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Photo Voltaic Mppt and Inverter using Fuzzy Logic

Anurag S.D. Rai, Anil Kurchania, Reeta Pawar

***Abstract:** In this paper the photo voltaic (i.e. PV) system is used with the SEPIC converter (i.e. single ended primary inductor converter) and MPPT (maximum power point tracker) by using fuzzy logic. The fuzzy logic controller is used for gaining high efficiency by outputting crisp values to the SEPIC for converting dc to dc that is a buck/boost converter for converting dc voltage level. The inverter is used for transforming dc to ac and reducing harmonics for better ac output.*
***Keyword:** PV, solar panels, inverter, fuzzy logic, SEPIC, MPPT*

I. INTRODUCTION

In the recent decades the photovoltaic energy that is solar energy is gaining interest from all over the world. The applications in electrical power of the solar energy has been increased to a significant level. The PV modules are used in generation of electrical energy, multiple panel converts the collected solar energy into electrical energy. The solar panel harnesses the solar energy from the sun, the basic principal of the solar to electric conversion is the conversion of photons energy into electrical energy. The output of the solar panels varies according to the variation in the sunlight, humidity, temperature, wind speed, and other factors. The MPPT that is maximum power point tracker is used to increase the output energy of the solar panels that are used with a SEPIC that is single ended primary inductor converter. The SEPIC converter are used for converting dc to dc i.e. buck and boost operations. The SEPIC converter changes its output according to the duty cycle from the controller's signal.

The Buck and boost converter have ability to increase and decrease the input voltage. Therefore the converter is able to convert energy at every radiation levels. The CUK and the SEPIC converters both are used for providing either high/low output voltage as compared to input voltage. The PV panels givean exponential curve for the current and the voltage where the maximum power comes at knee of curve [1][2]. After then the MPPT uses method to analyze maximum power point, the method/process is known as theperturb and observe (i.e. P&O) [3][4].

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* Correspondence Author
Dr. Anurag S.D. Rai*, Department of Electrical & Electronics Engineering, Rabindranath Tagore University, Bhopal
Dr. Anil Kurchania, Department of Electrical & Electronics Engineering, Rabindranath Tagore University, Bhopal
Dr. Reeta Pawar, Department of Electrical & Electronics Engineering, Rabindranath Tagore University,

The researchers have been using the PI controller to use for dc to dc converters, as in literature[5][6][7]. Authors uses PI controllers along with the MPPT, but there is limitations of the PI controller and is sensitive to the parametersand variations, i.e. weather conditions. Hence, there is a need to apply the converter that can be used as effective and can work on all conditions.

Nowadays there exist many controllers like neural, AI, fuzzy logic and from all of these the fuzzy logic is simplest one to work with system. The fuzzy logic has been gaining a large amount of attention from all over the world and is used or almost every applications that are in the market right now. The fuzzy logic has gained this much of attention from the world because of the use of fuzzy logic controller, the controller can be used in converters, motor control, and many other processes and methods [8][9][10]. In this paper multi-level inverter with the photovoltaic system along with the fuzzy logic controller (FLC). The mathematical model of system and simulation are shown by using the MATLAB Simulink.

II. THE PROPOSED SYSTEM

The dc to dc converter is used to convert and increase the output of the solar panel from the low voltage into high voltage and the increased output voltage is then fed to the inverter to further convert it to the AC voltage. In this paper the maximum voltage output of the solar panel depends upon the maximum power [11][12] and hence the controller changes its frequency to maintain level with the changing voltage and hence the duty cycle of the PWM changes.

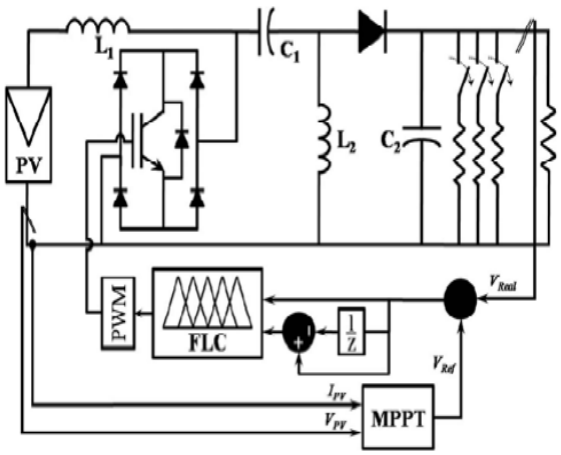

Fig. 1: Circuit diagram of the SEPIC converter for FLC based MPPT scheme.

The Figure 1 shows the circuit diagram used in the SEPIC converter with the MPPT and the fuzzy logic controller. The fuzzy logic controller design is selected from the mamdani method. The SEPIC uses single electronic switch for switching purpose.

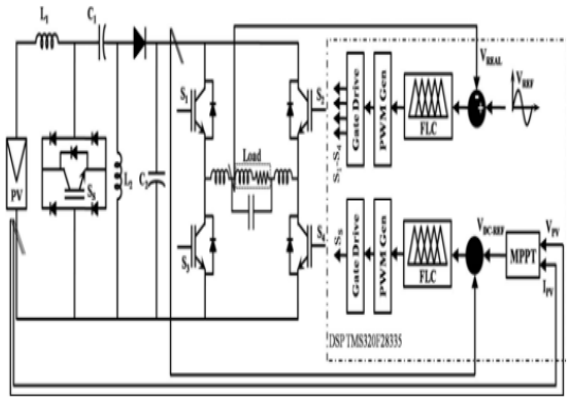

Fig. 2: Overall control scheme for the proposed FLC based MPPT scheme for the SEPIC converter

BLOCK DIAGRAM OF THE SYSTEM:

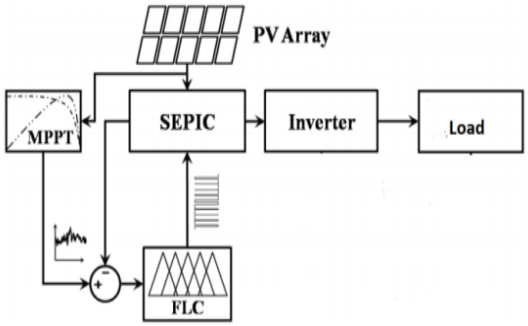

Fig. 3: Block diagram of PV system

Figure 3 shows the block diagram of the Photovoltaic system that includes PV array, MPPT, SEPIC, LOAD, FLC and other small components. The MPPT and the fuzzy logic controller outputs the duty cycle to the buck/boost converter for maximizing the output from the PV panels. The PV arrays outputs the DC voltage which is then fed to the SEPIC converter and after that the SEPIC converter boosts the output voltage for getting maximum power output.

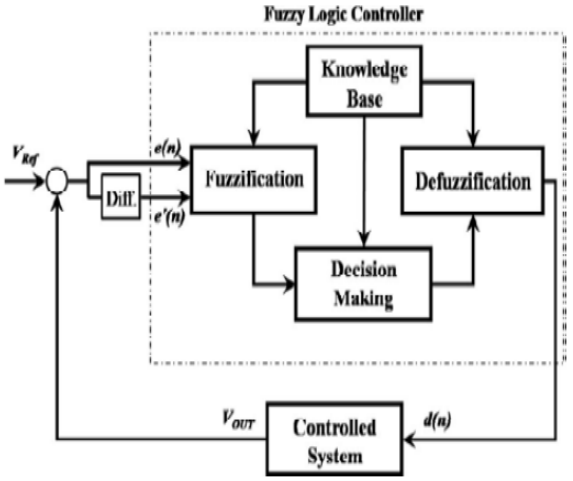

Fig. 4: Structure of the proposed FLC.

The fuzzy logic controller is based on the mamdani method that works on the membership function. The method works on 3 process like shown in the figure 4. Input variable of fuzzy logic controller are output voltage and the output of FLC is the duty cycle of the PWM signal that helpsin regulation of the output voltage from the PV array, as shown in the figure 5& figure6.

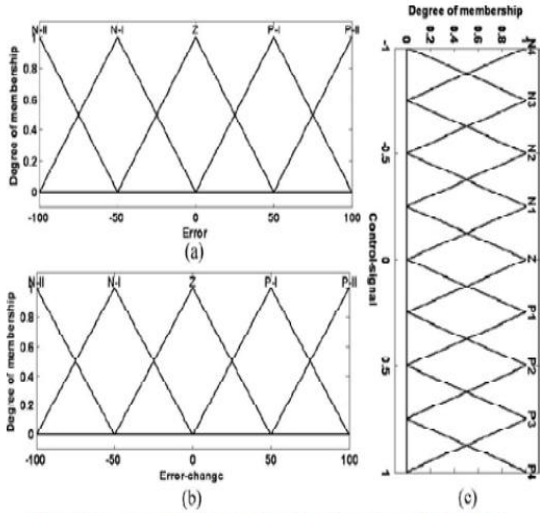

Fig. 5: Symmetrical membership function of the FLC. (a) e(n), (b) e(n)', (c) d(n)

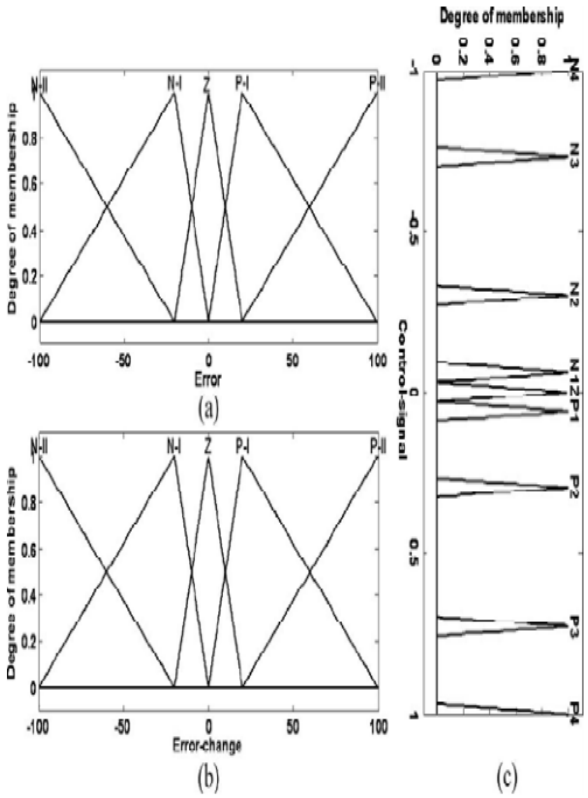

Fig. 6: Unsymmetrical Focused Membership Function of The FLC. (a) e(n), (b) e(n)', (c) d(n)

Table 1 showing different fuzzy rules on which it is working.

Table 1: Fuzzy Rule Based Matrix.

e / e′	N-II	N-I	Z	P-I	P-II
N-II	N4	N4	N4	N3	Z
N-I	N4	N2	N1	Z	P3
Z	N4	N1	Z	P1	P4
P-I	N3	Z	P1	P2	P4
P-II	Z	P3	P4	P4	P4

Figure 7 and figure 8 showing three dimensional surface corresponding to the table 1 value.

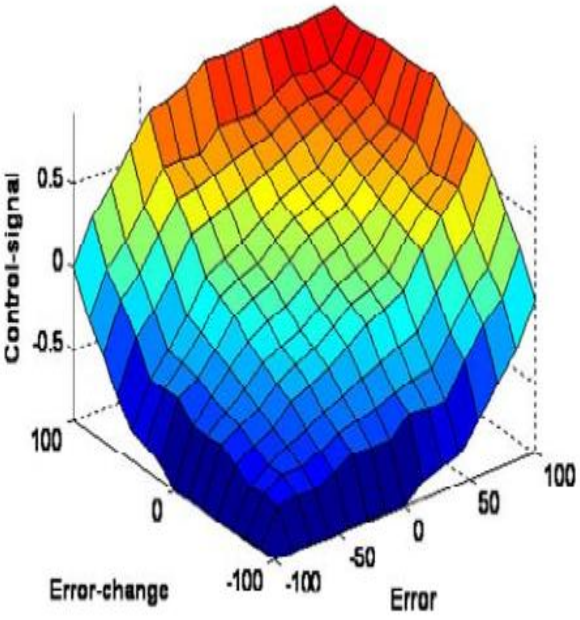

Fig. 7: Three-dimensional surface corresponding to the membership in fig.5 and the rules in table 1.

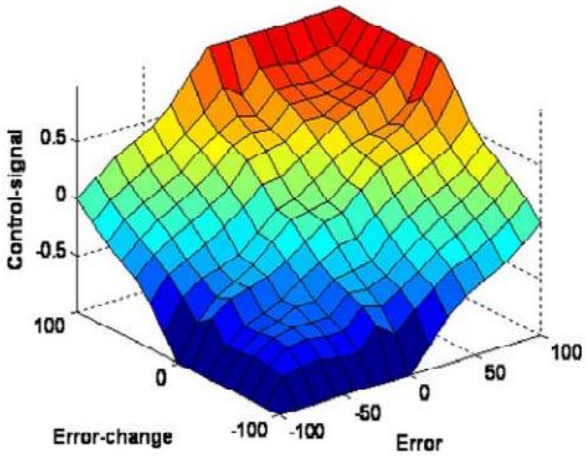

Fig. 8: Three-dimensional surface corresponding to the membership in fig.6 and the rules in table 1.

III. SIMULATION

The simulation shown are generated using the MATLAB.

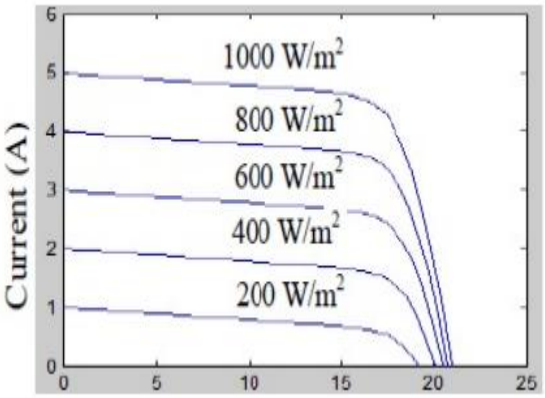

Figure 9: Current vs Radiations

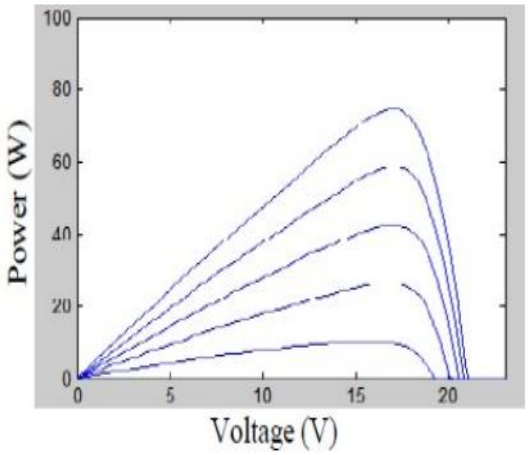

Figure 10: Power vs Voltage characteristics.

IV. CONCLUSION

The FLC based MPPT for SEPIC converter and the inverter system for the solar panel electrical power application has been shown in this paper and the performance of inverter has been functioning better then other single phase inverter and the FLC based inverter provides much better inverter output.

REFERENCE

1. B. van der Zwaan and A. Rabl, "Prospects for PV: A learning curve analysis," *Sol. Energy*, 2003.
2. M. Haouari-Merbah, M. Belhamel, I. Tobías, and J. M. Ruiz, "Extraction and analysis of solar cell parameters from the illuminated current-voltage curve," in *Solar Energy Materials and Solar Cells*, 2005.
3. M. A. Elgendy, B. Zahawi, and D. J. Atkinson, "Assessment of perturb and observe MPPT algorithm implementation techniques for PV pumping applications," *IEEE Trans. Sustain. Energy*, 2012.
4. D. Sera, L. Mathe, T. Kerekes, S. V. Spataru, and R. Teodorescu, "On the perturb-and-observe and incremental conductance mppt methods for PV systems," *IEEE J. Photovoltaics*, 2013.
5. N. Femia, G. Petrone, G. Spagnuolo, and M. Vitelli, "Optimization of perturb and observe maximum power point tracking method," *IEEE Trans. Power Electron.*, 2005.
6. I. V. Banu, R. Beniuga, and M. Istrate, "Comparative analysis of the perturb-and-observe and incremental conductance MPPT methods," in *2013 - 8th International Symposium on Advanced Topics in Electrical Engineering, ATEE 2013*, 2013.
7. J. Ahmed and Z. Salam, "An improved perturb and observe (P&O) maximum power point tracking (MPPT) algorithm for higher efficiency," *Appl. Energy*, 2015.
8. S. P, S. D.N, and P. B, "Temperature Control using Fuzzy Logic," *Int. J. Instrum. Control Syst.*, 2014.
9. B. N. Alajmi, K. H. Ahmed, S. J. Finney, and B. W. Williams, "A maximum power point tracking technique for partially shaded photovoltaic systems in microgrids," *IEEE Trans. Ind. Electron.*, 2013.
10. *Neural and Fuzzy Logic Control of Drives and Power Systems*. 2016.
11. B. Subudhi and R. Pradhan, "A comparative study on maximum power point tracking techniques for photovoltaic power systems," *IEEE Trans. Sustain. Energy*, 2013.
12. Y. H. Ji, D. Y. Jung, J. G. Kim, J. H. Kim, T. W. Lee, and C. Y. Won, "A real maximum power point tracking method for mismatching compensation in PV array under partially shaded conditions," *IEEE Trans. Power Electron.*, 2011.