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Novel Umbrella Optimization Mppt Technique: For Solar Photovoltic Systems

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Abstract
Due to the shortcomings of traditional energy sources, there has been a surge in interest worldwide in renewable energy sources like solar, wind, fuel cells, etc., for supplying electricity to isolated locations of the grid in recent decades. Renewable energy sources are environmentally benign, clean, and limitless. These strong energy sources can supply huge grid-isolated demands if they are appropriately harnessed. For this, solar and wind energy are often utilized because of their plentiful supply. These energy sources do have certain drawbacks, though, such as high investment costs and low efficiency. In the current work, isolated DC loads are driven by solar energy. Second, solar PV must always deliver the most power possible to meet the linked load requirement. Several maximum power point tracking (MPPT) controllers with various MPPT strategies are used for this purpose in order to increase PV systems' power generation. All MPPT techniques, however, include a trade-off between precision and stability near the maximum power point, which affects PV system performance.

Keywords: Photo Voltaic (PV) System, MPPT, T-Type Inverter, Pulse Width Modulation (PWM).

1. INTRODUCTION

In developing nations, the swift expansion of economic and industrial development increases the need for energy [Verma et al., 2016]. They can obtain energy from a variety of sources on Earth. Non-renewable and renewable energy resources are the two basic groups into which these sources can be broadly divided. The category of conventional energy sources includes resources like coal, gas, and oil that cannot be replenished once used. Since ancient times, humans have used these resources. If humans continue to use these finite energy supplies, they will run out in a matter of years. Humans will thus experience energy crises since the supply of energy cannot keep up with demand. Additionally, the utilisation of these resources contributes to global warming [Sharma et al., 2018].

With the aid of renewable energy generation systems, it is simple to convert energy from the sun, geothermal, biomass, wind, and water into heat or electricity. PV systems are capable of converting solar energy into electrical power. Wind electric generators may transform wind energy into electrical power. Additionally, water is pumped using wind pumps in isolated areas. uses for bioenergy derived from biomass include cooking, mechanical uses, pumping, and other conventional sources. Homes, hotels, and distant locations, among other places, use the potential energy produced by falling waves and tidal energy to generate electricity.This paper's primary goal is to implement a detailed model of a photovoltaic (PV) array that incorporates a Maximum Power Point Tracking (MPPT) control system. Similar research that use MATLAB/Simulink to analyse the PV module mathematically may be found in [2]–[6].

Additionally, a PV system's MPPT control is crucial since it can raise the system's efficiency. There are numerous MPPT methods in the literature. The majority of researches evaluate the methods' features in terms of their complexity, efficiency, equipment needs, reaction time, and cost. A few of them concentrate on their simulation performance, while others are theoretical. [7] through [11] In connection to the current-voltage relationship that created the solar cell I-V curve, this section explains the primary electrical properties of the solar cell or module. Since solar irradiance and temperature have an impact on the output current and voltage of solar cells, respectively, I-V characteristic curves show how solar cells function under different irradiance and temperature conditions. These curves assist in giving the information required to create a PV system that runs at MPP. Features of I–V: Under typical working conditions, the silicon PV module's I-V graph is shown in Fig. 1.6. Power curves for a given irradiance level can be derived by multiplying cell output voltage point-to-point with cell output current under short circuit to open circuit circumstances.

2. SOLAR PHOTOVOLTAIC SYSTEM

A solar power system uses photovoltaic principle to produce electricity. Several components are incorporated in these systems to convert solar energy efficiently into electricity. PV array, DC converter, Inverter, Mounting and cabling are few of its basic components. Based on particular applications, size of this system varies. Basic building block of any PV systems is solar cells. These cells are made up of semiconducting material generally silicon. Two semiconducting materials are combined to form two layered structure as shown in fig.1.1. One layer has deficit of electrons. When these cells are exposed to sunlight, upper layer absorbs photons. This phenomenon excites some of the electrons causing them to jump to another layer creating a electric charge.

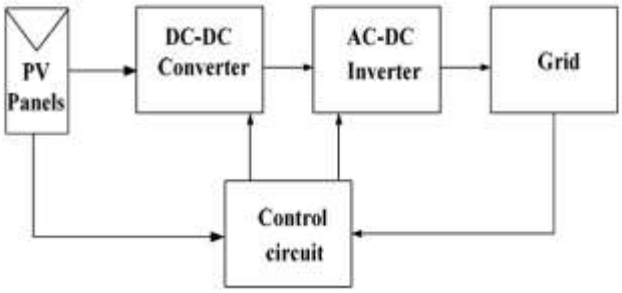

Fig.1. Block diagram of typical grid connected PV systems

TABLE I. STANDARDS FOR GRID CONNECTED PV SYSTEM [5,6]

Parameters	IEC 61727	IEEE 1547
THD	< 5%	< 5%
Power factor	0.90	-
DC current injection	Less than 1% of rated output current	Less than 0.5% of rated output current
Voltage range for normal operation	85% - 110%	88% - 110%
Frequency range for normal operation	49Hz to 51Hz	59.3 Hz to 60.5Hz

A solar module is made up of several solar cells that are merged into one unit because a single solar cell often produces less electricity. Sixty cells arranged in series make up a basic solar module. Although solar modules are sometimes confused with solar panels, a set of solar modules assembled as a single unit is technically referred to as a solar panel. A solar array is a collection of several solar panels joined together to produce more energy because a single solar panel produces a relatively small quantity of electricity needed by the associated load.

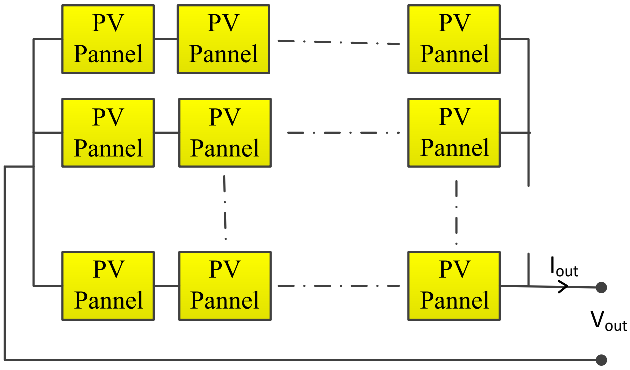

Fig.2 : series parallel array configuration

Mismatch losses between PV modules are minimised and MPP operation is also more accurate because each module has its own MPPT. More energy is collected and transmitted to the grid as a result of the system's improved efficiency than with a central or while generating a high-quality voltage waveform.

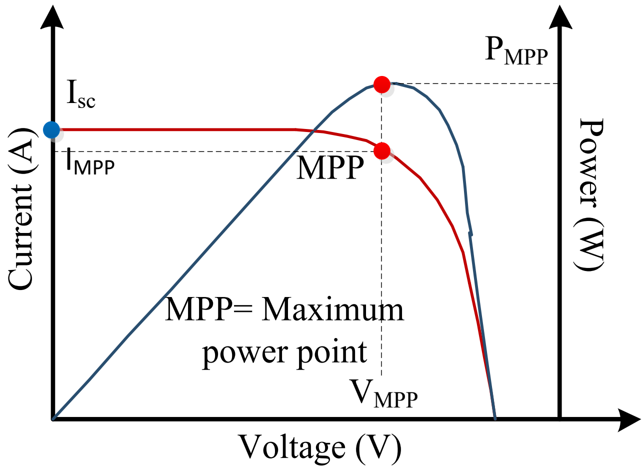

Fig.3 I-V and P-V characteristics of a PV cell

There is no difference in the performance of the other modules. Each module has its own MPPT, which reduces mismatch losses between PV modules and improves MPP functioning. The system's increased efficiency results in more energy being gathered and sent to the grid than with a central or With the elimination of DC connections and electrolytic capacitors due to microinverter architecture, the inverter has a longer lifespan and requires less maintenance. The microinverter's design is small and adaptable. It is easy to integrate modules with their own grid connection and inverter

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3. DIFFERENT TYPES OF MPPT TECHNIQUES

Utilising MPPT techniques, the maximum power from the PV system is extracted based on the

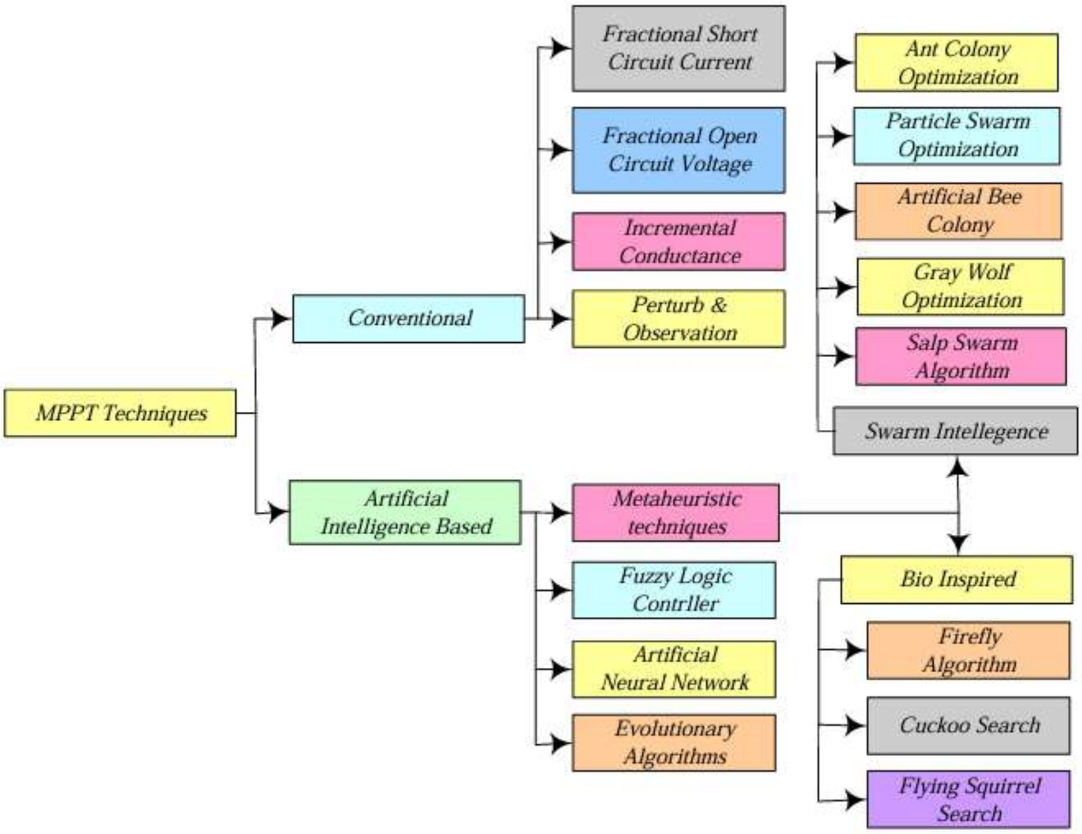


Fig.4 . MPPT Techniques Classifications

temperature of the PV module and the degree of irradiation. Temperature and irradiance variation nonlinearity, regrettably, reduces the efficiency of the PV system. Many LMPP thus show up on (P-V) and (I-V) characteristics when the entire PV array is not exposed to uniform solar radiation. There are various MPPT strategies that have been employed to maximise a PV system's output.

A. P & O MPPT technique

The Perturbation and Observation algorithm, sometimes referred to as the "hill climbing method," is one of the most widely utilised techniques because it is simple to employ. Figure 5 illustrates that at the maximum power, the curve's slope is zero. point (MPP), with a positive value on the left side (the area of growing power) and a negative value on the right. (region with decreasing power). Consequently, the procedure is iterated and repeated until the MPP is attained. Although the process of attaining the MPP is slowed down, the oscillation can be reduced by decreasing the step-size of the perturbation [10].

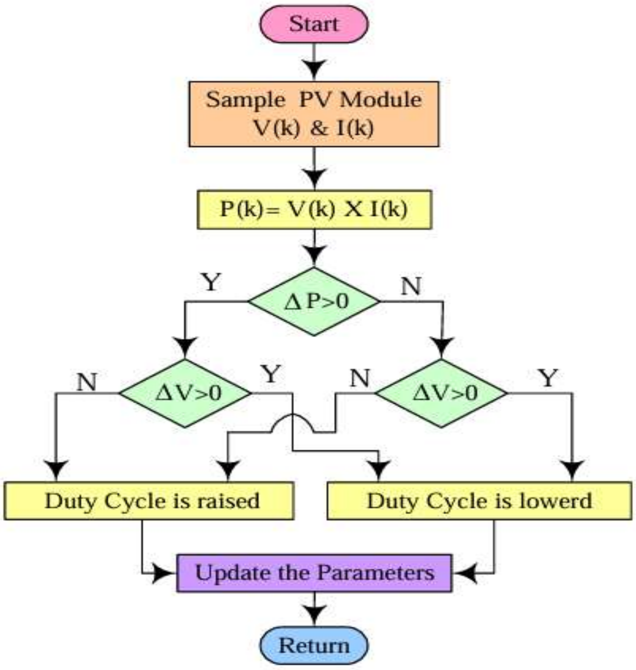
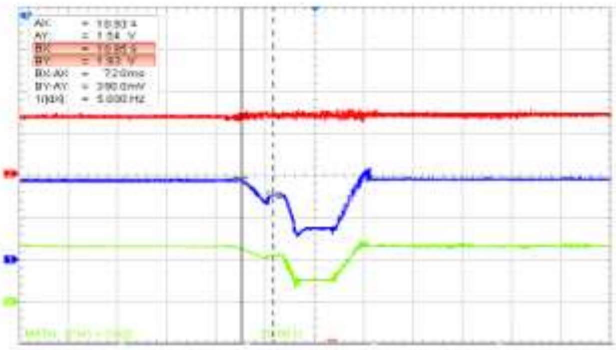


Fig.5. MPPT technique using P&O [Reddy et al., 2018].

Table II: Working of P&O based MPPT technique

Present Perturbation	Change in Power	Next perturbation direction
$\Delta V < 0$	$\Delta P < 0$	Positive
$\Delta V < 0$	$\Delta P > 0$	Negative
$\Delta V > 0$	$\Delta P < 0$	Negative
$\Delta V > 0$	$\Delta P > 0$	Positive

Mode	Perturbation	Status
$\partial i/\partial v = -v/i$	$\partial p/\partial v = 0$	$V_{PV} = V_{MPP}$
$\partial i/\partial v < -v/i$	$\partial p/\partial v < 0$	Raise the voltage till $V_{PV} = V_{MPP}$
$\partial i/\partial v > -v/i$	$\partial p/\partial v > 0$	Lowering the voltage till $V_{PV} = V_{MPP}$



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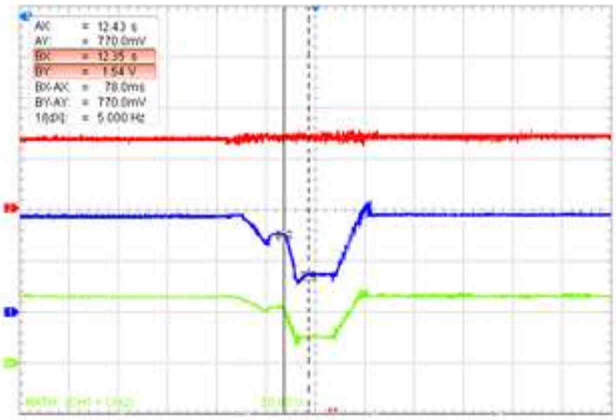

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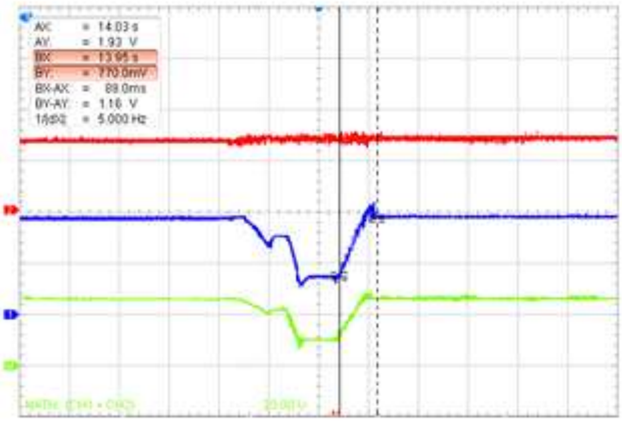


(c)

Fig.6 Voltage, current and power transient response using P&O MPPT

4. NOVEL UMBRELLA OPTIMIZATION TECHNIQUE

This algorithm is intended to identify GMPP in multiple LMPP under PSCs more quickly than the P&O algorithm. Figure displays the maximum values of estimated power P_{cal}) in the form of a raindrop pattern. Calculated power is the result of multiplying calculated voltage (V_{cal}) by calculated current (I_{cal}) at a specific time interval. The panel's configuration determines the computed voltage and current (V_{oc} and I_{sc}). Between zero and V_{oc} and I_{sc}, respectively, are the values of V_{cal} and I_{cal}. Conversely, real power, or P, is determined by multiplying the panel's actual voltage (V) and current (I) at the same intervals as P_{cal}. The system then keeps track of the locations where, for the greatest value of P_{cal}, the difference (P_{cal} P_r) is the smallest. The program separates the local and global peaks and distinguishes between any potential peaks that may be found.

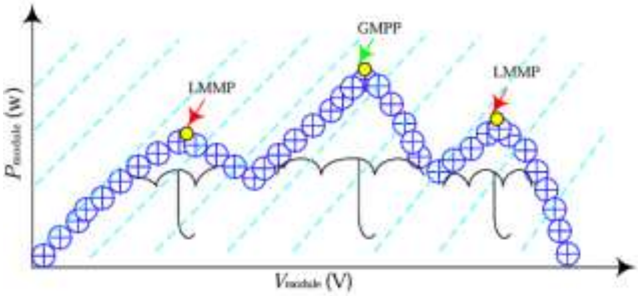


Fig. 7 Terminology of UOT based MPPT

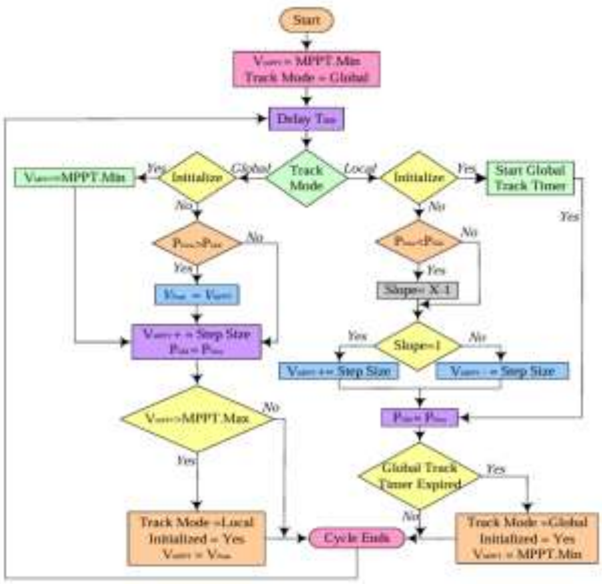
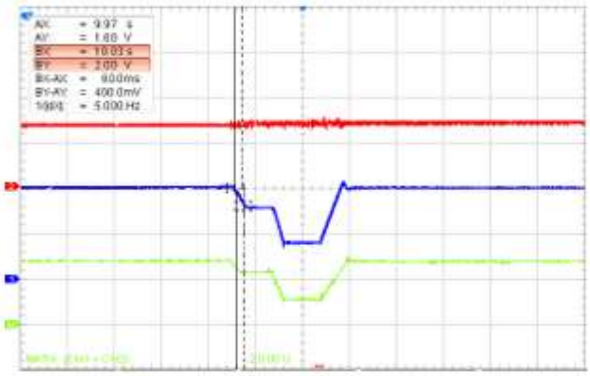


Fig.8 Flowchart of UOT based MPPT



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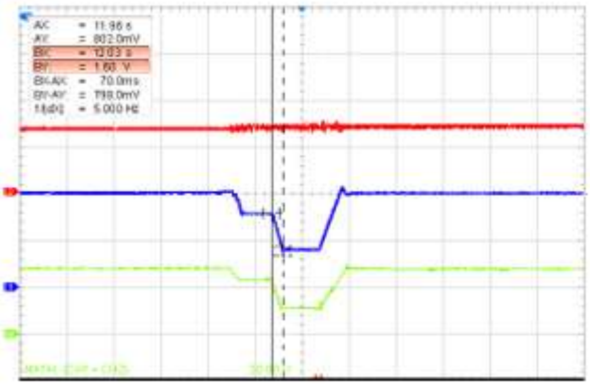

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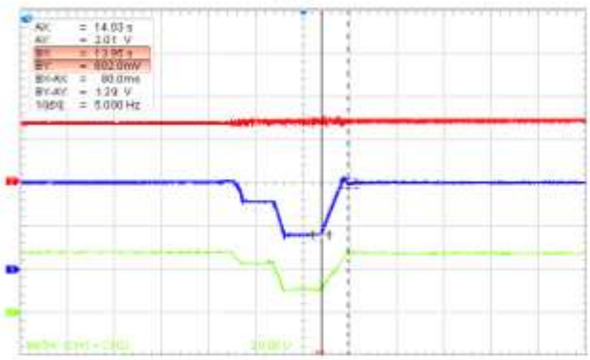

(c)

Fig.9 Voltage, current and power transient response using UOT MPPT

5. CONCLUSION

This survey describes in detail a number of newly published studies to measure GMPP in PSCs, along with their benefits and drawbacks. Currently, there are more than 80 MPPT optimization strategies published and more than 4 advanced MPPT innovations are reported in every year. In this paper a model of a PV array along with different MPPT techniques has been developed. Firstly, a mathematical analysis of the PV module is achieved. In addition, three MPPT algorithms have been studied. Specifically, the Perturbation and Observation (P&O) algorithm, the incremental conductance method and a fuzzy logic control have been examined. The most recent research in each MPPT approach is tabulated in this literature survey. Choosing one optimization strategy amongst numerous strategies that are described in the literature is difficult. Any optimization technique must prevent from being struck in local MPP and PV array local hotspots. Additionally, managing energy is necessary when these algorithms are being developed.

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