Gyanshauryam, International Scientific Refereed Research Journal
© 2019 GISRRJ | Volume 2 | Issue 6 | ISSN : 2582-0095

Maximum Power Point Tracking Method for Solar PV Cells by Using Flower Pollination Algorithm

Dr. T. Srinivas Sirish[1], M. Solomon[2]

[1]Professor, Department of Electrical and Electronics Engineering, GVP College of Engineering and Technology, Visakhapatnam, Andhra Pradesh, India

[2]Power Systems and Control Automation, GVP College of Engineering and Technology, Visakhapatnam, Andhra Pradesh, India

ABSTRACT

Solar technology is emerging as one of the main power source. Photovoltaic is a strategy for creating electrical power by changing solar radiation into direct current (dc). The performance of solar PV cell is effected by both temperature and irradiation. Power generation from solar PV has considerable attention of regular availability, Pollution free and eco-friendly nature. The mainproblem is vested with the solar is partial shading (i.e different irradiations) on the panels. In order to get the Maximum Power Point from the PV cells, So many Conventional and soft computing techniques are incorporated. One of the most popular and well known method is Particle Swarm Optimization (PSO). PSO is used to track the Maximum Power Point from the solar PV in uniform irradiation conditions. The PSO is miserably failed to track the MPP under partial shading conditions. The new natural based optimization method of Flower Pollination Algorithm is proposed. The Flower Pollination Algorithm is inspired by the natural pollination process in flowers. The FPA is good in tracking of MPP under uniform and partial shading conditions. In this work the FPA algorithm is applied to three cases of partial shading conditions, such as (i) Zero shaded condition, (ii) Weak Shaded condition and (iii) Strong Shaded condition. Flower Pollination Algorithm is done by two processes i.e, Global pollination and local pollination. The FPA technique has better advantages over PSO especially good tracking of MPP and less convergence time. The simulation results are proved FPA is better in good tracking and high efficiency compared to Particle Swarm Optimization.

Keywords : Particle Swarm Optimization, FPA , MPP

I. INTRODUCTION

Generally the solar array contains solar panels and cells with required manner. The connection of solar cells per the module is user defined to grab the maximum power. Whenever the sun shines, the light energy is fed on the solar panels it will directly converted into direct current (dc) electricity.

Maximum power point tracking controller is used to track the maximum power point of the solar panel. The MPPT track the solar panel point means which point is gives the constant power at any condition. In this proposed work Boost converter, Voltage sensor and Current sensors are used. Boost converter is used to step up the voltage which is generated from the solar pv panel. Voltage and current sensors are senses the solar panel output voltages and currents, these signals are given to the MPPT controller. The MPPT controller is send the pulses to the boost converter. The block diagram of the proposed system is shown in below fig1.

The block diagram of the proposed system expresses the mppt controller sends the duty cycles to the boost converter based the solar output with the help of PWM generator. Here the PWM generator is used to give the pulses to the converter.

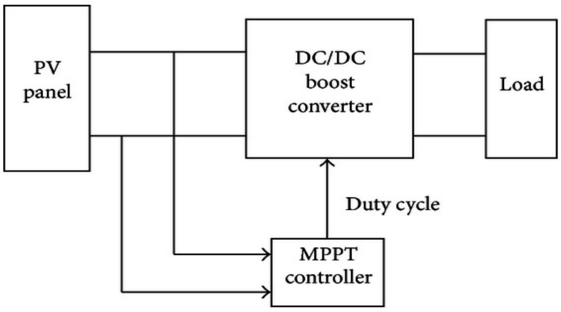


Fig1. Block diagram of the proposed System

II. METHODS AND MATERIAL

SOLAR PV SYSTEM

Nowadays non-renewable sources are less and less, because its occurrence is increasing day by day but it not renewable as its name suggests. With this criterion of the living environment and the increasing the demand of the power, Humans must find out new energy like solar, wind and tidal so on. And the most well known new energy is solar energy. The solar pv system has solar cells, solar panels and array as shown in below figure 2.

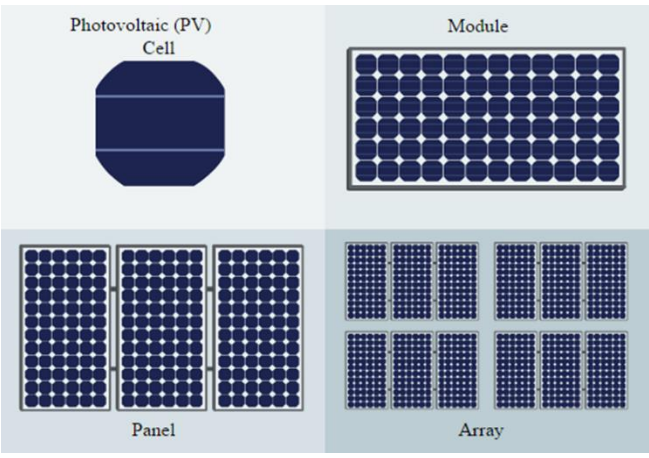


Fig2. General representation of solar pv system

MODELLING AND SIMULATION OF PARTIAL SHADING OF SOLAR PV CELL AND ITS EFFECTS

Partial shading is phenomenon to deliver the low power on pv panel or array of the panel due to the shading of the lighting. Why shading occurs on the lightning is moving of clouds, birds dropping and building or tree shadows on the solar pv cell. In this work we are taken three shading conditions i.e zero, weak and strong shading condition. These three shading conditions are fully dependent on the irradiation and temperature. In uniform condition the maximum power point tracking is easy and get the maximum output also. In case of two shading conditions i.e weak, strong shading conditions the tracking of mppt is difficult and also output is lower compared to uniform irradiation condition.

(i) ZERO SHADING CONDITION

Zero shading of the panel is there is no shading occurrence on the panel i.e uniform irradiation condition. Here we are taken four uniform irradiation is [1000 1000 1000 1000]. These four uniform irradiations are given to the solar panel output of the panel must be high because of mppt controller track the maximum power point. The string of four panel 4S are connected in series with uniform irradiation condition is shown in below figure4.

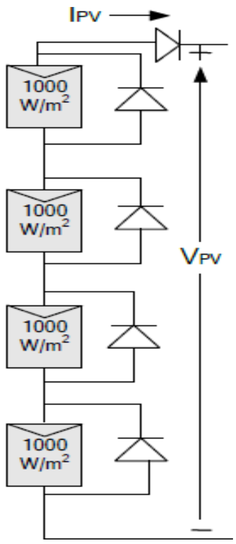


Fig 4. A string of four panel Zero shading condition – pattern1

The schematic of 4S PV array with bypass and blocking diodes are shown in above fig4.1 Bypass and blocking diodes are present to protect the panels and array against 'hotspots' and current reversal. The current reversal means in some situations the current flows from load to source, in that conditions the blocking diodes are incorporated to doesn't allow the current reversal which is load to source. Further, panels when uniformly illuminated that is at zero shading condition, the I-V curves of the individual panel sums up and forms a single peak in P-V curve.
First of the model of arrangement of the four panels is connected in series is shown n below fig 5. The simulation result of the solar panel with zero shading condition is shown in below figure 6.

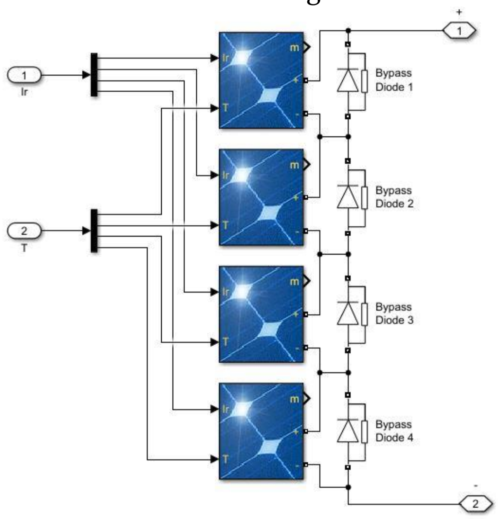


Fig 5. Series connection of four PV panelst

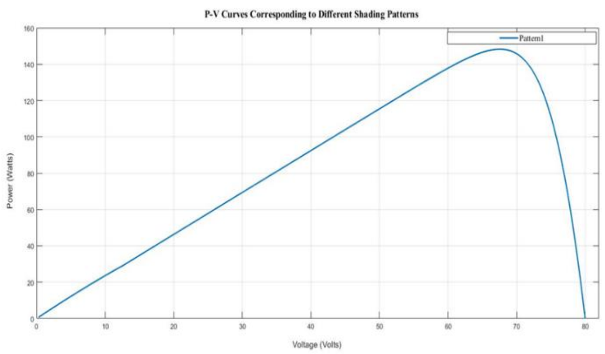


Fig.6. A string of 4 panels in series with zero shading condition, Corresponding PV curve.

The maximum power point of the solar pv cell output power is148W in zero shading condition. One important thing if we observe the graph single peak is arrived due to the uniform irradiation.

(ii) WEAK SHADING CONDITION

Weak shading of the solar panel means two shading occurrences on the panels i.e non-uniform irradiation condition. Here we are taken four panels with two non-uniform irradiation is [1000 1000 300 300]. The string of four panel 4S are connected in series with non-uniform irradiation condition is shown in below figure7.

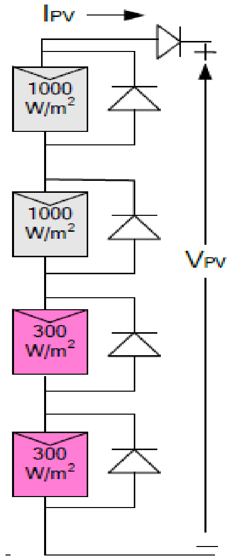


Fig.7. A string of four panel Weak shading condition – pattern 2

The two non-uniform irradiations conditions are occurred due to moving of clouds or building shadows. The corresponding resultant graph is show in below fig8. The graph has two peaks of the output power. These two peaks are different, so in order use the mppt to grab the best peak in the maximum power point.

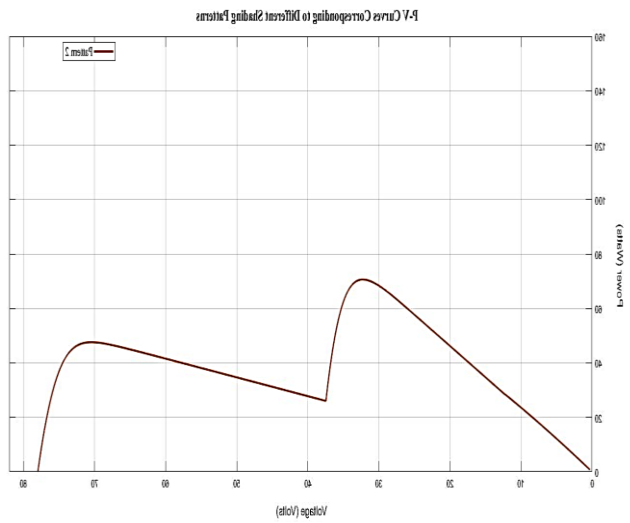


Fig8. A string of 4 panels in series with weak shading condition, Corresponding PV curve

The weak shading condition of the output power is 70W. The Two peaks of the output powers is 70W and 50W. Output power of the weak shading is lower as compared to zero shading condition, because of non- uniform irradiance conditions.

(iii) STRONG SHADING CONDITION]

Strong shading condition means the solar panel is fully shaded by the partial shading. In this work we are taken four different irradiation conditions [1000 700 500 300] are given to the panel. According to these four shades are gives the four peaks of the output power. The mppt controller is to reach the maximum output peak within the four peaks.

The strong shading output power is very less compared to zero and weak shading conditions. From this the output of the solar power is fully depends on the irradiance. The corresponding peaks of the strong shading conditions are 30W, 50W, 60W and 45W. These four peaks are developed due to the shading effects on the pv panel. Strong shading condition pattern model is shows in below figure9. A string of four panels connected in series with strong shading condition, Corresponding PV curve is shown in below figure 10.

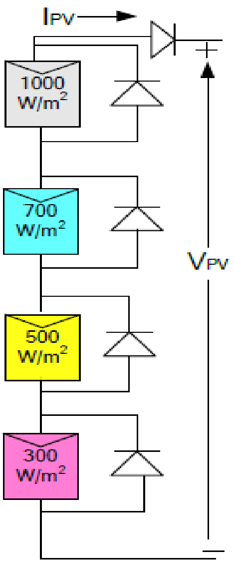


Fig 9. A string of four panel Strong shading condition – pattern3

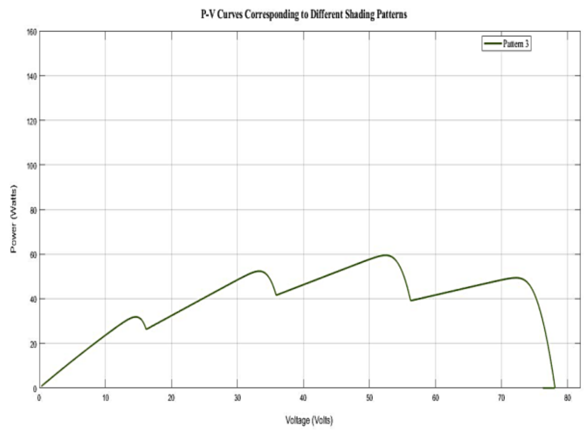


Fig 10. A string of 4 panels in series with weak shading condition, Corresponding PV curve

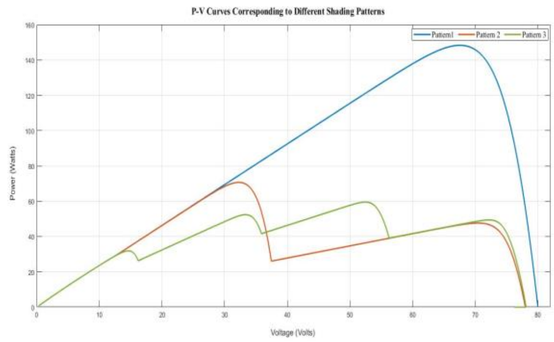
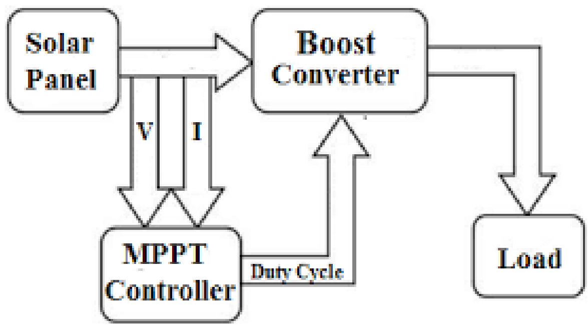


Fig11. P-V Curves corresponding to different shade patterns.

III. MAXIMUM POWER POINT TRACKING ALGORITHMS

Maximum power point tracking method plays important role in solar and wind energy systems. The solar pv cell has different peaks at different irradiation as we explained in chapter 4, In this tracking of maximum power point is a biggest task to mppt controllers. By using of mppt controllers the efficiency of the solar panel is maximum. In this work we are used DC-DC boost converter to step up the input voltage. The general schematic diagram of solar pv panel with mppt controller and boost converter is shown in below figure12.



The current and voltage characteristic of a solar array is non-linear, which makes it difficult to determine the Maximum power point. The figure 13 gives the characteristic of I-V and P-V curve for fixed level of solar temperature and irradiations are obtained by varying external resistance from short circuit to open circuit. At which point the maximum power is delivered.

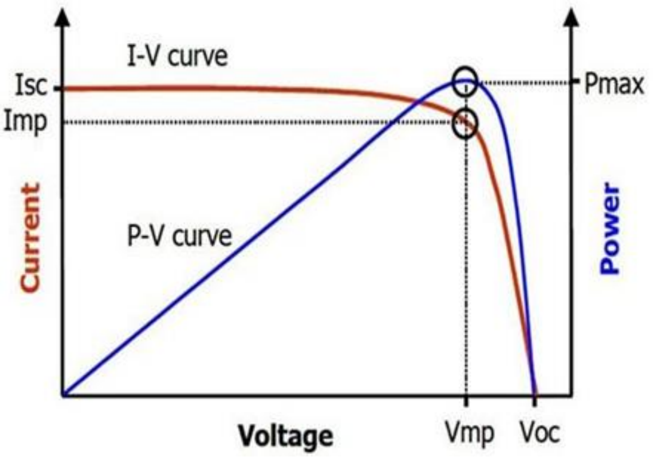


Fig 13 solar array I-V & P-V curves with MPP

(i) TYPES OF MPPT TECHNIQUES

The maximum power point tracking methods are as follows

- Particle Swarm Optimization
- Perturb and Observe method
- Incremental Conductance method
- Constant Current method
- Constant Voltage method

The perturb and observe method is also called hill climbing method. This method is very popular and well known to every one for Maximum Power Point Tracking applications. Comparison of PSO algorithm With P&O algorithm is less efficiency. The P&O algorithm tracking is excellent under uniform irradiation conditions, but this method is poor in tracking of MPP in partial shaded conditions.

(ii) PERTURB AND OBSERVE ALGORITHM

This P&O method is a very common technique in maximum power point tracking of solar pv array. The P&O algorithm is mainly depending on the perturbation and observation of operating voltage of the solar pv array. The *dp/dv* value is very important in mppt algorithm. If the value of *dp/dv* is positive, then the algorithm increases the voltage value towards the MPP until *dp/dv* value is negative. This iteration process is continued until the algorithm reaches final value of the solar pv MPP.

The P&O techniques can be classified into five groups according to the controlled variable output from the MPPT block and the perturb value generation. These five different types of p&O techniques are classified as

- Conventional P&O with fixed perturb
- Modified P&O with fixed perturb
- Conventional P&O with adaptive perturb
- Modified P&O with adaptive perturb
- Novel P&O with fixed/adaptive perturb

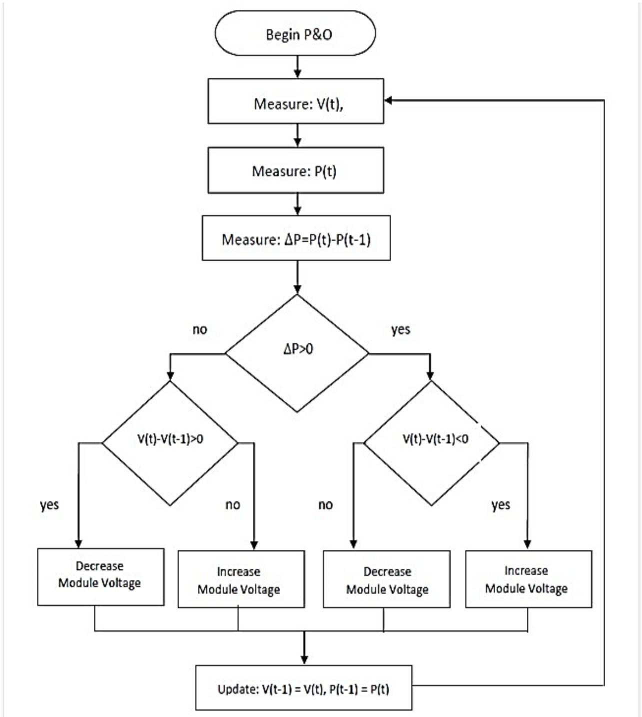


Fig 14. Flowchart for P&O MPPT Algorithm

From the above fig flowchart for P&O MPPT Algorithm method is understood that initially current and voltage values are taken from the output of pv array using current and voltage sensors. The output of pv array is given to the MPPT controller. The MPPT controller verifies the output of the array with reference maximum output power, if it is less power the mppt controller gives pulses to the switch with the help of PWM generator. After grab the maximum output power from pv array the boost converter supplies the power to the load. Next thing is reinitializing the parameters for the next iteration.

It is taken that P&O technique is suffers with some disadvantages. For fixed step size, values the steady state oscillations are proportional to the perturb value. Larger oscillations are due to higher perturb values.

IV. PARTICLE SWARM OPTIMIZATION MPPT WITH SIMULATION RESULTS

Particle swarm optimization is the natural optimization method inspired by the nature of bird flocking. The all the birds in the search process are grouped into one swarm, rather than they have been dispute to search the food in search process. Here we are call it as particles in the place of birds. Each particle has its own best and they are co-ordinate with the other particles, which has in swarm. After sharing the information between the particles, finally they get the maximum peak point. The ultimate goal of each particle is getting maximum peak, when it reach each and every particle co-ordinates with one and another totally the swarm reaches the maximum peak, which is in the search space. One important thing is each particle has its own best called particle best, after they reached the particle best, the particle are updates and they find the global point in the search is called global best.

The learning process of particles is based on two rules: attracted towards the global best position discovered by others (social influence) and drawn towards its local best promising position (cognition influence). The each particle position will be evaluated by a fitness function. In this work the fitness function utilizes the output voltage (V) and output current (I) are calculated by the fitness function of the each particle. The local and global best positions are determined by how much power is generated by a specific operating voltage. The highest power point is the global best.

In this work we are taken three different shading conditions of zero, weak and strong shading conditions. Here the PSO algorithm is applied to the maximum power point tracking method for solar pv cell. PSO algorithm is applied to three different shading conditions of solar pv cells. The Matlab program of PSO algorithm coding is incorporated to matlab Simulink model via matlab function block.

The Particles movement in search process is shown in below figure7.1 The particle position, x_i is adjusted using

$$x_i^{k+1} = x_i^k + v_i^{k+1}$$

Where the velocity component, v_i, represents the step size. The velocity is calculated by

$$v_i^{k+1} = wv_i + c_1 r_1\{P_{besti} - x_i^k\} + c_2 r_2\{G_{besti} - x_i^k\}$$

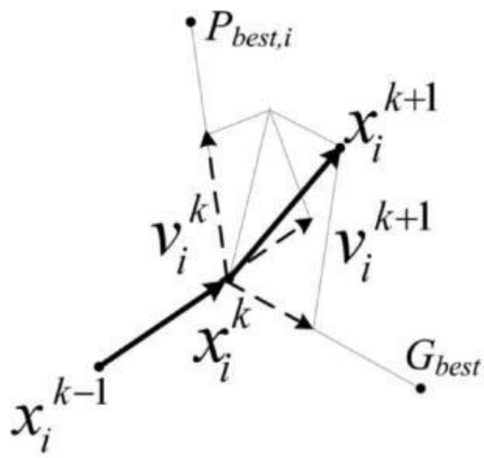


Fig15. Movement of particles in the optimization process

(i). PSO ALGORITHM

The flowchart for the PSO algorithm is shown in below fig15. The PSO algorithm is used so many applications, but in this work we have used to MPPT application. In this algorithm the initialization of the particles is very important.

The evaluation process is involved in identifying the optimal duty cycle using PSO method is applied to the solar maximum power point tracking. Here in this work developed the algorithm for three partial shading cases.

The procedure of the PSO Algorithm is same either uniform irradiation condition or partial shading conditions. The PSO algorithm is developed in five steps to track the Maximum power point within the convergence time irrespective of any disturbances. The Particles of the each Pbest is updated via matlab program. The matlab program is same for all conditions of solar pv panel. The fig16 shows the flowchart of PSO MPPT algorithm.

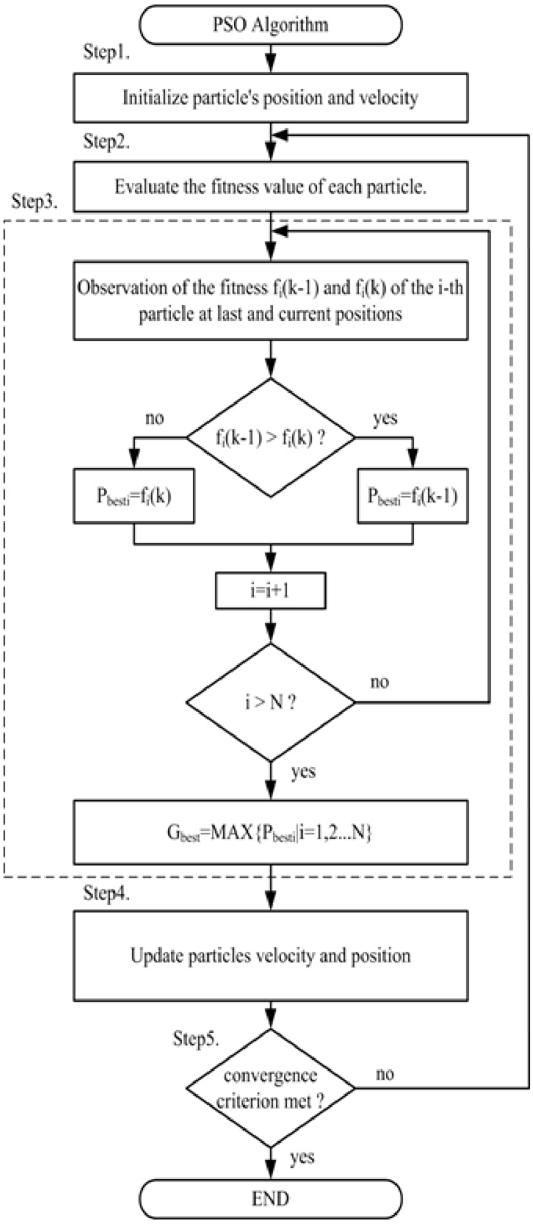


Fig16. Flowchart of PSO MPPT Algorithm

(ii). PSO MPPT SMULATION RESULTS

The simulation diagram of PSO MPPT technique has matlab function, boost converter, saturation region and pwm generator. In this diagrams has uniform and non-uniform irradiance is given to the solar pv cell in three shading conditions i.e [1000 1000 1000 1000], [1000 1000 300 300] and [1000 700 500 300]. Boost converter is to step up the voltage of the input voltage. Pwm generator is used to generate the pulses to the switch. Saturation region is range of the duty cycle, which is generated by the pso mppt technique. The matlab work space program is dump into the simulation file through matlab function block. The simulation results of zero shading, weak shading and strong shading conditions of the solar pv panel with corresponding duty cycle is shown in below figures 17,18 and 19.

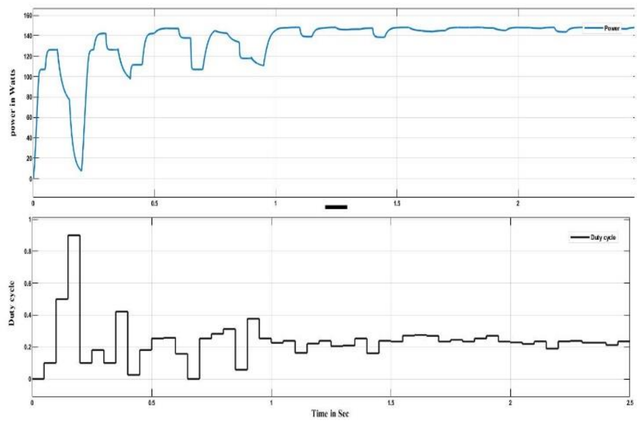


Fig17. Simulated Power and Duty cycle curves of zero shading PSO MPPT

The output power is 148W in zero shading condition by using PSO MPPT technique, but the settling time is 2.3Sec. The number of oscillations in the output curve is less, because of uniform irradiation condition.

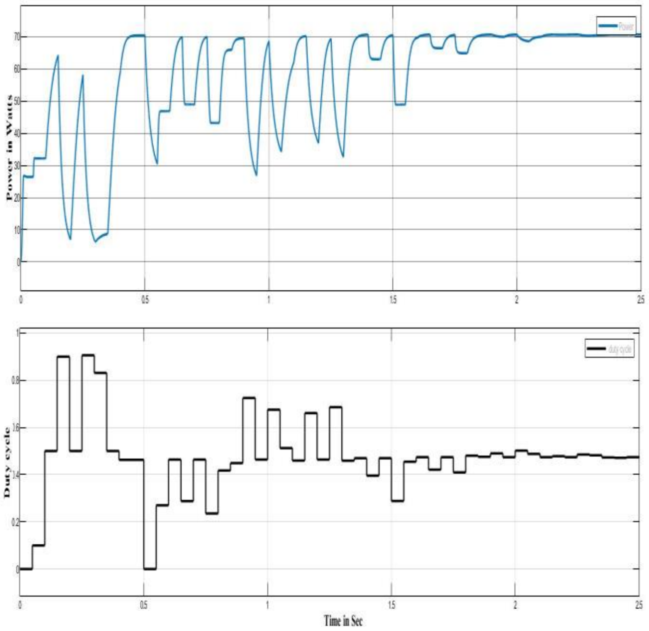


Fig18. Simulated Power and Duty cycle curves of weak shading PSO MPPT

The output power is 70W in weak shading condition by using PSO MPPT technique, but the settling time is 2.0Sec. The number of oscillations in the output curve is more, because of non- uniform irradiation condition.

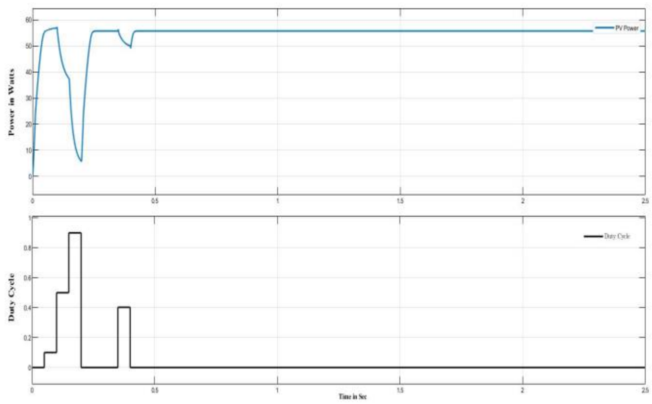


Fig19. Simulated Power and Duty cycle curves of Strong shading PSO MPPT

The output power is 55W in Strong shading condition by using PSO MPPT technique, but the settling time is 0.4Sec. The number of oscillations in the output curve is less, and the settling time is also less.

By the observation of three cases output results first two cases are getting output power is good, but strong shading condition is less power compared to partial shading curves which are discussed in above partial shading conditions. The settling time is more in two cases of zero and weak shading conditions, but in strong shading condition the settling time is less.

(iii) DEMERITS OF PSO MPPT

The major problem vested with PSO method is its initial duty cycle selection.

Less convergence Less tracking speed especially in partial shading condition

V. FLOWER POLLINATION ALGORITHM WITH SIMULATION RESULTS

The Flower Pollination Algorithm was first proposed by Mr. Xin - She Yang in the year of 2012. Pollination is a phenomenon refers to transfer of pollens from one species to other. The term pollination is generated either by self pollination or cross pollination. This process helps the flowers to emerge new species. Based on the pollen, two types of pollination were occurred as

(a) Abiotic pollination – Self pollination

The One flower species of same type, i.e., pollens of the same plants, fertilize to emerge new species where wind is the pollinating agents, this process is called Self- pollination.

(b) Biotic pollination – Cross pollination

The transfer of flower pollens takes place between two different species where the pollinators are honey bees, bats and birds, this process is called Cross- pollination. Here, it is noteworthy to mention that in FPA, 90% of pollination are cross pollination and remaining 10% is self-pollination. the controlling between two processes of self and cross pollination is restricted by a probability switch P. Flower constancy is measured by reproduction probability where it is directly proportional to flowers involved in pollination. To implement FPA, Two fundamental rules are designed as

Rule 1: Biotic or cross pollination represents the global pollination process and follows levy flight for transfer of pollens. For instance, the i^{th} pollen on k^{th} iteration updated via biotic pollination process can be expressed as

$$x_i^{k+1} = x_i^k + L(g_{best} - x_i^k)$$

Where 'g_{best}' current best solution obtained with a set of pollens ('x_i^k'). 'L' is the levy factor responsible for the transfer of pollens. Further it is a key parameter that strengthens the pollination process. Since the pollen transfer follows the levy distribution, the flight of the pollen in levy distribution is given by

$$L = \frac{\lambda \Gamma(\lambda) \sin\left(\frac{\pi\lambda}{2}\right)}{\pi} \frac{1}{S^{1+\lambda}} \; (S \gg S^0 > 0)$$

Where '$\Gamma(\lambda)$' the standard gamma function and the distribution is applicable to a large step size which is greater than zero ($S \gg S^0 > 0$). Based on trial and error method the value of 'λ = 1.5' to ensure fast convergence.

Rule 2: Abiotic or self-pollination is characterized by the local pollination process. The characteristic equation for local pollination is given as follows,

$$\boldsymbol{x_i^{k+1} = x_i^k + \varepsilon\,(x_m^k - x_j^k)}$$

Where 'x_m^k' and 'x_j^k' are different pollens i.e., flowers of the same species. The term 'ε '(epsilon) represents the local search in distribution $\varepsilon \in [0, 1]$. Local pollination occurs in neighborhood of flowers that are at shorter distance, while global pollination happens with plants at elongated distance.

Thus, to control the switching between pollination process "probability switch '$P \in [0, 1]$' is used. In this work the probability switch is taken as 0.95 as trial and error method.

The FPA method is very much desirable to apply for nonlinear optimization problems. This method is best suited for MPPT applications, it explores globally and exploits locally within a single iteration. This FPA algorithm introduces randomness in every iteration via self pollination.

(i) IMPLEMENTED FPA FOR MPPT APPLICATION

The steps involved in implementation of the FPA method in MPPT application are devised and are explained as follows.

Step 1: Initialization of parameters: Maximum iteration number (*N*), limits on duty cycle (x_{min} & x_{max}), probability switch (p) and initial duty cycle population size (*X1, X2, X3, X4 & X5*) are set to five different values respectively.

Step 2: Fitness evaluation: In this step, pollens suitability is evaluated using fitness function.

Step 3: Pollination process: which one is the better pollen is marked as global best with higher values. A random number between 0<rand<1 is generated based on probability switch (P) and the condition (if rand>P) every pollen in the pool must undergo either cross or self pollination. In this step the pollination is done in two processes

(i) Cross pollination

(ii) Self pollination

Step 4: Pollens new position: Following step 3, all the pollens in the pool arrive at their new position (i.e., duty cycle) via cross or self pollination.

Step 5: Termination Criterion: Repeat the steps between 2 to 5 until all the pollens converge to reach the maximum power for the given iteration count (i.e) *N=25*.

Step 6: Reinitiating search on Insolation changes: To identify the occurrence of partial shading condition/ irradiation change, threshold changes in voltage and current values between iterations are monitored. Based on the change in threshold values, the irradiation change is noted and the algorithm gets reinitialized with the search process restarts from step 1.

(ii) FLOWCHART OF FPA ALGORITHM

The flowchart for the implemented FPA MPPT is shown in below figure 20. The algorithm is designed to solar maximum power point tracking in three cases of partial shading conditions. Whatever the input of the solar panel, but the algorithm is track the maximum power point.

The Fpa algorithm is developed to search the maximum power point globally in the fixed boundary limits of duty cycles. This global process is normally accompanied by levy flight and once the algorithm determines the nearest value of mpp it starts to go in the direction of local pollination.

To improve the performance of the FPA is effectively tuned by the two parameters such as probability switch and scaling factor. These two parameters successfully selected in that way the algorithm should converge at a faster rate. Here we are taken the probability switch rating is 0.95. The scaling factor is varied based on the step size. Thus the above changes lead to shorter convergence time and better output values were given corresponding to other optimization techniques.

(iii) FPA MPPT SIMULATION MODEL WITH RESULTS

The block diagram of the proposed system is shown in below figure21. It is noteworthy to mention that both PSO and FPA method follow five randomly selected duty cycle initialization. The proposed MPPT control structure with DC-DC boost converter is shown in Fig.21. The sampling time between duty cycles is taken as 0.03 Sec.

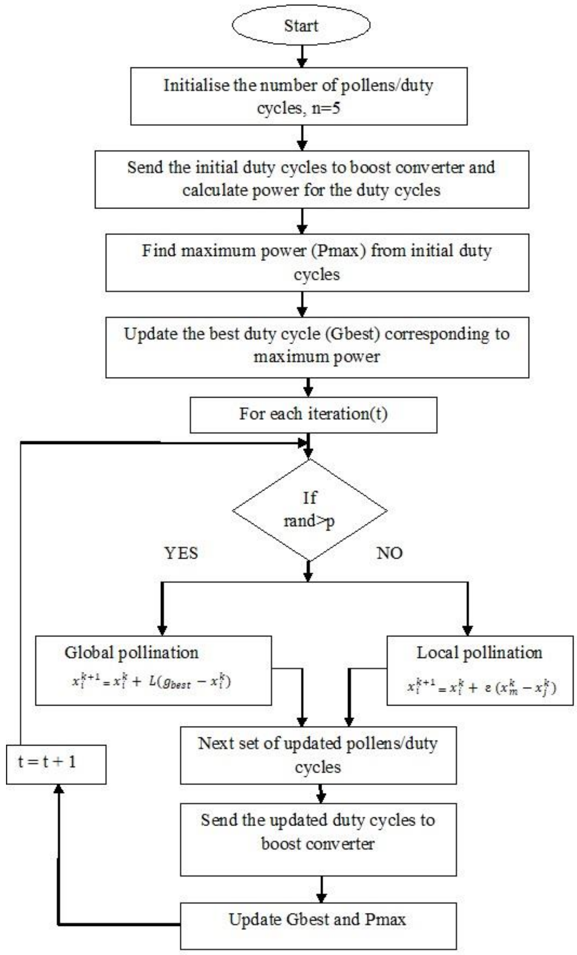


Fig 20. Flowchart for FPA implemented MPPT

Generally, parameter tuning is one of the essential stipulations that decide the performance of bio inspired algorithms. Further, it is an important factor in achieving faster convergence towards Global MPP.

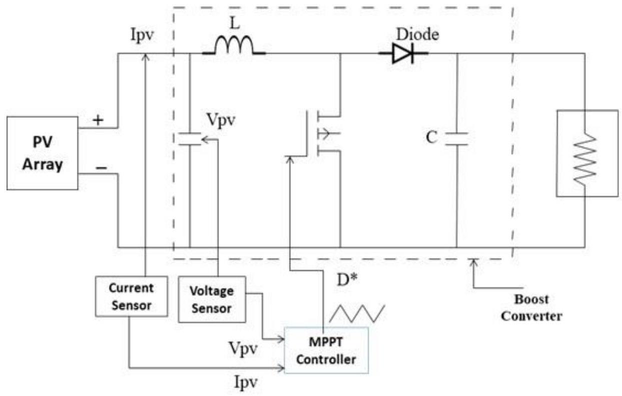


Fig21.Block diagram of the proposed system

(iv). FPA MPPT SMULATION RESULTS

The simulation diagram of FPA MPPT technique has matlab function, boost converter, saturation region and pwm generator. In this diagrams has uniform and non-uniform irradiance is given to the solar pv cell in three shading conditions i.e [1000 1000 1000 1000], [1000 1000 300 300] and [1000 700 500 300]. Boost converter is to step up the voltage of the input voltage. Pwm generator is used to generate the pulses to the switch. Saturation region is range of the duty cycle, which is generated by the FPA mppt technique. The matlab work space program is dump into the simulation file through matlab function block. The simulation results of zero shading, weak shading and strong shading conditions of the solar pv panel with corresponding duty cycle is shown in below figures 22,23 and 24.

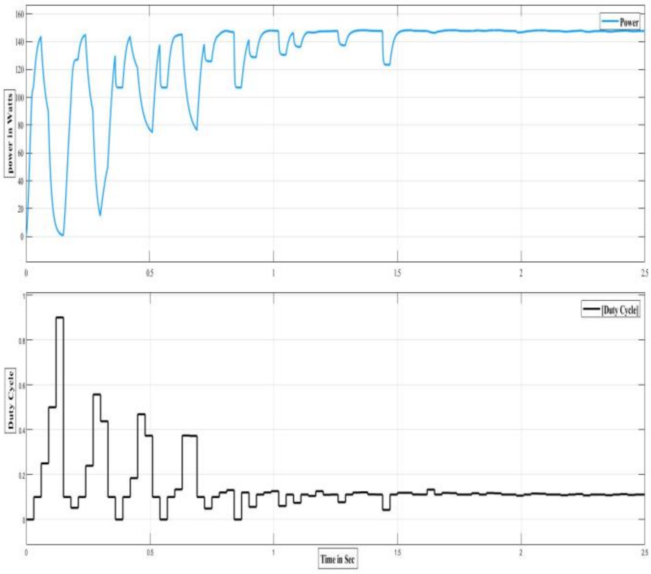


Fig 22. Simulated Power and Duty cycle curves of FPA MPPT for zero shading

The FPA method reaches to a global peak within 1.5Sec. Further, it is intresting to note that FPA locates the optimized position in quick time (i.e) converges after 3rd iteration.

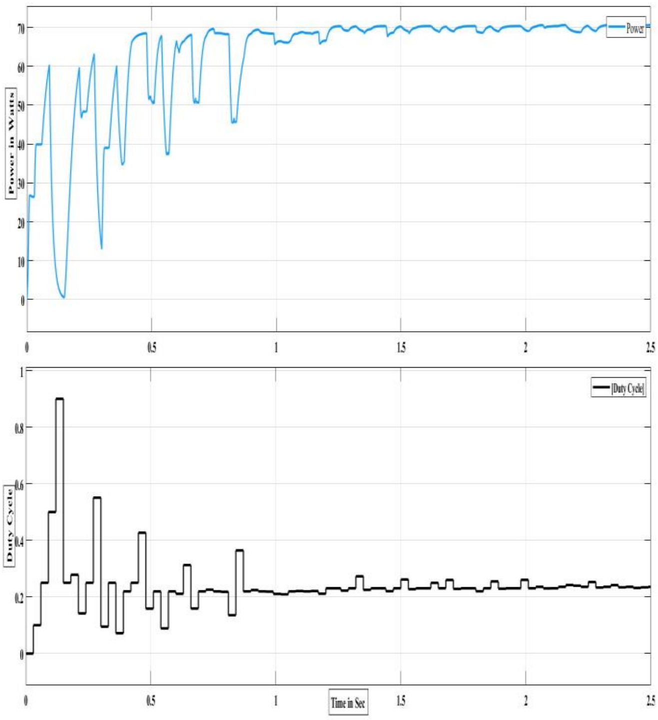


Fig 23 : Simulated Power and Duty cycle curves of FPA MPPT for weak shading condition

The FPA MPPT converges to GMPPT of 70W, in less than 1.1Sec. However the time taken to converge is more time compared to zero shading because in this partial shading. Here the two peaks are arrived as already seen in chapter4, due to the partial shading the convergence time is quitly larger to compare with the zero shading FPA MPPT.

The MPPT curves under non-uniform irradiation (i.e) taken as strong shading condition case-3 is employing the power convergence with time. In the output curve exists a single peak at 60W, reaching this peak using FPA MPPT method is especially excellent in partial shading condition.

The performance of the MPPT method can be critically analyzed when strong shade occurs due to exposure of more number of panels to different irradiation.

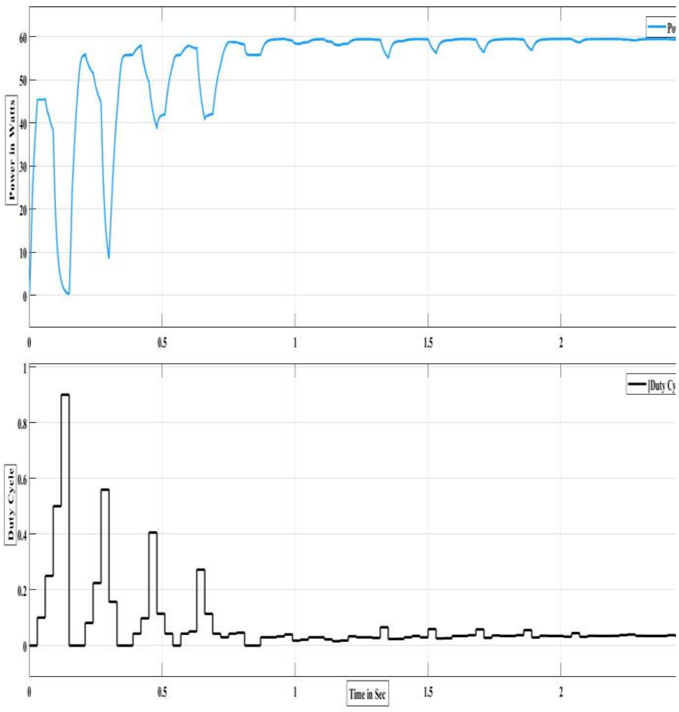


Fig 24 : Simulated Power and Duty cycle curves of FPA MPPT for strong shading condition

VI. COMPARISON OF FPA MPPT AND PSO MPPT WITH EXPERIMENTAL RESULTS

(i). Case 1: Zero shading condition

The comparison of FPA MPPT with PSO MPPT of zero shading condition is shown in below figure25.

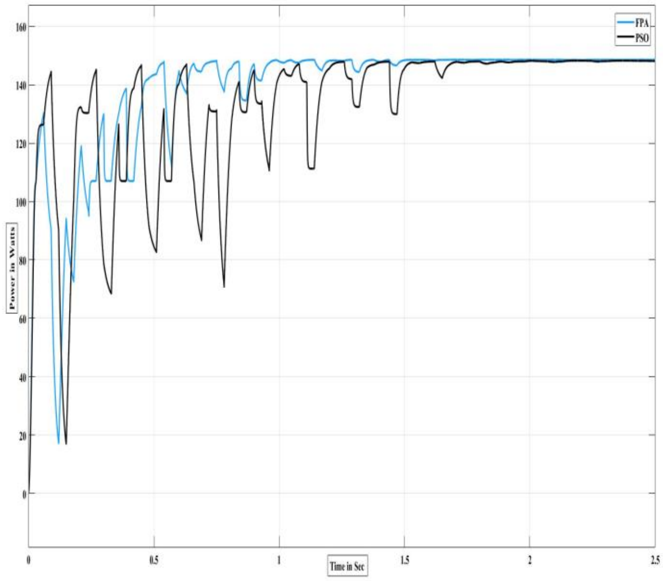


Fig.25: Simulated Power curves of FPA and PSO MPPT for case-1

In this case, FPA converges to GMPP of 148W in less than 1.0 Sec while PSO takes 1.8Sec to converge at GMPP. Even though PSO method senses GMPP in first iteration larger velocity created during position updation slows down its convergence speed and increases the iteration count.

(ii). Case 2: Weak shading condition

The comparison of FPA MPPT with PSO MPPT of weak shading condition is shown in below figure26.

In this case, FPA converges to GMPP of 70W in less than 1.1Sec while PSO takes 1.8Sec to converge at GMPP. Even though PSO method senses GMPP in first iteration larger velocity created during position updation slows down its convergence speed and increases the iteration count.

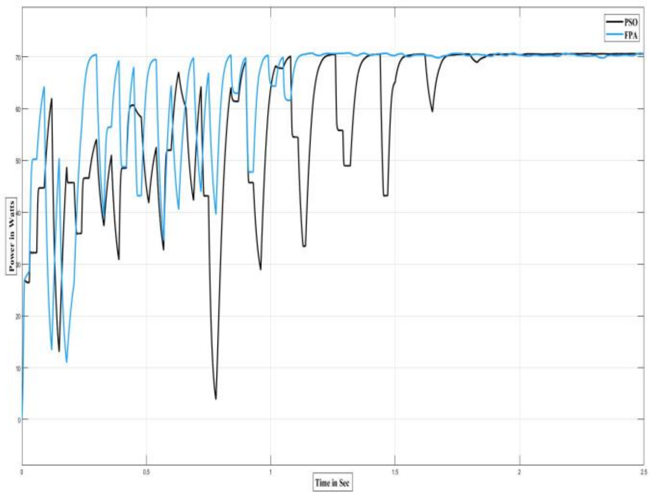


Fig.26: Simulated Power curves of FPA and PSO MPPT for case-2

(iii). Case 3: Strong shading condition

The comparison of FPA MPPT with PSO MPPT of Strong shading condition is shown in below figure27. The performance of the MPPT method can be critically analyzed when strong shade occurs due to exposure of more number of panels to different irradiation.

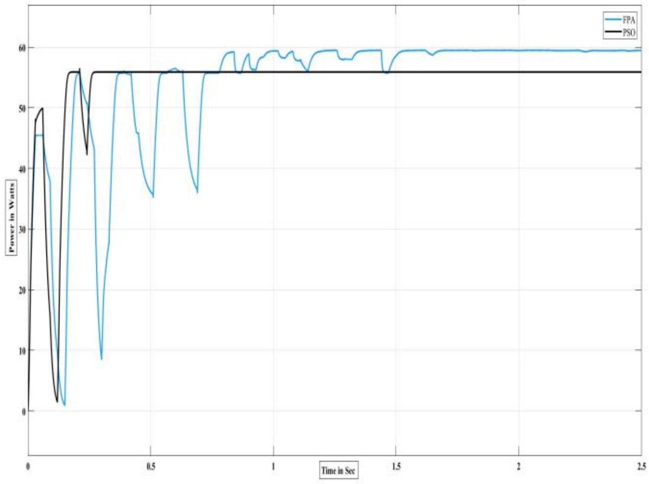


Fig.27: Simulated Power curves of FPA and PSO MPPT for case3

The FPA MPPT power is 60W, here it is successfully tracked the MPPT under strong shading condition. The FPS and PSO convergence times are 1.5Sec, 0.3Sec correspondingly. The PSO MPPT is miserably failed to track the MPPT output is 5W less than the FPA MPPT. The three cases of FPA MPPT and PSO MPPT output power and settling time values are placed in the below table 1.

Condition	PSO MPPT		FPA MPPT	
	Output Power in watts	Settling Time in sec	Output Power in watts	Settling Time in sec
Case-1 Zero shaded	148	1.7	148	1.0
Case-2 Weak shaded	69	1.8	70	1.1
Case-3 Strong shaded	55	0.3	60	1.5

Table1: Comparison of PSO and FPA MPPT Techniques

VII. CONCLUSION

In this research work, a new implemented FPA method is used for maximum power point tracking of solar pv cell was performed. The various simulation results are performed with three different case and test cases. From the simulation results,

- The FPA-MPPT is unique in solar pv mppt , due to the updation of duty cycle on each and every iteration is performed via cross and self pollination.
- In the different partial shading conditions, irrespective of the shading pattern the FPA has capability track global peak.
- The FPA method is good in updation of duty cycle to every iteration and it is performed via cross and local pollination leading to quick convergence with high accuracy.
- Hence the proposed FPA in comparison with other PSO method yield faster convergence and good tracking.

VIII. REFERENCES

[1]. Sheikh, N. M. "Efficient utilization of solar energy for domestic applications", second international conference on electrical engineering, doi: 10. 1109/ice.4553911, published in Jan 2008.

[2]. X.Zhang, Cui. F, Zhao, Q., Zhang, L. Wang, J. Xiong, G, and Che. G, "Comprehensive assessment on development application of solar based technologies based on analytic hierarchy process," IEEE conference on energy internet and energy system integration, Doi: 10.1109/ei2.2017.8245695, published in May 2017.

[3]. J.W. Bishop, "Computer Simulation of the effects of electrical mismatches in photovoltaic cell interconnection circuits", Solar Cell technologies, vol.250, pp.73– 89, published in Jan 1988.

[4]. Juan David Bastidas -Rodriguez, Edinson Franco, Giovanni Petrone, Carlos Andrés Ramos-Paja and Giovanni Spagnuolo, "Maximum power point tracking architectures for photovoltaic systems in mismatching conditions:a review", IET Power Electron., Vol. 7, Iss. 6, pp. 1396–1413, published in Jan 2014.

[5]. R Bruendlinger, "Maximum power point tracking performance under partially shaded PV array conditions", In: Proc 21st EUPVSEC, 2157–60, published in Germany 2006.

[6]. Shongwe, Samkeliso, and moin hanif. "Comparative analysis of different single-diode PV modeling methods", IEEE journal of photovoltaics, Vol.5, no.3,pp.938-946, published in May 2015.

[7]. Jih-ShengLai, AhmedKoran and ThomasLaBella, "High Efficiency Photovoltaic Source Simulator with Fast Response Time for Solar Power Conditioning Systems Evaluation", IEEE Transactions On Power Electronics., Vol. 29, no. 3, pp.1285-1296, published in Mar 2014.

[8]. Bashar Zahawi, Elgendy Mohammed, and David J, Atkinson, "Operating Characteristics of the P&O Algorithm at High Perturbation Frequencies for Standalone PV Systems", IEEE transactions on energy conversion; Vol.30, no.1,pp.189-198, published in Mar2015.

[9]. Saad Mekhilef Azadeh Safari, "Simulation and Hardware Implementation of Incremental Conductance MPPT With Direct Control Method Using Cuk Converter," IEEE transactions on industrial electronics.,; Vol 58, no.4,pp.1154-1161, published in Apr 2011.

[10]. Hung-I Hsieh, Cheng-YuanTsai, Guan-Chyun Hsieh and Chi-Hao Wang, "Photovoltaic Power-Increment-Aided Incremental-Conductance MPPT With Two-Phased Tracking". IEEE transactions on power electronics., Vol.28, no.6, pp.2895-2911, published in Dec 2012.

[11]. Abdullah Noman, Ali Faisal Murtaza, Hadeed Ahmed Sher, Khaled E. Addoweesh, Kamal Al-Haddad, "A New Sensorless Hybrid MPPT Algorithm Based on Fractional Short-Circuit Current Measurement and P&O MPPT", IEEE transactions on sustainable energy., Vol.6,no.4.;pp.1426-1434, published in Oct 2015.

[12]. DB Snyman, JHR Enslin, MS Wolf, W Swiegers,"Integrated photovoltaic maximum power point tracking converter", IEEE Trans. Ind. Electron., Vol.44,No.6.pp.769–773, published in Dec 1997.

[13]. K. S. Low, T. L. Nguyen, "A maximum power point tracking method employing direct search algorithm for photovoltaic systems", IEEE transactions, Ind. Electron, no.10. pp. 4473-4482, Vol.57, published in Sep 2010.

[14]. Chian-Song Chiu, "T-S Fuzzy Maximum Power Point Tracking Control of Solar Power Generation Systems", IEEE transactions on energy conversion., Vol 25, no 4,pp.1123-1132, published in Nov 2010.

[15]. Karatepe T. Hiyama, E.Syafaruddin, "Artificial neural network-polar coordinated fuzzy controller based maximum power point tracking control under partially shaded conditions". IET Renew. Power Gener.,Vol 3, no.2,pp.239–253, published in May 2009.

[16]. Ezeldin Zakzouk, Ahmed K. Abdelsalam, Lina M. maximum power point tracking techniques: a survey". IET Renewable Power Generation., Vol.9, No. 8,pp-1043-1063, published in Nov 2015.

[17]. M. Miyatake ,M. Veerachary, "Maximum power point tracking of multiple photovoltaic arrays: a PSO approach", IEEE Trans. Aerosp. Electron. Syst., Vol. 47, No.1,pp.367-380, published in Jan 2011.

[18]. Zainal Salam and Kashif Ishaque. "An Improved Particle Swarm Optimization (PSO) Based MPPT for PV With Reduced Steady-State Oscillation," IEEE transactions on power

electronics.,Vol 27, no.8, pp.3627-3638, published in Jan 2012.

[19]. K. Sangeetha, N. Rajasekhar and T. Sudhakar babu, “Modified PSO technique based MPPT for uniform and non-uniform condition”, Applied soft computing, Vol 34, pp 613-624, published in May 2015.

[20]. SankaranPalani, Kinattingal Sundareswaran, Sankar Peddapati, “Application of random search method for maximum power point tracking in partially shaded photovoltaic systems.” IET Renew. Power Gen, Vol 8, no.6, pp.670-678, published in Aug 2014.

[21]. M. Karamanoglu and Xin-She. Yang, “Multi-objective Flower Algorithm for Optimization application, Procedia Computer Science, vol. 18, pp. 861-868, published in 2013.

Cite this article as :

Dr. T. Srinivas Sirish, M. Solomon, "Maximum Power Point Tracking Method for Solar PV Cells by Using Flower Pollination Algorithm", Gyanshauryam, International Scientific Refereed Research Journal (GISRRJ), ISSN : 2582-0095, Volume 2 Issue 6, pp. 48-62, November-December 2019.
URL : http://gisrrj.com/GISRRJ19265