ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 2, Issue 2, pp: (130-135), Month: April 2015 - June 2015, Available at: www.paperpublications.org

Design and Implementation of Maximum Power Point Tracking Using Fuzzy Logic Controller for Photovoltaic for Cloudy Weather Conditions

K. Rajitha Reddy[1], Aarepalli. Venkatrao[2]

[1]MTech, [2]Assistant Professor, [1,2] Department of Electrical and Electronics Engineering,
St. Mary's College of Engineering and Technology (JNTUH), Telangana, Hyd-8, India

Abstract: **The maximum power point tracking (MPPT) is a process which tracks maximum power point from array input, varying the ratio between the voltage and current delivered to get the most power it can. This paper proposes Maximum Power Point Tracking (MPPT) of a photovoltaic system using Fuzzy Logic Algorithm. For efficient utilization of solar energy, the PV panel should track the maximum power point (MPP) under various weather conditions. Boost converter increases output voltage of the solar panel and converter output voltage depends upon the duty cycle of the MOSFET present in the boost converter. The change in the duty cycle is done by Fuzzy logic controller by sensing the power output of the solar panel. Fuzzy logic controller (FLC) provides an adaptive nature, fast response, good performance and ability to handle non-linear characteristics. The proposed controller is aimed at adjusting the duty cycle of the DC-DC converter switch to track the maximum power of a solar cell array. MATLAB/SIMULINK is used to develop and design the PV array system equipped with the proposed MPPT controller using fuzzy logic.**

Keywords: **MPPT, Fuzzy Logic Control, DC-DC Converter, Photo voltaic systems.**

I. INTRODUCTION

Recently, energy generated from clean, efficient, and environmentally friendly sources has become one of the major challenges for engineers and scientists. Among all renewable energy sources, solar power systems attract more attention because they provide excellent opportunity to generate electricity while greenhouse emissions are reduced. And solar energy is viewed as clean and renewable source of energy for the future. So the use of Photovoltaic systems has increased in many applications. The efficiency of solar cells depends on many factors such as temperature, insulation, spectral characteristics of sunlight, dirt, shadow, and so on. Changes in insulation on panels due to fast climatic changes such as cloudy weather and increase in ambient temperature can reduce the photovoltaic (PV) array output power. Therefore a maximum power point tracking algorithm is required to increase the efficiency of the solar panel as it has been found that only 30-40% of energy incident is converted into electrical energy. The design of DC-DC converter (Boost converter) helps in increasing the output of the panel thus increasing the efficiency and the output voltage using proper control technique [4]. This paper deals with the development of a fuzz logic control for MPPT to track the maximum power point and also compensate for fluctuating power during cloudy weather[5-7]. The block diagram of proposed main circuit is shown in Fig l. The simulation is done in MATLAB/SIMULINK.

II. MAXIMUM POWER POINT TRACKING

Maximum Power Point Tracking is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. The maximum power point of a solar panel depends on both the panel radiation level, load characteristics.Under Partial shading conditions it is possible to have multiple local maxima, but overall there is still only one true maximum power point P_{max} as shown in fig 2. It is essentially the operating point where the load curve and panel output meet at a maximum point. When the load is directly connected to the panel, the operating point may not be reaching at the maximum point. Hence boost I DC-DC converter helps the output voltage to be boosted to the Vmpp or the voltage at maximum power point.

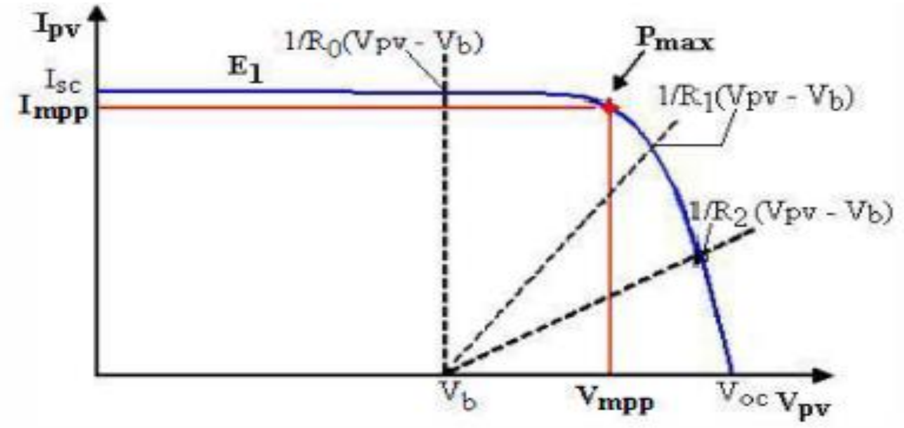

Fig. 2. V-I characteristics of a solar panel

The control of the switching pulses of the MOSFET to reach its maximum point i.e. the modification of the duty cycle to maximize the voltage is to be done. Panel VI and PV characteristics change when the insulation (solar radiation) varies.

A. MPPT Using Fuzzy Logic:

The concept of the control system can be explained by Fig 2. The objective of the system is to push the operating point towards the point Pmax using controller. The advantage of fuzzy control is that it is robust, fast and responds instantaneously to atmospheric changes. The inputs to the fuzzy logic system will be error (E) and Change in Error (C). The output will be the Change in Duty Cycle (dD) at sampling instant k [5]. The fuzzy logic consists of the following stages: fuzzification, rule base, inference system and defuzzification. Fig 3 shows the flowchart of fuzzy logic controller.

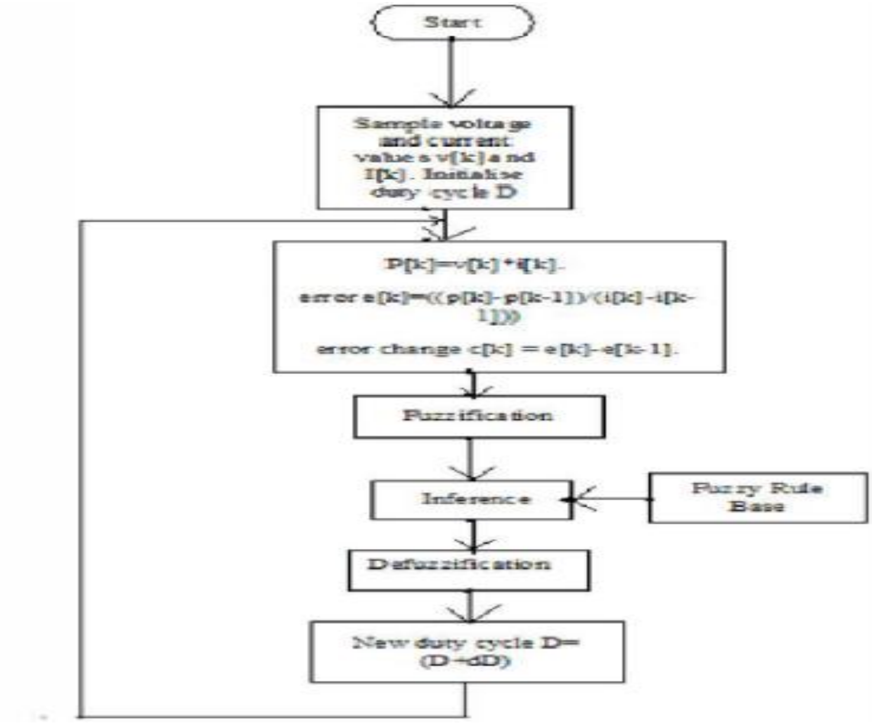

Fig: 3. Flowchart of fuzzy logic controller

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 2, Issue 2, pp: (130-135), Month: April 2015 - June 2015, Available at: www.paperpublications.org

B. Fuzzification:

The fuzzification is the process of converting the system actual inputs values error (e) and change of error (ce) into fuzzy membership function. The Fuzzy variables are divided into 5 linguistic hedges: Negative Big (NB), Negative Small (NS), Zero (ZE), Positive Small (PS) and Positive Big (PB).The membership functions are chosen as shown in Fig 4,Fig 5 & Fig 6 show that the linguistic hedges of change in error and change in duty cycle respectively.

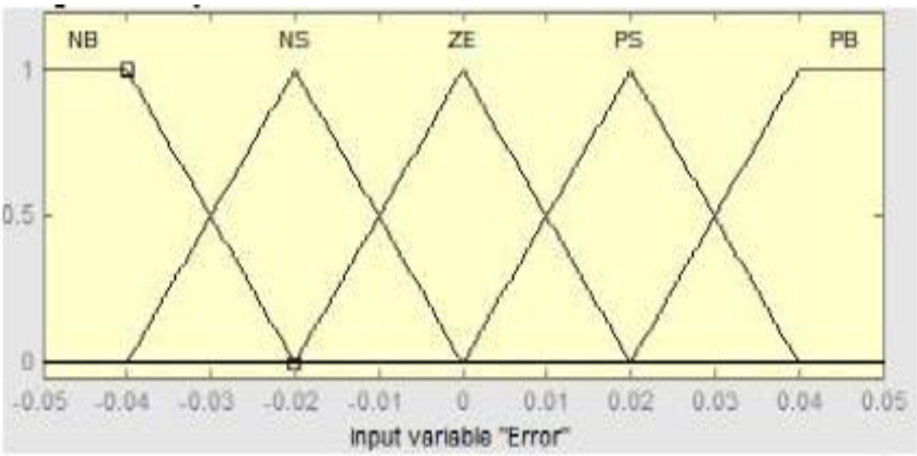

Fig. 4. Linguistic hedges of error

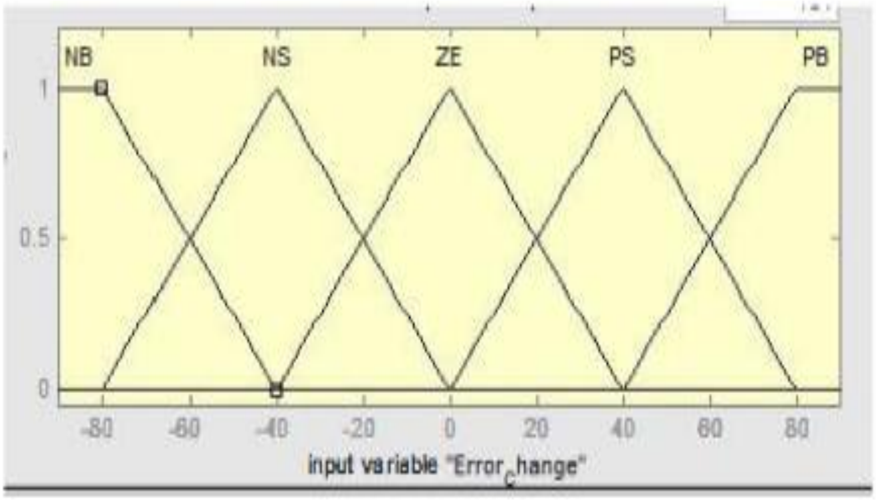

Fig. 5. Linguistic hedges of change in error

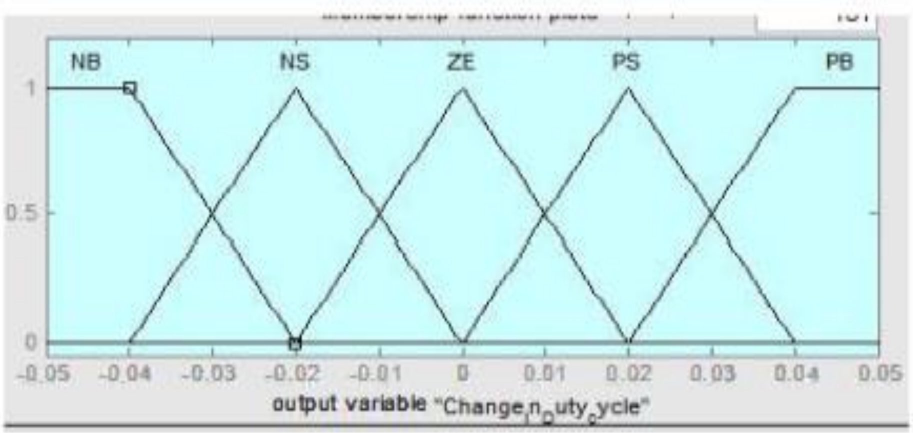

Fig.: 6. Linguistic hedges of change in duty cycle

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 2, Issue 2, pp: (130-135), Month: April 2015 - June 2015, Available at: www.paperpublications.org

C. Inference Method:

Table 1 gives the rules of the FLC .The output for each fuzzy input is tabulated in the form of a rule base. The rule base uses Mamadani implication. Fuzzy inference engine is an operating method that formulates a logical decision based on the fuzzy rule setting and transforms the fuzzy rule base into fuzzy linguistic output.

TABLE I. Fuzzy RULE BASE

CE / E	NB	NC	ZE	PS	PB
NB	ZE	ZE	NB	NB	NB
NS	ZE	ZE	NS	NS	NS
ZE	NS	ZE	ZE	ZE	PS
PS	PS	PS	PS	ZE	ZE

D. Defuzzification:

It should be noted that, the output of fuzzy controller is a fuzzy subset. As the DC/DC converter control requires a non-fuzzy value of duty cycle, defuzzification is required. This means, defuzzification converts the inferred fuzzy control action into a numerical value at the output by forming the union of the outputs resulting from each rule.

III. SIMULATION MODEL OF THE PROPOSED SYSTEM

Fig.7 shows the MATLAB Simulink model of the proposed system. PV is connected to the boost converter. Input of the boost converter is output current from the PV model and boost converter delivers the voltage depending on the switching time of IGBT switch. Output of the converter is given by the following equation 4.

$V_{out}/V_{in} = 1/(1-D)$ (1)

D is duty cycle adjusted with the help of FLC by sensing the output power of the solar panel. FLC algorithm is coded to vary duty cycle of the switch and generates 20kHz switching pulses.

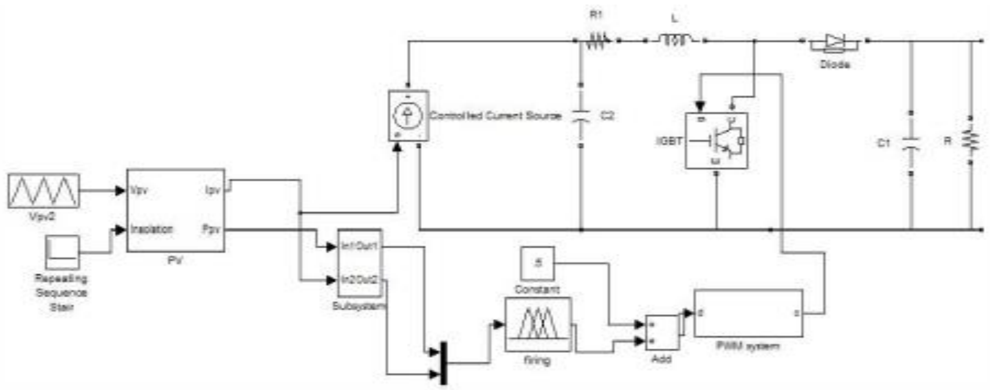

Fig. 7. Model of MPPT system

MOSFET is turned ON and turned off by the pulses given from Fuzzy controller. The proposed controller compares the p[k] and p[k-l], it decides the operating point, whether it lies left or right side of the maximum point of PV curve [4][6] in Fig.2, hence accordingly changes the duty cycle.

IV. SIMULATION RESULTS AND VALIDATION DISCUSSIONS

A. Solar Panel:

The photovoltaic panel is modelled based on its equivalent circuit. The insolation is considered a constant at 1000 w/m^2 the panel is driven by voltage which is considered to be a triangular function Fig 8. So that output voltage of solar panel varies from 0-8V. Maximum current obtained from the panel is 0.62 A. The corresponding characteristics of the solar panel are given in Fig 9 and Fig 10.

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 2, Issue 2, pp: (130-135), Month: April 2015 - June 2015, Available at: www.paperpublications.org

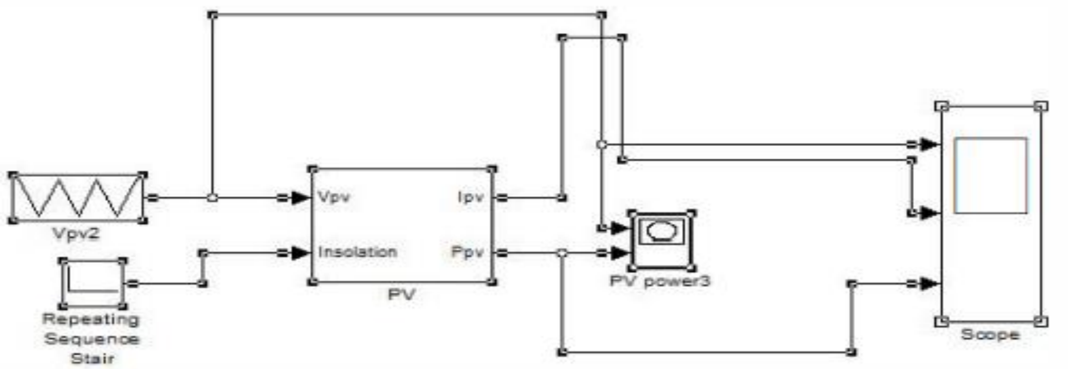

Fig. 8. Solar panel Model in SimulinkPower Vs output voltage

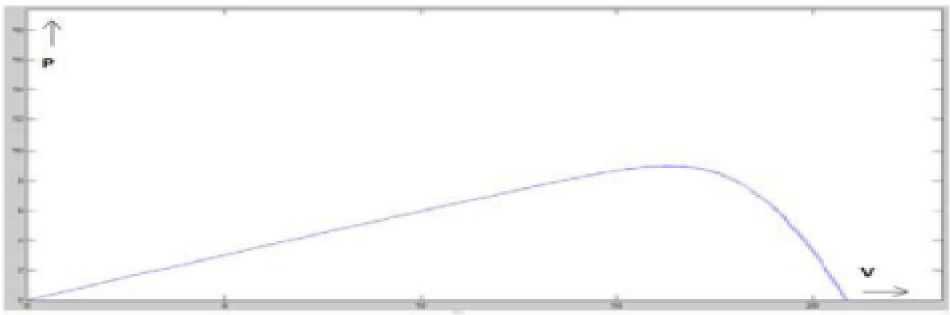

Fig. 9. Power Vs output voltage

Referring to the solar panel characteristics, boost converter design is done. Frequency of operation of MOSFET is selected as 20KHz. Inductor and capacitor values are selected by considering

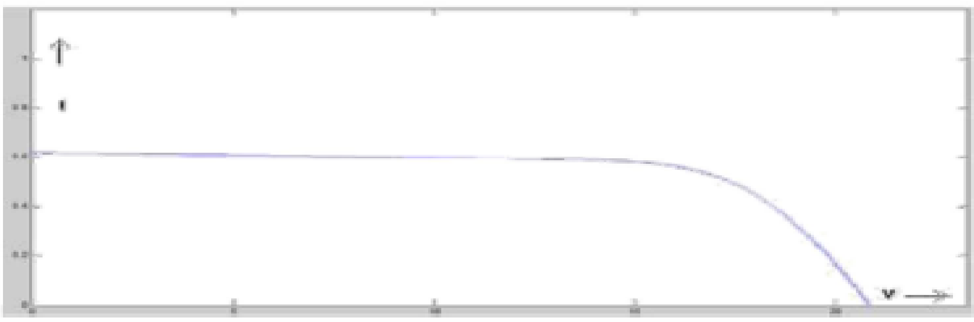

Fig. 10. Voltage Vs Current output of solar panel

Yin (0-8V) and Vout limited to 17 Volts. The panel output is compared without fuzzy based MPPT controller and with fuzzy MPPT controller. The results are shown in Fig .11 & 12.

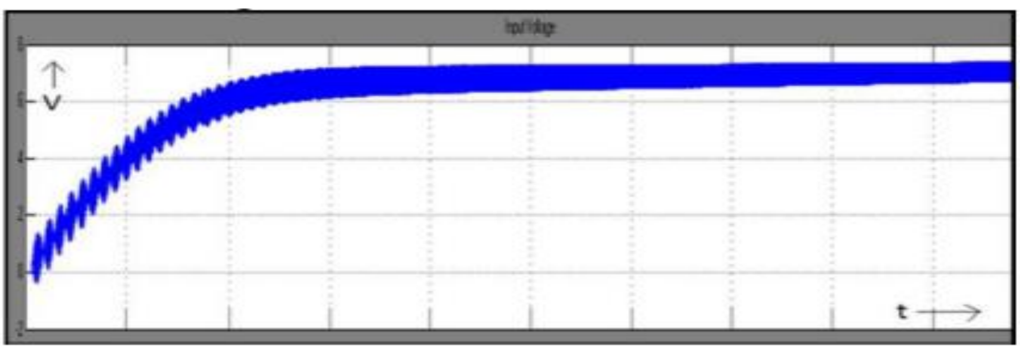

Fig. 11. Output voltage of the solar panel without MPPT.

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 2, Issue 2, pp: (130-135), Month: April 2015 - June 2015, Available at: www.paperpublications.org

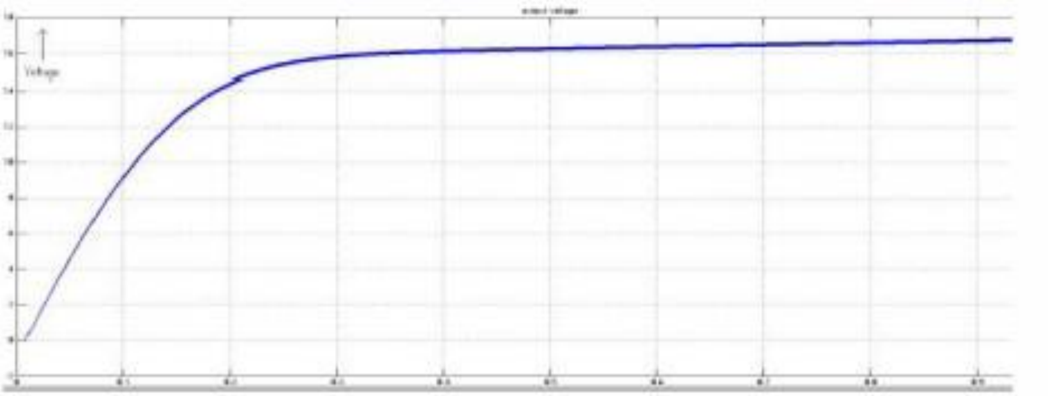

Fig. 12. Output of the solar panel with MPPT FLC under cloudy weather conditions

V. CONCLUSION

This paper presents the design and simulation for maximum power point tracking (MPPT) for photovoltaic system, which includes a high-efficiency boost converter with fuzzy logic algorithm. The converter can draw maximum power from the PV panel for a given solar insulation ad temperature by adjusting the duty cycle of the converter. Thus improves the efficiency of the PV system and reduces low power loss and system cost.

REFERENCES

[1] Chetan Singh Solanki," Solar Photo Voltaics ", PHI Learning pvt. Ltd ,2009.

[2] Bor-Ren Lin,"Analysis of Fuzzy Control Method Applied to DCDC Converter controf' , IEEE Prowe .h g APK'93, pp. 22- 28,1993.

[3] Rohin M.Hillooda, Adel M.Shard,"A rule Based Fuzzy Logic controller for a PWM inverter in Photo Voltaic Energy Conversion Scheme", IAS'SZ, PP.762-769, 1993.

[4] Pongsakor Takum, Somyot Kaitwanidvilai and Chaiyan Jettasen ; 'Maximum POlVer Point Tracking using fuzzy logic control for photovoltaic systems.' Proceedings Of International Multiconference of Engineers and Computer scientists ,Vol 2,March 2011.

[5] M.S.Cheik , Larbes, G.F Kebir and A ZerguelTas; 'Maximum power point tracking using a jilzzy logic control scheme.'; 'Department d'Electronique', Revue des Energies Renouvelables, VoI.lO,No 32 , September 2007, pp 387-395

[6] Chung -Yuen Won , Duk-Heon Kim, Sei-Chan Kim; , A New Maximum POlVer Point Tracker of Photovoltaic Arrays using Fuzzy contoller.'; Sung Kyun Kwan University.IEEE explore. Pp. 396-403,November,2008.

[7] Muhida, R., Minwon, P., Dakkak, M., Matsuura, K., Tsuyoshi, A., and Michira,M.: 'A maximum power point tracking for photovoltaic-SPE system using a maximum current controller', Solar EnergyMater.Solar Cells, 2003, 75, (3-4), pp. 697-706.

[8] N.Khaehintung and P. Sirisuk, "Implementation of maximum power point tracking using fuzzy logic controller for solar-powered lightflasher applications," Proceedings of the 47th IEEE InternationalMidwest Symposium on Circuits and Systems. 2004, pp. Ill-171-174.

[9] Vasantharaj,S, Vinodhkumar,G.,Sasikumar.M, " Development of a Fuzzy Logic based, Photovo/taic Maximum Power Point tracking control system using boost converter". lET Chennai 3rd International conference on Sustainable Energy and Intelligent Systems. December 2012,pp.I-6.