Review Article

Study of MPPT Techniques in PV Based Renewable Energy System

Prof. Samarjit Singh[1] and Prof. Ashwini Mishra[2]

[1,2]*Assistant Professor, Sityog Institute of Technology, Aurangabad, India*

ABSTRACT

Energy plays an essential role in the development process. It is almost impossible to achieve sustainable development without energy, "Since access to modern energy lies at the heart of human development. The energy requirement is increasing steadily worldwide, and this requirement is being met by both conventional(non-renewable) and non-conventional (renewable) energy sources. it is now realize that renewable energy has to be used to greater extent so as to achieve the country goals, i.e reduction of greenhouse gases and energy demand fulfilment, Due to non-availability of sufficient resources and a considerable amount of emission of pollutants from conventional sources and the increasing constraints led by the international agreement, In fact, in line with the problems and difficulties of acceptance of new technologies, there are barriers to solar energy use that cause difficulty for running and operating solar energy systems many research examinations show that a solar panel practically converts 30-40% of energy incident on it to electrical energy. To increase the efficiency of solar panel a Maximum Power Point Tracking approach is necessary. The objective of this examination to the use of photovoltaic (PV) applications are dominating in the renewable energy market today. The rise in PV application is mainly due to the improved PV efficiency and its low marginal costs. Along with this surge of PV application in today's electronic industry, the need for more efficient DC-DC converters that integrate with the PV panels are also in demand. Another important aspect is the development of a controller for the power converter board, which always ensures the maximum power out of the PV panels.

KEYWORDS

Renewable Energy, Photo Voltic cell, Solar Energy, DC-DC Converters, Green Energy Generation.

1. INTRODUCTION

Renewable energy is energy that can be obtained naturally. Natural resources such as sunshine, wind, tides, waves, biomass, and geothermal heat are used to create it. In contrast to fossil fuels, which are rapidly depleting, such resources are inexhaustible. Another significant issue working against fossil fuels is pollution caused by their combustion. In contrast to its conventional equivalents, renewable energy sources are recognized to be cleaner and produce energy without the adverse impacts of pollution, despite the world's increasingly diminishing stocks of fossil fuels.

The market for renewable energy technology has been steadily expanding, and renewable energy projects performed by developing countries contribute to poverty reduction. Because of mass production and market rivalry, as well as widespread adoption, renewable energy solutions are becoming more affordable.

There are various sorts of renewable energy sources, including

a. Solar energy

Solar energy is a significant source of renewable energy. The sun's energy is captured as heat and radiant light. Solar energy can be used to generate solar thermal energy, which is used in space heating. Solar energy may also be transformed into electrical energy, which can then be used for a variety of purposes. It has a higher initial installation cost, but it provides long-term benefits.

b. Wind energy

Using wind turbines, wind power is generated from wind flow. The wind's kinetic energy can be turned to mechanical energy, which can then be transferred to electrical energy. Wind turbines are used to collect energy from the wind. An air turbine's output power is exactly proportional to the cube of wind speed.

c. Hydro energy

Hydropower is a type of renewable energy that can be harnessed and converted into electricity and is found in flowing water. Hydropower is increasingly being used in

irrigation fields. Hydroelectric power is converted into electrical energy and used by water engines. Hydropower plants of up to 10MW are considered renewable energy sources.

d. Geothermal energy

The heat energy contained in the layers of the Earth is geothermal energy, a type of renewable energy. Due to temperature differences, heat is conducted from the earth's core to the surface. The heat is used to produce extremely hot steam, which is then used to power steam turbines.

e. Biomass

Biomass is a renewable energy source that is obtained from plants and plant-based compounds. Biomass functions as a natural battery, storing and releasing the sun's energy as needed. The most common biomass energy source is wood. Biomass is used to generate electricity.

f. Renewable Energy's Latest Trends

Renewable energy sources are currently being implemented at a constant rate. Renewable energy provided an estimated 19 percent of the world's total energy consumption in 2012, and it has only increased since then. For the past 4-5 years, solar PV has grown at a rapid rate, with annual growth capacity of 55 percent. It should be highlighted, however, that the usage of renewable resources is still limited in relation to their enormous potential.

2. LITERATURE REVIEW

In 2018, R. Faranda et al. present a comparison evaluation of ten frequently used MPPT algorithms, evaluating their performance using the simulation programme Simulinkreg. This research analyses the behaviours of each approach in the context of varying sun irradiation [1].

Solar energy will play an essential role as an energy source in the future. By means of a photovoltaic array More than 45 percent of the world's essential energy will be generated. As a result, we must concentrate our efforts in order to lower application costs while also improving performance. To get to this last point, keep in mind that a photovoltaic array's output characteristic is nonlinear and fluctuates with solar irradiation and cellpsilas temperature. To maximise the amount of energy produced, a maximum power point tracking (MPPT) technique is required to draw peak power from the solar array [1].

To track high power, MPPT algorithms are used, and a DC-DC Boost converter is used to determine impedance measurements between identical PV components and loads. Despite the fact that a variety of strategies have been proposed in the literature, perturb and observe (P&O) methods are the most commonly employed in commercial goods. The reason for this is that P&O may be implemented in low-cost digital devices while yet maintaining excellent robustness and MPPT efficiency. In 2014, A. Gaga et al. presented the design and development of a photovoltaic system based on the upgraded P&O algorithm, which allows solar systems to be more efficient, stable, and accurate. The suggested solar control system's performance is verified using the PowerSim tool simulator and test results under our improved system, which employs two MPPT algorithms: the old P&O and the new advanced P&O. [6].

Solar energy is a free and abundant source of renewable energy that comes from the sun (RES). It can be used as an alternate energy source to fossil fuels and petroleum products as a non-renewable energy source (NRES). Solar cells are frequently used to collect sunlight, which meets the user's energy needs rather than generating electricity through NRES. From one epoch to the next, solar cells have undergone a variety of changes. The cost and efficiency of solar cells are the roadblocks to progress. Operators must perceive the basic mechanisms and topologies of various solar PV using maximum power point tracking (MPPT) approaches that have been thoroughly tested in order to select suitable solar photovoltaic (PV) cells for a certain location. In 2018, O. Singh et al. evaluated and analysed the growth of solar PV cell research from one decade to the next, and predicted future styles and behaviours. This article also tries to stress a variety of experiments and technologies that contribute to solar energy's benefits [2].

Variability in solar irradiation and ambient temperature necessitates the use of maximum point tracking (MPPT) in photovoltaic (PV) systems in order to ensure continuous harvesting of maximum power. This study looks at a sensorless current (SC) MPPT method that employs model predictive control (MPC). The use of model-based predictive control principles to eliminate the present sensor that is generally required for well-known MPPT approaches like perturb and observe is the most significant contribution of M. Metry, et al's study (P&O). The proposed technology becomes a chic, embedded controller by forecasting PV system states in horizons of your time, allowing for faster response and reduced power ripple in steady state than the standard P&O methodology under quickly changing atmospheric conditions. This has become achievable without requiring expensive sensing and communications equipment and networks for direct detection of solar irradiation variations. The suggested SC-MPC-MPPT with reduced load sensitivity is tested using the concept of the commercial European Efficiency Test, EN 50530, which evaluates PV system performance under dynamic environmental conditions. To verify the simulation results, the proposed control mechanism is implemented experimentally on the dSPACE DS1007 platform [3].

In 2011, A. Durgadevi and colleagues investigated and implemented the Maximum Point Tracking (MPPT) algorithm for photovoltaic systems, which deals with the planning, simulation, and experimentation of a simple yet effective photovoltaic system. It comprises theoretical and experimental investigations of Photovoltaic arrays with 36 cells that offer maximum power to the load at the maximum point. Photovoltaic generators, on the other hand, have nonlinear I-V characteristics and a maximum point that varies depending on solar insolation. By matching the solar system to the load and running the photovoltaic cell arrays at their maximum point, an intermediate converter can improve efficiency. During these investigations, a Maximum Point tracking algorithm for a water pumping system is created and proven in simulation utilising the Perturb and Observe approach using array voltage (V pv) and array current (I pv). The I-V and P-V properties with variable Temperature and Insolation are modelled and experimentally determined. It can be seen from the results that the simulation and experimental results are identical. The MPPT with ck converter simulation results are also shown [4].

In 2016, A. S. Ahmed et al. created the Maximum Point Tracking approach, which is one of the most significant variables in maximising the use and efficiency of any photovoltaic (PV) system (MPPT). Maximum power is commonly obtained by tracking the utmost point (MPP) using specialised algorithms like Perturb and Observe (P&O) and Incremental Conductance Tracking (ICT) (INC). These algorithms are the most often used due to their ease of implementation in comparison to other algorithms. Within the paper, the good impact of the MPPT approach on the PV system is demonstrated. It also demonstrates the operation of both the P&O and INC algorithms. The simulation work (using Matlab/Simulink) evaluated the algorithms under various operating conditions (temperature and solar irradiance) and revealed that each algorithm has advantages over the others: P&O is the fastest to reach the MPP and charge the battery, but it cannot maintain the MPP as well as INC algorithm; however, INC can reach the MPP with fewer perturbations, resulting in a lower switching rate, higher efficiency, and longer battery life.

In 2019, C. V. Ramachandra Rao et al. introduce a Generalized MPPT control-based DC-DC boost converter that provides continuous power while maintaining the dynamic system's integrity. The PV array is modelled using an algebraic loop to achieve an accurate solution over a large number of iterations. This model makes use of longer time steps to achieve a faster simulation. In a PV system, an MPPT controller is used in conjunction with the Generalized P and O approach to manage the duty cycle and achieve maximum continuous power. The MPPT controller and suggested converter are intended for use in a strategy to extract continuous power regardless of irradiance or temperature. In MATLAB SIMULINK, a 100kW PV array connected to a 25kV utility grid is investigated and compared to other models in the literature to demonstrate the usefulness of the constructed model [7].

The performance, design, and economic analyses of solar panels and/or collector systems working under varied climates, tilt angles, and geographic locations all need the estimation of radiation distribution. A detailed study was conducted to maximise the PV array power production by combining the effects of angle and ambient temperature. To begin, we compare several isotropic and anisotropic models, finding that the anisotropic model gains 5% more energy than the isotropic one [8].

3. MPPT AND PHOTOVOLTAIC SYSTEM

Maximum Power Point Tracking (MPPT) is an algorithmic approach for extracting the most power from solar panels under specified conditions. Solar irradiation, ambient temperature, and cell temperature all influence the maximum power output of a PV panel.

At a cell temperature of 25°C, a PV module delivers maximum power voltage. It can, however, decline or raise depending on the ambient temperature.

MPPT identifies a specific PV panel output and determines the most effective voltage, or maximum power point voltage, by comparing it to battery voltage.

A MPPT system's goal is to apply beneficial resistance after sampling the output of a PV cell in order to maximise power.

Because PV modules operate better in cold temperatures, MPPT is more efficient in cooler situations. It is also particularly effective when the battery is deeply drained because greater current can be recovered under low charge circumstances.

MPPT devices, such as solar inverters, convert DC to AC power and are used with power electronics to build an electric power converter system.

A photovoltaic cell, also known as a photoelectric cell, is a semiconductor device that transforms light into electrical energy using the photovoltaic effect. A photovoltaic cell differs from a photodiode in that when the energy of a photon of light exceeds the band gap, an electron is emitted, and the flow of electrons produces current. In a photodiode light falls on nchannel of the semiconductor junction and gets transformed into current or voltage signal but a photovoltaic cell is always forward biassed.

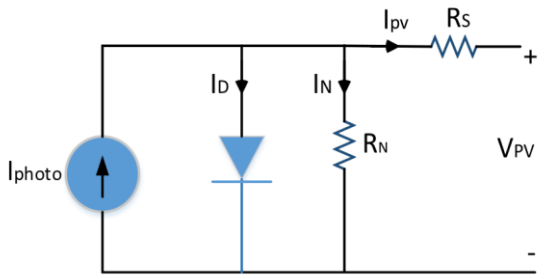

Fig. 1 PV cell Single diode model.

Several PV modules are usually connected in series and parallel to meet energy demands. PV modules come in a variety of sizes that are commercially available (generally available sized from 60W to 170W). A typical small-scale desalination unit, for example, uses a few thousand watts of power.

4. CONCLUSION

A photovoltaic panel is made up of several cells, each of which behaves differently under changing environmental conditions, resulting in a variation in the maximum power point (MPP) of that panel. The term MPPT refers to the process of controlling and optimizing the system's maximum power efficiency. In previous research studies, a wide range of optimization algorithms and methods such as conventional, novel, and hybrid were used. Because solar PV arrays behave in a non-linear dynamic system. Previous MPPT techniques were extracted from the literature and reviewed and discussed in this study based on their benefits and drawbacks. Other evolutionary computing techniques for determining maximum power for a PV system can also be investigated. The obtained MPPT can be applied to a Solar-Wind Hybrid system to improve energy conversion efficiency.

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