

A Review on maximum power point tracking system under complex operational conditions

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Abstract

There are two types of energy sources in the world, renewable sources of energy and non-renewable energy sources. Renewable energy is the type of abundant energy from the earth. Wind energy, solar energy, geothermal energy and biomass are different types of renewable energy sources. These resources are inexhaustible. The known benefits of renewable energy sources are their own nature, rich in quantity and above all ecological, as opposed to non-renewable energy sources. In India, petroleum is the main and natural supplier of electric power. But the traditional energy crisis has forced the world to prepare for the solar system. The MPPT algorithm for PV systems based on the cuckoo search is discussed in detail in this research. Additionally, Cuckoo search (CS) has a number of advantages, including a simple tuning method with great efficiency as well as fast convergence. This article contains a brief information about the different MPPT techniques and their role to enhance the efficiency of photovoltaic system.

Keywords: Photovoltaic System, Maximum Power Point Tracking, Partial Shading, Renewable Energy Sources.

Introduction

It is expected that from the total electricity consumption of 36,346 TWh (compared to 15,578 TWh in 2001, IEA), renewable energy will cover 29,808 TWh, with solar power dominating to a large extent. (Source: EREC) [3]. The Renewable Energy Sources Report 2016 states that "renewable energy sources have grown significantly, with the largest global additions to date, although problems remain, especially beyond the electricity sector in 2015. The World Bank Group has signed an agreement with the International Solar Alliance (ISA), which is made up of 121 countries led by India, to work together to increase the use of solar energy around the world to mobilize investments of 1 trillion dollar till 2030 "[1].

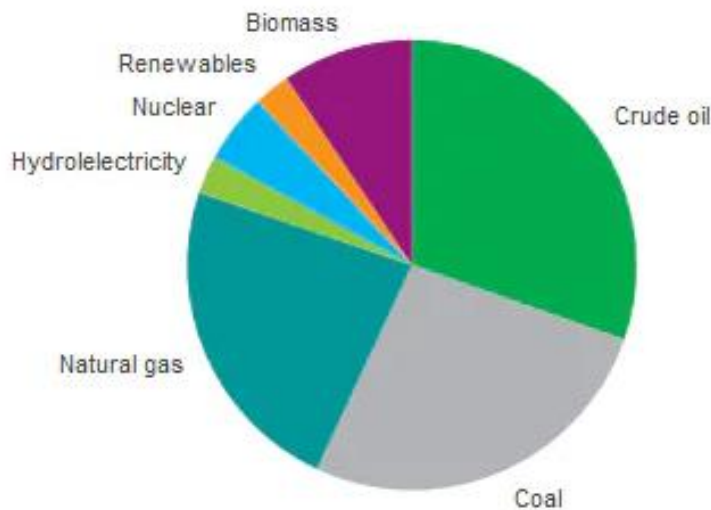


Figure 1: Global Energy Consumption in the Year 2020

Scope of The Research Area

Global energy demand is constantly growing, and fossil fuel exploration is a priority. These oils are not durable but pollute the environment. The use of RE is affected by the scarcity of fossil fuels and the unfavourable climate because renewable energy is a large part of the energy obtained from solar. Energy from the sun is a natural source that its use will not damage and is becoming increasingly popular in order to reduce the demand for electricity in the traditional sector of power generation, the optimal use of these natural resources is essential for power generation. There are various methods of using a solar system with MPPT to generate electricity in practice. For maximum power transmission the constant flow technique is used. This technique should have some significant functions to improve stability and efficiency.

Related Research

Hamzeh et al. (2015) DC Micro-grid with photovoltaic. Controlled energy storage systems include batteries, supercapacitors, DC loads, electric motors, and energy management systems (EMS). The main goal is to manage the demand for goods effectively. Simple adaptive energy management control is achieved. In MATLAB / Simulink, the system is configured with different input conditions and loads, and the results are obtained.

Lee et al. (2013) proposed MPPT monitoring technology for solar photovoltaic systems. This technique considers the thermal stress exerted by the semiconductor switch on the converter. As a result, losses are reduced, and overall efficiency is improved. The algorithm works better with climate change changing the environment.

Wei et al. (2016) MPPT algorithm developed for energy conversion systems. Combine the artificial neural network and the Q learning algorithm to obtain the maximum energy point. Follow the maximum power of the corresponding rotor speed.

Elbhairry et al. (2019) proposed an optimization study to apply a flower pollen optimization algorithm to obtain high yield power in an independent PV system under different shade conditions. The characteristic properties of photovoltaic systems can have multiple power peaks in shady conditions.

Syskakis and Ordonez (2019) To build the utilization of miniature and pico-grid systems, simple to utilize dispersed age arrangements that are industrially suitable are required. The multiplication of appropriated wind turbines has speeded up

examination and execution as suitable sustainable power arrangements. Refined MPP calculations are not carried out with SWTs for huge breeze turbine establishments as they need turbine definition and costly sensors like anemometers.

Chitra et al. (2021) presents the demonstrating and recreation of sunlight based controlled DC engine speed controls utilizing MPPT and DSMC. DC engines have non-straight qualities like rubbing, kickback and the voltage produced by the photovoltaic generator are incredibly fluctuating because of the variety in luminance.

Ghamrawi et al. (2020) In this plan to make a photovoltaic force framework more productive. The decrease of change misfortunes permits to work on this productivity. In this article we work on the variation venture between sun oriented boards and loads to decrease misfortunes. In the initial step, we will look at a standard DC-DC help converter that is generally utilized in close planetary system with a solitary switch.

MPPT Techniques

MPP is defined as a point where the solar module provides maximum power. The current and the voltage corresponding to this point (I_{mpp} and V_{mpp}) are called current and maximum voltage respectively. The solar panel does not deliver its maximum power during normal operation. To achieve maximum conversion efficiency, it is desirable to apply a smart algorithm. In addition, it is also important to connect the module to the load so that maximum load power is available. To this end, a number of DC-DC converters have been proposed in recent years. The block diagram of the MPPT algorithm [28] is presented in figure 2 below;

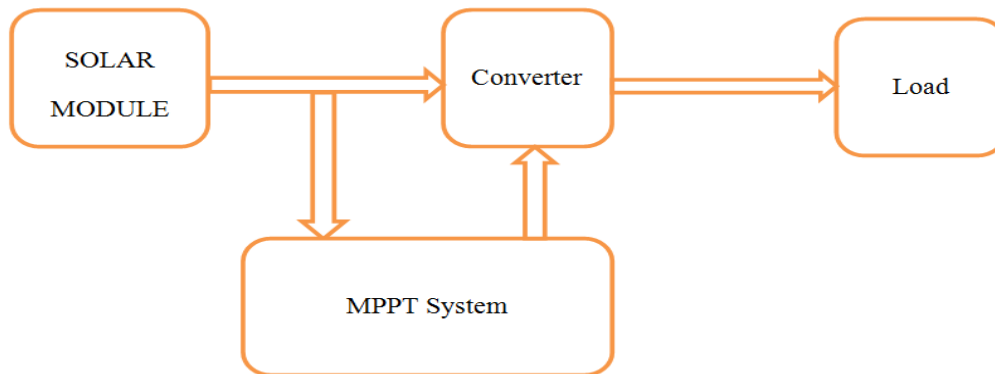


Figure 2: Block Diagram of MPP Tracking System

Hill-Climbing Techniques

Many types of MPPT algorithm are available. Some of the popular MPPT schemes are hill climbing method, incremental conductance method, constant voltage control method, modified hill climbing method, system oscillation method and ripple correction method etc. In hill claiming method the duty cycle is continuously perturbed at regular intervals and the resulting voltage, current and then power is obtained. Once the power is obtained, the slope of the PV curve is checked. Based on the positive slope and negative slop of the PV curve the following correction is carried out.

In voltage source region, $\frac{\partial P_{pv}}{\partial V_{pv}} > 0 \rightarrow D = D + \Delta D$ (Increment D)

In the current source region, $\frac{\partial P_{pv}}{\partial V_{pv}} < 0 \rightarrow D = D - \Delta D$ (Decrement D)

At MPP, $\frac{\partial P_{pv}}{\partial V_{pv}} = 0 \rightarrow D = D \text{ or } \Delta D = 0$ (Retain D)

Algorithmic steps

Step 1: Measure the value of voltage and current of solar PV.

Step 2: Set the modulation index m .

Step 3: Calculate the initial power P_m .

Step 4: Increase the value of m .

Step 5: Sense the voltage and current of solar PV.

Step 6: Calculate the modified power P_f .

Step 7: If the change in power is positive, increase m , if it is negative decrease the value of m . If no change the value m is maintained.

Step 8: Repeat step 5.

Perturb and Observe

The P&O algorithm is also called "climbing," but both names refer to the same algorithm depending on its application. The correction includes disruption of the power cycle of the power converter and P&O and disruption of the working power of the DC link between the photovoltaic array and the power converter. On the upside, interrupting the power converter's circuit breaker means changing the DC link between the PV array and the power converter so that one technology refers to the same technology. In this method, the final turbulence and the increase in the final turbulence signal are used. To determine the expected subsequent turbulence.

Algorithmic steps:

Step 1: Measure the two consecutive values of voltages and currents of solar PV.

Step 2: Calculate the powers $P(n)$ and $P(n-1)$.

Step 3: If the powers are increasing, then decrease the duty cycle.

Step 4: If the powers are decreasing, then increase the duty cycle.

Step 5: Go to step 1.

Incremental Conductance

The incremental conductance method is to determine the terminal voltage of the PV module by measuring and comparing the incremental conductance with the instantaneous conductance. The maximum power is reached when the incremental conductance is equal to the instantaneous conductance. The terminal voltage of the PV module is continuously perturbed at regular intervals until the incremental conductance is equal to the instantaneous conductance. This is represented in the following equation (Ting-Chung & Yu-Cheng 2012).

Algorithmic steps:

Step 1: Sense the two consecutive voltages and current of solar PV

Step 2: Calculate the dI/dV .

Step 3: If $dI/dV > 0$, the operating point is in the left of MPP. Increment the voltage.

Step 4: If $dI/dV < 0$, the operating point is in the right of MPP. Decrement the voltage.

Step 5: Go to step 1.

Fuzzy Logic Control

Over the past decade, fuzzy logic controls have become more popular because they can handle inaccurate inputs, do not require accurate mathematical models, and tolerate inequalities. A single microcomputer contributes to the information of fuzzy logic controls. Fuzzy logic consists of 3 stages: development, system thinking, and destruction. Fuzzification involves the procedure of transforming a digital entry into a language change depending on the level of membership in a particular group.

Neural Networks

Another MPPT strategy truly appropriate for microcontrollers is the earphone network [8]. They have fluffy rationale and have a place with what is designated "delicate registering." The most straightforward illustration of a neural organization has three layers: an info layer, a secret layer, and a yield layer, as displayed in Figure 3.6. More intricate NN develops add more secret layers. The quantity of layers and hubs in each layer and the activities utilized by each layer will be unique and rely upon the information on the client. The application factors can be various principles, climatic information, or a mix thereof. The yield is generally at least one signs, for example, heading cycles or DC transport input voltage.

Cuckoo Search MPPT Methodology)

The CS algorithm was first proposed by Yang and Deb. The CS algorithm is an MH method inspired by the behavior of cuckoo bird species in their reproduction process. Cuckoos are one of the parasitic organisms which lay their eggs inside the other birds' nests instead of building their own nests. Cuckoo birds will fly randomly from one nest to another nest in order to search for the host nest candidate. Then, it will choose the best nest such that their eggs have the best chance to hatch and generate a new generation of cuckoo. In some conditions, cuckoo bird will make some efforts to boost the hatching chance by strategically laying their eggs in a good position and sometimes dropping the host bird eggs outside the nest. Some species of cuckoo even evolves to be able to produces similar eggs to other specific bird species. Nevertheless, there is still a possibility that the host bird finds the alien eggs and abandons their nest. In this case, the cuckoo's eggs will fail to hatch. Based on this natural behavior, the CS optimization algorithm is developed.

Results & Discussion

The problem of partial shading has serious effects on the performance of photovoltaic (PV) systems. Adding a bypass diode in shunt to each PV module avoids hot-spot phenomena, but causes multi-peaks in the power–voltage (P–V) characteristics of the PV array, which cause traditional maximum power point tracking (MPPT) techniques to become trapped in local peaks. This problem has forced researchers to search for smart techniques to track global peaks and prevent the possibility of convergence at local peaks. Swarm optimization techniques have been used to fill this shortcoming; unfortunately, however, these techniques suffer from unacceptably long convergence time. Cuckoo search (CS) is one of the fastest and most reliable optimization techniques, making it an ideal option to be used as an MPPT of PV systems under dynamic partial shading conditions.

Swarm optimization techniques have been used as an MPPT technique of partially shaded PV systems to avoid the limitations of traditional techniques.

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