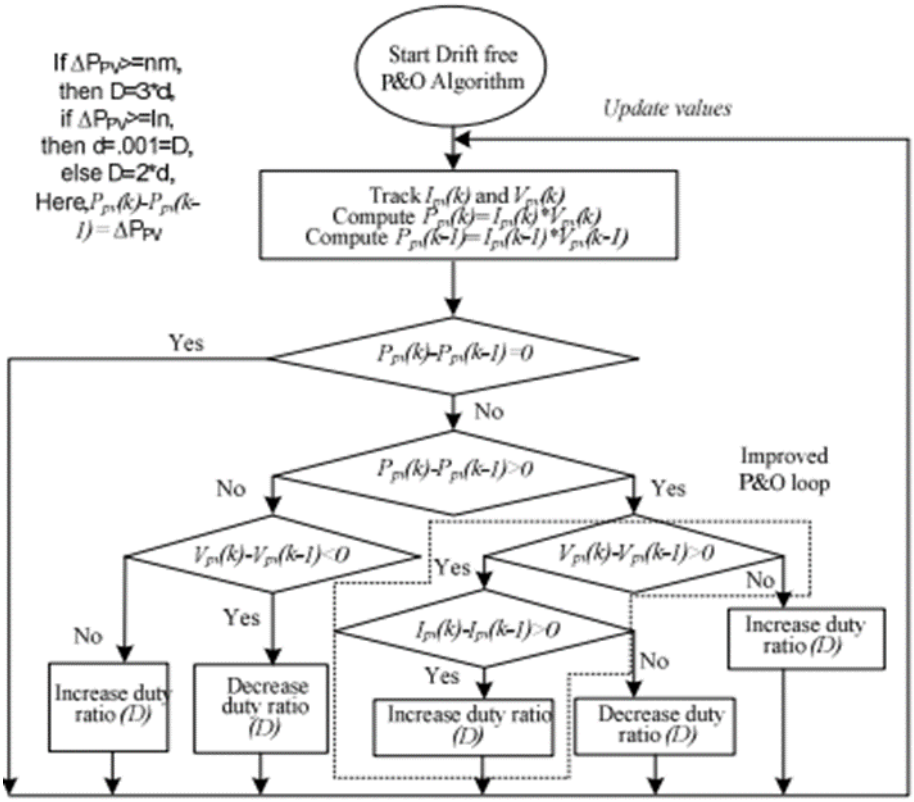


Fig 9 P& O Algorithm

$V_{MPP}$ = 26.3 V; SPV module current, $I_{MPP}$ = 7.61 A; SPV array power,

$P_{MPP}$ = 30 kW; Ns = 27; Np = 6; DC bus voltage,

$V_{dc}$= 700 V; DC bus capacitor, $C_{dc}$ = 6 mF;

interfacing inductor, $L_f$ = 2.5 mH;