

Maximum Power Point Tracking Using Ant Colony Optimization for Photovoltaic System Under Partially Shaded Conditions

K.Rajalashmi, Carolin monisha.C

Abstract: Renewable energy is that the energy that comes from natural resources like daylight, wind, rain, tides and geothermic heat. These resources are unit renewable and may be naturally restore. Therefore, for all sensible functions, these resources are often thought-about to be inexhaustible, not like dwindling typical fossil fuels. Energy are often extracted from variety of close conditions like vibration, solar, thermal gradient etc. the utmost power from these systems are often extracted by mistreatment MPPT beside power converters. a replacement technique to trace the world MPP is bestowed, that is predicated on hymenopteran Colony optimization (ACO) that dominant a DC-DC device connected at the output of PV array, such it maintains a relentless input-power load

Key words – PV panels, solar system, boost converter

I. INTRODUCTION

In the globe several energy sources are unit out there. one in all the foremost vital renewable energy sources is star energy. It is effectively accessible contrasted with alternative vitality sources and moreover provided substantial live of vitality to the planet. Sun power-driven vitality is spic and freed from emanations, since it does not produce any contamination or hurtful to the character. Among the fluctuated manners by which amid which of changing light into power, the PV frameworks straightforwardly convert radiation into power by the physical marvel result. Congregations of star cells construct star modules thus the huge scale PV frameworks by and large grasp many star modules associated nonconcurrent or parallel. noticeable of the nonlinearity between the PV yield voltage and current, there's a remarkable most divider connection (MPP) at intervals the power– voltage (P– V) characteristics underneath uniform atmosphere. when the PV bunches unit of estimation foursquare identified with the pile, potential power that might be free from the PV shows is lost. as an outcome of the ability yield of the PV displays inside the rudimentary relies on the customary for the pile. amid this implies on enlarge the ability from the PV system,

accomplice MPP searcher is frequently implanted between the PV displays and thereupon the store. it's made bound that the system operational style is changed as per be place at the MPP. All the above-named topologies aren't abundant correct and desires further hardware demand. so, it's higher to maneuver towards a sway rule that is principally supported improvement technique.

The limitations of traditional MPPT techniques are:

- To produce the best results in uniform irradiance and get stuck at local maxima when irradiance is not constant.

To improve the effectiveness of PV boards.

The fundamental commitment of this paper could be a non-established method that brings about the confinements of the ordinary MPPT strategies.

The MPPT algorithm determines if the PV system is able to operate at the global MPP. Ant colony optimization helps to obtain the global maximum and it improves the efficiency of solar panels. Output power of solar panel varies with respect to irradiance and temperature. So the maximum power can be extracted from solar panels using Maximum Power Point Tracking.

The maximum electric outlet (MPP) varies consistent with the quantity of star irradiance that hits the module and its temperature. The MPPT techniques are often categorized into 2 sorts. The first is called the typical MPPT, which incorporates perturb and observe (P&O), hill climb (HC), progressive electrical phenomenon, down electrical circuit voltage and short current. The second sort is predicated on soft computing (SC), which incorporates formal logic controller (FLC), artificial neural networks (ANN) and biological process algorithmic rule (EA). Most of the standard MPPT techniques demonstrate an honest steady-state and dynamic performance underneath traditional irradiance condition. several papers are unit mentioned concerning MPPT. [1] Has underlined the objective of a MPPT controller is to fulfill the accompanying displays criteria: truth, precision, speed, force and dealing with the down shading issue once climatically changes assortments occur. [2] Has shown the output current depends upon irradiance and temperature. [3] Has main objective to extract maximum power generated by the PV systems under varying condition of temperature and solar insolation [4] has broken down that the PV age frameworks regularly utilize a microcontroller-based charge

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controller associated with battery and furthermore the heap.[5] Proposed a major challenge in photovoltaic (PV) systems is making them energy efficient. [6] Has examined that to get economical most electric outlet pursuit operation below varied and steady state environmental conditions that relies on hymenopteran Colony improvement (ACO) combined with Particle Swarm improvement (PSO) that controls an interleaved DC-DC device connected at the output of PV array and maintains a continuing input-power load. [7] Had inspected that output power of solar panel varies with respect to irradiance and temperature. [8] Illustrated that there are different neighborhood tops when the PV exhibits are lit up under non-uniform irradiance.

II. EVOLUTION OF MAXIMUM POWER POINT TRACKING (MPPT)

Maximum wall plugs chase (MPPT) was 1st introduced within the Nineteen Eighties and galvanized the star trade to search out solutions to module inefficiencies. one among the biggest problems with solar energy continues to be the inefficiencies of the panels, that sometimes hovers below twenty fifth. most wall plug chase was designed to counteract the inefficiencies of those panels and still build them cheaper and powerful. MPPT doesn't have any correlation to mechanical trackers, which may oftentimes be utilized in combination with star modules.

The most outrageous outlet following (MPPT) could be a higher rehearsed DC-DC gadget advancement stood out from "shunt controller" and "heartbeat measurement modification (PWM)" technologies [5].Each electric cell contains a reason at that this (I) and voltage (V) yield from the cell lead to the most extreme power yield of the cell.

Fig 1 shows the maximum power point in the voltage, power and current characteristics. Fig 2 shows the PV curve for the different temperature levels of 25°C, 50°C and 75°C.

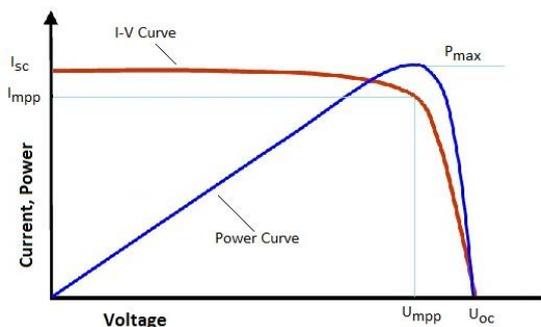


Fig 1. MPPT IV Curve

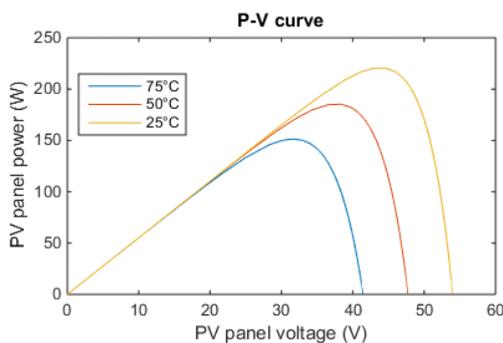


Fig 2. MPPT PV Curve

2.1 ANT COLONY OPTIMIZATION MECHANISM

Ant colony optimization improvement (ACO) takes motivation from the search conduct of some creepy crawly species. These ants store emission on absolute bottom in this manner on imprint some good way that got the chance to be trailed by various individuals from the state. creepy crawly province improvement abuses a comparative component for finding improvement issues. The main plan is that the self-organizing principles which permit the extremely coordinated behavior of real ants are often exploited to coordinate populations of artificial agents that collaborate to resolve process issues. many totally different completely different} aspects of the behavior of hymenopterous insect colonies have impressed different sorts of hymenopterous insect algorithms. Examples square measure forage, division of labor, brood sorting, and cooperative transport. altogether these examples, ants coordinate their activities via stigmergy, a type of indirect communication mediate by modifications of the atmosphere. This algorithmic rule supported a forage hymenopterous insect deposits a chemical on the ground that will increase the likelihood that alternative ants can follow an equivalent path

2.2 PROPOSED PV ARRAY CONFIGURATION STRUCTURE

PV modules can be associated in arrangement, parallel or a cross breed, among which the half and half associations are mainstream. By and large, the PV modules are not associated absolutely in parallel or arrangement since it may not meet the heap current and voltage necessities. Also, it diminishes the framework steadiness. For example, when one of the PV modules associated in arrangement is closed down, all the PV modules will be impacted by this single agitated module.

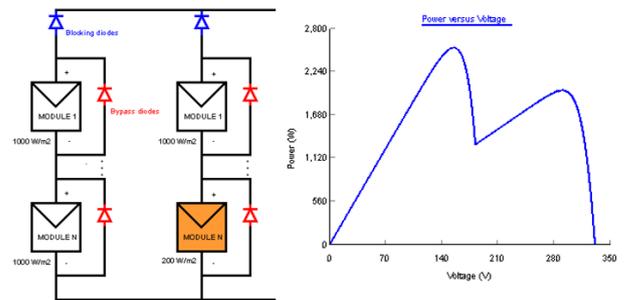


Fig 3. Operation of PV Array under Partial Shading

Fig 3. Shows the Operation of PV Array under Partial Shading the Ant Colony Algorithm (ACO) is combined with Particle Swarm Optimization algorithm (PSO). The subterranean insect province advancement (ACO) calculation is motivated by genuine insect conduct, which is utilized to locate the worldwide ideal answer for a nonlinear issue. ACO imitates the scrounging conduct of the ants to accomplish improvement of the way in a chart. The aggregate practices of a substantial number of ants shape a positive input wonder and ants at first pursuit the way unsystematic, and set down pheromone for different ants to pursue.



III. METHODOLOGY

ACO mimics the behavior of ants to find the optimized path. Initially ants move randomly in different directions in search of food. They deposit pheromone on their way for other ants to follow.

The deposited pheromone can also evaporate as time passes, so the probability of finding pheromone is more for the shortest path. This process is repeated for a number of iterations so that optimized path can be found.

1. Initialize the parameters (Max_Ite, Z, Y, Q, ζ).
2. Obtain voltage, current and calculate power for each ant. Repeat the same till Y ants.
3. Obtain Z new solutions using Gaussian function.
4. Rank M+K solutions and store best K solutions.
5. The above four steps are repeated till maximum number of iterations.
6. The corresponding current and voltage for obtained maximum power is noted. Duty cycle is calculated and is given to the boost converter.
7. Step Steps 2-7 will be repeated if there is a large change in Irradiance.

3.1 THE NEW PHEROMONE UPDATE BASED ANT COLONY OPTIMIZATION

The Ant Colony Optimization based New Pheromone Update (ACO NPU) is primarily founded on another procedure for refreshing the pheromone amid execution which is performed by choosing the best arrangements . For sure, the ants are constantly pulled in towards the best arrangements because of the intensification of the pheromone esteem. The ACO NPU uses a sporadic dispersal look for strategy.

The algorithm performs in three main steps, First, the archive (pk , k = 1 . . archive size) is initialized using values randomly generated in the interval [a, b] (the search space) and associate each solution to its fitness value calculated by the fit- ness function F. Then, the archive solutions are sorted according to the fitness values (F), which further help in choosing the best solutions to update the archive. The best solutions are selected from the archive, and an ant is assigned to each solution. A number of ants “m” of the best solutions in the archive are selected, where a pheromone initialization for each solution is performed as follow:

Calculate the distances Di between each xi solution among the selected solutions (i = 1 . . m) and the best solution x best in the archive

$$D_i = |p_i - p_{best}| \tag{1}$$

Where Di correspond to the Euclidean distance, 1 < i < m

1. Compute the Gaussian Φi by the equation below

$$\Phi_i = e^{-D^2/2t} \tag{2}$$

Where t is the standard deviation of the Gaussian (usually t = 0.0.5).

2. The pheromone’s value τi is calculated as follows:

$$\tau_i = \Phi_i / \sum_j^m \Phi_j \tag{3}$$

The movement of ants is conditioned by secretion values i antecedently calculated for every resolution of the archive. firstly choose a indicator that is that the resolution to that AN hymenopteran is attracted.

The probability that an ant is attracted to the kth solution is k. Once the reference point pk (t-1) is selected, the position of the ith ant is obtained by the equation:

$$p_i = p_k (t - 1) + dx \tag{4}$$

Where: pi is the solution vector of the kth ant at iteration t;

xk (t-1) is the selected best solution in the solution archive (reference point);

dx is a variable produced arbitrarily in [- ,] to determine the length of jump.

For each value of xi , the corresponding value di is calculated using the relationship:

$$d_i (t) = 1 - p_i (t) / x_{ref} \tag{5}$$

At the end of the second stage of the algorithm, m new solutions are generated, where only the K best solutions in the archive are selected among all m + K solutions.

When the document is reinitialized by the best arrangements, we select the m best arrangements and refresh their pheromones with Eqs. (1)–(3).

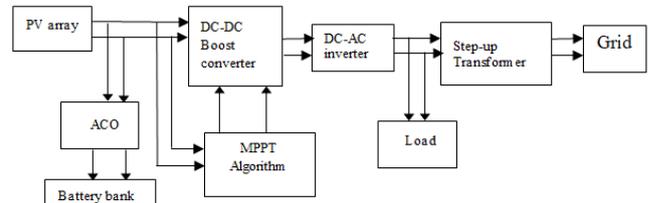


Fig 4. Block diagram of MPPT system with ACO

3. Figure 4. Demonstrates the square graph of the proposed technique. This framework utilizes buck help converter to alter the yield voltage of PV board. This converter can ready to venture up or venture down the yield voltage from the source voltage. The yield voltage of the Buck Boost converter is constrained by shifting the obligation cycle of the PWM flag. Duty cycle refers to ratio of the conduction time and the total switching period. During its operations, MOSFET turns-on (ton) and turns-off (toff)

3.2 APPLICATION OF ACO TO THE MPPT PROBLEM

The ACO-based optimization is currently modified to resolve the MPPT downside in PV systems. The management variable is that the current of every PV string. There area unit multiple native peaks once the PV arrays area unit lighted beneath non-uniform irradiance. so as for instance the management method, outline the management vector as,



$$S^t = [I_1^t, I_2^t, \dots, I_3^t] \tag{6}$$

Where s_t is the present vector at the t_{th} step, Int is the present control an incentive for N_{th} PV string at the t_{th} step. The target capacity of this streamlining issue $f(s_t)$ is the summation of the power yield from each PV sub-string subsequent to applying current variable to each PV string. It tends to be depicted by

$$F(s^t) = \sum_{j=1}^{N_{pp}} (I_j^t * V_j^t) \tag{7}$$

where I_{jt} and V_{jt} are the current management variable esteem and also the voltage esteem for j_{th} PV string at the t_{th} step one by one. Expecting that there are M new arrangements created in each stress and also the most extreme variety of emphases is T , the estimations of current for every sub-string (s_t) modification within the attendant arrangement request

$$(S_1^t, S_2^t, \dots, S_M^t) \rightarrow (S_1^{t+1}, S_2^{t+1}, \dots, S_M^{t+1}) \tag{8}$$

The intensity of every present vector, $f(st)$, is determined and assessed at each stage at the same time. Amid the pursuit procedure, the arrangement document is refreshed iteratively with the recently created arrangements. Every one of the procedures are rehashed until the worldwide MPP is gotten. Here, we utilize the accompanying methodology to distinguish the difference in shading designs, which is given by

$$\frac{I(s_{i+1}) - I(s_i)}{I(s_{i+1})} \tag{9}$$

At whatever point (9) is satisfied or the period set by the clock is accomplished, the interest system will be executed yet again.

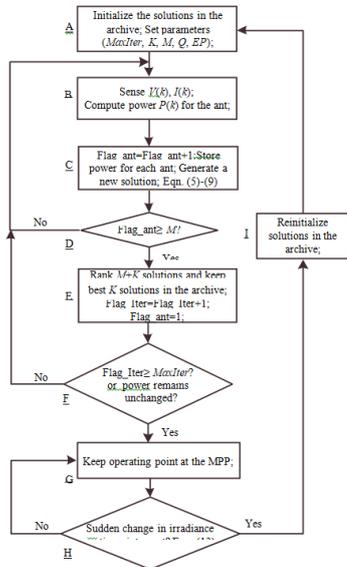


Fig 5. Stream diagram of ACO-based MPPT calculation for PV framework

In any case, instate the plans in the annual range and set the check parameters (avoid A), which harden the most insane number of emphases ($MaxIter$), the dimension of the record (K), the proportion of ants (M), the value coefficient (Q),

and the intermixing speed decided (EP). By then, sense the voltage and current from the entire PV assembling and figure the power (square B). From that point forward, mark the taking a gander at dreadful little creature by utilizing a sign variable (Flag underground bug) and make another game-plan subject to the analyzing procedure (square C). By reiterating strategy squares, B and C, M new courses of action square measure made. From that time, these M new plans and furthermore the first game plans inside the s_{th} K best courses of action into the game plan record.

The quantity of the cycle (Flag_Iter) is likewise set apart in each progression (square E). The handling of squares (B, C, D, E, F) is rehashed until the most extreme emphasis number (Max_Iter) is come to or the power esteem stays unaltered (with exceptionally little change) inside a specified number of progressive cycles. With the above techniques, the worldwide MPP can be found. At last, keep this working point (square G) until a clock hinders happens or an unexpected irradiance change is detected by (square H). At whatever point these two events occur, the entire calculation will be reinitialized (squares I and A) with the goal that it can find the worldwide MPP for the new condition conditions.

The connection between the size of the file and accordingly the extent of the extricated power for every one of the cases researched inside the tests is appeared in fig five. In this way, the exchange off between snappy assembly speed and pursue exactness should be made once choosing the quantity of ants. the objective of the MPPT algorithmic program is to encourage brisk union with a base assortment of ants, Associate in Nursing chronicle size of seven. The neighborhood of the pursuit strategy (Q) decides the harmony between the diversification and intensification. Diversification inside the hunt abstains from being stuck inside the local pinnacles, and along these lines the intensification guarantees a brisk pursuit technique. when letter of the letter set is modest, the best-positioned arrangements inside the chronicle territory unit a ton of conceivable to be picked, while once it's huge, the probability of choosing arrangements is uniform.

MPPT	PSO based MPPT	ACO based MPPT
Control strategy	Probabilistic	Probabilistic
Accuracy	Medium	High
Speed	Fast	Fast
Procedure	system is initialized with a population of random solutions	Based on ants pheromone higher probability

Table 1. Comparison of MPPT Methods

IV. SIMULATION RESULTS

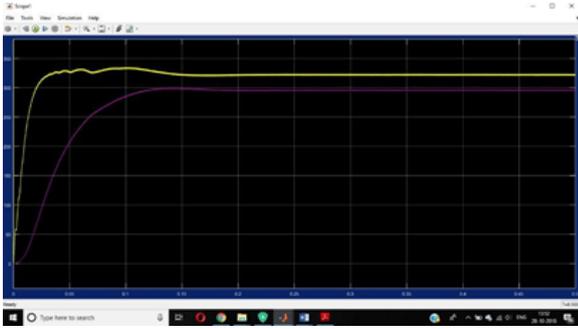


Fig 6.Voltage Variation

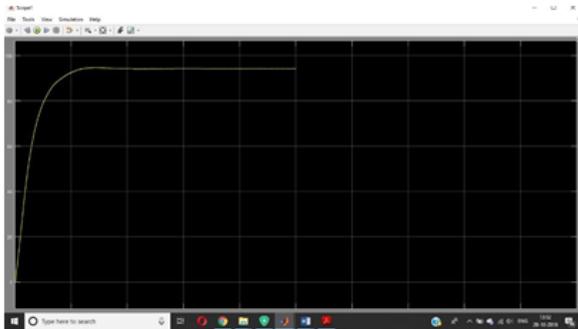


Fig 7.Current Variation

From the figure 6&7 The connection between the size of the file and accordingly the extent of the extricated power for every one of the cases researched inside the tests is appeared in fig five. In this way, the exchange off between snappy assembly speed and pursue exactness should be made once choosing the quantity of ants. the objective of the MPPT algorithmic program is to encourage brisk union with a base assortment of ants, Associate in Nursing chronicle size of seven. The neighborhood of the pursuit strategy (Q) decides the harmony between the diversification and intensification. Diversification inside the hunt abstains from being stuck inside the local pinnacles, and along these lines the intensification guarantees a brisk pursuit technique. when letter of the letter set is modest, the best-positioned arrangements inside the chronicle territory unit a ton of conceivable to be picked, while once it's huge, the probability of choosing arrangements is uniform.

4.1 CONCLUSION AND DISCUSSIONS

Another Bio Inspired arrangement of strategies especially Ant Colony Optimization principally dependent on an in-vogue pheromone supplant (ACO NPU) ended up utilized for ideal power viewpoint checking. Its extraordinary strides of progress have been advertised. The got ACO NPU MPPT controller turned out to be at that point dissected and in contrast with the popular customary system the PSO and ACO basically based totally MPPT from the BIM.

The outcomes demonstrate that the proposed Ant Colony Optimization ACO NPU MPPT controller offers the fine exhibitions in term of intermingling speed, exactness, soundness and strength. In this paper, the reenactment of the PV framework with molecule swarm improvement MPPT calculation has been effectively executed in the Mat lab/Simulink. With the goal that it powers the PV module to

work at near most extreme power activity point to draw greatest accessible power.

The aftereffects of the yield converter control demonstrate that it is accomplishing the greatest separating force and it is always working close to the greatest working purpose of the PV Module, The ACO NPU MPPT can be mulled over as one of the greatest forceful calculations for checking the most power issue of a Photovoltaic contraption under quick forms of climate. Utilizing a Simulink show created in MATLAB/SIMULINK programming, an examination was completed to research the impact of incomplete shading on the P-V, I-V bends of arrangement associated photovoltaic modules

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