www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 6 June 2015, Page No. 12352-12356

Solar Irradiance Measurement Using Neuro Fuzzy Network

Meega T[1], Kumarasabapathy N[2]

[1]PG Scholar, ME- Embedded System Technologies,
Regional Office:Anna University, Tirunelveli, Tamilnadu.
[2]Assistant Professor, EEE Department, University VOC College of Engineering,
Tuticorin, Tamilnadu.

Abstract— **Solar irradiance is a key parameter for MPPT in pv power plants.The operating point at which a pv array deliver its maximum power ,changes as a function of irradiance and temperature.If we sensed the both solar irradiance and temperature values we can easily compute maximum power point,moreover forcing pv array to operate at that point to increase effiency . Temperature sensing is easy, however, measuring solar irradiance is difficult because irradiance sensors are expensive and difficult to calibrate.To overcome those difficulties we go for measuring irradiance based on neuro fuzzy networks . The proposed sensor is implemented through a photovoltaic cell, a temperature sensor, and a low-cost microcontroller. The use of a microcontroller allows for easy calibration, updates, and enhancement by simply adding code libraries. Furthermore, it can be interfaced via standard communication means with other control devices, integrated into control schemes, and remote-controlled through its embedded web server.**

Index terms— **Neuro fuzzy network, DTH11, Arduino, irradiance monitoring.**

INTRODUCTION

The conversion of sun light into electricity produce solar power, either directly using photovoltaics , or indirectly using concentrated solar power. Concentrated solar power systems use lenses or mirrors and tracking systems to concentrate a large area of sunlight into a small beam. Photovoltaics convert light into electric current using the photovoltaic effect.Now a days photo voltaic cells are widely used in industries,home appliences such as calculator,solar heater,etc The cost of the cell is inexpensive and each cell produce upto one to two watts solar power.

Photo voltaic cells[8][6] are made up of two semiconductor layers.One layer is positive layer and the other layer is negative layer.When pv cells are exposed to sunlight the photons present in the sunlight is absorbed by the pv cell.Negative layer absorbed this photons so electrons are fre to move from negative layer to positive layer.the movement of electrons from negative layer to positive layer creates current,if we connect to the circuit it will produce electricity.

If we increase power output ,cells are tightly connected as a module.Each module consist of one to thousands number of solar cell which are connected either serial or parallel manner

I. SYSTEM ARCHITECTURE

Solar irradiance is a measure of the irradiance (power per unit area on the Earth's surface) produced by the Sun in the form of electromagnetic radiation, which is perceived by humans as sunlight. Solar irradiance in a specific area may be measured as insolation, the solar radiation energy per unit area during a given time, or as direct insolation, insolation which reaches a location on Earth after absorption and scattering in the atmosphere. Total solar irradiance (TSI), is a measure of the amount of solar radiative energy incident on the entirety of the Earth's upper atmosphere. This represents a fraction of the Solar constant, the total amount of electromagnetic radiation emanating from the Sun in all directions.

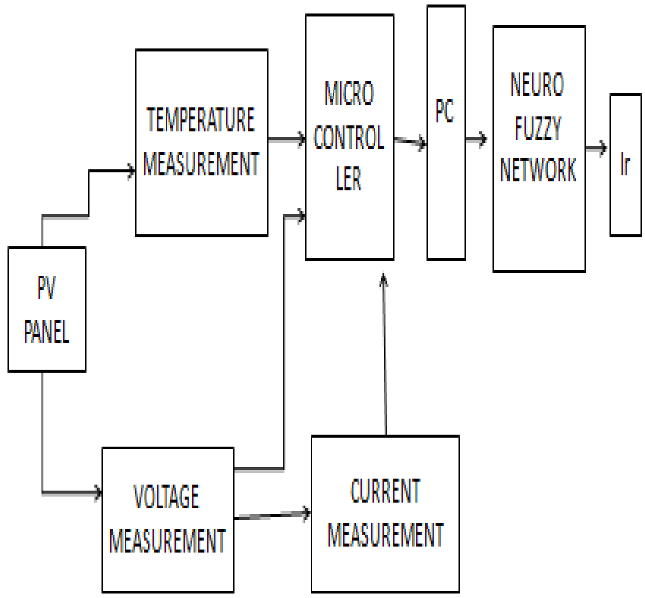

Fig 1 System architecture

In the proposed system, the irradiance are measured by means of voltage ,current and temperature calculation instead of direct measurement of irradiance.Measuring irradiance we need irradiance sensor which is high cost moreover calculating irradiance is a tedious task. Although the energy output of the Sun is fairly constant, solar irradiance "varies significantly from one place to another and changes throughout the year".[1] Sunlight only reaches the parts of the Earth that are facing the Sun at any given time, and the most intense irradiance is experienced by those parts that are not at an angle to the Sun as it passes over. The calculation of solar irradiance for a given area is useful for planning to obtain solar power.[1] Solar activity and irradiance measurement is a concern of space agencies.

II. IRRADIANCE COMPUTATION

PREPARING THE TRAINING-SET

The NN training process and hence the performance of the sensor proposed herein relies on a detailed knowledge of the PV array's *I–V* performance curves for different irradiance and temperature values, such as those illustrated in Figs. 1 and 2, respectively. Performance *I–V* curves for PV cells can be obtained using their mathematical model along with standard information provided by manufacturer's datasheets. Alternatively, operating points may be experimentally generated in the laboratory under controlled environmental conditions. In either case, a suitable training-set must be constructed by using N different *I–V* curves depending on the irradiance using a constant temperature. Likewise, M different *I–V* curves must be obtained by varying the temperature at a constant irradiance. Thus, $N \times M$ training-set patterns must be created. This section provides a detailed description of *I–V* curves' generation from manufacturer's datasheets and an overview on the experimental synthesis

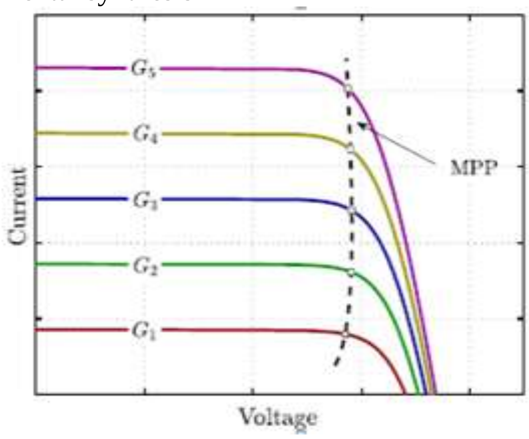

Fig 2.Typical I-V performance curve for different irradiance values with G1<G2<G3<G4<G5

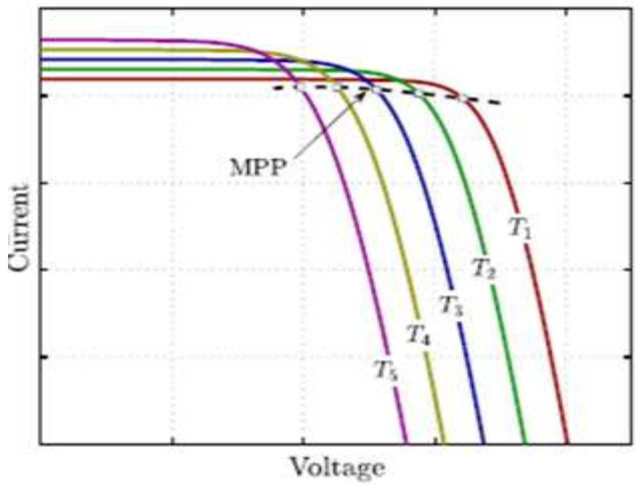

Fig. 2. Typical I-V performance curve for different cell temperature values with T1<T2<T3<T4<T5

.

Measuring solar irradiance allows for direct maximization of the efficiency in photovoltaic power plants. However, devices for solar irradiance sensing, such as pyranometers and pyrheliometers, are expensive and difficult to calibrate and thus seldom utilized in photovoltaic power plants. Indirect methods are instead implemented in order to maximize efficiency. This paper proposes a novel approach for solar irradiance measurement based on neural networks, which may, in turn, be used to maximize efficiency directly. An initial estimate suggests the cost of the sensor proposed herein may be price competitive with other inexpensive solutions available in the market, making the device a good candidate for large deployment in photovoltaic power plants. The proposed sensor is implemented through a photovoltaic cell, a temperature sensor, and a lowcost microcontroller. The use of a microcontroller allows for easy calibration, updates, and enhancement by simply adding code libraries. Furthermore, it can be interfaced via standard communication means with other control devices, integrated into control schemes, and remote-controlled through its embedded web server. The proposed approach is validated through experimental prototyping and compared against a commercial device.

III. IMPLEMENTATION

The circuital model for a single PV cell and its generalization to a number of cells in series is well established in terms of a current source, an anti-parallel diode, a series resistance and shunt resistance . This paper makes use of a modified circuit, which replaces the anti-parallel diode by an external control current source as illustrated in Fig. A chief advantage of this model is that it allows for including an arbitrary number of cells connected in series and/or parallel into a single circuital representation including all details of each cell. This model corresponds to the building block to generate performance *I–V* utilized to train the Neuro Fuzzy network.

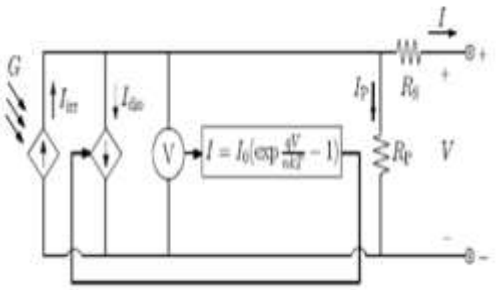

Fig 4.equivalent circuit

A. SOFTWARE DESIGN MODEL

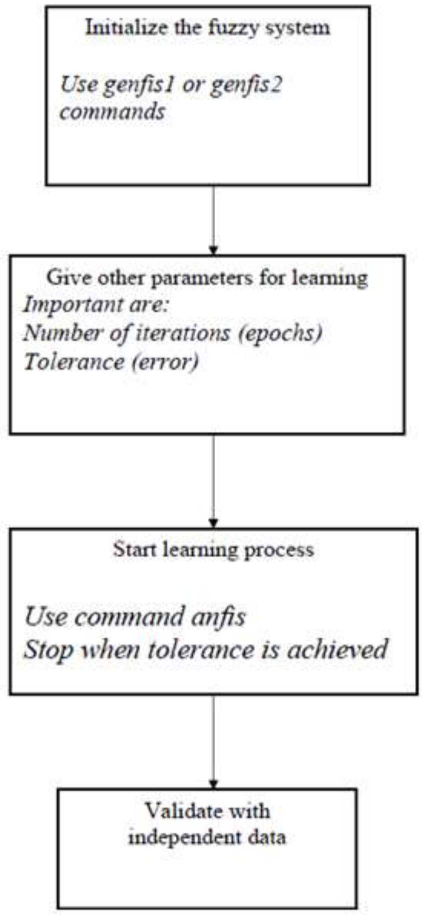

Fig 5. ANFIS basic flow diagram

ANFIS (Adaptive Neuro-Fuzzy Inference System) –method is used as a teaching method for Sugeno-type fuzzy systems. System parameters are identified by the aid if ANFIS. Usually the number and type of fuzzy system membership functions are defined by user when applying ANFIS.[1] ANFIS –method is a hybrid method, which consists two parts: gradient method is applied to calculation of input membership function parameters, and least square method is applied to calculation of output function parameters.

The restrictions of Matlab ANFIS-method:

- only Sugeno-type decision method is available
- there can be only one output
- defuzzification method is weighted mean value

In Fuzzy Control Toolbox a useful command called ***anfis*** exists. This provides an optimization scheme to find the parameters in the fuzzy system [5] that best fit the data. It is explained in the Toolbox manual that since most (not all) optimization algorithms require computation of the gradient, this is done with a neural network. Then, in principle, any of the optimization schemes, say those in the MATLAB Optimization Toolbox, can be used.

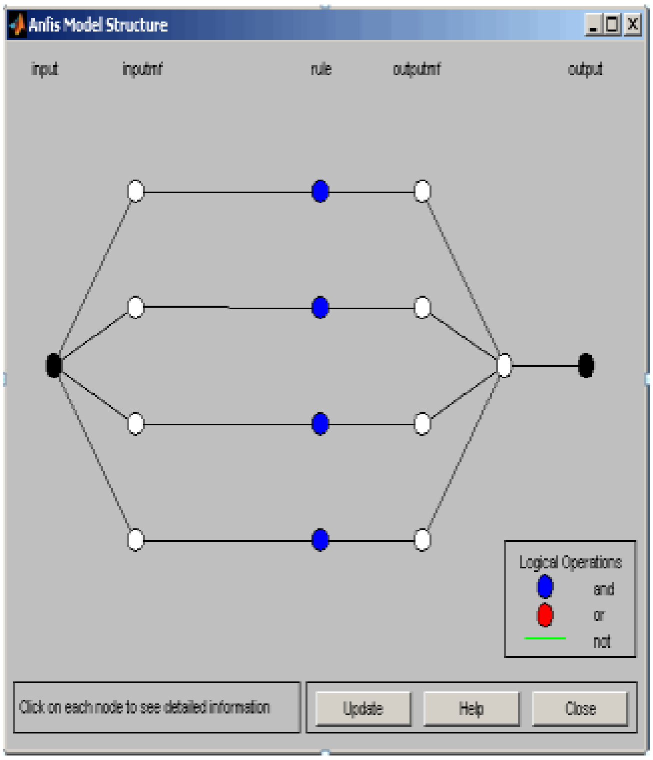

Fig 6. Anfis model structure

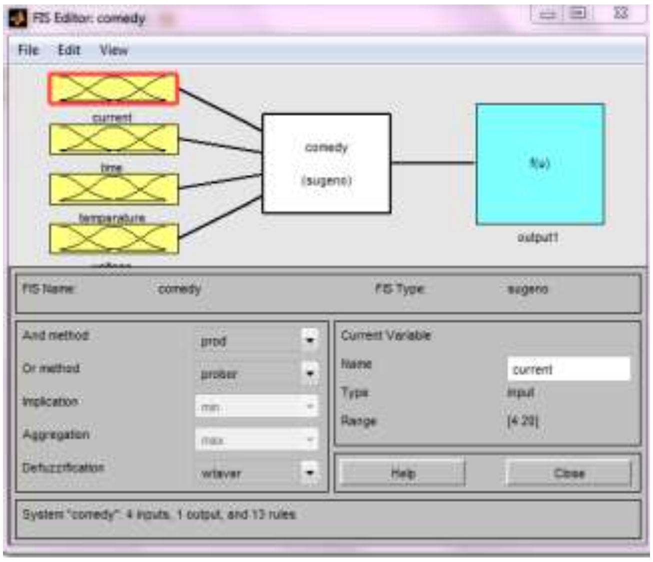

Fig 7. FIS editor

B HARDWARE DESIGN MODEL

The proposed system makes use of ideas developed for both MPPT and solar irradiance estimation to introduce a low-cost solar irradiance sensor. The approach consists of using one or a small number of PV[3] cells together with a Neuro fuzzy network algorithm[9][10] appositely tailored for the solution of an inverse problem. While the traditional approach has been to make use of NNs to track the MPP without the knowledge of the solar irradiance, the approach herein considers the implementation of a Neuro fuzzy approach to sense the irradiance, which in turn can be also used to track the MPP.

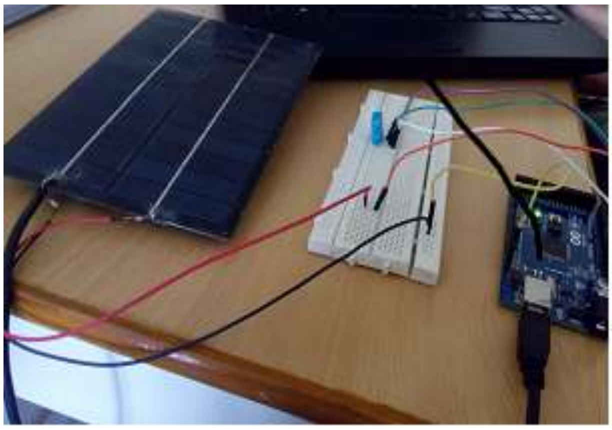

Fig 8.Hardware implementation diagram

The chief advantage of the approach proposed herein lies in the simplicity of construction long with great accuracy. Furthermore, the use of a microcontroller allows for a straightforward calibration and interfacing via RS232, RS485, or Ethernet with the rest of the PV power plant control system. Microcontrollers have widely been utilized in industrial applications. Arduino mega2560 used herein to acquire the voltage from pv panel.

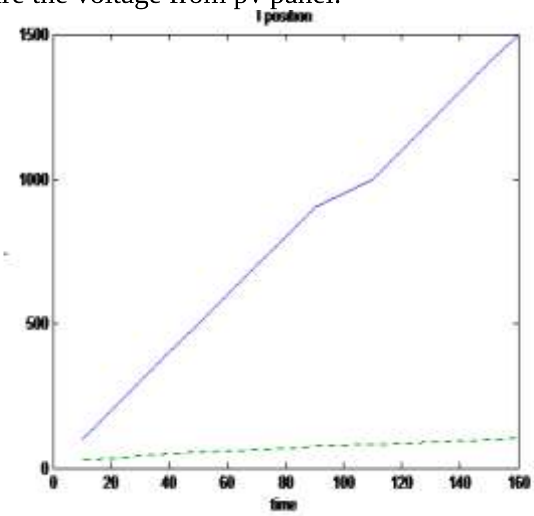

Fig 9.Irradiance position vs time

Fig shows the values of irradiance changes with respect to time.Irradiance value is computed with the use of voltage,current and temperature.

IV. CONCLUSION

This project has reported the design, development and evaluation of low-cost Neuro fuzzy network-based solar irradiance sensor conceived to be utilized in large PV power plants for precise tracking of solar irradiance within the PV power plant layout. An important feature of the approach proposed herein lies in the simplicity of construction along with a high degree of accuracy. The selection of this architecture was motivated by its reasonable computational cost and simple structure suitable to be embedded into an inexpensive eight-bit microcontroller. The use of a microcontroller allows for updates, enhancement, and customization by simply adding code libraries. Moreover, it can be interfaced via RS232 or RS485 with other instruments or connected via Ethernet and remote controlled through its embedded web server. A chief advantage of this sensor is that it can be conveniently located next to a power producing PV panel or even integrated with it. As a result, leading to precise irradiance tracking thereby improving MPPT performance.

REFERENCES

[1]Fernando Mancilla-David, Member, IEEE , Francesco Riganti-Fulginei, Member, IEEE , Antonino Laudani, Member, IEEE , and Alessandro Salvini, Member, EEE, A Neural Network-Based Low-Cost Solar Irradiance Sensor, IEEE transactions on instrumentation and measurement, vol. 63, no. 3, march 2014

[2]S. Kuszamaul, A. Ellis, J. Stein, and L. Johnson, “Lanai high-density irradiance sensor network for characterizing solar resource variability of MW-scale PV system,” in Proc. 35th IEEE Photovolt. Specialists Conf. , Jun. 2010, pp. 283–288.

[3] M. Shams El-Dein, M. Kazerani, and M. M. A. Salama, “Optimal photovoltaic array reconfiguration tmaximize power production under partial shading,” in Proc. 11th Int. Conf. Environ. Electr. Eng. ,May 2012, pp. 255–260.

[4]T. Hiyama and K. Kitabayashi, “Neural network based estimation of maximum power generation from PV module using environ-mental information,” IEEE Trans. Energy Convers. , vol. 12, no. 3, pp. 241–247, Sep. 1997.

[5] D. R. Myers, “Solar radiation modeling and measurements for renewable energy applications: Data and model quality,” Energy , vol. 30, no. 9, pp. 1517–1531, Jul. 2005.

[6] R. Kadri, J. P. Gaubert, and G. Champenois, “An improved maximum power point tracking for photovoltaic grid-connected inverter based on voltage-oriented control,” IEEE Trans. Ind. Electron. , vol. 58, no. 1, pp. 66–75, Jan. 2011.

[7] F. Mancilla-David, A. Arancibia, F . Riganti-Fulginei, E. Muljadi, and M. Cerroni, “A maximum power point tracker variable-dc-link three- phase inverter for grid-connected PV panels,” in Proc. IEEE PES Innovative Smart Grid Technol. , Oct. 2012, pp.1–7.

[8] G. M. Masters, Renewable and Efficient Electric Power Systems .New York, NY, USA: Wiley, 2004.

[9] W. Lin, C. Hong, and C. Chen, “Neu ral-network-based MPPT control of a stand-alone hybrid power generation system,” IEEE Trans. Power Electron. , vol. 26, no. 12, pp. 3571–3581, Dec. 2011.

[10] A. Chatterjee and A. Keyhani, “Neural network estimation of micro- grid maximum solar power,” IEEE Trans. Smart Grid, vol. 3, no. 4, pp. 1860–1866, Dec. 2012.