International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 11 | Nov -2016 www.irjet.net p-ISSN: 2395-0072

Fuzzy Logic Controller based Single Ended Primary Inductor Converter for MPPT for Variable Load Conditions

Abhimanyu[1], Mr. Parmeshwar Kumawat[2], Vineet Kumar[3]

[1]*Mtech Scholar, Dept. of Electrical Engineering, VGU Jaipur, Rajasthan, India*

[2]*Head of Dept., Dept. of Electrical Engineering, VGU Jaipur, Rajasthan, India*

[3]*Mtech Scholar, Dept. of Electrical Engineering, VGU Jaipur, Rajasthan, India*

Abstract – *In this study, simulation and hardware implementation of Fuzzy Logic (FL) Maximum Power Point Tracking (MPPT) used in photovoltaic system with a direct control method are presented. In this control system, no proportional or integral control loop exists and an adaptive FL controller generates the control signals. The designed and integrated system is a contribution of different aspects which includes simulation, design and programming and experimental setup. The resultant system is capable and satisfactory in terms of fastness and dynamic performance. The results also indicate that the control system works without steady-state error and has the ability of tracking MPPs rapid and accurate which is useful for the sudden changes in the atmospheric condition.*

Key Words: Current, FLC, MPPT, Power, PV Characteristics, Solar Panel, Solar energy, Temperature

1.INTRODUCTION

Solar based energy is the most copious asset on earth. Uses of solar based energy are across the board in industry, business, and military applications. It will get to be one of the essential energy supply assets later on [1, 2]. Adequacy of the use of the sun oriented energy relies on upon the advancements of the sun oriented power administration framework. Power converter for maximal power point tracking (MPPT) and voltage or current direction is embedded between the sun based cell board and the heap to control power stream. It specifically influences its productivity and execution of the sun oriented power administration framework.

To amplify use of accessible solar based power drawn from the sun oriented board and extend the utilization of sun powered energy, configuration and use of buck-help converters are researched in numerous studies [1]. It created buck-help converters for versatile applications. The study proposed a buck support fell converter for high power applications, for example, energy component electric vehicles. A broad examination and configuration of Li-particle battery charging utilizing a four-switch sort synchronous buck-help power converter was exhibited in [2]. In this study, we direct a relative study for photovoltaic (PV) board imitating utilizing distinctive buck-help converter topologies through circuit reenactment including Zeta, SEPIC (single-finished essential inductor converter), and four-switch sort synchronous buck-support converters.

MPPT capacity is generally consolidated in the solar based power administration framework to guarantee that most extreme accessible power is gotten from the sun powered photovoltaic board. As of late, fuzzy logic controller has gotten an expanded thoughtfulness regarding specialists for converter control and MPPT plan. A dependable and exact PV imitating model is vital for quickening the improvement of a MPPT framework. The PV imitating model needs to give very much managed output voltage and current as indicated by the attributes of the PV model. A voltage controlled buck converter based PV emulator plan. Configuration of current controlled buck converter based PV emulator. In [3], an 8-bit microcontroller controller two-switch buck-support converter based PV emulator utilizing piecewise straight way to deal with speak to the PV qualities is accounted for; configuration of a double mode power controller for PV module imitating framework. To abstain from exchanging clamor and voltage great uses a direct controller for the power source as opposed to utilizing exchanging sort power converters.

In this study, we concentrate on circuit reproduction for buck-support converter based MPPT framework. A voltage and current controlled double mode buck-support converter based PV copying framework is produced first. In this PV copying framework, three buck-support converter topologies (Zeta, SEPIC and four-switch sort synchronous converter) are examined. Circuit recreations utilizing MATLAB based Simulink piecewise straight electric circuit reenactment apparatus (PLECS) are led for various burden conditions [4]. The outcomes demonstrate that the proposed buck-help converter based PV imitating model will precisely copy the qualities of the PV board. After the accomplishment of the outline and circuit recreation of the PV imitating framework, a SEPIC buck-help converter based MPPT framework is then created utilizing fuzzy logic to play out the MPPT capacity. The MPPT framework is controlled by

the buck-help converter based PV imitating framework [5]. Circuit reproductions for the complete buck-support converter based MPPT framework are effectively checked in MATLAB/Simulink PLECS environment.

Objectives of the paper:

- The goal of this project is to present an advanced SEPIC converter with fuzzy logic controller based maximum power point tracking in the standalone systems.
- Our goal is to develop such a system with the purpose of obtaining as much energy from a solar cell as possible.
- Our secondary goal will be to create such a system that operates with the optimum efficiency as well.

2. BACKGROUND STUDIES

Proposed approach is based on following studies:

Yun-Pam Lee et al concentrated on a DC to AC Inverter; power exchanging framework; capacity to create the drive voltage and exchanging the power supply between the city electrical framework and the solar based power framework [6].

The primary point is to develop a stabled, finished and minimal effort of sun oriented energy transformation frameworks. Novel photovoltaic converter framework was proposed by J. H. R. Enslinan, actualizing another most extreme power point following system [7]. The three capacities, battery direction, transforming and most extreme power point following, required for photovoltaic frameworks with battery go down, and were incorporated in a solitary practical converter. This converter charges the battery, works near the greatest power purpose of the photovoltaic exhibit and structures a dc to air conditioning inverter for a mind boggling power load. The progression down charger permits the mix of high-voltage PV clusters with low voltage batteries. A full depiction of the circuit and handy measured results with efficiencies were exhibited.

A battery-coordinated support converter for module-based arrangement associated photovoltaic (PV) framework has been examined by Yang Du et al [8]. Each PV module has its own battery and DC/DC converter. The converter accomplishes most extreme power point following (MPPT) and battery charging. Utilization of proposed converter to module based arrangement associated PV framework can keep up string voltage and recovery an extra voltage enhancement stage. Enduring state examination of the converter to decide the power stream conditions was introduced. Three preferences contrasting and the customary arrangement associated help converter were accounted for. Reproduction and test consequences of a research facility model were displayed.

Another MPPT framework has been created by Eftichios Koutroulis et al [9], comprising of a Buck-sort dc/dc converter, which was controlled by a microcontroller based unit. The principle distinction between the strategy utilized as a part of the proposed MPPT framework and different procedures utilized as a part of the past was that the PV cluster output power was utilized to straightforwardly control the dc/dc converter, in this manner lessening the many-sided quality of the framework. The subsequent framework has high-proficiency, lower-cost and can be effortlessly altered to handle more energy sources (e.g., wind-generators). The test results demonstrate that the utilization of the proposed MPPT control builds the PV output power by as much as 15% contrasted with the situation where the dc/dc converter obligation cycle was set such that the PV cluster creates the most extreme power at 1 kW/m2 and 25 C.

A framework with an option wellspring of energy supply from photovoltaic energy framework which works if there should rose an occurrence of utility power disappointment has been examined by C. Thulasiyammal [10]. The proposed PV framework is made out of traditional novel single pivot following framework and PV framework with DC-DC help converter and PWM voltage source inverter. The PV board voltage is taken as info parameter to amplify the output power.
The execution examination of photovoltaic modules in non-perfect conditions and the topologies to minimize the corruption of execution brought about by these conditions was presented by Weidong Xiao et al [11]. It was found that the top power purpose of a module was essentially diminished because of just the smallest shading of the module, and that this impact was proliferated through other non-shaded modules associated in arrangement with the shaded one. Taking into account this outcome, two topologies for parallel module associations have been plot. Moreover, dc/dc converter advances, which were important to the outline, were thought about by method for their dynamic models, recurrence qualities, and part cost. Out of this examination, were acclamation has been made.

S. Yuvarajan et al proposed a quick and exact most extreme power point following (MPPT) algorithm for a photovoltaic (PV) board that uses the open circuit voltage and the short out current of the PV board [12]. The scientific conditions portraying the nonlinear V-I attributes of the PV board were utilized as a part of building up the algorithm. The MPPT algorithm is legitimate under various protection, temperature, and level of debasement. The algorithm is confirmed utilizing MATLAB and it is found that the outcomes acquired utilizing the algorithm were near the hypothetical qualities over an extensive variety of temperature and brightening levels.

3. PROPOSED WORK

At any minute the working purpose of a PV module relies on upon changing the protection level, sun course, irradiances and the temperature, and additionally a heap of the frameworks. The measure of the power that can be separated from a PV cluster likewise relies on upon the working voltage of that exhibit. As we watch, a PV's Maximum Power Point (MPP) will be determined by its voltage-current (V-I) and voltage-power (V-P) trademark bends. With the always showing signs of change environmental conditions and the heap variables, so it is exceptionally hard to use the greater part of the sun oriented energy accessible without a controlled framework for best exhibitions. It gets to be important to constrain the framework to work at its ideal power point [13].

The answer for such an issue is a Maximum Power Point Tracking framework (MPPT). A MPPT is typically worked with the utilization of a Bidirectional Buck-Boost Converter. The converter is in charge of exchanging most extreme power from the sun based PV module to the heap. The most straightforward method for actualizing a MPPT is to work a PV exhibit under steady voltage. This will keep operation steady at or around the Maximum Power Point. Actualizing such an outline will be helpful later on the grounds that sun based cell use is restricted incredibly by effectiveness impediments and cost components. If producers exploited MPPT frameworks, it is point of fact that sun powered cells will turn out to be all the more normally utilized [14].

1. Maximum power point tracking (MPPT) is performed by using SEPIC converter
2. MPPT is designed such that to vary temperature and irradiance
3. FUZZY Logic controller is implemented
4. Capacitor and inductor values are calculated with respect to circuit parameters
5. FUZZY rules are created with respect to input parameters
6. FUZZY rules are tuned to get precise output
7. Voltage and currents are controlled independently

Proposed**:**

1. Both voltage and current loops are implemented simultaneously in the proposed system
2. Output voltage is made constant with respect to load variations
3. Fast response to input variations

The Renewable energy source decided for this anticipates is solar based energy. Different studies was attempted to decide the capacities of the PV Module to exchange proficiently the sun oriented energy to the heap with the assistance of bidirectional twofold help converter with high transformation proportion. The improvement of renewable energy has been an undeniably basic theme with the developing issue of an unnatural weather change and other natural issues. With a more noteworthy examination, elective renewable sources like wind, water, geothermal and sun based energy have turned out to be progressively vital for electric power era. Despite the fact that the photovoltaic cells are unquestionably just the same old thing new, their utilization has turned out to be more normal, functional, and valuable for individuals around the world.

PV Panel: The Mono crystalline Photovoltaic boards are utilized. 40 cells are associated in arrangement to shape a solitary module. The Voltage of single cell is 0.6V so the voltage of a solitary module is 24V. In this proposed strategy 3 modules are utilized.

SEPIC Converter: The buck support highlight of the SEPIC extends the material PV voltage and hence expands the embraced to the Photovoltaic module the adaptability. SEPIC converter can raise the output voltage to the reasonable extent, the supply a confinement course to disconnect the info and the output terminals subsequent to ending the charging. Be that as it may, this circuit has two impediments; one is low productivity and alternate needs two inductors. Here the effectiveness is not the central point when charger is composed and utilization of coupling inductor comprehends the other burden. Consequently the SEPIC is a decent decision for steady current converter outline.

Fuzzy Logic Controller: Fuzzy logic (FL) is characterized as multi-esteemed logic which manages issues that have fluffiness or ambiguity. This is to actualize in equipment, programming, or a mix of the both. Fuzzy logic gives a basic approach to touch base at an unmistakable determination based upon an unclear, uncertain, loose, uproarious, or missing the information data. Fuzzy logic is the way to deal with control issues copies how a man would decide, just much speedier. The control algorithm of the procedure that depends on Fuzzy Logic Controller (FLC) or Fuzzy induction structures (FIS) is characterized as a fuzzy control.

Table 1: Electrical specifications of the 200 W multi-crystalline photovoltaic modules

Parameter (at STC)	Abbreviation	Value
Maximum power	P_{max}	200W
Rated voltage	V_{MPP}	26.6 V
Rated current	I_{MPP}	7.52 A
Open circuit voltage	V_{OC}	33.2 V
Short circuit current	I_{SC}	8.36 A
Temperature coefficient of I_{SC}	k_i	$5.02 * 10^{-3}$ A/°C

Temperature coefficient of V_{OC}	k_v	-1.20* 10^{-1} V/° C
Normal operating cell temperature	NOCT	47.9°C
Cell serial modules	n_i	54

The information voltage of the buck-support converter is supplied by a 15 V DC source. The voltage and current of the PV board are measured right away and associated with the MATLAB programming by a DAQ card. At that point, the power is ascertained and spared in a vector. The info variables of the Fuzzy logic controller are made taking into account the Equations (1) and (2).

$$e(t) = \Delta P(t)/\Delta V(t) = (P(t)- P(t-1)) / (V(t)- V(t-1)) \quad (1)$$

$$\Delta e(t) = e(t)- e(t-1) \quad (2)$$

In this study, a fuzzy method of reasoning MPPT controller is proposed to focus most noteworthy possible power from a photovoltaic appear. The estimation fills in as a quick methodology for MPPT through a buck-help converter set in parallel with the PV group. The gained impacts from reenactment and trial setup insist that the arranged structure is snappy, energetic and beneficial. The results in like manner exhibit the limit of the proposed FL MPPT structure to track the voltage which is individual to the best output power. It achieves growing the profitability of the PV board and lessening the terrible effects of atmosphere changing however much as could sensibly be normal.

4. RESULTS

Results of our proposed technology will be like following below figures:

Run the Matlab platform and initialize the project.

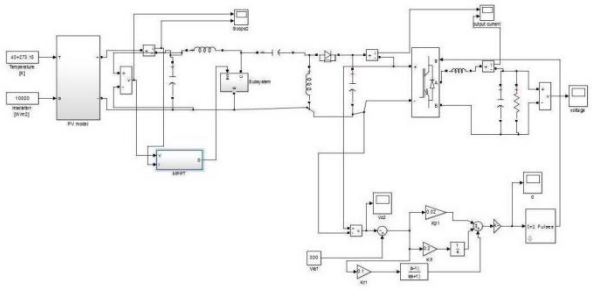

Figure 1: Proposed simulation system

The circuit used to make the sinusoidal signs is showed up in fig.1.

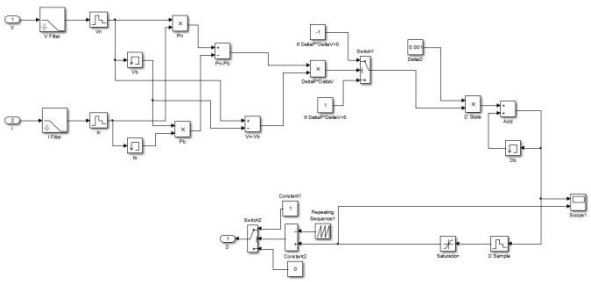

Figure 2: Proposed simulation MPPT architecture

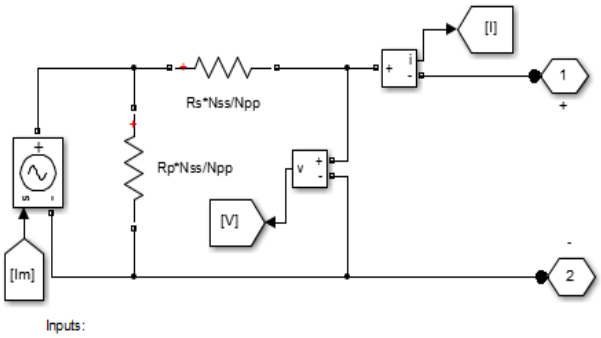

Figure 3: Proposed simulation PV panel 1

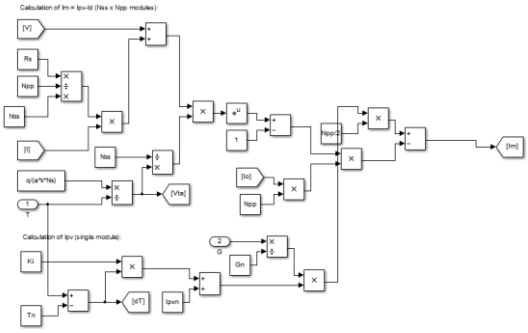

Figure: Proposed simulation PV panel 2

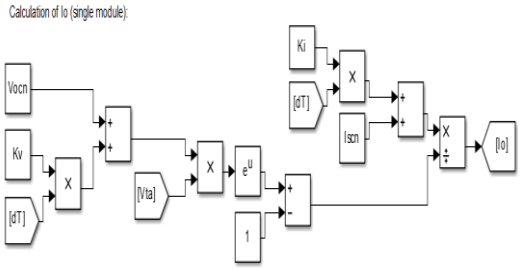

Figure 5: Proposed simulation PV panel 3

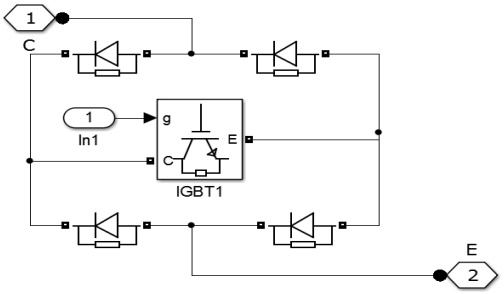

Figure 6: Proposed simulation for subsystem of converter

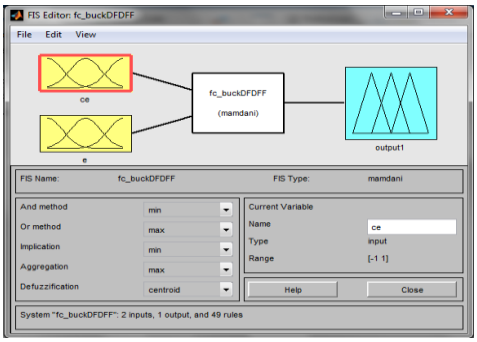

Figure 7: Fuzzy editor to load fuzzy input file

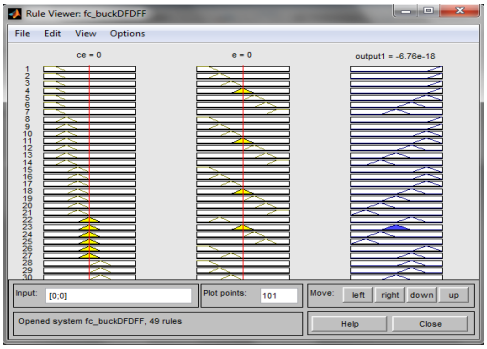

Figure 8: Fuzzy rule viewer

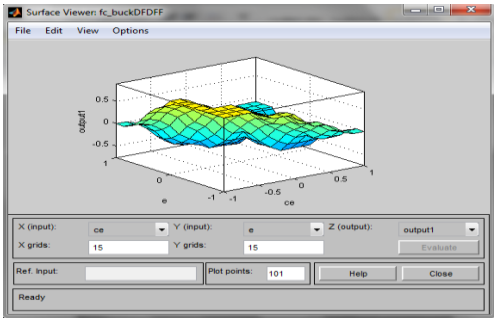

Figure.9: Fuzzy surface viewer to show model genenrated

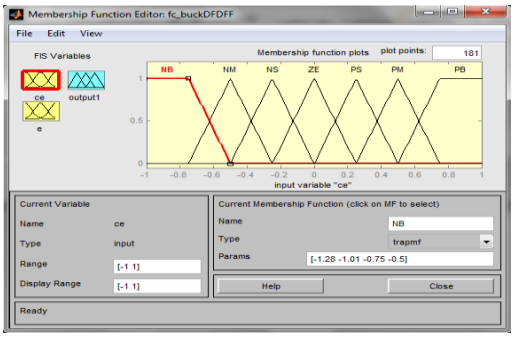

Figure 10: Fuzzy membership functions to locate two fuzzy paprameters

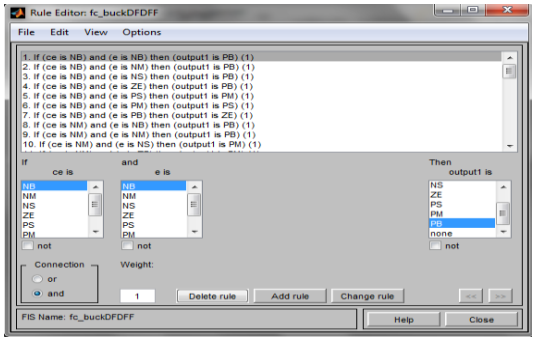

Fig.11: Fuzzy rule list showing list of rules for temparature and irraidance

Performance evaluation:

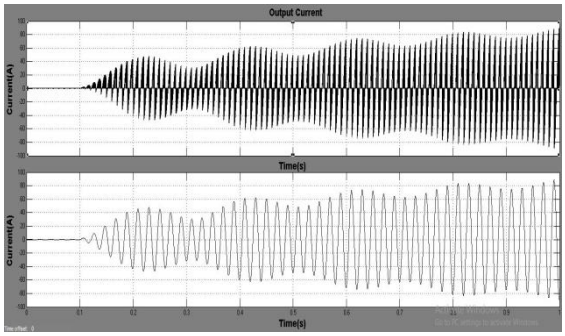

Figure 12: Scope of Output current

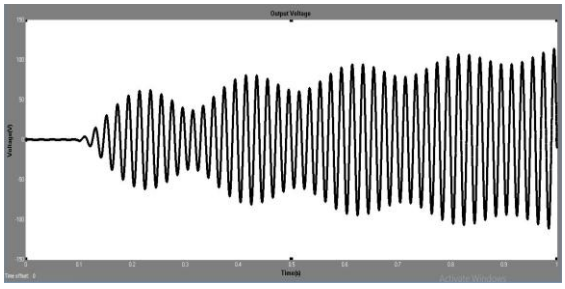

Figure 13: Scope of output voltage

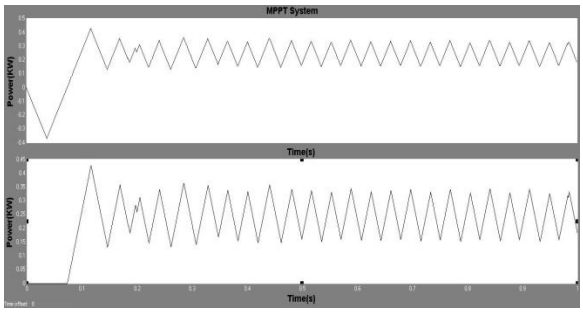

Figure 14: Scope of MPPT system

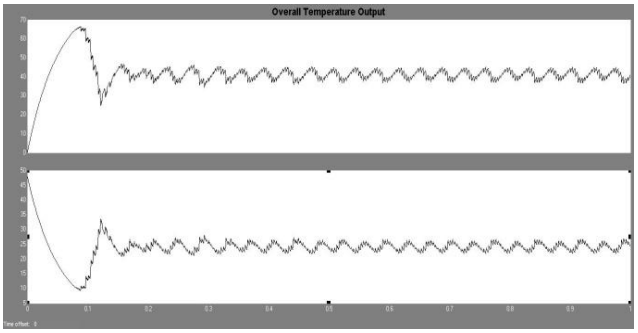

Figure 15: Scope of overall temperature output

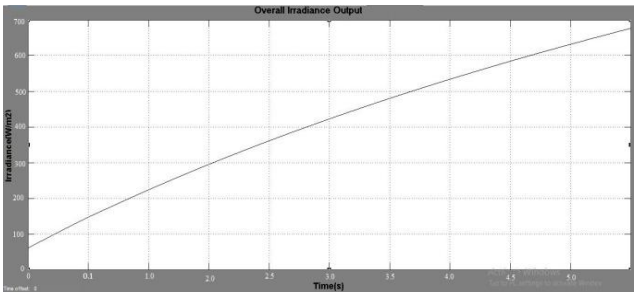

Figure 16: Scope of overall irradiance output

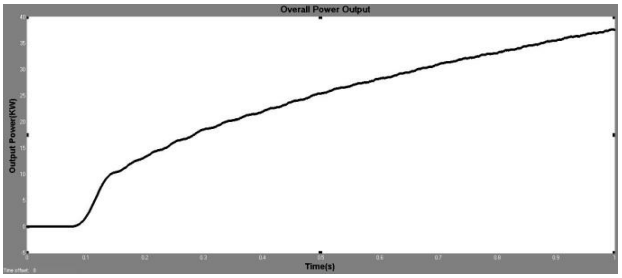

Figure 17: Scope of overall power output

5. CONCLUSIONS

To meet execution requirements, SEPICs are charming subsequent to their execution can without quite a bit of a stretch surpass the execution of microcontrollers and DSPs. By virtue of their high method of reasoning point of confinement, SEPICs could be changed in accordance with control MPPT for multi-occupy structures in parallel without driving complex correspondence between the unmistakable controls of every one channel. In like manner, given their programmability, SEPICs could be used to lead in-circuit experimentation, testing and improvement of various parameters that impact the execution of the MPPT control structure.

REFERENCES

[1] Hung-I Hsieh, Jen-Hao Hsieh, et al., "A Study of High-Frequency Photovoltaic Pulse Charger for Lead-Acid Battery Guided by PI-INC MPPT".

[2] K.H. Hussein, I. Muta, T. Hoshino and M. Osakada, "Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions," IEEE ploc.-Gener. Transmission and Distribution, Vol. 142, No. 1, Jan. 1955.

[3] M. M. Rashid, N. A. Rahim, M. A. Hussain, and M. A. Rahman, "Analysis and experimental study of magneto rheological-based damper for semi-active suspension system using fuzzy hybrids," IEEE Trans, *Industry Applications*, vol. 47, no. 2, pp. 1051-1059, March/April 2011.

[4] M. Singh and A. Chandra, "Application of adaptive network-based fuzzy inference system for sensorless control of PMSG-based wind turbine with nonlinear-load-compensation capabilities," IEEE Trans, *Power Electronics*, vol. 26, no. 1, pp. 165-175, Jan 2011.

[5] M. N. Uddin and R. S. Rebeiro, "Online efficiency optimization of a fuzzy-logic-controller-based IPMSM drive," IEEE Trans, *Industry Applications*, vol. 47, no. 2, pp. 1043-1050, March/April 2011.

[6] Yun-Pam Lee, En-Chi Liu, and Huang-Yao Huang, "A Small Scale Solar Power Generation, Distribution, Storage, MPPT and Completed System Design Method," IEEE, 2010.

[7] J. H. R. Enslinand D. B. Snyman, "Combined Low-Cost, High-Efficient Inverter, Peak Power Tracker and Regulator for PV Applications," IEEE Transactions on Power Electronics, Vol. 6. No. 1, Jan. 1991

[8] Yang Du and Dylan Dah-Chuan Lu, "Analysis of a Battery-Integrated Boost Converter for Module-Based Series Connected Photovoltaic System," The International Power Electronics Conference, 2010.

[9] Eftichios Koutroulis, Kostas Kalaitzakisand Nicholas C. Voulgaris, "Development of a Microcontroller-Based, Photovoltaic Maximum Power Point Tracking Control System," IEEE Transactions on Power Electronics, Vol. 16, No. 1, Jan. 2001.

[10] C. Thulasiyammal and S Sutha, "An Efficient Method of MPPT Tracking System of a Solar Powered Uninterruptible Power Supply Application," 1st International Conference on Electrical Energy Systems, 2011

[11] Weidong Xiao, Nathan Ozog and William G. Dunford, "Topology Study of Photovoltaic Interface for Maximum Power Point Tracking," IEEE Transactions on Industrial Electronics, Vol. 54, No. 3, June 2007

[12] S. Yuvarajan and Juline Shoeb, "A Fast and Accurate Maximum Power Point Tracker for PV Systems," IEEE, 2008.

[13] M. F. Naguib and L. A. C. Lopes, "Harmonics reduction in current source converters using fuzzy logic," IEEE Trans, *Power Electronics*, vol. 25 no. 1, pp. 158-167, Jan. 2010.

[14] L. Hang, S. Liu, G. Yan, B. Qu, and Z. Lu, "An improved deadbeat scheme with fuzzy controller for the grid-side three-phase PWM boost rectifier," IEEE Trans, *Power Electronics*, vol. 26, no. 4, pp.1184-1191, April 2011.