A REVIEW ON PHOTOVOLTAIC SOLAR POWER GENERATION WITH MAXIMUM POWER POINT TRACKING

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ABSTRACT

Photovoltaic (PV) system is one of the promising renewable energy technologies. Although the energy conversion efficiency of the system is still low, but it has the advantage that the operating cost is free, very low maintenance and pollution-free. Maximum power point tracking (MPPT) is a significant part of PV systems. This paper presents a novel intelligent MPPT controller for PV systems. For the MPPT algorithm, an optimized fuzzy logic controller (FLC) using the Hopfield neural network is proposed. It utilizes an automatically tuned FLC membership function instead of the trial-and-error approach. The MPPT algorithm is implemented in a new variant of coupled inductor soft switching boost converter with high voltage gain to increase the converter output from the PV panel. The applied switching technique, which includes passive and active regenerative snubber circuits, reduces the insulated gate bipolar transistor switching losses. The proposed MPPT algorithm is implemented using the dSPACE DS1104 platform software on a DS1104 board controller. The prototype MPPT is tested using an Agilent solar array simulator together with a 3 kW real PV panel. Experimental test results show that the proposed boost converter produces higher output voltages and gives better efficiency (90%) than the conventional boost converter with an RCD snubber, which gives 81% efficiency. The prototype MPPT controller is also found to be capable of tracking power from the 3 kW PV array about 2.4 times more than that without using the MPPT controller.

This paper deals with the optimization of maximum power point tracking when a Photovoltaic panel is modelled as two diodes. The adopted control is implemented using a sliding Mode control (SMC) and the optimization is implemented using an improved Pattern Search Method.

Keyword : - *Maximum power point tracking (MPPT), MPPT algorithm , MPPT controller*

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1. INTRODUCTION

Energy generation based on renewable energy resources has received a great attention. Photovoltaic (PV) system is one of the promising renewable energy technologies. The photovoltaic (PV) generation system is a promising renewable, clean, and environmentally friendly source of energy. Each solar cell produces only about one-half volt of electricity, and dozens of individual solar cells are interconnected in a sealed, weatherproof package called a PV module. PV modules can be connected in series, parallel, or both into what is called a PV array. This PV array is connected to a power conditioner and then to a load or grid tie as a grid connected PV system.

In general, the two main problems with PV power generation systems are the low conversion efficiency and that electrical power generated by a typical PV panel varies with weather conditions. Thus, many studies on enhancing the energy-generation efficiency of PV applications have been carried out. A PV generation system should operate at its maximum power point (MPP) to increase system efficiency. Therefore, MPP tracking (MPPT) is very crucial for PV power generation systems to operate at the maximum point as much as possible at any time. However, the MPP also changes with the irradiation level and temperature due to the nonlinear characteristics of PV modules. To overcome this problem, many MPPT algorithms have been developed.

Recently, fuzzy logic has been applied in tracking the MPP of PV systems because it has the advantages of being robust, simple in design, and minimal requirement for accurate mathematical modeling. However, fuzzy logic methods depend on a careful selection of parameters, definition of membership functions, and fuzzy rules.

Developing fuzzy logic methods also requires expert knowledge and experimentation in selecting parameters and membership functions. For this reason, adaptive fuzzy logic control has been developed by adding an inverse fuzzy knowledge base, parameter tuning of fuzzy logic control by optimization techniques such as genetic algorithms, and particle swarm optimization. A number of studies on MPPT have also concentrated on the application of artificial neural networks (ANN). In most ANN-based MPPT methods, large amounts of field data considering atmospheric conditions are required to train the ANN. The main drawback of ANN-based MPPT methods is that it is system dependent and requires time-consuming implementation of PV arrays with different characteristics. Thus, MPPT algorithms are not robust against the rapidly changing temperature and irradiation, as well as partial shading. For the purpose of developing a more robust MPPT algorithm, a new type of intelligent technique based on the Hopfield neural network (HNN) is proposed and used together with a fuzzy logic-based MPPT controller in a PV system. Here, the fuzzy logic MPPT controller is integrated with the HNN to optimize the membership function of the fuzzy system.

In any PV system, the MPP of a PV module is tracked by the MPPT algorithm and a DC-DC boost converter, which is controlled by a triggering signal with a specific duty cycle to trigger the switch of the converter and locate its operating point as closely as possible to its MPP. Boost converter with MPPT plays an important role in PV power systems because it maximizes the power output from a PV system under various conditions, thereby maximizing the PV array efficiency. To improve the boost conversion efficiency, many modified boost converter topologies have been developed. Conventional boost converters operate in the hard-switching mode, thus rendering it inefficient when voltages and currents in semiconductor switching devices are changed abruptly from high values to zero and vice versa at turn-on and turn-off times. Consequently, switching losses and electromagnetic interference occur. An improved boost converter topology using a coupled inductor together with a passive snubber has been developed and applied in standalone PV and grid-connected PV systems. Considering these facts, a new variant of a high gain, soft-switching DC-DC converter is proposed in to reduce the number of series-connected PV modules and improve the conversion efficiency.

The transformation of energy by means of photovoltaic panels has progressively aroused great Interest due to the steady increase in oil prices, the environmental pollution caused by hydrocarbons, And a constant reduction in the prices of photovoltaic (PV) panels. Nevertheless, the low energy Efficiency due to the conversion of solar energy into electric energy is one of the main obstacles to the Widespread increase of this type of energy source. Therefore, the extraction of the maximum possible Power of each panel is the main technological challenge nowadays.

2. LITERATURE REVIEW ON PHOTOVOLTAIC SOLAR POWER GENEREAION WITH MAXIMUM POWER POINT TRACKING

For instance, shows five different approaches to solve the MPPT:

1. tracking techniques with constant parameters, that is, algorithms that consider, during the Maximum power point (MPP) prediction, parameters such as constants, e.g., voltage of maximum Power point independent of temperature and irradiance, linear dependency the PV current in MPP and The short-circuit current , linear relation between voltage in MPP and open-circuit voltage , etc.
2. Tracking techniques with measurement and comparison, namely, the look-up table method and Linear current control method ;
3. tracking techniques with trial and error, namely, the perturb and Observe (P&O) algorithm and its modifications ;
4. tracking techniques with mathematical Calculation, namely, incremental conductance (INC) ; and finally
5. Tracking techniques with Intelligent prediction (soft computing), which will be explained in detail below.

Soft computing-based techniques have revealed a powerful tool to deal with MPPT optimization. Furthermore, the availability of high-performance and affordable microcontrollers makes the Implementation of these algorithms possible in practical situations. These facts have boosted the Research on soft computing-based approaches to tackle the MPPT problem. Thus, in, an Artificial Neural Network (ANN) MPPT controller, based on fixed and variable step size, is proposed. In this Work the data required to generate the ANN model are generated using P&O. The controller is Developed in two steps: (is) an offline step required to define the neural networks and aimed at finding The optimal structure (the number of layers and neurons, activation functions, parameters, and training Algorithm) of the MPPT controller; and (ii) an online step where the optimal neural network MPPT Controller found in the previous step is used in the PV system. Other works in this direction can be Found in. Moreover, other soft computing techniques, such as Fuzzy logic control (FLC) And Particle swarm optimization (PSO), can also be used for MPPT optimization. An interesting Paper where many different techniques for MPPT are discussed is presented in. The paper presents an Interval Type 2 Fuzzy Logic in combination with a Genetic Algorithm For MPPT. In, a novel algorithm is described for global maximum power point tracking (GMPPT) Control in parameter optimization corresponding to variable environmental and partial shading Conditions; a definable non-linear relation has been presented between variable environmental Parameters and the output current of solar arrays at every MPP. Some research has been based on Modeling multi-junction solar cells to improve conversion efficiency. In this manner, the multi-junction Photovoltaic cell also has been investigated to obtain its maximum performance compared to the Conventional silicon PV cell, as presented in. In, a FLC for MPPT is presented. Finally, in, A PSO method is presented to optimize and to design an intelligent controller. A facet that all these Approaches have in common is that they only present simulation results. Recently, an MPPT optimization approach based on Pattern Search was proposed in. The technique presented is based on the Generalized Pattern Search Method (GPSM). The GPSM was Proposed in for derivative-free unconstrained optimization of continuously differentiable convex Functions and has been used since then in different control approaches. In this paper, a MPPT optimization method using an IPSM is proposed. In this case, the Optimization is based on the IPSM introduced in. The main advantage with respect to the previous Work is that the pool search guarantees that the global maximum is attained in all cases and this Fact is tackled in this paper by means of theoretical convergence results. Additionally, the present Paper considers the modeling of a photovoltaic panel with two diodes. This is to highlight that the System is controlled by the sliding mode controller formulated in, which is based on voltage Error and input capacitor current. In this way, it is possible to ensure a stable sliding regime in all The desired operation ranges of the system. Finally, two of the proposed optimization algorithms Commonly used for the MPPT, P&O and PSO, are compared with the proposed approach. It is shown That the proposed approach presents lower energy losses in comparison with other two algorithms but also the advantage of ensuring the MPPT in all cases simulated.

3. CONCLUSION

This paper has presented a new MPPT controller for PV generation systems using an improved boost converter design and a novel MPPT algorithm. This novel MPPT algorithm based on the HFLC is developed for extracting the PV array power at its maximum. A hardware prototype of the proposed boost converter is developed and tested for verification. The proposed boost converter gives better energy conversion efficiency (90%) than conventional boost converters (81%). Laboratory testing of the MPPT controller is implemented using a 1 kW Agilent PV solar array simulator. For the actual field testing of the MPPT controller, it is connected to a 3 kW Solaria STF-120P6PV PV array.

- MPPT can improve the power conversion efficiency of PV panels
- Produces maximum power at all times
- High cost of MPPT controllers but no change in LCOE

In the present work, we compared three optimization algorithms, namely, P&O, PSO, and IPSM, For MPPT. We described each one of the algorithms, we used the SMC and we simulated all of them in PSIMR. In the simulation, different number of models (particles) were taken into account. The figures Display the results produced by each of the tests. From the simulation results, we conclude that the P&O algorithm is the fastest one to obtain The MPP, but its constant oscillation around the MPP generates considerable energy losses to the system. The PSO algorithm presents great oscillations, the greatest energy losses, and in some cases it cannot Obtain the MPP. Besides, the IPSM algorithm is slower to obtain the MPP but presents lower energy Losses in comparison with the other two algorithms. Additionally, the convergence to the maximum Power point can only be ensured by the proposed IPSM algorithm, which is the main advantage with Respect the other approaches (P&O and PSO). We highlight that the IPSM is the algorithm recommended for the implementation in real Systems, since this algorithm presents lower energy losses versus adequate settling time, as well As a soft behavior, which is recommended to extend the useful life of the power electronics.
Photovoltaic (PV) power has been successfully applied for over three decades. PV cell provides power for systems in many applications on earth and space. PV cell exhibits nonlinear voltage-current characteristics and its maximum power point varies with solar illumination and ambient temperature. With the development of power electronics

technology, it is now possible to operate photovoltaic system with its maximum power point (MPP) in order to increase the overall system efficiency. This paper presents a novel algorithm for maximum power point tracking in PV systems based on the optimal gradient method. The algorithm can track maximum power point quickly and accurately. In this paper, the method of optimal gradient for maximum power point tracking (MPPT) is deduced, and the algorithm has been verified based on simulation results in Mat lab. The simulation shows the novel algorithm significantly improves the efficiency during the tracking phase compared with a conventional algorithm. The novel algorithm is especially suitable for fast changing environmental conditions. The proposed algorithm can be implemented on any fast controller such as the digital signal processor.
In this paper we applied T2FLC on photovoltaic panel. We observed it is proper for performance in Noisy environments just like these environments. Noise importation is unavoidable .so using controller Which is could decrease noise effect is very important. By considering the results of simulation which Were achieved in this paper it is noticeable; T2FLC has better operation than FLCT1 whenever noise was Present. On the other hand because of its complicating and time consuming calculation T2FLC is slower Than T1FLC.

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