Pakistan Journal of Engineering and Technology, PakJET
Multidisciplinary & Peer Reviewed
Volume: 4, Number: 2, Pages: 28- 31, Year: 2021

Maximum Power Point Tracking using Direct Control with Cuckoo Search for Photovoltaic Module under Partial Shading Condition

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***Abstract*- In these days, our country Pakistan is facing numerous crises. Electric power is one of them. Therefore, it is time to presents such sources to beat the crises of power. Sources should be like which do not upset the atmosphere. In most of the methods, CO2 generated that spoil the nature solar energy is becoming vital source of renewable energy resources. As such, it is very essential that those in engineering fields be aware of the technologies related with this area. Many cities are built totally with plan of executing Solar technology and this is one of the renewable resources has multiplied across loads areas. Still, it is behind in the track of being a leading energy resource. This work proposes direct control for MPP for photovoltaic module using cuckoo search under partly covered state. It is accredited that artificial intelligence Cuckoo search algorithm shows several merits like fast convergence and higher efficiency using fewer tuning parameters. To justify direct control using CS as a viable MPPT option, a brief analysis is accomplished against two different algorithms, Direct Control and Cuckoo Search algorithm. The ability of the algorithm is to handle the partial shading condition is verified.**

***Index Terms*-- Analog to Digital Convertor, Proportional Integral, Particle Swarm Optimization, Maximum Power Point Tracking**

I. INTRODUCTION

Now a day's population is expanding day by day. Therefore, there is need of more energy for people's utilization. No doubt, Oil and coal are the major sources for producing energy through these days, it is predicted that after some years, the need of energy will be doubled and it will be a main issue for the population and the sources, which are used for producing energy because these are going to decline. Fossil fuels i.e. petroleum, coal and gases are not only enough for producing electrical power. Renewable energy exhibits a better substitute for fossil fuels with greener effect on atmosphere because other ways of energy generate carbon dioxide in atmosphere [1-4].

Solar energy will be cheaper than other means of generating energy. It would continue for long time. The countries where the sunshine for about two/third of the day is more suitable for generating power by the use of sunlight. In Pakistan, summer runs for approximately 7½ months a year. Our barren areas like Bahawalpur, Cholistan and Rahim yar khan etc are the best places for generating electricity. These areas are very suitable for generating energy by solar panel. Many countries introduce tariff schemes and other initiatives to promote continuous use of green energy and they commercialize large-scale solar panel systems due to their considerable long-term advantages [5-8].

In these days, our country Pakistan is facing numerous crises. Electric power is one of them. Therefore, it is time to presents such sources to beat the crises of power. Sources should be like which do not upset the atmosphere. In the majority of the methods, CO2 generated that spoil the nature. However, generating electrical power using solar energy is standout amongst the best renewable sources that do not ruin the environment [7-9].

Photovoltaic power system, for converting energy from sun into electrical one, is becoming well-liked renewable energy source, as it is economical, long-term and easy to maintain. There is need of assurance of solar energy to continue such costly system. A huge amount of work has done to make better performance of such solar panels [1].

A block diagram of a system shown in Fig.1, consists of a load, which is powered by a sun-oriented board prepared for MPPT. The four blocks are used in this design: a sun-oriented panel, a DC to DC power converter, MPPT controller with load. DC to DC energy convertor which transforms those voltages of the sunlight based boards to required voltage of the batteries. It likewise determines the maximum operating power point of the sunlight based boards [10].

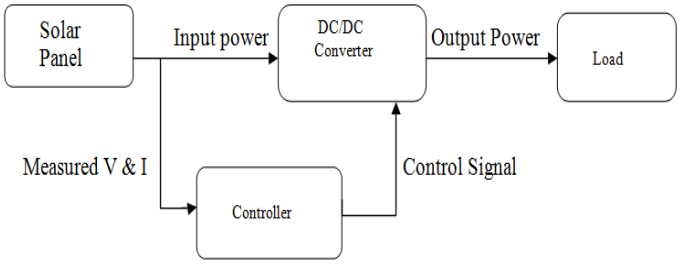


FIGURE 1: MPPT Block Diagram

The colossal concern is to obtain MPPT. The reason is to make sure that for any condition (temperature and irradiance), the zenith output is obtained from solar panel by making a comparison with its PV operating point with subsequent power inverter. Maximum power point tracking (MPPT) enhances the overall performance of solar panel [1, 11].

A MPPT is an electronic DC to DC converter fixed between the Photovoltaic module and load to get maximum matching of power. DC/DC converter is a balance of system (BOS) to alter the properties about load. The aspects of solar panel that nonlinearly varies with respect to accepted insulation Also

temperature would the primary testing assignment to MPP following. Likewise, these parameters change rapidly, those P-V characteristics curve illustrates disagreeing MPP, devising a difficulty to the tracking. The problem is further made complex when solar panel does not get homogenous insulation. This is partly covering [2].

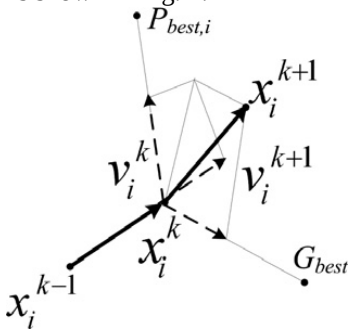
In incremental conductance algorithm the derivative of power

and voltage becomes as under

$$\frac{dP}{dV} = V\frac{dI}{dV} + I\frac{dV}{dV} = V\frac{dI}{dV} + I \quad (1)$$

This algorithm is capable of distinguishing a local peak from the global peak in partly covered state. Global maximum operates near the local maxima so that output of the solar panel reduces.

Particle swarm optimization basically is a soft computing algorithm, which is applicable for MPPT. It repeatedly attempts to better a candidate solution (particle) with respect to a given measure of quality. The concept regarding the movement of particles in PSO is shown in Fig. 2.



FIGUREE 2: Particles movement in PSO

Individual particle position is defined by given equation

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

The tracking success of the mostly previous MPPT methods has condensed by the existence of repetitive maxima in P-V curve because of their inability to distinguish the local and global points. Actually, the perfect MPPT is one that tracks the genuine greatest energy side of the point for all the atmospheric conditions, mainly in partly covered states. It is very important that MPP algorithm is capable to find and track the genuine operating point of PV modules in order to raise overall efficiency of Photovoltaic module, as the efficiency is low and the initial cost is high for PV module [3].

In proposed methodology maximum power point tracking design is discussed. The evaluation of the proposed algorithm is present in results and discussion section.

Section II explain the proposed methodology for this system, Section III describes the results. Finally, section IV concludes this paper.

II. PROPOSED METHODOLOGY

In this proposed work, the design system works in fast changing conditions of irradiance and when the sun-oriented panels are not fully shaded. Particularly one of the important things of the algorithm is its efficiency, because we want to achieve maximum power point with high efficiency. At the end, there should be synchronized system, which is in proper running condition.

A. DIRECT CONTROL SCHEME

Implement MPPT controller without any control loops. This scheme is called direct MPPT control technique. Both the current and voltage control loops are not present in this direct scheme and duty cycle is computed with the help of implemented method. [4]

B. CUCKOO SEARCH ALGORITHM

Some species of cuckoos lay eggs in the host birds' nests. The behavior from cuckoos is very aggressive one in term of reproduction strategy as female cuckoo lays her eggs in the nest of host and flew away and host birds unknowingly bring up her offspring. Female cuckoos have ability to mimic the color of host bird's eggs. In this way, there is less chance of eggs to be destroyed and rate of reproduction is increased. There is also a chance that host may know that the eggs laid by cuckoo are not its own, it will throw them out from the nest or destroy that nest and construct new nest at another place [5].

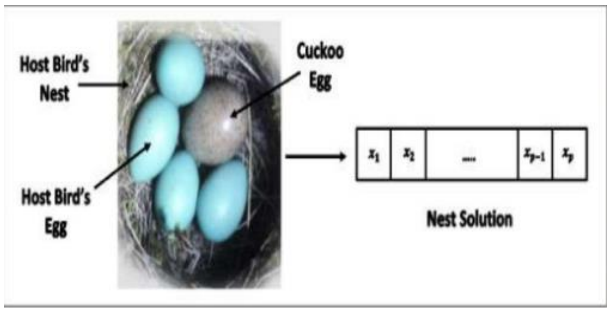


FIGURE 3: Cuckoo Algorithm

Every egg in the nest shows a solution, and a cuckoo egg shows a new solution. The purpose to utilize cuckoo's egg in the nest is good solution instead of replacing host bird egg, which is not a good solution. To get simple solution there is need of one egg in one nest. In complex cases, a number of eggs may be placed in one nest to show a set of solution. The flow of cuckoo search algorithm is depicted in Fig.3.

C. THREE PRINCIPLE OF CUCKOO SEARCH ALGORITHM

Every cuckoo lay only an egg at one time and put sit randomly selected nest. Good nest with good quality eggs (solutions) would become cause of upcoming generations. The numbers of existing host nests are predetermined, and the probability for the host to recognize an unknown egg is [0, 1].

D. CONVENTIONAL BLOCK DIAGRAM USING CUCKOO SEARCH ALGORITHM

The block diagram of a conventional MPPT system is shown in Fig. 4 that it has two self-directed control loops. The first loop controls voltage which works on the basis of comparison of PV voltage with a reference signal got from maximum block [6].

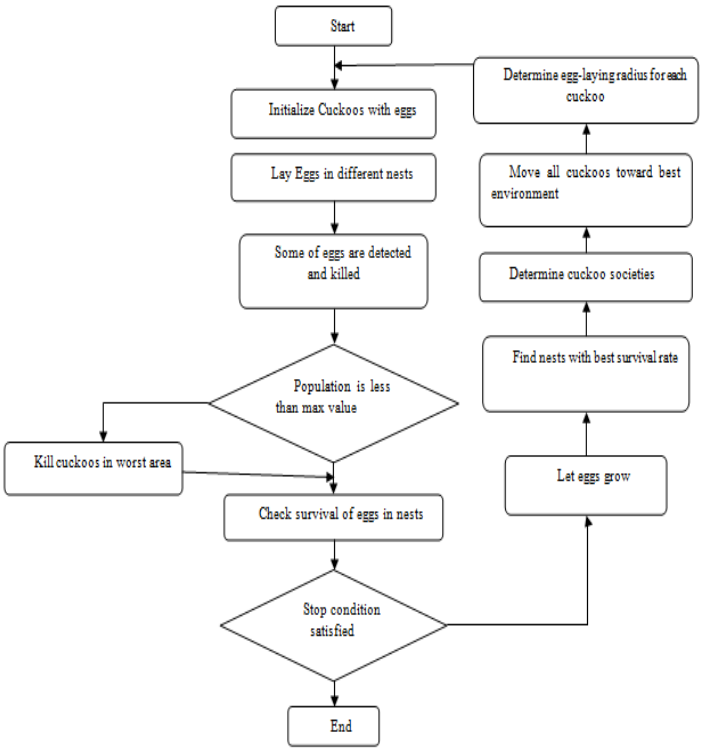


FIGURE 4: Flow chart of cuckoo search algorithm

This output from1st control loop is assumed as a reference signal for the 2nd loop which is known as the current control loop. 2nd loop attempts to adjust the tracking error to zero at the maximum power point.

There are three types of controller:

1. Proportional Derivative Controller (PD)
2. Proportional Integral Controller (PI)
3. Proportional Integral derivative Controller (PID)

PI controller is easy to design and cheap commonly used in these loops. However, they are not preferable for single panel systems due to the non-linear properties of PV module and changeable atmospheric conditions [7-12].

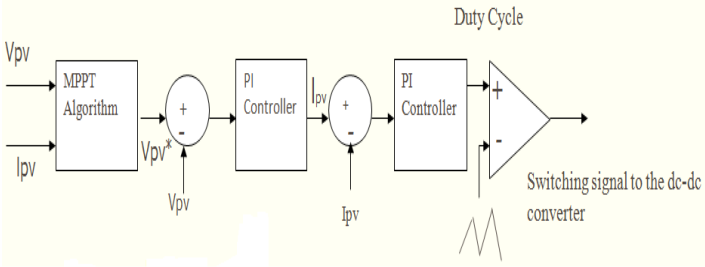


FIGURE 5: Conventional Block diagram using cuckoo search algorithm

E. PROPOSED METHOD DIAGRAM SCHEME

In proposed algorithm, we are going to remove two PI controllers shown in Fig. 5 (current and voltage controllers) from the conventional method. In the proposed method, we are providing solar panel voltage and current to maximum block shown in Fig. 6. Duty cycle is directly calculated in the implemented algorithm.

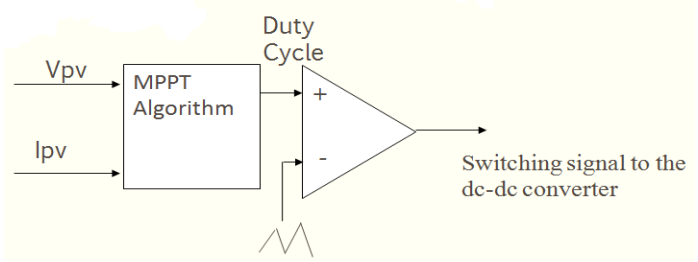


FIGURE 6: Block diagram for direct control using cuckoo search algorithm

III. RESULTS

a. Voltage graph for direct control V/s direct control using cuckoo search

Blue color graph representing voltage for direct control method, which shows that oscillations are present in it and we are not able to find the exact value of voltage in this method due to the oscillations present in it. Oscillations cause loss of output. Red color graph showing the voltage of direct control using cuckoo search algorithm. From this method, we are getting exact value of the voltage and no oscillations are present shown in Fig. 7.

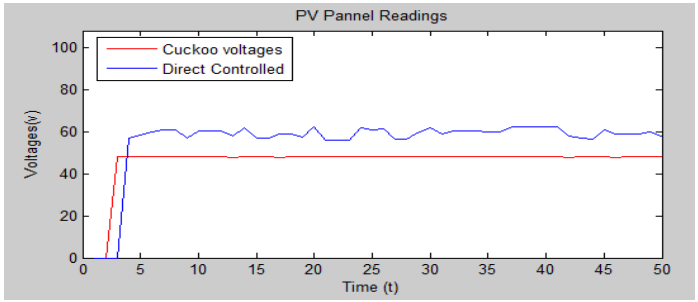


FIGURE. 7: Voltage graph for direct control and direct control using cuckoo search method

b. Current graph for direct control V/s direct control using cuckoo search

Blue color graph representing current for direct control method, which shows that oscillations are present in it and we are not able to find the exact value of current in this method due to the oscillations present in it. Oscillations cause loss of output. Red color graph showing the current of direct control using cuckoo search algorithm. From this method, we are getting exact value of the current and no oscillations are present shown in Fig. 8.

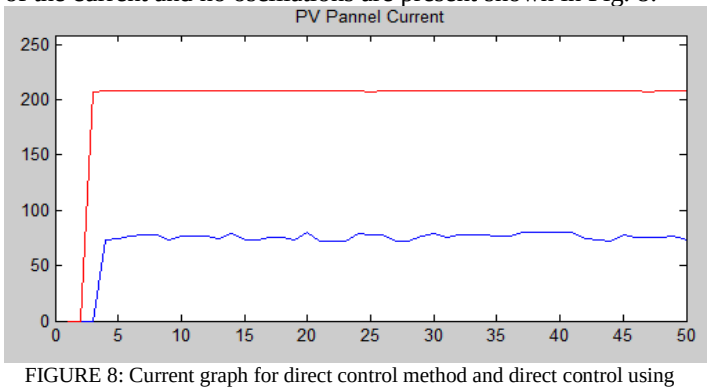


FIGURE 8: Current graph for direct control method and direct control using cuckoo search method

c. Power graph for direct control V/s direct control using cuckoo search

Blue color graph representing current for direct control method, which shows that oscillations are present in it and we are not able to find the exact value of current in this method due to the oscillations present in it. Output is oscillatory .Local and global peaks cannot be identified clearly. Therefore, there is loss of power due to the oscillations present in output. Red color graph showing the current of direct control using cuckoo search algorithm. From this method, we are getting exact value of the current and no oscillations are present shown in Fig. 9.

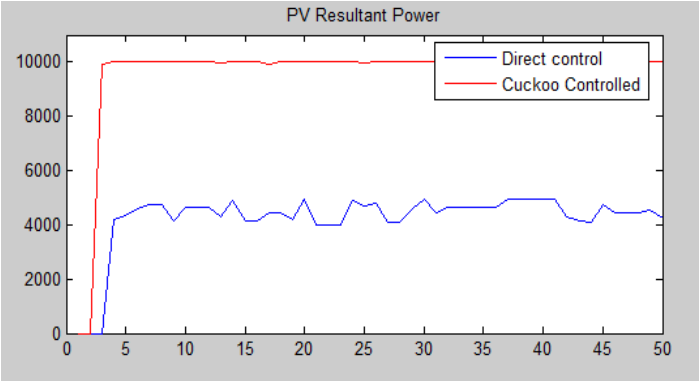


FIGURE 9: Power graph for direct control method and direct control using cuckoo search method

d. Data fitted curve for direct control using cuckoo search

Blue color graph representing scattered data and red color graph represented the fitted data for the direct control method using cuckoo search algorithm.

IV. CONCLUSION

Proposed system works in fast changing conditions of irradiance and when the sun-oriented panels are not fully shaded. Particularly one of the important things of the algorithm is its efficiency, because we want to achieve maximum power point with high efficiency. The system basic purpose is to track the maximum power from the solar panel. Method discuss in this paper is direct control using cuckoo search algorithm to track the maximum power from the PV module. Comparisons done between direct control and direct control using cuckoo search algorithm.

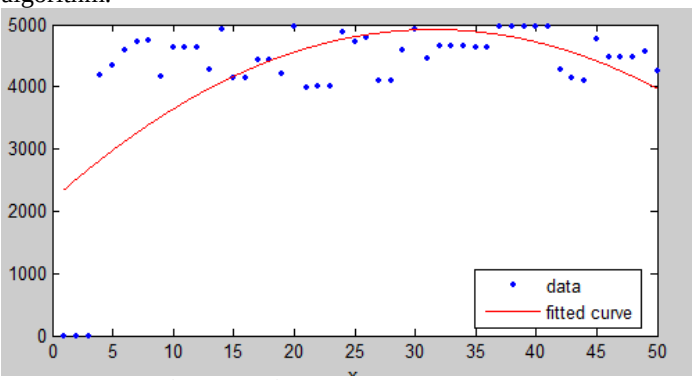


FIGURE 10: Data fitted graph for direct control using Cuckoo search algorithm

Direct control has oscillations in the output. Oscillations present in the output cause the loss of power. Local and global peaks present in the output make difficulty to track the maximum power from the solar panel. From direct control, we are getting power of 4kVA.From proposed algorithm, which is direct control using cuckoo search algorithm, oscillations are eliminated from the output shown in Fig. 10. Output power we are getting from proposed algorithm is 10kVA.So we are able to track the maximum power from PV module and convergence of speed is increased by using this method. Further, this algorithm can be intermixed with other soft computing method like Particle swarm optimization to achieve the maximum power from PV module.

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