JES
Journal of Engineering Sciences

Vol 13, Issue 02, FEB /2022

ISSN NO:0377-9254

ANN BASED MPPT TO A SOLAR BASED PV SYSTEM FOR EXTRACTION OF MAXIMUM POWER

[1]Mr. KANNEKANTI SHIVA PRASAD, [2]DR. M. SARAVANAN

[1]PG scholar in Holy Mary Institute of Technology & Science ,Bogaram (V), Medchal District, Hyderabad, India in the Dept. of Electrical & Electronics Engineering.

[2]Associate Professor in Holy Mary Institute of Technology & Science, Bogaram, R.R. Dist, Hyderabad, Telangana, India in the Dept. of Electrical & Electronics Engineering.

Abstract: In grid connected photovoltaic (PV) systems, maximum power point tracking (MPPT) algorithm plays an important role in optimizing the solar energy efficiency. In this paper, the new artificial neural network (ANN) based MPPT method has been proposed for searching maximum power point (MPP) fast and exactly. For the first time, the combined method is proposed, which is established on the ANN-based PV model method and Perturb and Observe (P&O) algorithm. The advantage of ANN-based PV model method is the fast MPP approximation base on the ability of ANN according to the parameters of PV array that used. The advantage of P&O algorithm is the ability to search the exactly MPP based on the feedback voltage and current but don't care the characteristic on PV array. The rapid depletion of fossil fuels and rising environmental problems opened a door for renewable energy resources. Among mostly used renewable energy resources solar energy is the one. Due to higher cost of solar panel efficient operation is essential. In this paper an artificial neural network based MPPT is proposed.

I. INTRODUCTION

Maximum power point tracking (MPPT) is a technique to maximize the power output. Photovoltaic Cells and other similar devices use this technique to get maximum power. Photovoltaic cells have a complex relationship between their operating environment and power they can produce. [1] The power output depends mainly on solar irradiance, temperature, and total resistance. Due to nonlinear I-V characteristics, where output power varies with cell voltage it is necessary to develop a mechanism that will harness the maximum power available from sun at all the times.

The typical I-V and P-V characteristics of PV cell are as below, the point at which $dP/dV = 0$ in the P-V curve is called the Maximum Power Point also called as 'knee' point. There are various algorithms to track the maximum power point.

Classical perturb and observe algorithm approach compares the current operation point and subsequent perturbation point to observe their changes in the power and the controller increases or decreases the PV arrays output voltage based on the difference in the power. If this difference is positively weighted, then duty cycle of converter increases and if negatively weighted then duty cycle of converter must decrease. But if positive and negative weighted error come subsequently them maximum power is not reached. [2] Incremental Conductance method has advantages over P&O in that it can determine when the MPPT has reached the MPP, where P&O oscillates around the MPP. Also, incremental conductance can track rapidly increasing and decreasing irradiance conditions with higher precision than perturb and observe. The disadvantage of this algorithm is the increased complexity. [3] Constant Voltage algorithm assumes that maximum power point voltage at different irradiance is approximately equal and is around 76% of open circuit voltage. In last few years artificial intelligence is gaining popularity to track maximum power point. Artificial Neural Network is one of them. The major advantage with this algorithm is that it doesn't need to solve the complex mathematical relation between power output, solar irradiance, solar temperature, and total resistance plus the outputs are obtained in a very less time with no oscillations at all. Mathur in his inspiring paper [2] presented a method to track the maximum power point voltage using artificial neural network. He also simulated the MPPT in Simulink for operating a solar panel which is supplying load using Buck-Boost Converter. However, model is simulated using control blocks. In this paper, I used ANN based MPPT to operate the solar panel so that it can provide constant output voltage across the load using Boost Converter. I also compared the performance with classical perturb and Observe method. The upcoming section consists of proposed system.

II. OVERVIEW OF THE PV SYSTEM

PV array characteristic Considering economy and maintainability, centralized inverter topologies are generally used in PV power generation systems. Centralized inverters are connected to many PV modules, usually using S-P configuration, as shown in Fig. 1. The output current of this configuration can be expressed as [22]

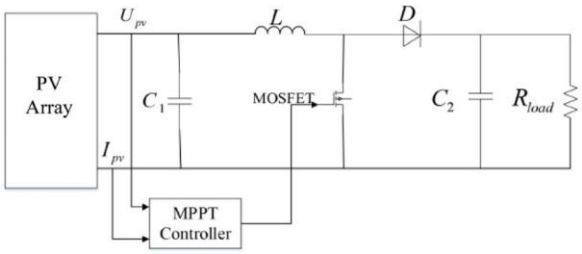


Fig1. PV system with Boost Converter.

$$I = N_{PP}[I_{PV} - I_O(I_P - 2)] - \left(\frac{V + IR_S\Gamma}{R_P\Gamma}\right)$$

Where

$$I_P = exp\left(\frac{V + IR_S\Gamma}{V_T N_{SS}}\right) + exp\left(\frac{V + IR_S\Gamma}{(P-1)V_T N_{SS}}\right)$$

$$\Gamma = \frac{N_{SS}}{N_{PP}}$$

I and V are the solar cell output current and voltage, respectively. IPV is the photocurrent, IO is the reverse saturation current, and VT is the thermal voltage of PV arrays. RS and RP are the equivalent series and parallel resistances, respectively. The output characteristics of PV cells are closely related to the solar irradiance. When solar irradiance changes, the PV array has strong nonlinear volt-ampere characteristics. It is neither a constant voltage nor a constant current and cannot provide constant power for load. The output current is approximately constant in most of the working voltage range, though near the open circuit voltage, the current decline rate is very large. Figure 2 shows the simulation results under different solar irradiance at the PV array temperature of T = 25 °C. It can be seen from the figure that the output characteristics of the photovoltaic array vary greatly under the influence of solar irradiance. When the solar irradiance increases, the output power increases.

The proposed system is as below, it consists of solar panel, ANN Based MPPT and Boost Converter. Solar Panel The model of PV array is taken form MATLAB/Simulink library whose model number. The specification sheet for this panel is as below.

III. ANN BASED MPPT

Artificial neural networks (ANNs) are a family of statistical learning models inspired by biological neural networks (the central nervous systems of animals, in particular the brain) and are used to estimate or approximate functions that can depend on many inputs and are generally unknown. Artificial neural networks are generally presented as systems of interconnected "neurons" which send messages to each other. The connections have numeric weights that can be tuned based on experience, making neural nets adaptive to inputs and capable of learning. [4] The ANN model is developed in MATLAB/Simulink environment. A feedforward based neural network with two neurons in input layer, five neurons in output layer and one in output layer is constructed. The model of network is as below.

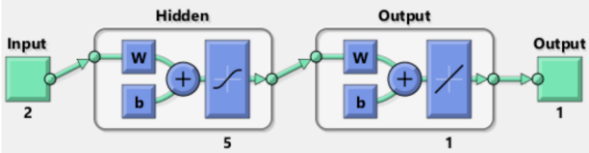


Fig.2 Neural Network Model

The inputs to neural network are temperature and irradiance and the output is the voltage at the maximum power point. In hidden layer the basis function is weighted linear sum and activation function and tansig. For output layer basis function is linear weighted sum whereas activation function is Linear. The algorithm used is Levenberg-Marquardt. Among 16 data sets 10 data sets are used for training, 4 data sets for validating and 2 for testing. The MATLAB program for developing neural network is,

x1=[20 1000;25 1000;30 1000;35 1000;40 1000;45 1000;50 1000;25 200;25 300;25 400;25 500;25 600;25 700;25 800;25 900;25 1000]; x=x1';

t1=[296.8;290;283.2;276.6;270;263.4;256.8;287.5; 291.1;292 .6;293.3;293.3;292.6;291.9;289.6;290];

t=t1';

net = feed-forward-net(5);

net = train(net,x,t);

view(net) y = net(x);

perf = perform(net,y,t)

The function ‘gensim’ is used to produce Simulink block from above program. Now, so generated output from neural network is compared with the PV cells output voltage and error is passed through the controller. The MATLAB/block of ANN based MPPT controller is as below,

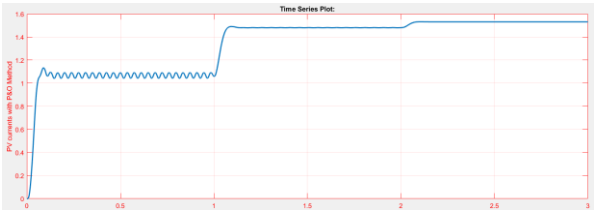
IV. BOOST CONVERTER

A boost converter is like step up chopper i.e., used to step up the input voltage level. The basic circuit diagram for a Boost regulator using IGBT, when the IGBT (Insulated gate bipolar transistor) is on current flows through inductor and IGBT and energy gets stored in the inductor. Now when IGBT is turned off then energy previously stored in the inductor is released through capacitor and load. The amount by

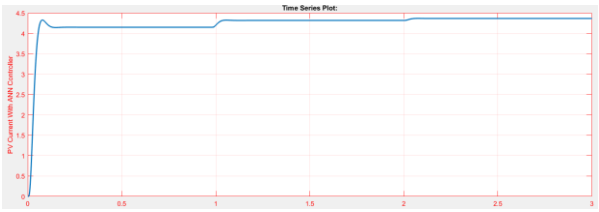
which the output voltage gets boosted up depends upon the duty ratio.

Duty ratio= $\frac{T_{ON}}{T_{ON}+T_{OFF}}$ k, and $Vo = \frac{V_{in}}{1-k}$ = output voltage.

V. SIMULATION RESULTS

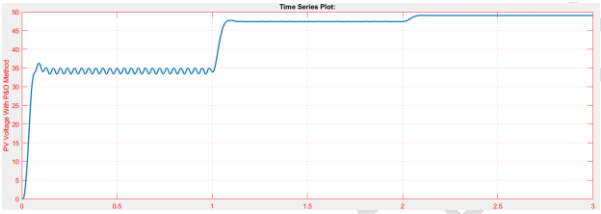


(a)

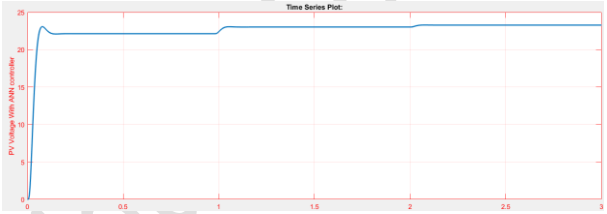


(b)

Fig 3. PV system Currents with Different methods (a)P&O method (b) ANN method.

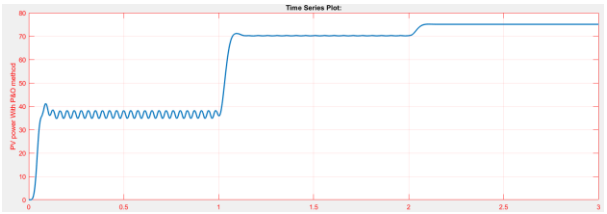


(a)

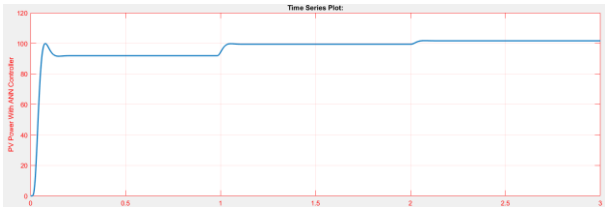


(b)

Fig 4. PV system Voltages with Different methods (a)P&O method (b) ANN method.



(a)



(b)

Fig 5. PV system Powers with Different methods (a)P&O method (b) ANN method.

CONCLUSION

In this paper, an incremental conductance algorithm is proposed to track the MPP for a PV module under a fast-changing solar irradiation level. The confusion faced by the conventional algorithm is discussed and modifications are proposed to mitigate the inaccurate response. Compared with the current research status, the control system structure of the proposed algorithm is simpler and more stable and can accurately respond and track MPP. This improves the stability of the system and avoids mis-judgment when the irradiance changes. Simulation results validate that the algorithm is more stable than the traditional algorithm and improves not only the tracking speed but also the tracking accuracy of the system. The output voltage using ANN based MPPT controller is smoother and contained lesser oscillations. The controller is more robust and faster in nature. In this paper only 16 number of data sets are used but if large number of data sets are used to train the network, then still more robust and accurate controller can be made.

REFERENCES

[1] https://en.wikipedia.org/wiki/Maximum_power_point_ tracking

[2] Mathur, D., “Maximum Power Point Tracking with Artificial Neural Network” International Journal of Emerging Science and Engineering (IJESE) ISSN: 2319–6378, Volume-2, Issue-3, January 2014

[3] Atallah, A.H., Abdelaziz, A.Y., and Jumaa, R.S., “Implementation of perturb and observe mppt of pv system with direct control method using buck and buck boost converter” Emerging Trends in Electrical, Electronics & Instrumentation Engineering: An international Journal (EEIEJ), Vol. 1, No. 1, February 2014

[4] https://en.wikipedia.org/wiki/Artificial_neural_network.

[5] He, Y. Q., Chen, Y. H., et al. (2018). A review on the influence of intelligent power consumption technologies on the utilization rate of distribution

network equipment. Protection and Control of Modern Power Systems, 3(2), 183–193.

[6]. Salam, Z., Ahmed, J., & Merugu, B. S. (2013). The application of soft computing methods for MPPT of PV system: A technological and status review. Applied Energy, 107, 135–148.

[7]. Cui, Y., Cai, B. H., Li, D. Y., et al. (2006). Comparative study on MPPT control algorithm of solar photovoltaic system. Acta Energiae Solaris Sinica, 27(6), 535–539.

[8]. Alajmi, B. N., Ahmed, K. H., Finney, S. J., et al. (2011). Fuzzy-logic-control approach of a modified hill-climbing method for maximum power point in microgrid standalone photovoltaic system. IEEE Transactions on Power Electronics, 26(4), 1022–1030.

[9]. Liu, B. Y., Duan, S. X., Liu, F., et al. (2009). Maximum power point tracking of photovoltaic array based on improved disturbance observation method. Transactions of China Electrotechnical Society, 24(6), 91–94.

[10]. Salman, S., Ai, X., & Wu, Z. Y. (2018). Design of a P-&-O algorithm based MPPT charge controller for a stand-alone 200W PV system. Protection and Control of Modern Power Systems, 3(3), 259–266.

Authors Details

Mr Kannekanti Shiva prasad received the Diploma in Electrical and Electronics Engineering from Jawaharlal Nehru Govt. Polytechnic, Ramanthapur, Hyderabad, Telangana, India, and received the B.tech Degree in EEE from Geethanjali college of engineering & technology Cheeryal, Medchal-Malkajgiri(Dt) Telangana, India from JNTUH University. Pursuing M.tech in Electrical Power System at Holy Mary Institute of Technology and Science, Bogaram(V), Medchal Dist, Hyderabad, India in the Dept. of Electrical & Electronics Engineering.

Dr M. SARAVANAN received a B.E. degree from Sri sai ram Engineering college, Chennai in 2004, an M.E degree from the College of Engineering, Chennai in 2010, and a PhD degree from Anna University, Tamilnadu, India in 2018. He is a member of the ISTE. He serves as Reviewer of science and technology Transactions, His research interests are in Robotics and Automation, Intelligent systems and Control, Power Electronics, and Electrical Machines.