Two Stage Solar Photovoltaic Energy Conversion System Using Adaptive Neuro -Fuzzy Interface System MPPT

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Abstract— ***Energy that can be obtained from photo voltaic is a natural energy source and it has main advantage of environmental sustainment, inexhaustibility. This paper presents solar energy conversion system implementing with ANFIS technique to deliver maximum power to the load at any time. ANFIS based MPPT offers the benefits of both fuzzy and neural network. The proposed ANFIS MPPT provides faster response for dynamic stability under environment changing conditions. The proposed system is executed on MATLAB Simulink and the results are checked under changing environmental conditions. The major outcomes of this model include increased power output to the grid making it easier for power transmission and reducing the distortions in the tracking maximum power.***

Index Terms— ***Adaptive neuro –fuzzy interface system (ANFIS), MPPT, Grid, Power quality.***

I. INTRODUCTION

Power generation from sun light (solar energy) increases from recent years with the increase of efficiency of solar system and the improvements made by the manufacturing of photovoltaic panel [1]. Energy that can be obtained from photo voltaic is a natural energy source and it has main advantage of environmental sustainment, inexhaustibility and it is distributed over the earth. generation from distribution system increases with the development, renewable energy from PV system becomes a great demand of energy source.

With the increase of photovoltaic system installation, the system needs a suitable control algorithm to extract maximum amount of power. Hence there are many researches are developing MPPT algorithm to improve the solar energy conversion system.

MPPT algorithms will increase the solar energy conversion system efficiency and minimizes the ripple content .The reduction of ripple in current or voltage is the main goal of researches [2].

Here in our paper we propose a method where current and voltage are used as inputs parameters to ANFIS system that determines the power delivered to the grid and makes lower cost in design [11].

This paper was organized in 4 sections presenting the section 1 with introduction, Section 2 presents equalent model of a PV cell, boost converter simulink model and section 3 consist system modeling with ANFIS technique. Simulation results for proposed system are provided in section 4.

II. PHOTOVOLTAIC SYSTEM

Photovoltaic cell is made of semiconducting materials similar to those are used in electronic component devices. Photovoltaic cells works whenever the sunlight is absorbed by the cell, the electrons loose there atoms and allowing the electrons to pass through the semiconducting material in order to generate electricity. Hence Photovoltaic (PV) effect is conversion of sun light(Photons) into electricity (Voltage).

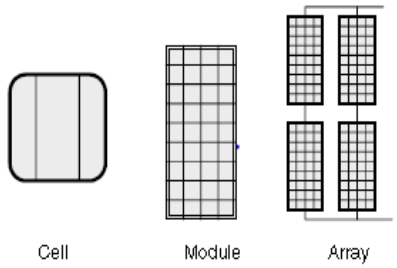

Fig1: Basic solar cells, modules, and array module

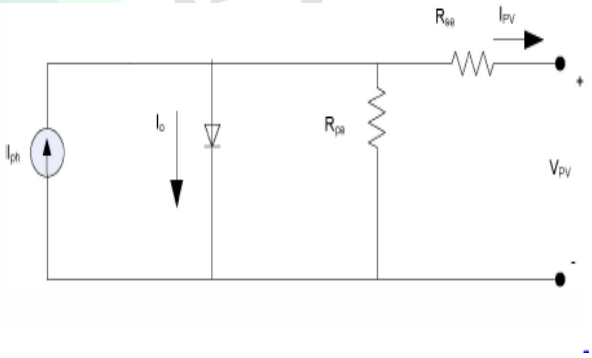

Fig2: Basic structure of PV cell

Here diode called as Bypass diode it will mitigate the shadings on PV cell. For a PV cell diode is placed in parallel connection.

Table1 : Photovoltaic array simulation circuit configuration:

Photovoltaic cell voltage V_{MPP}	26.3V
Photovoltaic cell current I_{MPP}	7.61A
Photovoltaic array MPP	30KW
PV cells connected in Series	27
PV cells connected Parallel	6
PV array output voltage	700V
DC Bus Capacitor	6mF

Photovoltaic system generates electricity in the form of DC current without using of any rotating elements in their configuration.
Photovoltaic (PV) array characteristics are varying with the atmosphere conditions such as temperature and irradiance.

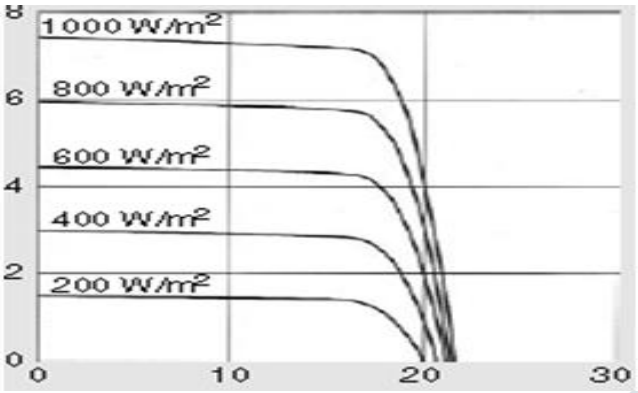

Fig3: current-voltage relationship of PV cell at different irradiance levels.

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Here one module develops 200.143W power, maximum voltage=26.3V and maximum current =7.61A. In this configuration we are connected 27 cells in series , 6 modules in parallel and it will delivers 30KW from PV array.

2.1 BOOST CONVERTER:

Boost converter is connected at output side of PV array to get regulated DC from PV . It is placed in between PV array and three phase inverter. A capacitor is placed at the output of boost converter to reduce the voltage ripples caused due to periodic variation of PV array voltage. Switch used in boost converter is typically IGBT and it is faster device.

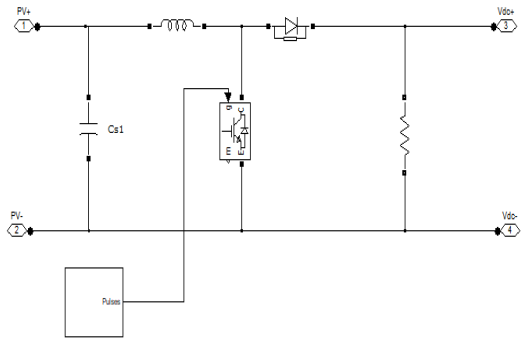

Fig4: Boost converter simulink model

The output obtain from boost converter will be converted into 50HZ ac by inverter.

Table2: Boost converter simulation circuit configuration:

Interfacing Inductor	1.8mH
Interfacing Capacitor	6 mF
Sampling Frequency	1 μs
Resistance	1 Ω
Diode voltage drop	0.8 V
IGBT voltage drop	1 V

III. MPPT TECHNIQUE

A MPPT technique delivers the photovoltaic array voltage to grid voltage that is the conversion of DC to DC. MPPT will deliver maximum power from photovoltaic array generated power to battery to supply the variable voltage loads. MPPT has advantage of increasing the photovoltaic array efficiency than the PWM method, most effectively used in cold, cloudy environments. MPPT are improves the efficiency of photovoltaic system by adjusting load resistance equals to internal resistance[3].Hence MPPT plays a major role in a photovoltaic system and different techniques will be developed by the researches [5].In this paper we are implementing ANFIS MPPT algorithm for proposed system to get the faster response .

SYSTEM CONFIGURATION:

The proposed topology employing ANFIS is shown in Fig 5. The VSI is used to deliver AC power to the load and ANFIS control technique is used for VSI. Interfacing inductors are used to eliminate current switching ripples and ripple filter used for eliminate PCC voltage switching ripples [8].

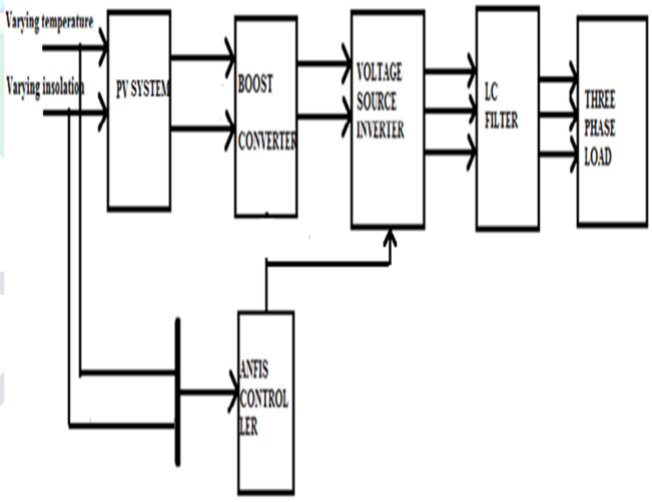

Fig5: Block diagram of proposed system

ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM:

Artificial intelligence systems are makes decisions just like humans by adopting the situations and take a correct decision for future similar instants [11]. ANFIS is the most powerful intelligent technique which integrates neural network and fuzzy logic control to extract maximum power under changing environment conditions [5].ANFIS is a learning technique that tradeoff between the combination of Neural networks and Fuzzy logic system provides smoothness due to fuzzy logic interference and adaptive due to back propagation of Neural network. Fuzzy logic transforms the data that is given to inputs to a output through a interconnected neural

networks. Neural networks are weighted to map the numerical inputs to output [12].

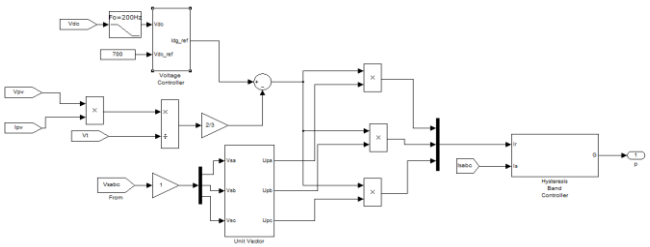

Fig 6: control structure for inverter using ANFIS algorithm

ANFIS algorithm is a hybrid one combines backpropogation and gradient-descent [16].

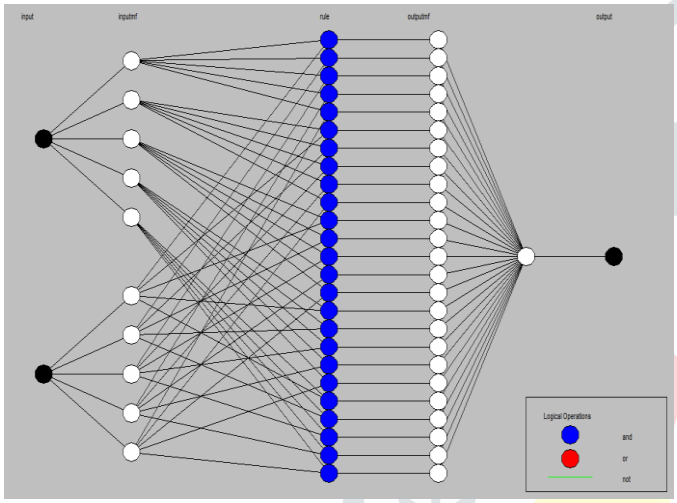

Fig 7: ANFIS MPPT structure

IV. SIMULATION RESULTS

The performance of a ANFIS MPPT algorithm for two stage photovoltaic energy conversion system is executed in Matlab under different irradiance atmosphere conditions.

Characteristics at constant irradiance of two stage photovoltaic energy conversion system:

Two stage solar photovoltaic energy conversion system steady state characteristics (making constant irradiance) are shown in Fig (8). Here the irradiance level is maintained constant and its value is 1000 W/m^2.

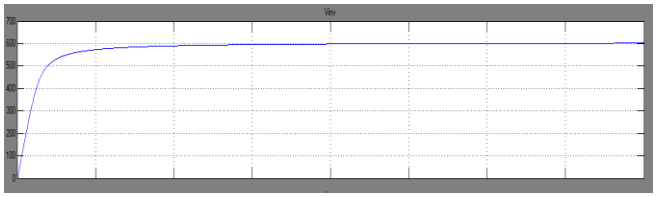

Fig 8(a): PV array voltage

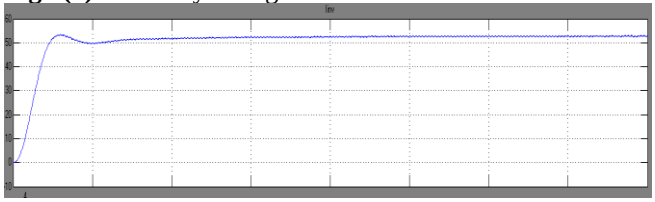

Fig 8(b): PV array current

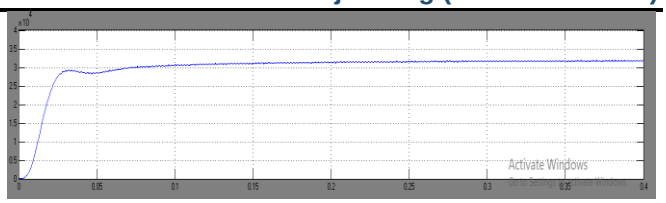

Fig 8(c): PV array power

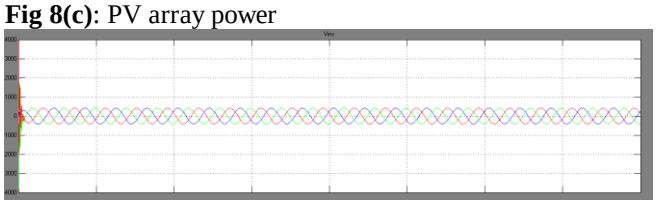

Fig 8(d): Load voltage

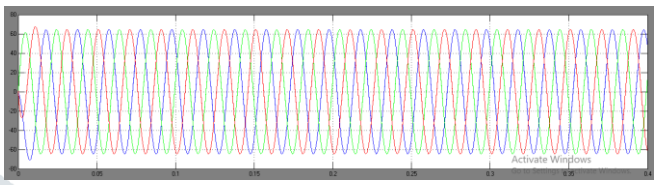

Fig 8(e): Load current

Fig8: Steady state behavior under constant irradiance at 1000W/m^2

Three phase load voltage and load current harmonics at constant irradiance is shown fig (9)

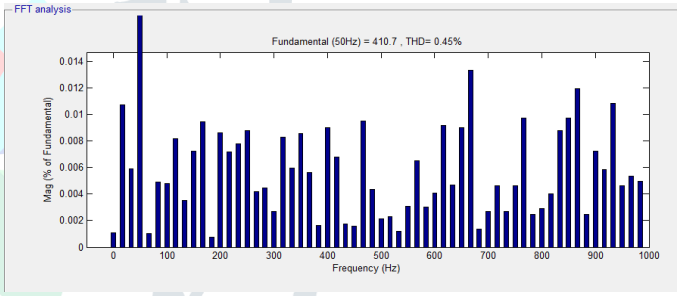

Fig 9(a): Load voltage THD

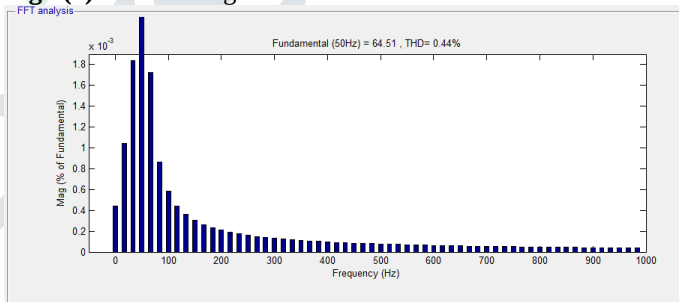

Fig 9(b): Load current THD

Characteristics at changing irradiance of two stage solar photovoltaic energy conversion system:

Two stage solar photovoltaic energy conversion system dynamic state characteristics (changing the irradiance) are shown in Fig (10). Here solar array first operates 700W/m^2 irradiance level and characteristics are observed by changing irradiance level 1000 W/m^2.

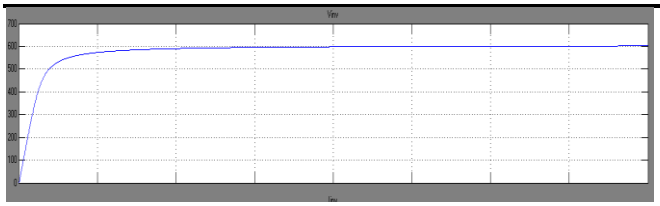

Fig 10(a): PV array voltage

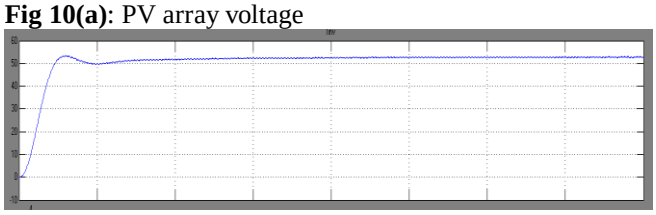

Fig 10(b): PV array current

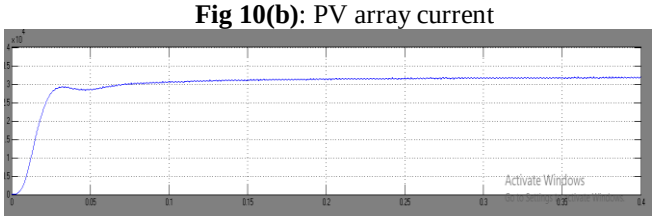

Fig 10(c): PV array power

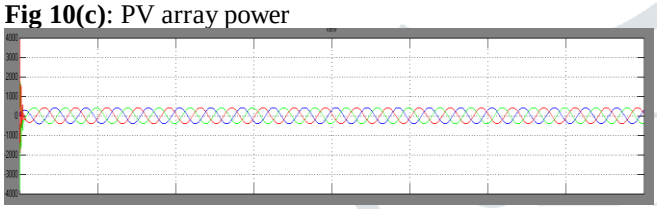

Fig 10(d): Load voltage

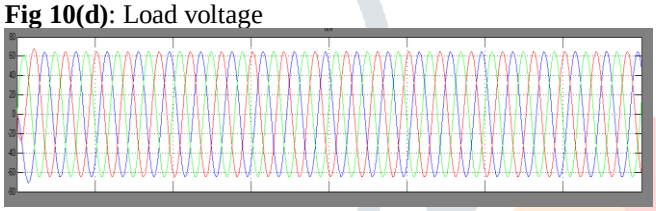

Fig 10(e): Load current

Fig 10: Dynamic behavior under changing irradiance from 700W/m2 to 1000W/m2

Three phase load voltage and load current harmonics at changing irradiance level is shown in Fig (11).

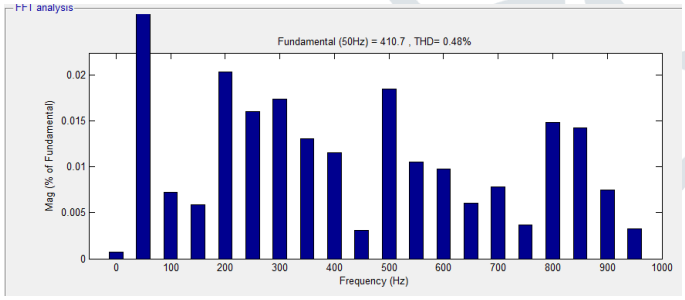

Fig 11(a): Load voltage THD

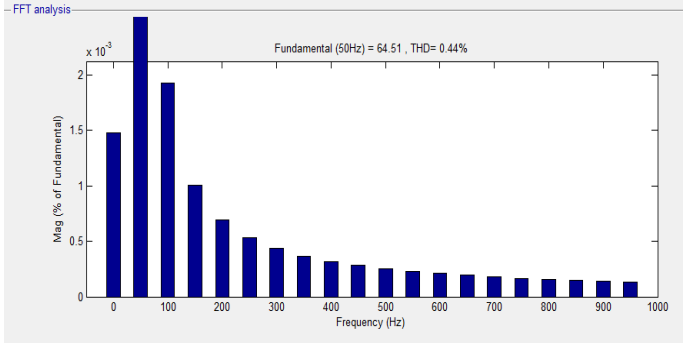

Fig 11(b): Load current THD

CONCLUSION

Two stage solar photo voltaic energy conversion using proposed ANFIS MPPT has been interfaced to distribution system and implemented successfully. Power delivered to the three phase load has lesser amount of harmonics on current and voltage and it will be maintained the low THD value as per IEEE standards [16]. ANFIS based MPPT technique proves that it is the fastest and most robust method in tracking MPP. The Proposed ANFIS MPPT performs better at environment changing situations that are changing their irradiance levels.

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