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Cuckoo Search Optimization MPPT Technique for Grid Connected Photovoltaic System

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Abstract: The PV system is a different model established to encounter the request for electricity essential by numerous services. Primarily the features of any smart grid rest on reliability, performance optimization and efficiency. The planned article comprises of PV system, connected to a DC-DC converter then attached to a DC-link bus again converted to AC using an inverter and then fed to the grid. Optimization technique like Cuckoo Search Optimization MPPT is used to maximize the generated power and the structure is established in the MATLAB environment Simulink. The outcomes indicate the CSO is better compared to the P&O and PSO approaches.

Keywords: Cuckoo Search Optimization, MPPT, Solar PV System, Particle swarm optimization, P&O.

1. Introduction

Conventional energy sources are the primary sources of electrical supply used to supply utility. Owing to restrictions such as supply, environmental impact, global warming, and so on, we are looking for alternate energy sources such as non-conventional energy sources [1]. Because of the increasing need for electricity, it is becoming increasingly hard to produce power from fossil fuels without harming the environment and to solve such challenges, utilities must not only maintain supply for demand but also maintain continuity [2-3].

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Non-conventional energy systems such as solar and wind can create enough energy to fulfill demand [4-6]. Solar and wind energy sources are intermittent at varying climatic circumstances, making it difficult to achieve extreme yield from them all of the time since they change with time and depend on ecological variables [7]. Optimization approaches such as Maximum Power Point Tracking (MPPT) controllers can be performed to overcome such limits [8-9]. These methods are used to determine maximum power under various climatic circumstances. Several MPPT approaches have been investigated, and in this research Cuckoo Search Optimization (CSO), Particle Swarm Optimization (PSO) and Perturb and Observation (P&O) methods are recommended to monitor the maximum output power of PV systems [10-11]. A DC-to-DC converter is used with MPPT, which creates the duty cycles needed to run and provides some constant DC as output, which is then sent to a DC link and converted into AC employing an inverter arrangement [12-14].

2. Modeling of the PV system

The electrical design of solar cell Fig. 1, consists of a series, shunt resistors and a diode which is built in MATLAB/Simulink and mathematical expressions of output current and voltage are expressed as (1-2). PV current expression is given by (1)

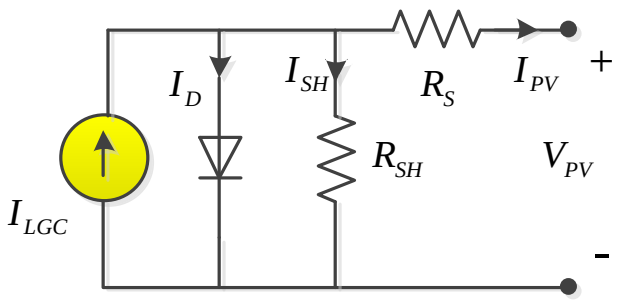


Fig. 1: Equivalent circuit of a PV cell

$$I_{PV} = I_L - I_o\{\exp\left[\frac{V + I_{RS}}{nV_T}\right] - 1\} - \frac{V_J}{R_{SH}}$$

$$I_{PV} = I_{LGC} - I_D - I_{SH} \quad (1)$$

Where

I_{LGC} is light-generated current

I_D is the diode current

I_{PV} is the PV cell current

I_{SH} is shunt current

$$V_J = V + I_{PV}R_S \quad (2)$$

V_J is the voltage across both shunt resistor and diode

R_S is series resistance

V_{PV} is output voltage

$$I_D = I_O\{\exp\left[\frac{V_J}{nV_T}\right] - 1\} \quad (3)$$

I_O is the reverse saturation current

n is the diode density factor

T is absolute temperature

K is Boltzmann's constant

$$V_T = KT / q$$

From Fig. 1, ohms law $I_{SH} = \frac{V_J}{R_{SH}}$

$$I_{PV} = I_{LGC} - I_O\{\exp\left[\frac{V + I_{RS}}{nV_T}T\right] - 1\} - \frac{V_J}{R_{SH}} \quad (4)$$

$$I_{PV} = I_{LGC} - I_O\{\exp\left[\frac{V + I_{RS}}{nV_T}T\right] - 1\} - \frac{V + I_{RS}}{R_{SH}} \quad (5)$$

With the above equations (3-5), the output is I_{PV}

3. Test system under study

The photovoltaic panel's inputs include solar irradiance and temperature, which are nonlinear since they are alternating and change owing to climatical environments all the time, causing the output power to fluctuate continually. To address such issues, we must operate the PV module using the MPPT approach. To get maximum power, we employed P&O, PSO, and CSO strategies in the suggested model. MATLAB is used to create the control model. The outputs are I_{pv} and V_{pv}, which are fed as the inputs to the MPPT which frequently compares the increase or decrease in the value of the operating current of the array. Whenever a new value is set then it generates the duty pulses essential for the operation of the DC/DC converter and then increases the yield voltage with the help of the boost converter and connected to the DC link. Further, it can feed to DC load or be converted in AC by using an inverter and then fed to the grid shown in Fig. 4 [15-16]

4. Proposed Cuckoo search optimization approach

The procedure of the CSO method seems in Fig.2. To begin with, framework parameters and factors, in particular, power, current, voltage, the number of tests and the value of b is chosen from the framework and initialized. The new valuation of voltage and power are put away in the voltage and wellness exhibits, separately [7]. Levy Flight Function: The velocity function which evaluates the fitness function (6-7)

$$V_i^{t+1} = V_i^t + \alpha \oplus levy(\lambda) \quad (6)$$

$$S = \alpha_o(V_{best} - V_i) \oplus levy(\lambda) \quad (7)$$

5. Results and discussion

Fig. 3(a), and 3(b) illustrate the I-V and P-V appearances. The produced current and power from the PV model are primarily subject to input and working voltage. The required constraints are exposed in the Table. 1.

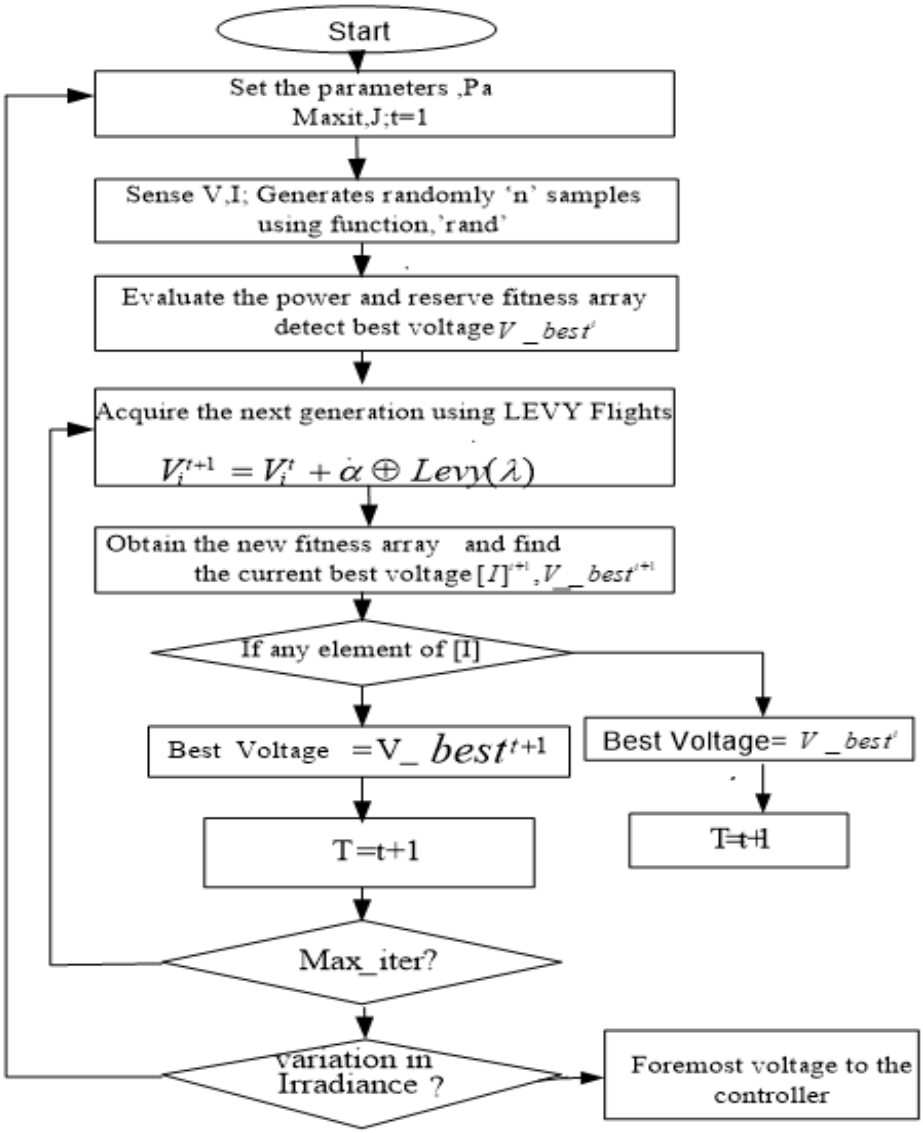
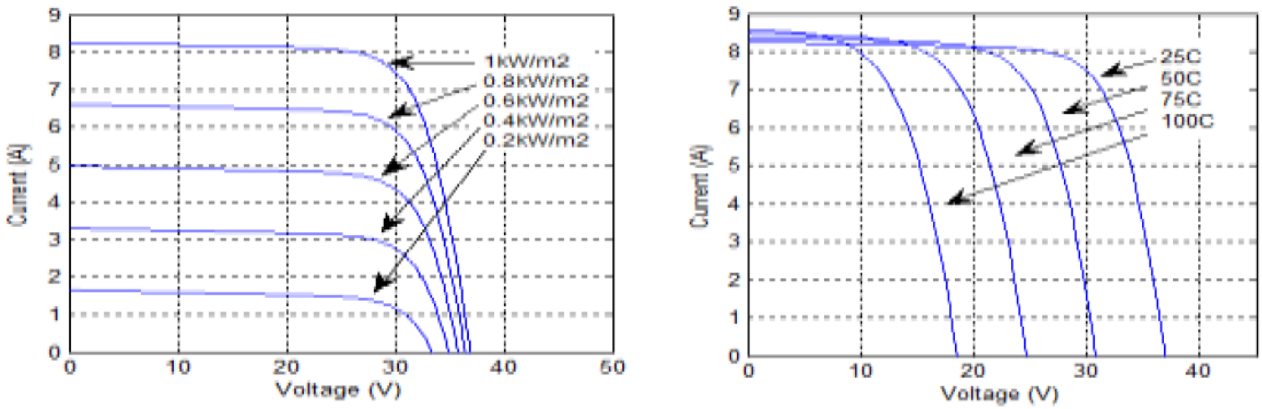


Fig.2: Flow chart of proposed CSO optimization method



(a)

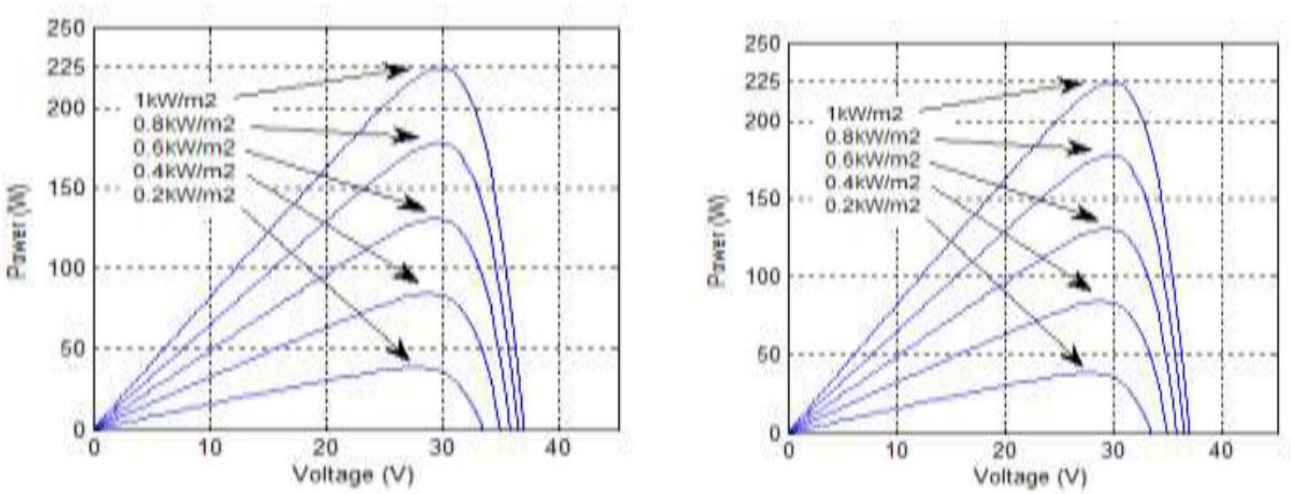


Fig. 3: Solar PV system (a) I-V Curves, and (b) P-V Curves

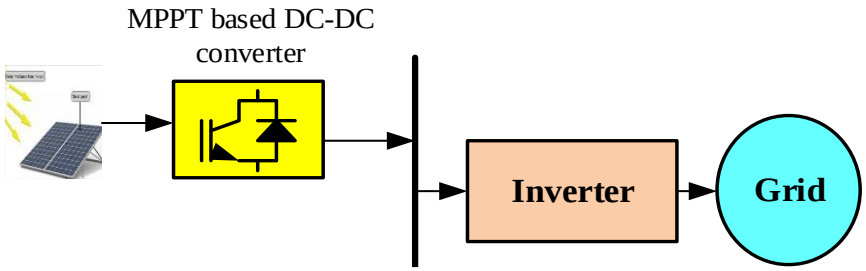


Fig. 4: Test diagram of the proposed model

Table 1: PV panel specifications

Name	Range
No. of cells and connections	60
Maximum power (P_m)	225 W
Voltage at P_m	29.76 V
Current at P_m	7.55 A
Short circuit current (I_{sc})	8.27 A
Open circuit voltage	36.88 V

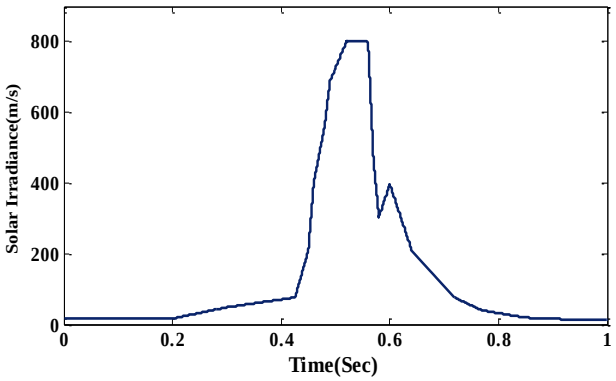


Fig. 5: Solar Irradiance of PV panel

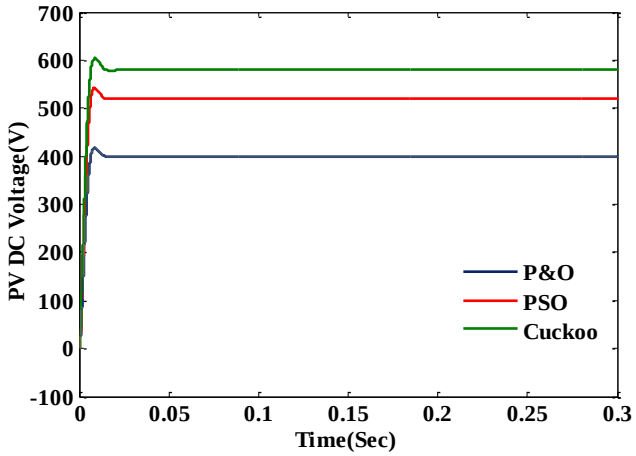


Fig. 6: DC/DC converter output voltage using Cuckoo

The proposed system characteristics are checked over time. Irradiance is the input to PV whose data is being collected from [11] as shown in Fig. 5. As the input is intermittent the output of the proposed system is maintained at a constant voltage of 600 V shown in Fig. 6 with the help of the cuckoo technique over some time. The main aim of the optimization

technique is to set the reference current (I_{ref}) which helps the system to operate at MPPT to generate a maximum power of about 33 kW shown in Fig. 7. From Fig. 5 we examined that during time 0.4s and 0.6s the power from solar is very low due to lower irradiance. To overcome this constant voltage is maintained at the dc bus and then transformed into AC at 60 Hz 440V line to line 60 Hz 440V line to line. Table. 2, presents the comparative results of the proposed method with existing methods.

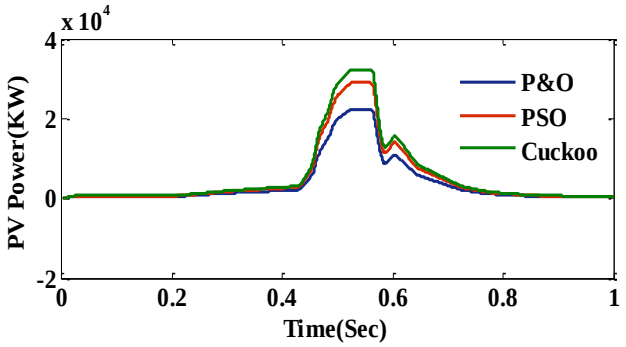


Fig. 7: Solar Power output using Cuckoo

Table. 2: Comparative Studies

Sl. No	Method	Power output
1	P&O	23 KW
2	PSO	28 KW
3	Cuckoo	33 KW

6. Conclusion

Optimization techniques are playing a significant part in grid-coupled systems, where the energy is generated with the help of renewable energy systems. The main aim is to track more output from these sources since they are alternating in nature. In this paper, CSO is applied and their performance characteristics were observed with the comparison of existing methods and proved the proposed method is giving better results. The equivalent converters were established and modeled using MATLAB/Simulink plot form. The CSO approach is better than the two existing methods such as P&O and PSO techniques. The proposed approach has 33 KW maximum power.

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Conflict of Interest

The authors declare that they don't have any conflict of interest

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