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Maximum Power Point Tracking of Ann in Photovoltaic Application Using FPGA Chip

C.PRIYA DHARSINI
PG Scholar
M.E.,VLSI Design
Sethu Institute of Technology
Virudhunagar -626115

Dr.R .GANESAN
Professor & PG Program Head
M.E.,VLSI Design
Sethu Institute of Technology
Virudhunagar -626115

K.MONISHA
Assistant Professor
Department of ECE
Sethu Institute of Technology
Virudhunagar -626115

***Abstract* --- In solar Power generation system, a maximum power point tracking (MPPT) control system is deployed to extract maximum power from the panel, since the solar panel's output power depends on atmospheric conditions, solar irradiation and temperature. In our proposed model, An Artificial regression neural network (ARNN) based tracking deployed as MPPT algorithm for tracking maximum point at fast manner. Initially training data derived from P&O MPPT algorithm was used as training dataset of feed-forward neural network. The trained neural network MPPT deployed along with boost dc-dc converter for learning and extracting maximum power from solar panel.**

Index Term - Perturb and observe (P&O), Maximum Power Point Tracker, Regression Neural Network (RNN), Artificial Neural Network (ANN),

I. INTRODUCTION

One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. Demand has increased for renewable sources of energy to be utilized along with conventional systems to meet the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard. In order to tackle the present energy crisis one has to develop an efficient manner in which power has to be extracted from the incoming solar radiation. The power conversion mechanisms have been greatly reduced in size in the past few years. The power delivered by a PV system of one or more photovoltaic cells is dependent on the solar irradiance, temperature, and the current drawn from the cells **.**Maximum Power Point Tracking (MPPT) is used to obtain the maximum power from these systems. It is crucial to maintain the PV operation at its maximum efficiency at any time, and such goal is complicated by uncertain and nonlinear current–. voltage (I–V) and power–voltage (P–V) characteristics. The use of the newest power control mechanisms called the Maximum Power Point Tracking (MPPT) algorithms has led to the increase in the efficiency of operation of the solar modules and thus is effective in the field of utilization of renewable sources of energy.

In order to achieve maximum power at load different kind of MPPT techniques have been proposed, most of which based on static optimization algorithms, e.g., the perturbation and- observation, the incremental conductance, and the hill climbing method. The static optimization-based searching methods often have slower convergence and especially under quick change of environment conditions. Our proposed MPPT control deployed regression neural network (RNN) to extract approximated maximum power from the solar panel.

II. RELATED WORK

The efficiency of a solar cell is very low since its I-V curve is non-linear. In order to increase the efficiency, the control methods deployed between source and load to maximize utilization of source. One such method is the Maximum Power Point Tracking (MPPT). This is a technique used to obtain the maximum possible power from a varying source. This is done by utilizing a boost converter whose duty cycle is varied by using a MPPT algorithm.

A. Perturb And Observe

Perturb and Observe method is the most common. In this method very less number of sensors are utilized. The operating voltage is sampled and the algorithm changes the operating voltage in the required direction and samples dP/dV. If dP/dV is positive, then the algorithm increases the voltage

value towards the MPP until dP/dV is negative. This iteration is continued until the algorithm finally reaches the MPP. This algorithm is not suitable when the variation in the solar irradiation is high. The voltage never actually reaches an exact value but perturbs around the maximum power point (MPP).

B. Incremental Conductance

Incremental Conductance method uses the PV array's incremental conductance dI/dV to compute the sign of dP/dV. When dI/dV is equal and opposite to the value of I/V (where dP/dV =0) the algorithm knows that the maximum power point is reached and thus it terminates and returns the corresponding value of operating voltage for MPP. This method tracks rapidly changing irradiation conditions more accurately than P&O method. One complexity in this method is that it requires many sensors to operate and hence is economically less effective.

C. Mppt Using Neural Network

An artificial neural network (ANN) is ideally suited for rapid approximation of various nonlinear functions. Also online learning abilities allow constant adoption to a specified system. So that the ANN is introduced in MPPT system to improve tracking point of solar PV curve. A three-layer neural network (Input, Hidden and Output Layer) is used to reach MPP on PV curve. Temperature (T) and irradiance (G) are two input variables and voltage of MPP (mpp) is the output variable of ANN. and hence DC (duty cycle) value is measured.

In power generation from solar panel, MPPT algorithm is essential for extracting maximum power on present atmospheric condition. The changes in atmosphere turn change in maximum output power of the panel. In order to reach panel's maximum power at fast convergence of MPPT algorithm based on regression neural network technique is proposed in this paper.

III. PROPOSED MODEL

Our proposed model of simulation system consists of three modules, solar panel design, boost converter and MPPT control algorithm based regression neural network.

D. Solar Pv Module Design

The solar PV module, electrical source designed with help of matlab/simulink blocks is shown in figure 1. The designing and simulation is based on the datasheet of Siemens SM110-24 photovoltaic module. The parameters of this solar module give in Table 1. The module is made of 72 solar cells connected in series to give a maximum power output of 110 W.

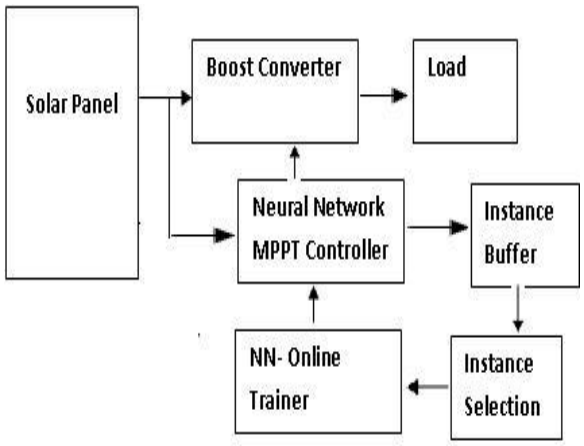

Fig.1 Proposed Stand-Alone PV Model

The block diagram of proposed model MPPT tracking method shown in figure(). The PV panel, which generates electrical energy from solar irradiance, is connected to boost converter and MPPT controller which designed using neural network. The MPPT controller that connected with Instance buffer to store input samples and their output value temporarily, is trained whenever needs or periodically by Neural network On-line Trainer with selected instances from Buffer.

Irrradian-ce	**Temp (in K)**	**Ideal Power (in W)**	**P&O (in W)**	**Propos-ed (NN) (in W)**
1000	292	116.22	109.63	114.56
500	292	54.89	50.12	52.62
250	292	25.84	22.08	23.24
100	292	09.49	07.13	07.84

Table 1 : Performance of proposed MPPT model

With simulating designed PV module at three different irradiance values 250,500 and 1000, the output PV module's I-V (current vs. voltage) curve and P-V (power vs. voltage) curve shown in figure 2 and 3. From these curve, it knows that setting irradiance (G) equal to 1000, The PV panel datasheet

value approximately obtained at maximum irradiance (G) value

Parameters	**Value**
Maximum output power ( )	**110 W**
Maximum output current **( )**	**3.15 A**
Maximum output voltage ( )	**35 V**
Short circuit current **( )**	**3.35 V**
Open circuit voltage **( )**	**43.5 V**
Short circuit temperature coefficient **( )**	**1.14 mA/°C**
Open circuit temperature coefficient( )	**-152 mV/°C**
Number of cells (**N**)	**72**

Table 2. Parameter of PV panel Siemens SM110-24

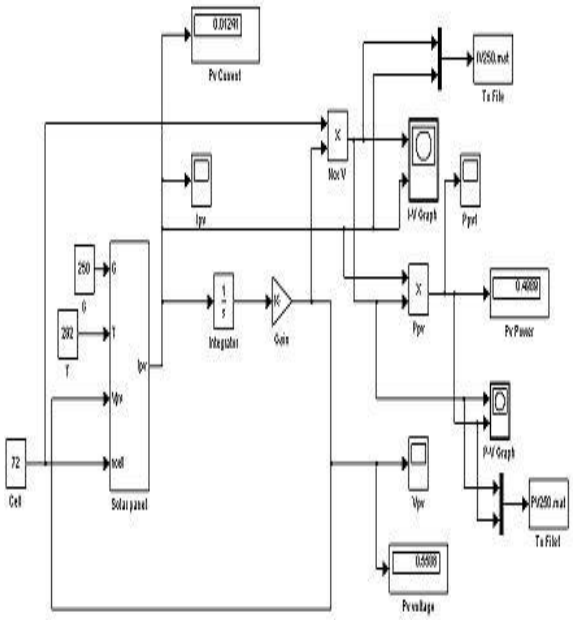

Fig 2. Solar panel simulink model

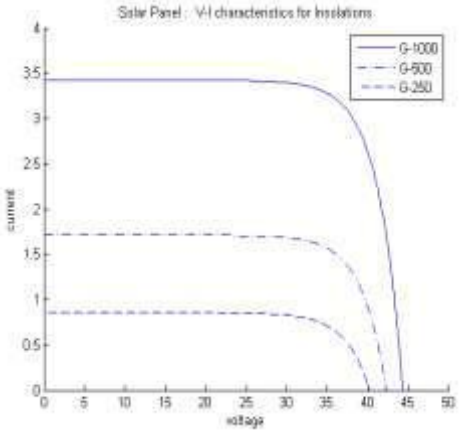

Fig 3. V-I Curve of solar panel for three different irradiance values

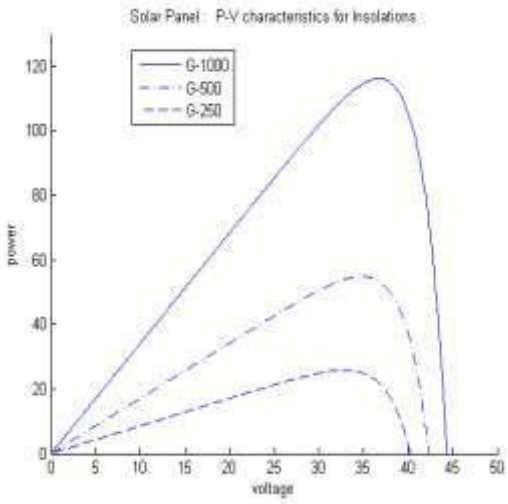

Fig 4. P-V Curve of solar panel for three different irradiance values

E. MPPT Control

MPPT control algorithm, RNN consists of three layered network, they are called input, hidden and output layer arranged in sequential order shown in figure 4. The input layer has two neurons which represents number of input variables in the network. In the second layer called hidden layer, different number of neurons can be fixed for fast convergence and accurate prediction of output variable. On last layer neural network, output layer contains neurons called output neuron or dependent variables which need to be predictable from input variables.

In our MPPT control, two input variable's samples taken from PV panel called voltage and current are given to input of first layer of neural network. The number of neurons to be fixed in hidden layer is carried out from repeated experiments. When increase neuron in the layer increase fast convergence in training period, however on testing period slow performance because of computation cost. Hence our experiment carried out by setting different number of neurons in hidden layer and selecting optimal number of neurons via cross validation performance. The output layer has single neuron's output value given to PWM (pulse width modulation) which determines duty cycle of switching circuit of MOSFET.

RNN training carried out in matlab software with training samples collected from P&O MPPT algorithm simulation by implemented in simulink block. The figure 5 shows that training, cross validation and testing performance curve of RNN by conducting on training samples 50%, 30% and 20% respectively.

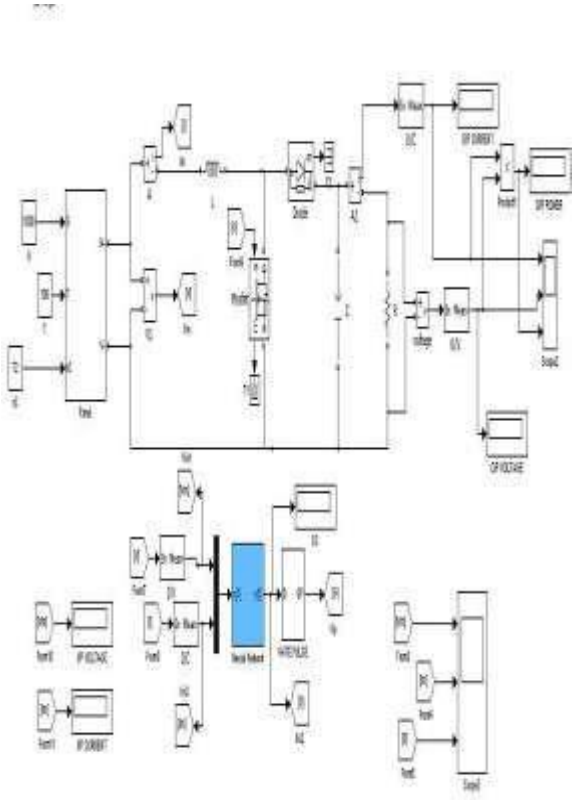

Fig 5. Regression Neural network (RNN) based MPPT Control for Solar panel Boost Convertor

IV.RESULT

Software Simulation's is done by the MAT LAB Simulink tool. the developed intelligent provide accurate tracking of the MPP and improve considerably the efficiency of the PV system .using this software tools .The Stand-Alone PV System is designed in the MAT LAB/SIMULINK model. the well-known P&O algorithm has been implemented on a FPGA for real time tracking of the maximum power point of a photovoltaic system. Due to its simplicity and velocity, the P&O algorithm has been chosen. A low-cost hardware prototype has been developed and tested. The prototype includes current and voltage measurements.

In The final result shows ,the output voltage is increased depends on the time, this is the final output of the Stand-Alone PV System.The buck-converter is used to produce the voltage in the form of double.

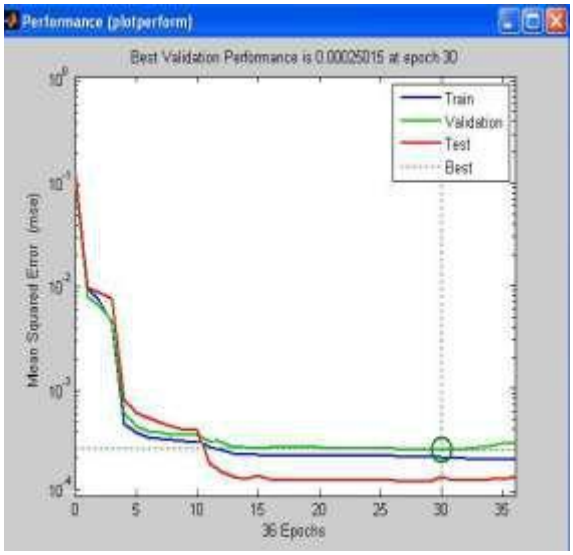

Fig. 6. RNN's training, validation and test performance curve

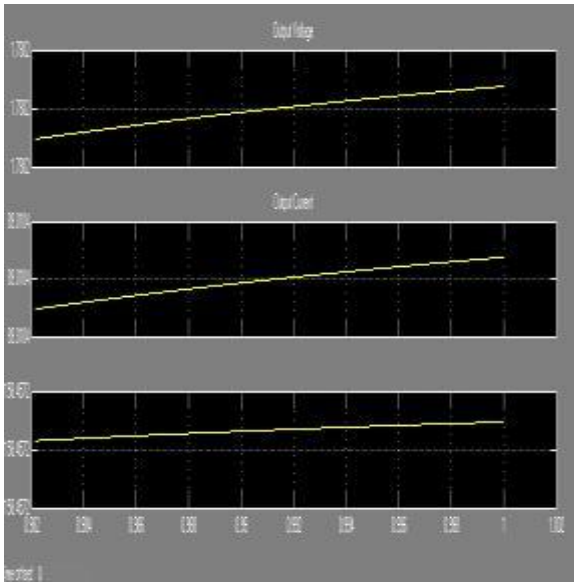

Fig 7. Result Of The Stand-Alone PV System

V. CONCLUSION

We proposed a neural network based MPPT for PV systems under varying condition of irradiation and temperature. The feasibility of the proposed MPPT for PV arrays under steady and transient irradiance conditions are verified by simulation with various shading patterns. The results show that, compared to some traditional MPPT methods, such as P&O, the proposed NN-based MPPT algorithm provides better performance to find the global MPP under various varying conditions of irradiance

The developed intelligent controllers provide accurate tracking of the MPP and improve considerably the efficiency of the PV system. Due to its simplicity and velocity, and inorder to collect the data set for ANN ,the P&O algorithm has been chosen.ANN is easy to be implemented and requires less memory space. However, it requires the heuristic sense and it works as a black box. In addition, its robustness depends on the good training parameters. Although, better performance is observed in case of rapid variation of the weather conditions.

In our future work, we plan to extend this work from a simulation study of the proposed NN-based MPPT algorithm for tracking MPP on multiple PV array system

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AUTHOR'S PROFILE

C.PRIYA DHARSINI received her **B.TECH.** degree in Electronics and Instrumentation Engineering from kalasalingam university.,Anand Nagar ,Krishnankoil. ,India in 2013.Pursuing M.E. degree in VLSI Design from Sethu Institute of Technology, Anna University, Chennai, India. Her research interest includes digital electronics and VLSI design.

DR.R.GANESAN received his **B.E**. in Instrumentation & Control Engineering from Arulmigu Kalasalingam College Of Engineering and **M.E.** (Instrumentation) from Madras Institute of Tech- nology in the year 1991 and 1999 respectively. He has completed his **Ph.D**. from Anna University, Chennai, India in 2010. He is presently working as Professor and head in the department of **M.E-VLSI Design** at Sethu Institute of Technology, India. He has published more than 25 research papers in the National & International Journals/ Conferences. His research interests are VLSI design, Image Processing, Neural Networks and Genetic algorithm

K. MONISHA received her **B.E.** Electronics and Communication Engineering from K.L.N College of Engineering in the year 2010 and **M.E. VLSI DESIGN** from Sethu Institute of Technology in the year 2012. He is presently working as an Assistant Professor in the department of ECE at Sethu Institute of Technology, India. His research interests include Low Power VLSI and Analog VLSI.