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IMPROVED PSO ALGORITHM FOR A PV SYSTEM UNDER PARTIAL SHADING CONDITION

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ABSTRACT

Maximum power point tracking is essential for utilization of more amount of solar irradiation. Partial Shading condition is one of the reason behind not getting maximum power point. Partial shading condition may cause due to trees, chimney, clouds and so on. Due to partial shading, multiple peaks occurs in P-V characteristics of PV array. Conventional maximum power point algorithms are not able to track the maximum power point. To overcome this drawback, Particle swarm optimization algorithm is used for maximum power point tracking. Improved version of PSO also used in given paper for better results. In this paper comparative study of particle swarm optimization is done.In this paper particle swarm optimization with time varying inertia weight(PSO-TVIW) is applied for maximum power point tracking(MPPT). Results of classical PSO(particle swarm optimization) and POS-TVIW have analyzed. Effectiveness of both the algorithm have studied. Simulation of the PV system is done using MATLAB/Simulink.

Keywords: particle swarm optimization(PSO), partial shading condition(PSC), maximum power point tracking(MPPT),boost converter

I. INTRODUCTION

Global demand of energy consumption is rising day by day as well as the depletion of fossil fuel led quick development of renewable energy technology. Solar energy is one of the ideal energy resource because it has several advantaged like low installation cost, clean, widely distributed also it’s low maintenance. It has one disadvantage i.e. its efficiency is low. The point at which PV system give maximum power is called maximum power point. Maximum power should be maintain at a stable position. Maximum power point can be achieve with the help of maximum power point tracking algorithm. Partial shading one of the reason which affect the efficiency of PV modules. Partial shading can be cause by several reasons such as trees, clouds chimneys dust on PV array and so on. In order to improve the efficiency of PV generation system’s MPPT is an essential thing. In partial shading condition VI characteristics of PV array contain more than one local peak power output. Conventional maximum power point algorithms are failed to find the global maximum power point in partial shading condition. In order to overcome this drawback of conventional MPPT algorithms, one population based algorithm can be used to find the MPP in partial shading condition i.e. particle swarm optimization. Particle swarm optimization has one drawback that its conversion speed is slow to overcome this drawback PSO with time varying inertia weight is used in this paper. In,[5] analysis of two most significant methods i.e. perturb & observe and incremental conductance are proposed. Mathematical and practical implementation analysed and comparison had been carried out in which efficiency differences found out under steady state and dynamic conditions. In, [2] deterministic particle swarm optimization algorithm is proposed in which method maximum power point technique is given and make some improvement in conventional PSO algorithm . In [3] a convenient method for choosing the optimal parameter of the PSO algorithm is proposed. The topology and parameter of DC-DC converter are considered for the optimisation purpose. In, [6] the self predictive and decision This paper introduce effective work on analysis of the performance The proposed method have some advantages as follow: 1.It has easily understandable mathematical expression. 2. This method is easy to implement because of its uncomplicated solution. The results of PSO-TVIW algorithm is then compare with the classical PSO.

II. SYSTEM DECRIPTION

This comparative study was carried out on PV system with PSO algorithm. The block diagram of proposed system is given below in figure 1.

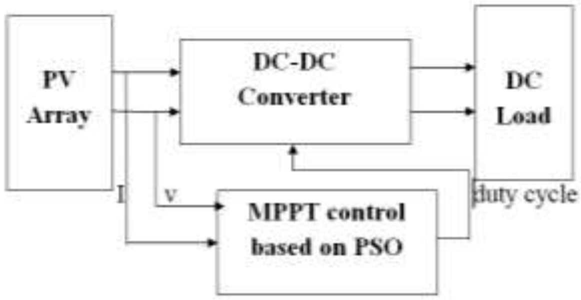

Figure: 1 Block diagram of proposed system

The main purpose of the proposed study is to find the maximum power point of PV. To find the maximum power, after controller output, pulse width modulation work in parallel with controller. Input to the PWM is PV voltage (V_{PV}) and PV current (I_{pv}), and output of PWM is duty cycle. Duty cycle further used as a input to the MOSFT. In this project MOSFET used as a switch in DC-DC boost converter. The DC–DC converter is interfaced with the proposed model, and it is used for matching the load with the characteristics of the PV panels. output of dc-dc converter finally fed to DC load.

PV modules considered in paper are connected in series. The temperature of PV modules are kept constant. Radiation of the PV module considered as variable radiation and study the variation in maximum power point. PV output characteristics are different in uniform radiation and in partial shading condition [5]. In this paper 4 PV modules in series are considered. Parameter of PV modules are as follow: Maximum power P_m/W = 249W Maximum power voltage V_m/V = 30V Maximum power current I_m/A = 8.3 A Open circuit voltage (V) = 36.8 V Short circuit current (A) = 8.83 A Number of series module ($N_{s)}$ = 4 Number of cells per module (Ncell) = 60. At 25^o temperature and radiation intensity is 1000W/m^2. Applied radiation intensity to the four PV modules is shown in Table 1. PV array output characteristics are analyzed under four different radiation intensity to the modules.

III. PSO UNDER PARTIAL SHADING CONDITION

Basic Particle Swarm Optimization

Particle swarm optimization algorithm is proposed by James Kennedy and Russel Eberhard in 1995. This algorithm is inspired by fish schooling and bird flock [2]. PSO algorithm is used to optimize the problem by considering population of candidate solution and movement of particle in search space. This algorithm has simple calculations and it can be easily implemented in system. PSO algorithm contains a swarm of particle in search space, individual particle has its own solution. PSO algorithm's solution is based on position of particle and velocity of particle. The mathematical expression for the position and velocity of particle can be represented by, the mathematical expression for the position and velocity of particle can be represented by,

$$X_i^k = [X_i^1 \; X_i^2 \; X_i^3 \; X_i^4 \; ...... \; X_i^{kmax}]$$

$$V_i^k = [V_i^1 \; V_i^2 \; V_i^3 \; V_i^4 \; ...... \; V_i^{kmax}]$$

Where,

X_i^k is position of particle

V_i^k is velocity of particle.

The position and velocity of the particle can be updated as,

$$x_i^{k+1} = X_i^k + V_i \qquad .... (1)$$

$$V_i^{k+1} = WV_i^k + c_1 r_1 (Pi + X_i^k) + c_2 r_2 (Pg - X_i^k) \qquad . \quad ..... (2)$$

Where,

Pi – Individual best position of particle.

Pg – Global Best position of particle.

PSO with time varying inertia weight (TVIW)

Main concept of PSO-TVIW is similar to classical PSO. However, for PSO-TVIW the velocity update equation is modified by constriction factor C and, in inertia weight w is linearly decreasing as iterations grows.

$$x_i^{k+1} = X_i^k + V_i \qquad \text{.........} (3)$$

$$V_i^{k+1} = C\{WV_i^k + c_1r_1 (Pi + X_i^k) + c_2r_2 (Pg - X_i^k)\} \qquad \text{.........} (4)$$

$$W = ((w_{max} - w_{min}) * ((k_{max} - k)/k_{max})) + w_{min.}$$

Where ,

$$C = (2/2 - \square - sqrt(\square^2 - 4\square))$$

Where,

$$4.1 <= \square <= 4.2$$

Flowchart of PSO-TVIW algorithm

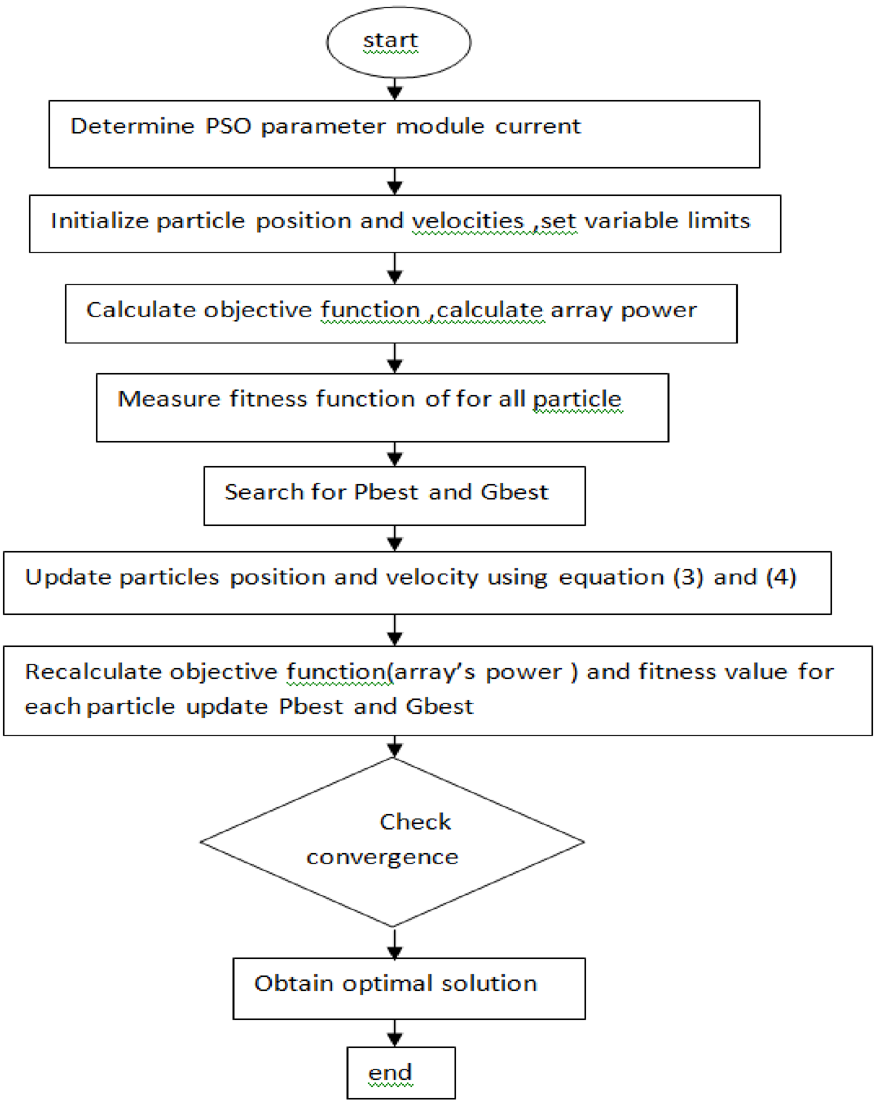

Figure: 2 Flowchart of PSO-TVIW algorithm

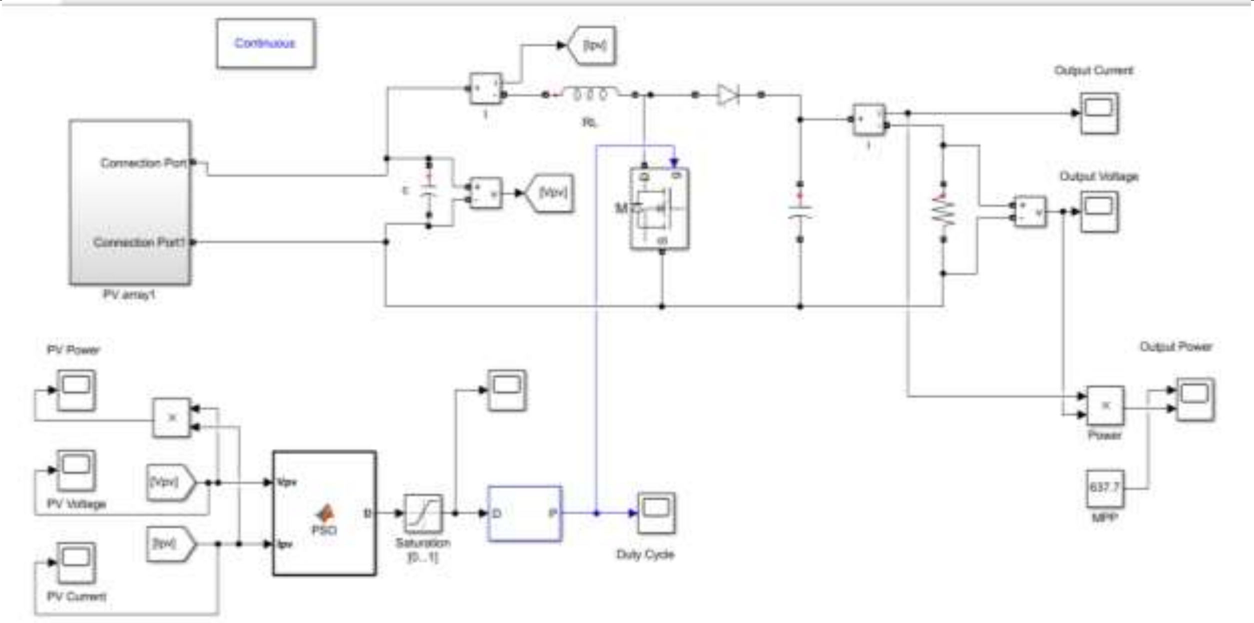

Figure 3 Simulink model of PV system with particle swarm optimization algorithm

III. SIMULATION RESULTS

The PSO method is used as MPPT for extract maximum power from PV panel. Here the MPPT is attached to PV 4 panels which are connected in parallel so that more power can be extracted for each module.. The modeling MPPT algorithm is done in MATLAB/Simulink as shown in Fig 3

Simulation results which are generated from the MATLAB/Simulink according to above algorithms are shown as follow. Different partial shading conditions were considered.

CASE 1: Power outputs in complex radiation

In this case complex radiation was considered in which three PV modules were kept under partial shading condition and only one module kept under fully irradiated condition. The radiation given to the PV modules were [1000 800 600 300] w/m^2.

Irradiation	PV Power	Output Power	Time
Type1: [1000 800 600 300]	319W	370W	300ms
Type2: [1000 800 600 300]	304W	341W	210ms

Type I : power waveform of PV system with classic PSO

Figure 3: PV power before applying classic PSO under complex shading

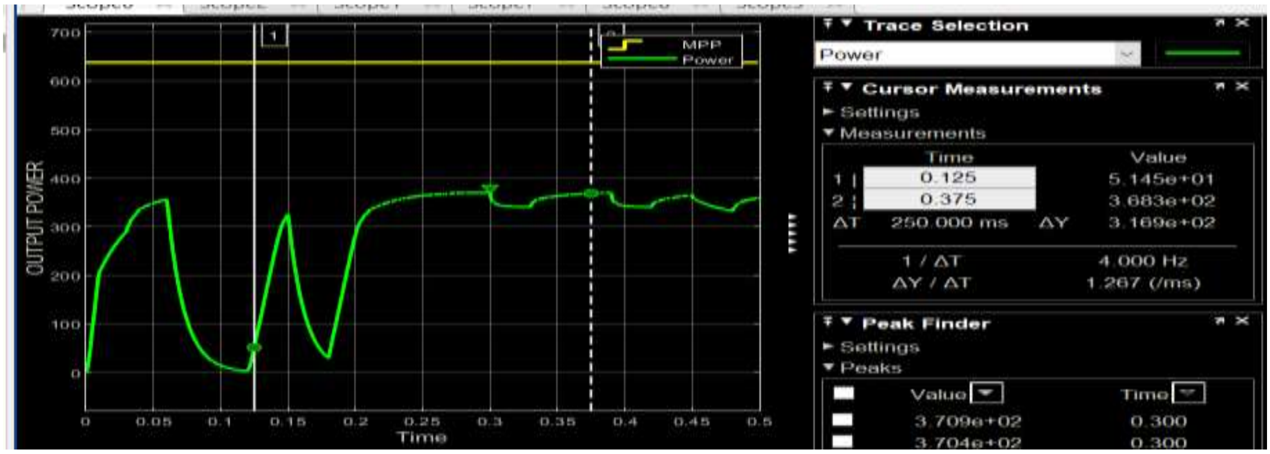

Figure. 4: Output power after applying classic PSO under complex shading

Type II : power waveform of PV system with PSO-TVIW

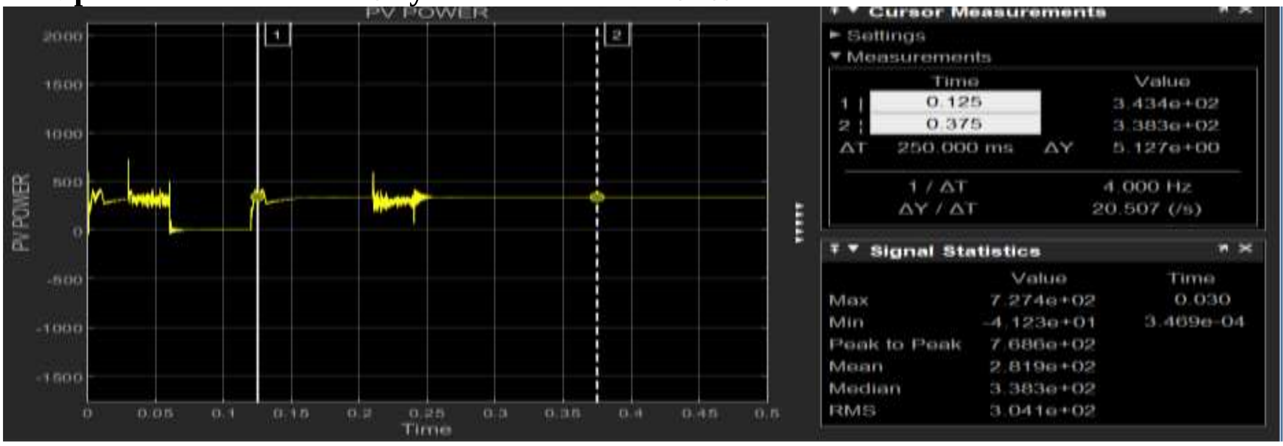

Figure 5: PV power before applying PSO TVIW under complex shading

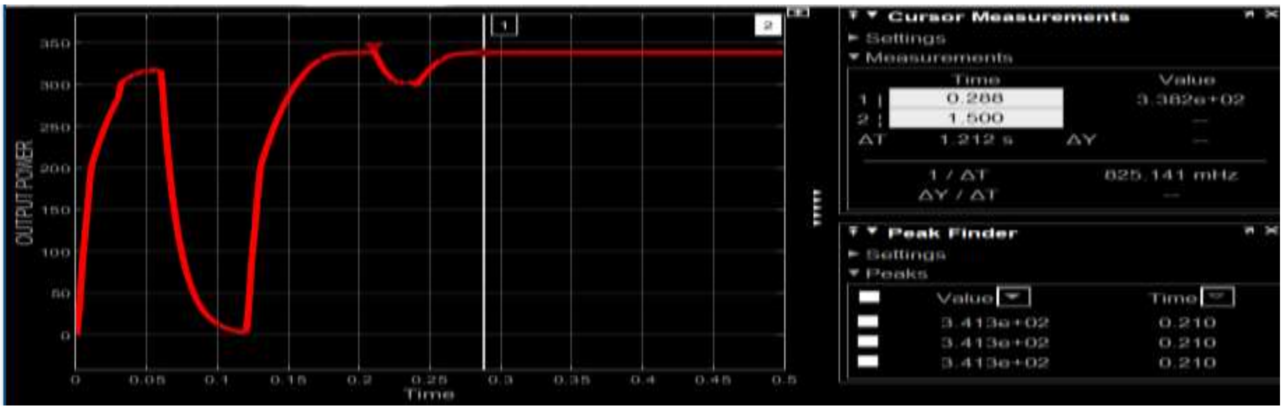

Figure 6: Output power after applying PSO-TVIW under complex shading.

It can be seen from the above waveforms of case I , Before applying the PSO-TVIW the waveforms had more oscillations in it. But after applying the PSO-TVIW the waveform got smoother and oscillations got dump. The power output also got increased .power output of the pv system was 304w before applying the PSO-TVIW but after the application of PSO-TVIW it increase to 341W.`

CASE 2 : Power output at normal partial shading condition

In this case normal radiation was considered in which three PV modules were kept under under fully irradiated condition and only one module kept under partial shading condition . The radiation given to the PV modules were [1000 500 1000 1000] w/m^2.

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Irradiation	PV Power	Output Power	Time
Type1: [1000 500 1000 1000]	687.6W	687.6W	520ms
Type2: [1000 500 1000 1000]	687W	680W	240ms

TYPE I : power waveform of PV system with classic PSO Figure: 7 PV power before applying classic PSO

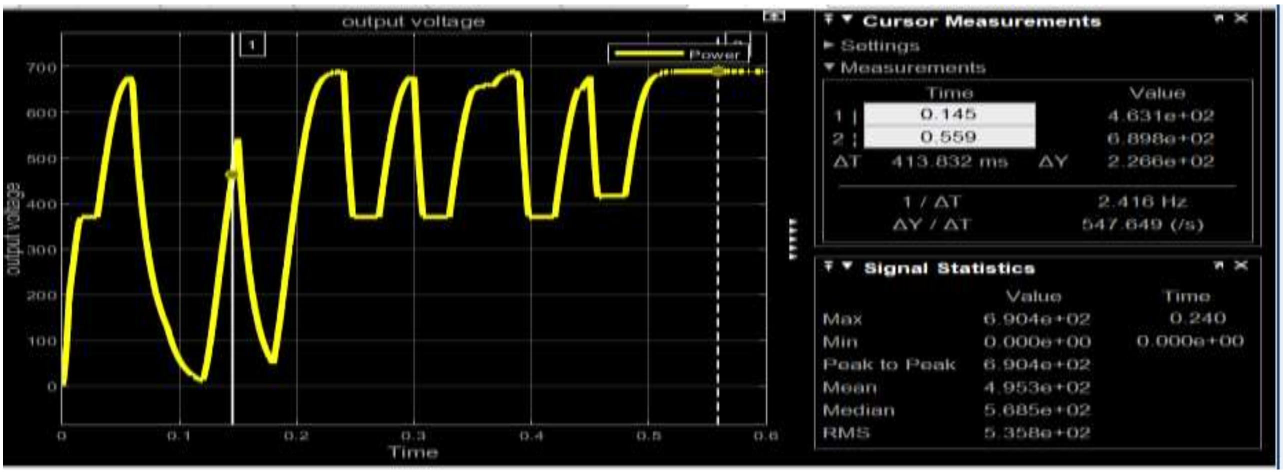

Figure 8 :Output power after applying Classical PSO

TYPE II : power waveform of PV system with PSO-TVIW

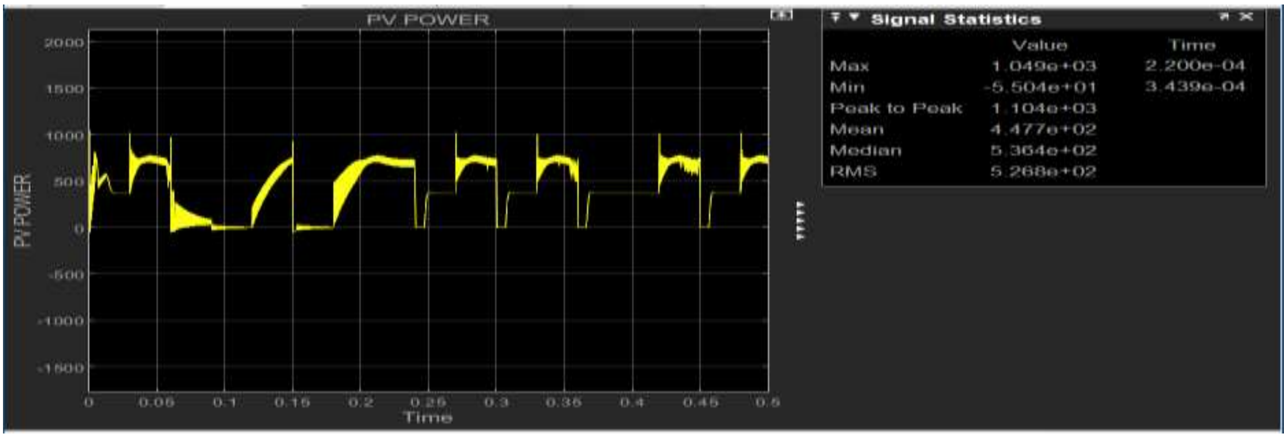

Figure: 9 PV power before applying PSO-TVIW under normal shading

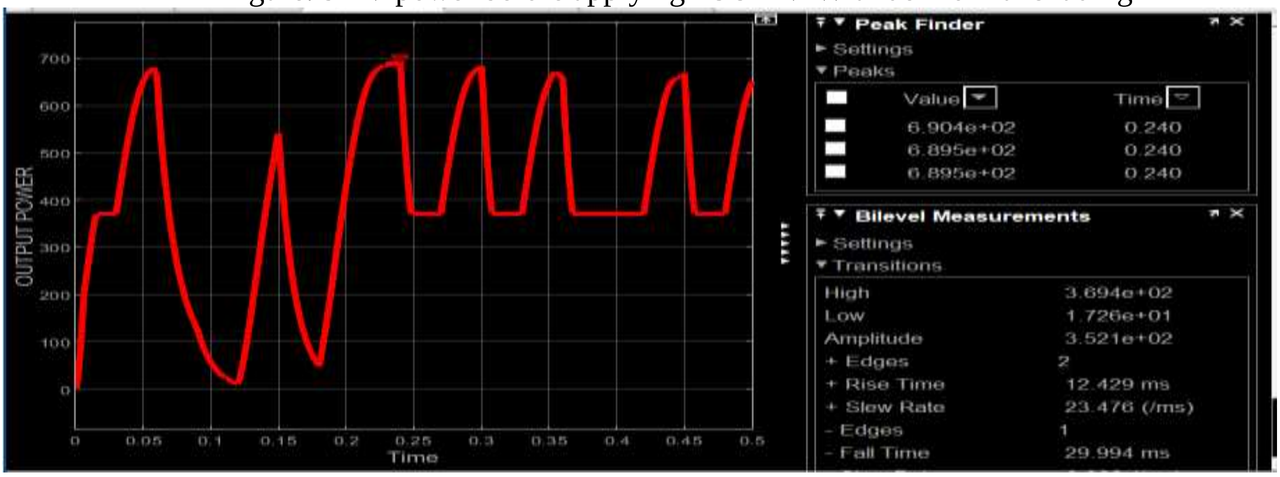

Figure 10 Output power after applying the PSO –TVIW under normal shading

V. RESULT AND CONCLUSION

The solar system is designed for household system it has 4 solar plates which are connected in series with each other with power rating of 250W, this designed system has been simulated using MATLAB/Simulink. The boost converter is used to boost the power .PWM is used to give the gate trigger to the switching device i.e. MOSFET with switching frequency of 50 KHz. The power of the PV system is boosted with the help of boost converter as well as PSO algorithm.

In this paper, PSO with time varying inertia weight is proposed to track the MPP of PV system. Nonlinear dynamic weighting control strategy is used to adjust the inertia weight adaptively. Simulation of constant partial shading and rapid changing partial shading in complex environment conditions is used to verify the feasibility of the algorithm. Based on MATLAB simulation platform, a PV array model with shadow is constructed to verify the feasibility of the PSO and PSO-TVIW algorithm. comparison between classic PSO algorithm and PSO-TVIW algorithm showed that PSO-TVIW can track the MPP quickly and accurately. The PSO-TVIW algorithm has strong robustness and reduces the fluctuation near the MPP of PV system. . The proposed PSO-TVIW is tested under different two cases, and its performances are compared with the conventional PSO algorithm From the simulation results, it was found that the IPSO provides reliable and efficient tracking of the global maximum power point of solar panels under partial shading. The developed PSO-TVIW algorithm can handle the PSC very efficiently under different shading conditions.

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