Adapting Neuro Fuzzy Inference System Based MPPT for Improved Performance of MJSC

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***Abstract* - The use of photovoltaic cells has become quite popular in the recent times as there is a growing demand in the energy sector. In this paper a novel Adaptive Neuro-Fuzzy Inference System has been utilized for Maximum Peak Power Transfer and it has been applied for multi-junction solar cells to provide better efficiency. The algorithm is designed utilizing adaptive neural and concept of fuzzy logic. The optimal value of firing angle's is calculated and fed to the Boost converter. The results are compared to that of an incremental conductance technique and it has been found that our approach performs quite better than its traditional counterparts in terms of transient state and the voltage magnitude.**

***Keywords*—component; formatting; style; styling; insert (key words)**

I. INTRODUCTION

Energy consumption is increasing day by day and also renewable sources of energy is also increasing .as our resources are limited, so renewable sources of energy are future. Several approaches are made over later years in search of renewable system such as wind energy, sea energy, solar energy, tidal energy. From these renewable resources solar energy is used nowadays as most environment friendly sources of energy. Installation of solar panel is very expensive. In order to control this issue, maximum power can be extracted from PV panel while using the MPPT methods to optimize an efficiency of all the PV system. The PV technology has many advantages such as its low maintenance requirement, environment friendly and absence of fuel cost.

Working of Solar Cell

That device which absorbs the sunlight and converts into the electricity is called photovoltaic cell Sunlight consists of little particles of solar energy called photons. As a PV cell is exposed to this sunlight, many of the photons are reflected, pass right through, or absorbed by the solar cell. When enough photons are absorbed by the negative layer of the photovoltaic cell, electrons are freed from the negative semiconductor material. Due to the manufacturing process of the positive layer, these freed electrons naturally migrate to the positive layer creating a voltage differential, similar to a household battery. When the 2 layers are connected to an external load, the electrons flow through the circuit creating electricity. Each individual solar energy cell produces only 1-2 watts. To increase power output, cells are combined in a package called a solar module. These are then wired up in serial and/or parallel with one another is called a solar array, to create the desired voltage and amperage output required by the given project.

Multi-Junction cell

Multi junction cell are normally found in the two configurations in series and in parallel. For these thin-film star cells with hetero-junctions, for the improved performances all layers contain the lattice constants/ crystalline structures.
In parallel configuration that is termed the multi-terminal bicycle for every cell which will be optimized severally, however whole system is often a lot of difficult. In series/ bicycle of star cells are often used that consists of the distinct tangency of sun power cells that area unit set one when alternative one, each utilized half of star spectrum could permit to the passage through alternative part. The star cells area unit high larger band gap that the parameter is often shriveled increasingly in followed cells.

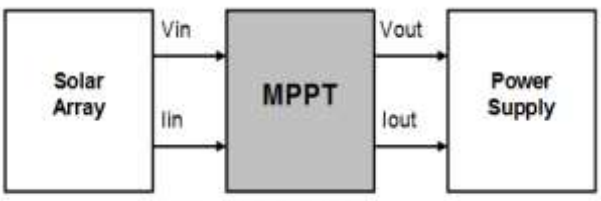


Figure 1: Basic Block Diagram

II. LITERATURE SURVEY

He, San, Yongli Zou [4] proposed Application of RBF neural network and ANFIS on the prediction of corrosion rate of pipeline steel in soil. RBF neural network and ANFIS are discussed and showed that ANFIS based model is better that RBF model. **Hung-I Hsieh, Jen-Hao Hsieh presented** voltage-based MPPT current-based MPPT approaches unit of the measurement is presented. Every unit of measurement can be simple and fast. **Islam, Tanvir, Prashant K. Srivastava [3]** suggested an exploratory investigation of an adaptive neuro fuzzy inference system (ANFIS) for estimating hydrometeors from TRMM/TMI in synergy

with TRMM/PR. The proposed algorithm is developed in synergy with the TRMM precipitation radar (PR) observed hydrometeor information. In this work, initially the fundamental hydrometeor parameters, liquid water path (LWP) and ice water path (IWP), are estimated from the TMI brightness temperatures. And then the rain rates are estimated from the retrieved hydrometeor parameters (LWP and IWP)**Hosoz, Murat, Huseyin Metin Ertunc and its coauthor** [5] describes the applicability of adaptive neuro-fuzzy inference system (ANFIS) approach for modeling the performance parameters and exhaust emissions of a diesel engine employing various fuels.in this paper, ANFIS modeling of the performance and emissions of a diesel engine using diesel fuel and biodiesel blends are presented and its performance is discussed in this work.

A new approach for time series prediction using ensembles of ANFIS models presented by **Melin, Patricia, Jesus Soto, Oscar Castillo [2]** .This paper describes an architecture for ensembles of ANFIS (adaptive network based fuzzy inference system), with emphasis on its application to the prediction of chaotic time series, where the goal is to minimize the prediction error. **K.H. Hussein** (2004), a strategy has been projected supported to the analysis and derivation of the I–V characteristics of PV panel by [4] natural exponent index. This method offers the faster track speed than quality of hill-climbing methodology, the used index is solely to complicate for amount calculation exploitation in an inexpensive 8- or 16-bit lC. Load Frequency Control in Power System via Improving PID Controller Based on Particle Swarm Optimization and ANFIS Techniques proposed by **Bahgaat, Naglaa K., M. I. El-Sayed, MA Moustafa Hassan [1]** .in this work LFC is described in two power system using PID controller.

III. PROBLEM FORMULATION

The main goal of this paper is to minimize the power. MPPT technique is used to solve the issue of maximum power drawing from solar panel. Also, algorithm is to be formulated for its better performance. MPPT technique can be categorized in two ways, dynamic and static respectively. In static MPPT, the ability of proposed algorithm is used to check and hold maximum power point under constant environment conditions. Dynamic MPPT is defined as it tracks maximum power point to consider the environmental conditions.

Objectives

The objective has to be solved using Modified Firefly algorithm and PSO approach. An algorithm for the improvement of the same needs to be designed. The major objectives of this paper are as follows:

- Investigation of the various approaches used for MPPT technique used in literature.
- Converter and integration has to be designed with same load.
- Neuro-Fuzzy algorithm will developed and also its modification for adaptation in MPPT.
- For improvement of MPPT technique Application of the ANFIS algorithm will develop.
- Contrast of result with Incremental Conductance approach has been described.

IV. PROPOSED METHODOLOGY

In this proposed methodology, we use ANFIS model to improve the MPPT technique. This model can be simulated in algorithm that can implement and control the included load. First of all Multi-Junction Solar Cell can be designed by combination of characteristics of PV cell.

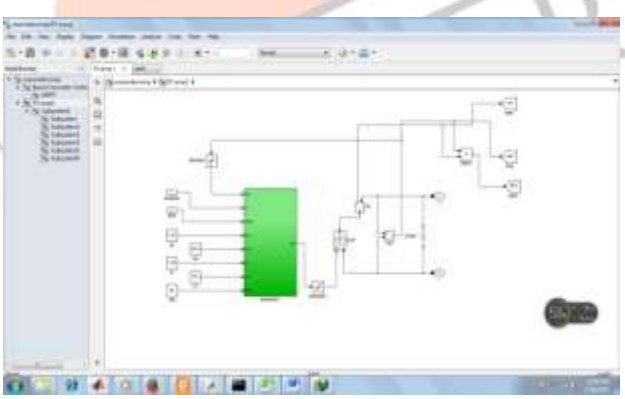


Figure 4.1: Representing the overall Solar cell model

Adaptive control is a method for time varying processes and neuron fuzzy control is method non-linear processes. This paper will initialized with adaptive control of linear systems. Nonlinear systems and related control issues will be then briefly reviewed. Neural network and fuzzy model will be described as general structures for approximating non-linear functions and dynamic processes. These two methods are compared and then neuron fuzzy model will be proposed as a promising technology for the control and adaptive control of nonlinear processes.

An adaptive neuro-fuzzy inference system or adaptive network-based fuzzy inference system (ANFIS) is a type of artificial neural network that is based on Takagi–Sugeno fuzzy inference system. It incorporates both neural networks and fuzzy logic principles, it has ability to capture the benefits of both in a single framework

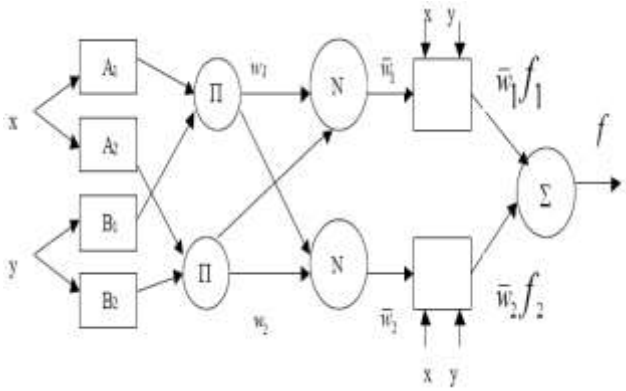


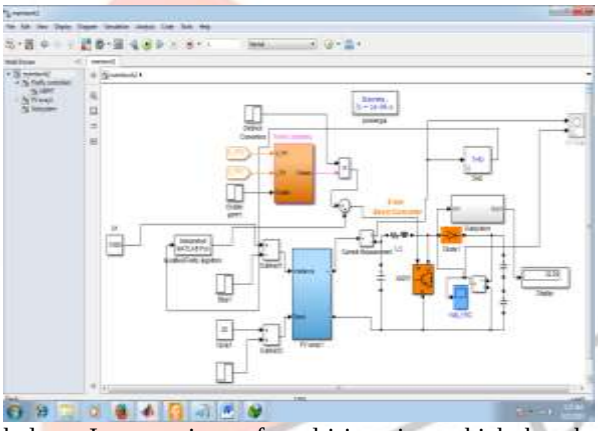
Figure 4.2: Structure of the ANFIS network

Algorithmic steps for applied density based improved k means clustering algorithm

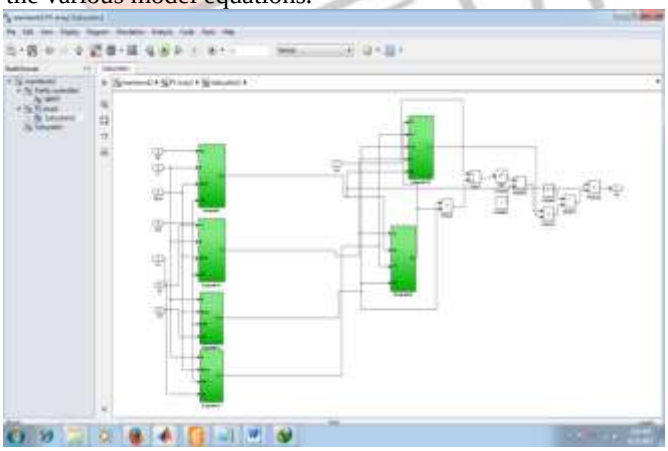
1. Randomly, define the centroid points.
2. The Euclidean distance can be calculated for each data point.
3. Calculate centroid of each cluster.
4. Maintain table of density around each data point.
5. Use initial inference provided by density based k means clustering algorithm for different membership function.

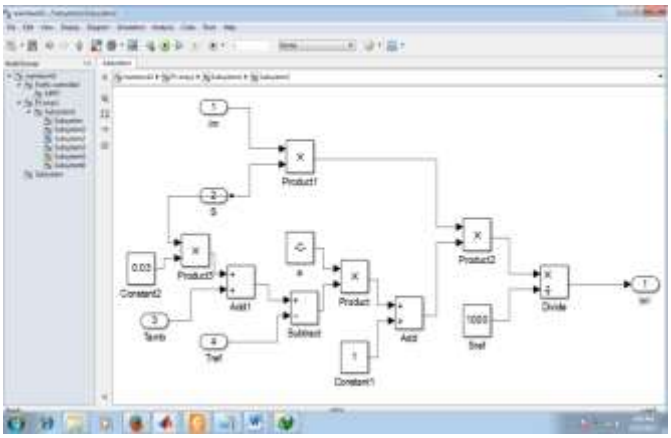
V. RESULTS

All the results have been simulated on 4 GB RAM, 2.7 GHz processor based system using MATLAB R 2013b. The whole model is described below.

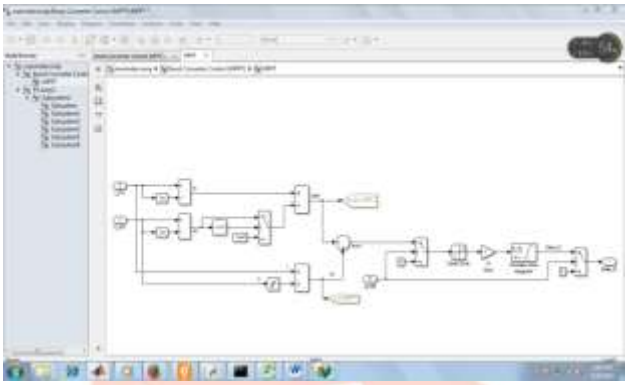


The photo-voltaic cell is depicted below. It comprises of multi-junction which has been designed and constructed using subsystems for implementation of the various model equations.

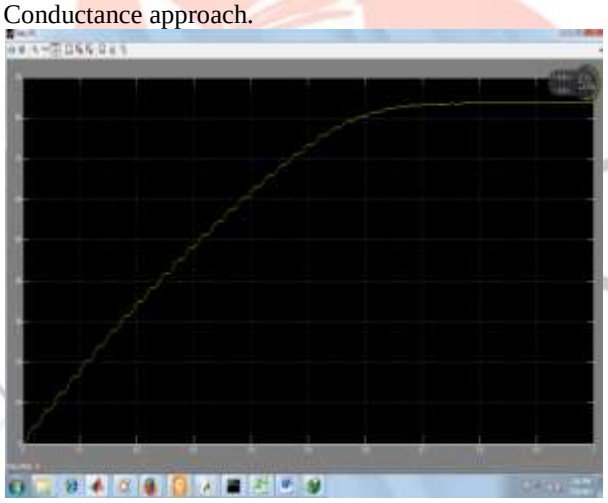




The results of Incremental Conductance technique as in figure below for the output voltage are shown below. As it is observed that the voltage rise after a certain initial threshold and after certain time achieves around a certain value.



The below figure represents the voltage using our porposed approach and it is observed that the modeified firefly approach performs better than the Incremental Conductance approach.



Voltage output of ANFIS based MPPT

The voltage output increases during the transient state smoothly and after sometime it reaches a constant value. This is quite expected and the transient state is found to be quite smooth which is a desired property in terms of switching losses.
As compared to the incremental conductance whose voltage output is given below, ANFIS performs better.

The voltage output of I&C based approach

The voltage increases gradually but the transients are quite high and also the transients are not smooth. This is a disadvantage as there are more losses in terms of damage to the switches in real time implementation. Also the voltage starts decreasing after certain time and a constant dc source is not obtained which was obtained in ANFIS based MPPT approach.

The performance is better in terms of both rise to the voltage and the voltage magnitude. While we achieve a voltage magnitutde of 32 V in ANFIS, only 27 V is obtained using the I&C approach for all other initial conditions remaining same.

VI. CONCLUSION AND FUTURE SCOPE

Photovoltaic cells have been there in the energy sector for a very long time now. In this paper a novel Adaptive Neuro-Fuzzy Inference System for Maximum Peak Power Transfer technique for multi-junction solar cells has been proposed. The multi-junction solar cells can be providing better efficiency. Neuro-Fuzzy based algorithm is designed utilizing Neural behavior and fuzzy logic.

The result of ANFIS algorithm was found to be quite better than the I&C in terms of output voltage magnitude and the transients. The transient state in ANFIS trained MPPT it quite smooth comparatively. Also when the current is compared, the oscillations die out very fast in case of ANFIS algorithm while in I&C approach it is more or less sustained.

In future this algorithm can be improved using other techniques and approaches. Also real time implementation of the algorithms can be done and hardware testing can be done. Hybrid with other algorithms can be utilised and the performances can be compared. Also clustering and other gradient learning methods can be utilised and the model can be tested for grid connection.

VII. REFERENCES

[1] Bahgaat, Naglaa K., M. I. El-Sayed, MA Moustafa Hassan, and F. A. Bendary. "Load Frequency Control in Power System via Improving PID Controller Based on Particle Swarm Optimization and ANFIS Techniques."Research Methods: Concepts, Methodologies, Tools, and Applications: Concepts, Methodologies, Tools, and Applications (2015): 462.

[2] Melin, Patricia, Jesus Soto, Oscar Castillo, and Jose Soria. "A new approach for time series prediction using ensembles of ANFIS models."Expert Systems with Applications 39, no. 3 (2012): 3494-3506.

[3] Islam, Tanvir, Prashant K. Srivastava, Miguel A. Rico-Ramirez, Qiang Dai, Dawei Han, and Manika Gupta. "An exploratory investigation of an adaptive neuro fuzzy inference system (ANFIS) for estimating hydrometeors from TRMM/TMI in synergy with TRMM/PR." Atmospheric Research 145 (2014): 57-68.

[4] He, San, Yongli Zou, Desheng Quan, and Hanyi Wang. "Application of RBF neural network and ANFIS on the prediction of corrosion rate of pipeline steel in soil." In Recent Advances in Computer Science and Information Engineering, pp. 639-644. Springer Berlin Heidelberg, 2012.

[5] Hosoz, Murat, Huseyin Metin Ertunc, Murat Karabektas, and Gokhan Ergen. "ANFIS modelling of the performance and emissions of a diesel engine using diesel fuel and biodiesel blends." Applied Thermal Engineering 60, no. 1 (2013): 24-32

[6] Avci, Derya, Mustafa Poyraz, and Mehmet Kemal Leblebicioglu. "An expert system based on Discrete Wavelet Transform-ANFIS for acquisition and recognition of invariant features from texture images." In *Signal Processing and Communications Applications Conference (SIU), 2015 23th*, pp. 1070-1073. IEEE, 2015.

[7] Sangaiah, Arun Kumar, Arun Kumar Thangavelu, Xiao Zhi Gao, N. Anbazhagan, and M. Saleem Durai. "An ANFIS approach for evaluation of team-level service climate in GSD projects using Taguchi-genetic learning algorithm." *Applied Soft Computing* 30 (2015): 628-635.

[8]Salami, Momoh Jimoh Emiyoka, and Md Khan. "Hardware implementation of ANFIS controller for gas-particle separations in wet scrubber system." In *5th International Conference on Computer & Communication Engineering*, vol. 5, pp. 277-280. IEEE, 2015.

[9] Jahani Fariman, Hessam, Siti A. Ahmad, M. Hamiruce Marhaban, M. Ali Jan Ghasab, and Paul H. Chappell. "Simple and Computationally Efficient Movement Classification Approach for EMG-controlled Prosthetic Hand: ANFIS vs. Artificial Neural Network." *Intelligent Automation & Soft Computing* ahead-of-print (2015): 1-15.

[10] Arumugam, Thangamani, Latha Parthiban, and Parthiban Rangasamy. "Two-Phase Anaerobic Digestion Model of a Tannery Solid Waste: Experimental investigation and Modeling with ANFIS." *Arabian Journal for Science and Engineering* 40, no. 2 (2015): 279-288.
[11] Najafi, G., B. Ghobadian, A. Moosavian, T. Yusaf, R. Mamat, M. Kettner, and W. H. Azmi. "SVM and ANFIS for prediction of performance and exhaust emissions of a SI engine with gasoline–ethanol blended fuels."*Applied Thermal Engineering* 95 (2016): 186-203.
[12] Gorai, Amit Kumar, and Pramila Goyal. "Development of ANFIS models for air quality forecasting and input optimization for reducing the computational cost and time." *Atmospheric Environment* (2016).
[13] Thomas, Sonia, G. N. Pillai, Kirat Pal, and Pushpak Jagtap. "Prediction of ground motion parameters using randomized ANFIS (RANFIS)." *Applied Soft Computing* 40 (2016): 624-634.