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Detection and Tracking Maximum Power Point of a PV system under PSC using Cuckoo Search Algorithm (CSA)

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Abstract

This research suggests using the Cuckoo search (CS) MPPT approach (MPPT). Using the array's maximum power point might make the system more expensive and less effective. The proposed solution is easy and cheap. PSC may cause the PV array's P-V curve to have several peaks. A conference this enormous has only occurred once in human history. The circumstances make traditional MPPT approaches less effective. For this, a two-stage MPPT approach was created. Continuous sampling of the array's P-V characteristic is utilised to discover the partition shading condition (PSC) and global maximum power point (GMPP) (MPP). An open loop makes the suggested technique straightforward and inexpensive to implement. Cuckoo search MPPT controller controls the Boost converter's duty cycle for optimal performance (CS). Fast and stable, it performs well as a dynamic partial shadow MPPT. This research addresses classic MPPT difficulties using CSA MPPT (such as incremental conductance MPPT, P and O MPPT, and PSO MPPT). To implement system simulation findings, MALTAB/SIMULINK is used.

Keywords. Photovoltaic (PV), Maximum Power Point Tracking (MPPT), Cuckoo search (CS) MPPT, Partial Shading Condition (PSC).

1. INTRODUCTION

As the world's population grows and the world's supply of fossil fuels depletes, we must find new ways to meet our energy needs. The potential of this new technology has drawn the attention of solar power experts. You can use the sun's power by using photovoltaic cells (PV). In the event that you can afford it, get equipment that needs little to no upkeep. When it comes to photovoltaic (PV) systems, the temperature and intensity of the sun's radiation may either help or hurt them. Solar radiation for photovoltaic (PV) systems is at its most efficient when it is 25 degrees Celsius and delivers 1000 watts per square metre. By comparing the voltage output and the current usage, you can figure out how much power the

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module puts out. The P-V curve in PV systems can only be converted at a single point. A D'P and DC-DC converter-based MPPT system is also available. Solar power controllers may be beneficial in certain situations. The MPPT system's instructions to the converter have been updated. Keeping the MPP away from the operation is essential. Consequently, PV modules are capable of producing large quantities of electricity. A possible link exists between the quantity of sunshine that solar panels get and the temperature that they experience (UI). which shows that the PV module's cells may generate large amounts of electricity in a short length of time without being damaged. It's possible to keep tabs on the MPP in this way. It's also possible to buy FSC controllers or fractional open-circuit voltage and current versions shaded, energy is lost. A hot spot may be extinguished by using an anti-polarity diode. The P-V curve of a circuit with a bypass diode has multiple power peaks. Hardware and software safeguards may be used to disguise sections of a structure. Improved PV module interfaces and DC-to-DC converters are two examples of this. Large and sophisticated systems need a long amount of time to test. For example, traditional technology might benefit from the use of soft computing. Fuzzy logic and artificial neural networks are two examples of this ever-evolving technology. MPPT also makes use of metaheuristics. Algorithms pollinate flowers. Toward the end of this study, we constructed an autonomous bee colony ABC (ABC). When the parameters of the governing equations are changed, these strategies become progressively complex to implement. This approach needs fewer tuning parameters since it has a better track record of regularity and regular convergence.

2. PROPOSED METHODOLOGY

A) Components of Grid connected PV System

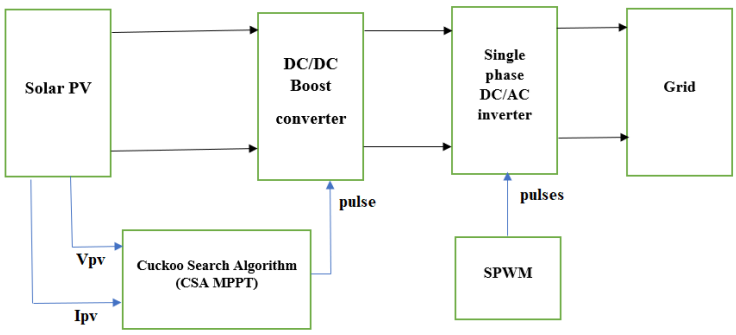

Figure. 1 Three basic components of grid-connected PV systems

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PV solar cells, power converters, and a grid interface control system. One of the primary goals of a PV grid-connected system is to regulate the flow of power between the renewable energy source and the utility grid, while also maintaining a high-power quality factor for the PV inverter grid connection. Maximum power point tracking (MPPT) is a way to get the most power out of photovoltaic (PV) solar systems no matter what the weather is like. In PV systems, there are different MPPT algorithms that can be used to reach the MPP. Depending on the weather, these algorithms can be easy or hard to understand. The best is CSA MPPT.

We have the following equation for the current in a solar cell:

$$I = I_{ph} - I_o[e^{\,q\,(V + I.Rs)/nkT)} - 1] - (V+IR_s)/R_{sh} \quad (1)$$

Where V_T signifies Voltage at the terminal

I_{ph} signifies the isolation current

V signifies voltage of the cell

I signify current of the cell I_o signifies opposite saturation current.

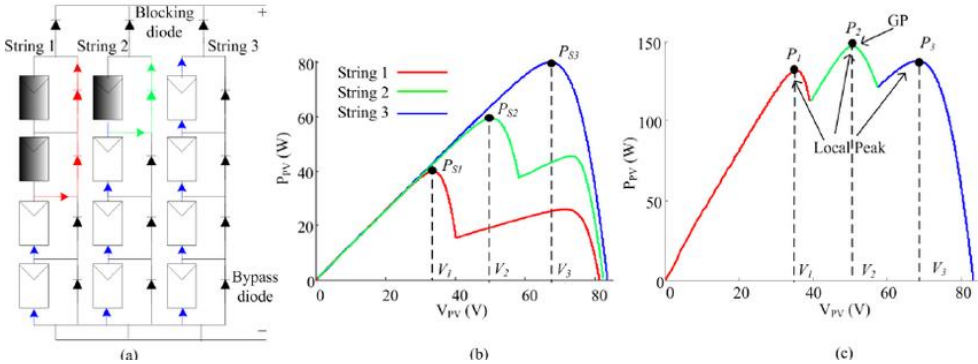

Figure. 2 (a) Sample partial shaded string structure. (b) PV Curve (c) Peak powers

R_{sh} is Parallel Resistance

R_s signifies Series Resistance

q signifies basic charge

n signifies ideality factor of diode

T signifies complete Temperature

V and P–V appearances of the dappled Figure. 2 (a) Sample shaded string structure. (b) I–string.

B) Boost Converter

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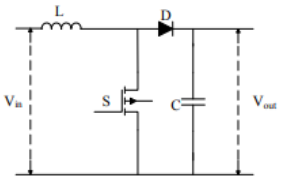

Figure. 3 Boost converter Construction

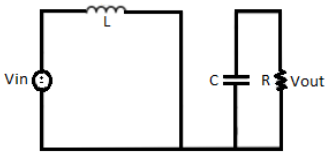

Figure. 4 Alternate Mechanism of boost converter

PV systems need a dc-dc converter because the PV panel doesn't put out enough voltage. A step-up converter, also called a boost converter, increases the value of the dc voltage that goes into it. The energy that is put in is temporarily stored, and then it comes out as a higher voltage at the output. This information is stored in inductors and capacitors. The capacitor smooths out the wave form of the voltage at the output. To cut down on switching Power losses, the MPPT controller sends a switching pulse to a switching device. Here are the specs for how a boost converter presented in figure.3. The boost converter works in two ways, depending on how the reactive parts are charged and drained. During the first mode of operation, the switching device is turned on and the inductor is charged to a certain level of energy. When the switch is in the "off" position, the reactive component is sent to the output to power the load. To power the load, the stored energy in the inductor is fed into an input voltage that drives the power diode and charges the capacitor. This means, as the name suggests, that the output voltage is higher than the input voltage. During this time, the average output voltage of the system is lower than the average input voltage. This cycle happens again and again until the MOSFET is turned back on. As the inductor's maximum value gets closer to zero, less current flows through it. If the inductor charge current is less than the current needed to provide the output when the switch is off, the converter won't boost the output to the right amount. In order to keep the converter from going into a mode called "discontinuous conduction," the values of the inductor and capacitor must be carefully calculated.

C) DC-AC Converter (Inverter)

By connecting an inverter to the DC-DC buck-boost converter's DC voltage output, power can be sent back into the grid. Grid Side Converter (GSC) is the common name for a three-phase inverter used for DC-to-AC conversion. Figure. 5 shows the three-phase inverter.

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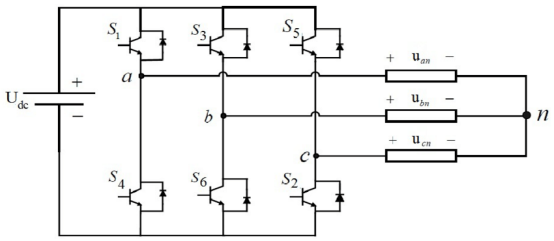

Figure. 5 Basic circuit of Three Phase Inverter

3. CONTROL METHODOLOGY

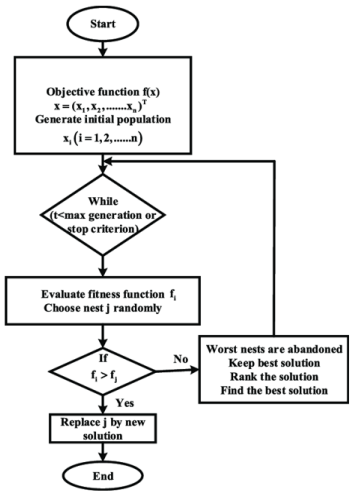

Figure. 6 Cuckoo Search Algorithm

In this project, MPPT with cuckoo search is suggested. The initial random PV voltage solution, V_a, in the cuckoo search method is equal to [0, 25, 0]. According to the CS technique, V_a denotes the nest. In order to determine a person's level of power Fitness.

$$P_a = V_a * I_a \qquad (2)$$

As soon as you've found the best current solution, you'll "select a random nest and produce a new solution via random walk as." The flow graph of proposed Cuckoo search algorithm is shown in figure.7.

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4. RESULTS & ANALYSIS

To verify the performance of the proposed GMPPT algorithm, an experimental setup is developed and the proposed MPPT method is applied to it. Fig. 7 to 11 shows the experimental setup. The setup comprises a boost converter that is paralleled with eight batteries with total 96 V to keep its output voltage (V_o) constant. It is noteworthy that because V_o is used in determination of desired duty cycle, its transients do not deteriorate efficiency of the proposed method.

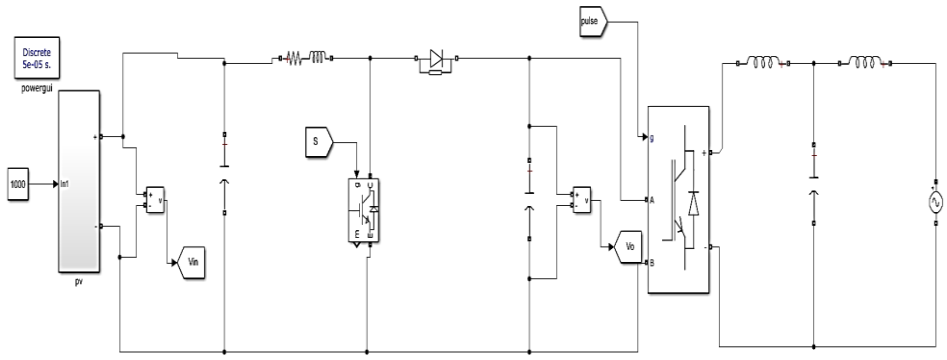

Figure. 7 MATLAB/SIMULINK circuit diagram of the proposed system

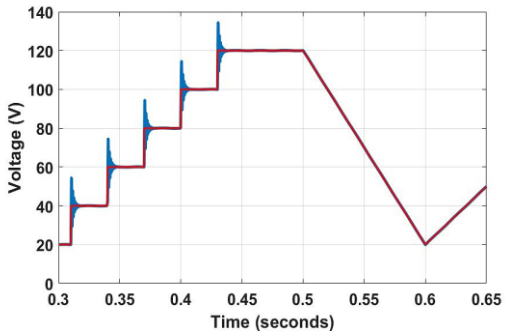

Figure. 8 When a step or ramp command is sent, the switching and averaging state space models of the PV system's boost converter respond accordingly.

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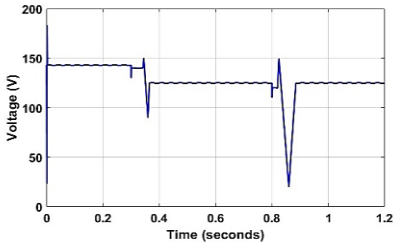

Figure. 9 Array Voltage

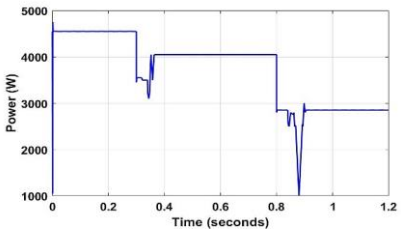

Figure. 10 Array power

5. CONCLUSION

A photovoltaic (PV) system that is connected to the grid and has a low distribution voltage is demonstrated in this article. It is suitable for use in households, in places of business, and even by individual consumers. The Cuckoo Search Method (CSA) and a boost converter topology are both used in the operation of a Maximum Power Point Tracking (MPPT) algorithm (CSA). The findings of a MATLAB/Simulink simulation show how the performance of photovoltaic (PV) systems and the grid shifts over time and in response to variations in irradiation. CSA MPPT is superior to INC and P&O when it comes to the monitoring of radiation conditions that are subject to fast change. The CSA methodology outperformed INC and P&O in terms of obtaining the TMPP more quickly and effectively than the other two ways due to the fact that there were no drifting problems involved.

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