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A Review Article of Improvement of Grid Connected Photovoltaic System Using Artificial Neural Network

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***Abstract*-Nowadays in order to meet the increase in power demands and to reduce the global warming, renewable energy sources based system is used. Out of the various renewable energy sources, solar energy is the main alternative. But, compared to other sources, the solar panel system converts only 30–40% of solar irradiation into electrical energy. In order to get maximum output from a PV panel system, an extensive research has been underway for long time so as to access the performance of PV system and to investigate the various issues related to the use of solar PV system effectively. This paper therefore presents different types of PV panel systems, maximum power point tracking control algorithms, power electronic converters usage with control aspects, various controllers, filters to reduce harmonic content, and usage of battery system for PV system. Attempts have been made to highlight the current and future issues involved in the development of PV system with improved performance.**

***Keywords*-PV cells, PV array, MPPT, dc-dc converter.**

I.INTRODUCTION

Amongst all renewable energy sources, solar energy provides excellent opportunity for the production of electricity and therefore this energy is widely used. Solar energy is a clean renewable resource with zero emission. Due to increase in power demand, the switch over to renewable energy sources which are eco-friendly and exist abundant in nature is extremely necessary. The efficiency of the PV system is improved by using the maximum power point tracking (MPPT) controller. Frequently used MPPT algorithms are Perturb & Observe (P&O) and Incremental Conductance (INC). In the incremental conductance algorithm, the gradient of the P-V curve is estimated [1], [2]. In this method , the peak power is being tracked even under the varying conditions of atmosphere.

This is the main advantage of INC method. In this incremental conductance method, the relationship between dI/dV& -I/V is used to identify the direction of perturbation of the operating point [3]. A dc-dc step-up converter is required to raise the voltage obtained from the PV panel.

The boost, buck, buck-boost, Cuk, single-ended primary inductance converter (SEPIC) converters are commonly used for this purpose [4]. Among these, the (SEPIC) gives a positively regulated output and non-inverted output. Eventhough the cost of buck-boost converters is less because of a single inductor and a capacitor, a more harmonics are generated. Therefore, a large capacitor or an LC filter are needed to eliminate these harmonics. Therefore it becomes inefficient or expensive, and also there is a complication in the usage of buck-boost converters. Cuk converters can eliminate these problems with the use of an extra inductor and capacitor [5]. But, buck-boost and Cuk converters generate greater amounts of electrical stress on the components during their operation, which results in overheating of device or device failure.

The SEPIC converters will eliminate these drawbacks. In this paper, the dc voltage available from the solar panel is regulated by the SEPIC converter and fed to the single phase inverter. The single phase Induction motor of the 1HP capacity is connected at the output of single phase inverter [6],[7]. The speed of the induction motor is used as a feedback signal. This is used to obtain the error voltage and change in error voltage. These are the inputs to the Neural Network controller. In [8- 11], MPPT of solar PV using ANFIS and fuzzy logic have been reported. The generated pulses from the controller the pulses obtained from the Incremental Conductance Algorithm of a Solar panel are combined and fed to SEPIC converter and desired voltage output is generated [12-15].

II. RELAED WORK

Blaabjerg et al. Digital implementation of this derivative term is generally a challenge with many methods presently developed for resolving it. These methods are however still facing drawbacks, which have comprehensively been explained in the paper. Two

derivatives are then proposed, based on either second-order or non-ideal generalized integrator.

Lin et al, proposed RFCMANN controller uses the signed distance and input space repartition mechanisms to convert the dual input variables to sole input variable and repartition the input space to an appropriate quantity. Therefore, the structure and computation complexities of the proposed RFCMANN controller are effectively reduced and make it more practical.
Yang et al. proposed intelligent controller regulates the value of reactive power to a new reference value which complies with the regulations of LVRT under grid faults. Moreover, a dual mode operation control method of the converter and inverter of the three-phase grid-connected PV system is designed to eliminate the fluctuation of DC-link bus voltage under grid faults.

X. Fu and S. Li et al, proposes a novel recurrent neural network based vector control method for a single-phase inverter with an LCL filter. The neural network is trained based on adaptive dynamic programming principle and the objective of the training is to approximate optimal control. The Levenberg-Marquardt plus Forward Accumulation through Time algorithm is developed for training the proposed recurrent neural network controller. The neural network vector control approach is compared with conventional control methods, including the conventional PI-based vector control method and the PR-based control technique for single-phase inverters.

Wang et al. [5], presents an effective control scheme using a line-commutated high-voltage direct-current (LCCHVDC) link joined with a damping controller based on adaptive-network-based fuzzy inference system (ANFIS) to achieve damping improvement of an integration of wind, solar, and marine-current power systems fed to a synchronous generator (SG)-based power system. The proposed ANFIS is an adaptive, robustness controller by combining the advantages of artificial neural network and fuzzy logic controller to face different operating conditions of the studied system. A time-domain scheme based on a nonlinear-system model subject to a three-phase short-circuit fault at the infinite bus is utilized to examine the effectiveness of the proposed control schemes.

Abd kadir Mahammad, et al. has compared conventional Proportional Integral Derivative(PID) and Fuzzy Logic(FL) under four different conditions which are : constant irradiation and temperature, constant irradiation and variable temperature, constant temperature and variable irradiation. After simulation results PID controller has shown better performance than FL controller under partially shaded conditions. PID controller has greater maximum power and average power compared to FL controller. A.Bouilouta, et al. has introduced a new method to track the global maximum power point (GMPP) under partially shaded condition for standalone PV systems. Advantages are that PV systems have fast response and good stabilization at the real MPP, efficiency is high. The disadvantage is that under rapid changes in isolation (or under dynamic loads) it takes small amount of time to reach MPP and has small overshoots. Further work is being conducted on the overall system design and experimental implementation.

KoraySenerParlak has offered a new novel method of Global MPPT operating under partially shaded conditions. A capacitor is connected to the array as load, and, its current and voltage parameters are sensed while charging from PV array. Advantages are ability to find GMPP in partial shading configuration, no need of multiple MPPT devices, very short computation time. In future challenges of application for the proposed MPPT method will be investigated since there may occur some technical difficulties in widely ranging irradiance level and for large scale system.

Jun Qi, Youbing Zhang has proposed AMPPT algorithm based on conventional MPPT method by introducing two more steps. They are change detection for partial shade and search for GPA. The proposed method is satisfactory in real global MPP tracking under a large number of different partial shade conditions; less number of sensors is needed. If implemented generation efficiency for PV power system will improve.

A. Elnosh, et al. has proposed Extremu-Seeking Control(ESC) to track the global power peak under non uniform irradiance conditions. It relies on the measurements of power and estimation of the power gradient to iteratively determine the segment of the PV characteristics in which the global peak lies, without converging at the local maxima. The proposed method can reach the global peak with a faster convergence rate and higher tracking efficiency than conventional approaches. Venkateswarlu, et al. has presented a method to quickly draw the characteristics and recording the result using an electronic load.

Kok Soon Tey et al. has proposed a Differential Evolution (DE) based optimization algorithm to provide the globalized search space to track the GMPP. The direction of mutation in the DE algorithm is modified to ensure that mutation always converges to best solution among all the particles in the generation. The proposed algorithm has benefits of rapid convergence to GMPP and higher efficiency than conventional approaches. Mohammad Mehdi SeyedMahmoudian, et al. has presented MATLAB-programmed modeling and simulation of PV systems, by focusing on the effects of partial shading on the output of the PV systems. The proposed model simulates the behavior of different ranges of PV systems from a single PV module through the multidimensional PV structure.

Nicola Femia, et al. has shown that negative effects of drawbacks of P&O can be limited by customizing P&O MPPT parameters to the dynamic behavior of the specific converter adopted. Also, theoretical analysis has been provided. Hiren Patel and Vivek Aggarwal has presented a MATLAB based modeling and simulation scheme suitable for studying the I-V and P-V characteristics of a PV array under partial shading, also , it can be used for developing new MPPT techniques. It can also be used as a tool to study the effects of shading patterns on PV panels with different configurations.

Hiren Patel and Vivek Aggarwal has proposed a new algorithm to track the GMPP under partially shaded conditions. The algorithm works in conjunction with a dc-dc converter to track GP. Also, to accelerate the tracking speed, a feed forward control scheme for operating the dc-dc converter is proposed, it uses the reference voltage information from the tracking algorithm to shift the operation toward the MPP. As compared to conventional controller, tracking time is reduced to one-tenth. Also entire P-V curve is not scanned. Shahariar Kabir, et al. has presented detailed analysis of impact of irradiance and temperature variations caused by partial shading condition. Also, an innovative MPPT scheme has been proposed which employs the Fractional Open-Circuit Voltage technique. Also, variable perturbation size concept is introduced. The proposed algorithm along with variable size control results in reduction of energy loss due to the fluctuation of tracker near MPP.

III. SYSTEM IMPLEMENTATION EXISTING SYSTEM

Existing technologies, vector control is usually used to control a three-phase solar inverter. However, to applying vector control to a single-phase inverter, an imaginary circuit needs to be created, which has caused challenges to ensure high performance of vector control in residential solar PV applications, including low reliability under variable PV power generation condition and high harmonic distortion. At present, the dominate control strategies for a single-phase inverter are proportional resonant (PR) control and sliding mode control (SMC) based upon hysteresis switching mechanisms. Compared to vector control, both require a high sampling frequency (e.g., 10s or 100s kHz) and switching frequency (e.g., 10s or 100s kHz), which would cause more energy loss, larger size of heat sink, and more expensive inverter systems.

IV.ARTIFICIAL NEURAL NETWORK CONTROL

The main considerations for integration of MPPT and ANN controls include:

- How the integration may affect MPPT efficiency and speed,
- How to maintain the stability of DC link voltage under variable output power of a PV array
- How to provide reliable reactive power or grid voltage regulations at the PCC in the integrated condition.

An ADP-ANN controller must be trained before applying it to the overall PV system. The ANN was trained repeatedly to track a variety of reference d-q current trajectories until satisfactory and excellent tracking performance is achieved. Each training experiment starts with randomly generated network weights. Thus, each may converge to different ADP cost. The final network weights are selected from those training experiments having the lowest ADP costs. After the network is well trained, the ANN controller for simulation or experiment case is able to track reference d-q current with minimum errors and in the optimal way according to ADP.

1. Integrating MPPT and ANN Controls

The integration of MPPT and ANN controllers is based on the PV system shown by Fig. 4.1. The MPPT controller is responsible for extracting power from the PV array with the maximum efficiency. Depending on the irradiance levels, the extracted power could go up and down, causing the DC-link voltage to increase and decrease. The stability of the DC-link voltage is maintained through the ANN controller. To achieve this, a PI-based DC-link voltage controller is added before the ANN current tracking controller. According to [6], this is achieved through the control of the PCC daxis current.

As shown by Fig. 4., the DC-link voltage controller generates a d-axis current reference to the ANN controller based on the error signal between the measured and reference DC-link voltages. The q-axis current tracking ability of the ANN controller is used for another control purpose. According to[7], this could be either reactive power control or grid voltage support control at the PCC. For reactive power control, a PI based reactive power controller is added before the ANN current tracking controller. The reactive power controller generates a q-axis current reference to the ANN controller based on the error signal between the measured and reference PCC reactive power.

For grid voltage support control at the PCC, a PI-based PCC voltage controller is used to generate a q-axis current reference to the ANN controller based on the error signal between the measured and reference PCC voltages. Certainly, the controller gains of the PCC voltage controller would be different from those of the reactive power controller. The PI gains of the DC-link voltage controller and reactive power or PCC voltage support controller were initially tuned without considering the PV array and MPPT control. Also, the ANN controllers are trained for current tracking purpose only. Thus, detailed performance evaluation of the overall integrated system is needed and important. This is discussed in Sections VI

and VII, in which we found that PI gains of the DC-link voltage controller and the reactive power or PCC voltage controller usually need to be re-tuned through trial and error to achieve the best control performance regarding the stability and response speed, particularly if the ANN current controller is replaced by a conventional current controller.

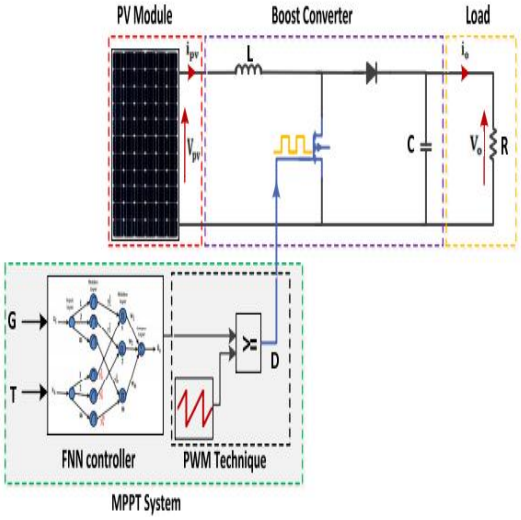

Figure 1 Block diagram of the PV system with an FNN controller based on MPPT.

V.COMPONENTS OF ARTIFICIAL NEURAL NETWORK

There are seven major components involved in the artificial neural network. These components are important whether the neuron is used in input, output or hidden layer [22-23].

- Determination of weight
- Summation function
- Transfer function
- Scaling and limiting
- Output function
- Error function and back propagated value
- Learning function J. Steps Involved in Framing ANN

Step1: Input to the Artificial Neural Network The error voltage from the motor is given at input of the artificial neural network.

Step2: Processing of Input From multiple inputs, a single input is chosen and assumed minimum value is subtracted and multiplied by the gain which is the ratio of output range to input range, and in some situation, additional bias is given to the input. This forms the first layer of an artificial neural network.

Step 3: Output Processing The layer 1 output is given as an input to this layer 2 and the output would be a two-dimensional element. This element is made dot products with weights assumed and then given to the transfer function and the process of step 2 is done in a reverse manner.

VI.CONCLUSION

The use of solar energy is essential for providing solutions to the environmental problems and also energy demand. The vast development to improve the efficiency by the MPPT algorithms encouraged the domestic generation of power using solar panels. The available MPPT techniques based on the number of control variables involved, types of control strategies, circuitry, and applications are possibly useful for selecting an MPPT technique for a particular application for grid tied or standalone mode of operations. This review has included many recent hybrid MPPT techniques along with their benefits for mismatched conditions such as partial shading, nonuniformity of PV panel temperatures, and dust effects.

Going by the amount of research work, it can be concluded that the MPPT is continuously being researched. This implies that improvements and new techniques are destined to happen in near future. In uniform isolations conditions there is no as such problems and only efficiency is being increased by improving or combining existing technique. But the real concern is for partial shading condition where still new techniques are being developed. In new techniques PSO shows the greatest viability. But research will continue to get the maximum power from PV system.

This DC is again fed to the inverter for converting the DC to AC with various PWM techniques. These PWM inverter techniques yield the better AC outputs which are used to connect the grid interconnections and standalone AC loads. Multilevel inverters with sinusoidal PWM and SVM are used to reduce the harmonics in the load voltage even in low switching frequency. Grid tied inverters with battery backup are preferred in hybrid systems for backup even if the grid goes down for both grid tied and off grid systems.

REFERENCES

[1] A. Mathew and A. Immanuel Selvakumar, “MPPT based standalone water pumping system,” in Proceedings of the IEEE International Conference on Computer, Communication and Electrical Technology (ICCCET ’11), pp. 455–460, Tamil Nadu, India, March 2011.

[2] R. Faranda and S. Leva, “Energy comparison of MPPT techniques for PV systems,” WSEAS Transactions on Power Systems, vol. 3, no. 6, pp. 446–455, 2008.

[3] C. Liu, B. Wu, and R. Cheung, “Advanced algorithm for MPPT control of photovoltaic

systems," in Proceedings of the Canadian Solar Buildings Conference, Montreal, Canada, 2004.

[4] F. Liu, Y. Kang, Z. Yu, and S. Duan, "Comparison of P&O and hill climbing MPPT methods for grid-connected PV converter," in Proceedings of the 3rd IEEE Conference on Industrial Electronics and Applications (ICIEA '08), pp. 804–807, Singapore, June 2008.

[5] A. Mellit and S. A. Kalogirou, "Artificial intelligence techniques for photovoltaic applications: a review," Progress in Energy and Combustion Science, vol. 34, no. 5, pp. 574–632, 2008.

[6] S. Ait Cheikh, C. Labres, G. F. TchoketchKebir, and A. Zerguerras, "Maximum power point tracking using a fuzzy logic control scheme," Revue des Energies Renouvelables, vol. 10, pp. 387–395, 2007.

[7] A. Saadi and A. Moussi, "Neural network use in the MPPT of photovoltaic pumping system," Revue des Energies Renouvelables, pp. 39–45, 2003.

[8] M. Yue and X. Wang, "A revised incremental conductance MPPT algorithm for solar PV generation systems," http://arxiv .org/abs/1405.4890.

[9] K. H. Hussein, I. Muta, T. Hoshino, and M. Osakada, "Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions," IEE Proceedings: Generation, Transmission and Distribution, vol. 142, no. 1, pp. 59–64, 1995.

[10] T.-Y. Kim, H.-G. Ahn, S.-K. Park, and Y.-K. Lee, "A novel maximum power point tracking control for photovoltaic power system under rapidly changing solar radiation," in Proceedings of the IEEE International Symposium on Industrial Electronics (ISIE '01), pp. 1011–1014, IEEE, Pusan, South Korea, June 2001.

[11] Y.-C. Kuo, T.-J. Liang, and J.-F. Chen, "Novel maximum-powerpoint-tracking controller for photovoltaic energy conversion system," IEEE Transactions on Industrial Electronics, vol. 48, no. 3, pp. 594–601, 2001.

[12] W. Wu, N. Pongratananukul, W. Qiu, K. Rustom, T. Kasparis, and I. Batarseh, "DSP-based multiple peak power tracking for expandable power system," in Proceedings of the 18th Annual IEEE Applied Power Electronics Conference and Exposition (APEC '03), pp. 525–530, IEEE, Miami Beach, Fla, USA, February 2003.

[13] H. Koizumi and K. Kurokawa, "A novel maximum power point tracking method for PV module integrated converter," in Proceedings of the IEEE 36th Power Electronics Specialists Conference, pp. 2081–2086, IEEE, Recife, Brazil, June 2005.

[14] K. Harada and G. Zhao, "Controlled power interface between solar cells and AC source," IEEE Transactions on Power Electronics, vol. 8, no. 4, pp. 654–662, 1993.

[15] K. Irisawa, T. Saito, I. Takano, and Y. Sawada, "Maximum power point tracking control of photovoltaic generation system under non-uniform isolation by means of monitoring cells," in Proceedings of the 28th IEEE Conference on Photovoltaic Specialists, pp. 1707–1710, September 2000.