ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

Simulation of Fuzzy Logic Based MPPT For PV Powered Water Pumping System

Ramya H[1], Sandhiya S[2], Sangeetha A[3], Magdelin Jennifer Princy P4

UG Scholar, Department of EEE, Saranathan College of Engineering, Trichy, India[1,2,3]
Assistant Professor, Department of EEE, Saranathan College of Engineering, Trichy, India[4]

Abstract: An increasing demand in the energy has brought more concern in utilizing the abundantly available energy resources like sunlight. Photovoltaic cells require maximum power point theorem to track maximum power for the available insolation at that instant. Among various MPPT techniques incremental conductance is found to have higher steady state accuracy and environmental adaptability. Implementing incremental conductance using fuzzy logic controller determines an optimum operating current for the maximum output power and has the advantage of low frequency switching. In this proposed manuscript, fuzzy logic based MPPT technique is used for tracking maximum power and to drive the water from the sump in an efficient manner.

Keywords: PV cells, Maximum power point tracking theorem (MPPT), incremental conductance technique, Fuzzy logic controller(FLC), Arduino.

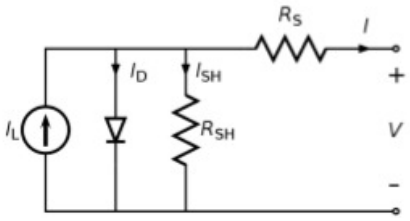
I. Introduction

After energy crisis & environmental issues such as global warming and pollution, great attention has been given for solar PV system. The main drawback of solar PV system is variation in output voltage with respect to irradiation and temperature. Due tohigh capital cost of solar PV system, full utilization of PV system is provided by MPPT techniques and hence maximize the return of capital investment. MPPT technique is implemented in order to track the maximum voltage and current at maximum power point. According to maximum power theorem, it is necessary to match the instantaneous impedance of PV panel with the load impedance to track the maximum power at the output.This can be achieved by adjusting the duty cycle of boost converter. There are different algorithms in MPPT based upon the hardware components and mathematical model of the system. It can be classified as direct and indirect techniques. Techniques comes under indirect method are fixed voltage method and fractional open circuit voltage method (constant current method). Techniques come under direct method are perturb and Observe method (P&O) and incremental conduction method. Among which P&O algorithm plays a vital role because of robustness and simplicity. The main drawback of this system, due to fixed step size there is more oscillation near the MPP.Steady state oscillation causes power loss. The drawbacks of P&O method is overcome by using fuzzy logic controller.Among all other controllers, fuzzy logic controller is chosen because of good stability&high response role.

The proposed system design is simulated on MATLAB Simulink. In this project, water will pumped in the efficient manner with the help of fuzzy based MPPT technique by using labview.

II. PV System Modeling

A solar PV cell is basically a p-n junction fabricated in thin wafer of semiconductor. Light falls on top surface of PN junction, external circuit is connected from positive to negative.
Photovoltaic cell can be represented as a current source with parallel connected diode, shunt resistor and a series connected resistor.



Photovoltaic Array (PVA) produces 60-70% of t with 30-40% loss. MPPT mainly composes DC-DC converter and FLC and needs PWM to attain maximum power that PVA can produce. PVA can produce more power with MPPT compared to PVA without MPPT.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

The net current is difference between the photocurrent I_{ph} and diode current I_D.

$$I = I_{ph} - I_D$$

$$I = I_p - I_o (\exp((V+IR_s)/nV_T)-1)-((V+IR_s)/R_{sh})$$

Where

I_o – reverse saturation current

V_T - Volt equivalent of temperature

$$V_T = KT/q$$

K denotes Boltzmann constant

T is the temperature of solar cell

Q denotes electron charge

PV module has unique voltage v/s current characteristics. In order to increase the PV efficiency , the PV system must operate at maximum power point(MPP)of specific current and voltage.

Using the PV panel specification indexed in table and output current equation (I_o) the V-I characteristic of PV panel with various radiation and temperature are given.

III. Fuzzy logic controller

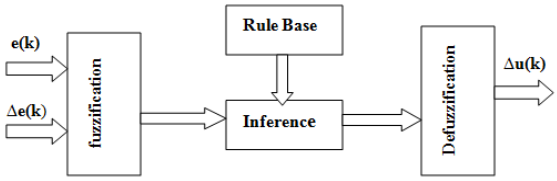
To improve tracking performance of PV system fuzzy logic controller(FLC) is introduced in addition with P&O controller. FLC uses fuzzy logic to make decisions and to control output of the controller.

The proposed scheme of FLC modifies the change to new step and P&O controller determines duty cycle.

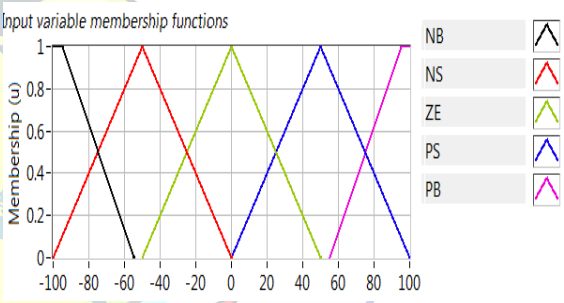
The main components in FLC are fuzzification, rule base, inference and defuzification.

FUZZIFICATION

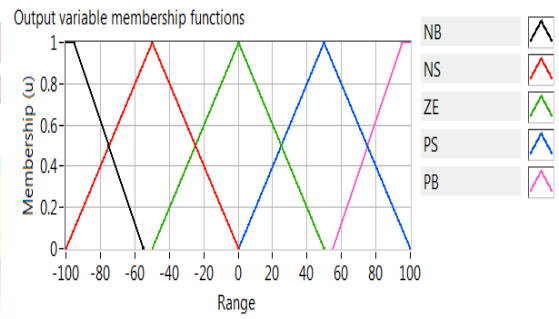
Two inputs processed by FLC , first one is error and second one is change in error. By using fuzzification, real values are converted into fuzzy sets using membership function. Each input to FLC made of three membership function are small, medium and large. FLC output has five normalized membership functions are negative big (NB), negative small (NS), zero(ZO), positive small(PS), positive big(PB).



For real time tracking of maximum operating point, fuzzy logic controller will determine change in new step size which will depend upon old perturbation voltage step size C_{old} and absolute power slope S_a.



Input Membership Function



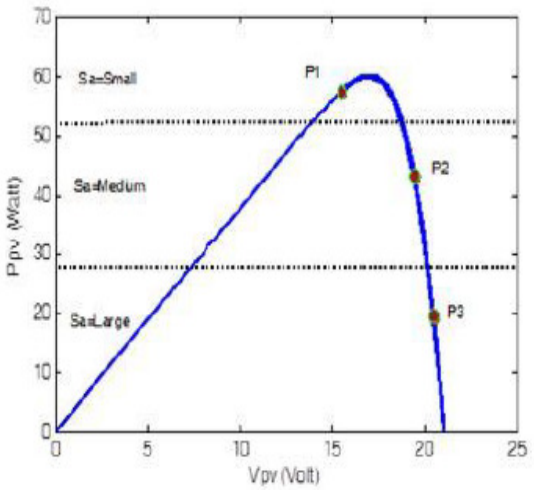
Output membership function

We are at operating point P_3, the measured slope value at that point is large. The given old step size has five possible different cases , first oneerror is NB and change in error PB, FLC has to produce change in step size negative big(NB). Second one error is NS change in error is PB, FLC has to produce change in step size is negative big(NB). Third one error is ZE change in error is PB, FLC has to produce change in step size is negative small(NS). Fourth one error is PS change in error is NB, FLC has to produce change in step size is positive big (PB). Fifth one error is PB change in error

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

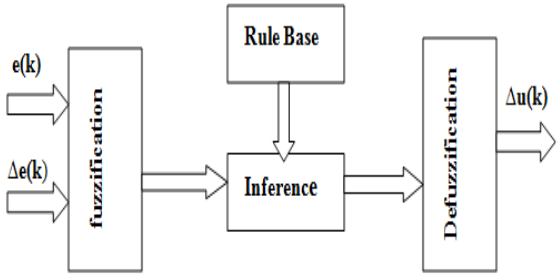
is PB, FLC has to produce change in step size is zero error(ZE) so as to avoid exceeding maximum operating point in opposite direction this situation may causes huge power loss.



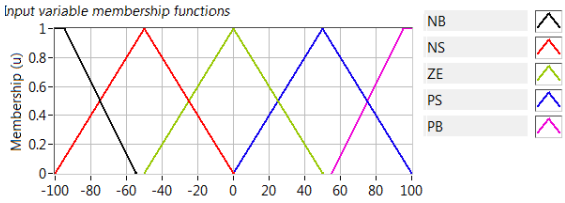
Fuzzy based MPPT PV curve

FUZZIFICATION

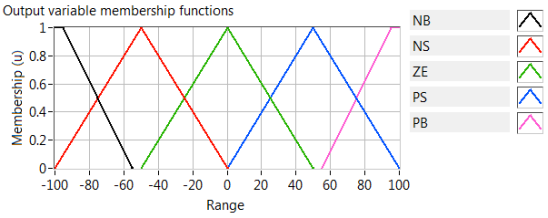
Two inputs processed by FLC , first one is error and second one is change in error. By using fuzzification, real values are converted into fuzzy sets using membership function. Each input to FLC made of three membership function are small, medium and large. FLC output has five normalized membership functions are negative big (NB), negative small (NS), zero(ZO), positive small(PS), positive big(PB).



For real time tracking of maximum operating point, fuzzy logic controller will determine change in new step size which will depend upon old perturbation voltage step size C_{old} and absolute power slope S_a.

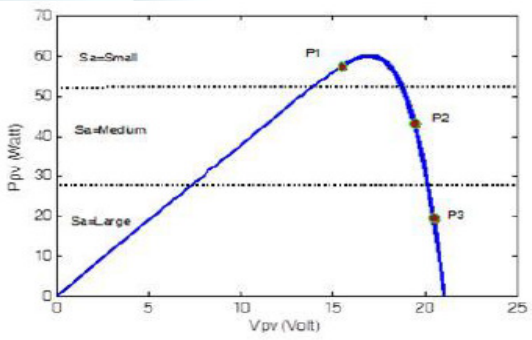


Input Membership Function



Output membership function

We are at operating point P_3, the measured slope value at that point is large. The given old step size has five possible different cases , first oneerror is NB and change in error PB, FLC has to produce change in step size negative big(NB). Second one error is NS change in error is PB, FLC has to produce change in step size is negative big(NB). Third one error is ZE change in error is PB, FLC has to produce change in step size is negative small(NS). Fourth one error is PS change in error is NB, FLC has to produce change in step size is positive big (PB). Fifth one error is PB change in error is PB, FLC has to produce change in step size is zero error(ZE) so as to avoid exceeding maximum operating point in opposite direction this situation may causes huge power loss.



Fuzzy based MPPT PV curve

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

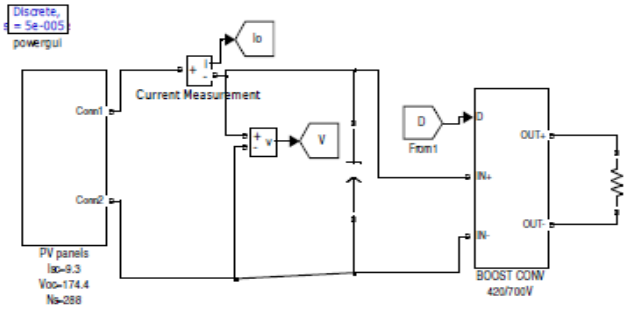
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

DEFUZZIFICATION

FLC output is in the form of fuzzy set it is mandatory to convert this into real value. In FLC, centroid method is generally used.

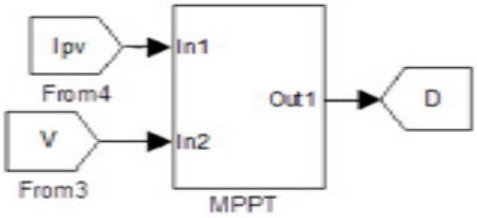
IV.MATLAB SIMULATION

The proposed system is simulated in MATLAB/SIMULINK. By P&O MPPT technique ,the duty ratio for boost converter is generated in MPPT block.

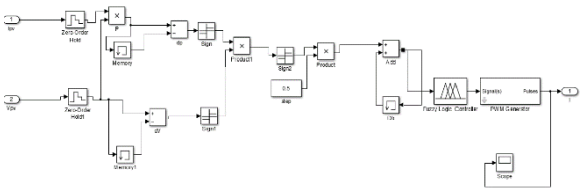


Matlab simulation of proposed system

V. PERTURBATION AND OBSERVATION

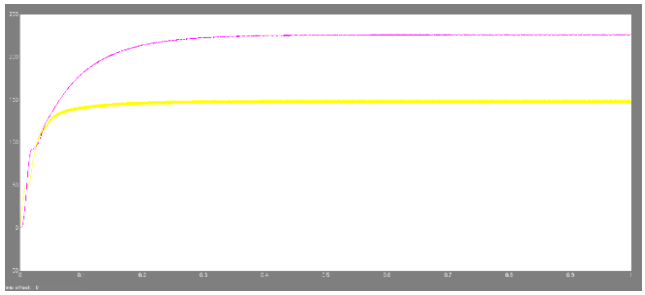


MPPT



Inside P&O MPPT block

VI.SIMULATION RESULTS



VIII.CONCLUSION

The photovoltaic panels are modeled and simulated in MATLAB/SIMULINK. The characteristics features of the panel were found and the effects of temperature and irradiance on the panel voltage and current were simulated and confirmed the good working of designed panel. To step up the voltage of the panels a boost converter is designed and connected to the panels. Different MPPT techniques are used to track maximum power. Incremental Conductance method and P&O based Fuzzy logic Control MPPT are implemented. The output power of the panels using two different methods is compared. It is found that the perturbation and observation based fuzzy logic control method is simple in implementation; incremental conductance method is very much similar to P&O method. It is observed that P&O based fuzzy logic control technique is quick in tracking the maximum power point than the IC method.

The entire PV system was simulated based on fuzzy logic MPPT algorithm and simulation results were verified. It is clear that the PV system becomes more efficient when MPPT controller with fuzzy logic is included in this system. By selecting number of membership functions, it has been proved the MPPT will follow exact MPP point , thereby overall efficiency of PV system can be improved.

REFERENCES

[1] M.S.Sivagamasundari,Dr.P.Melba Mary, V.K.Velvizhi " Maximum Power Point Tracking For Photovoltaic System by Perturb and Observe Method Using Boost Converter" IJAREEIE Vol. 2, Issue 6, June 2013

[2]M.G.Villalva, J.R. Gazoli, E. Ruppert F, "Comprehensive approach to modeling and simulation of photovoltaic arrays", IEEE Transactions on Power

[3]Krismadinataa*, Nasrudin Abd. Rahima Hew Wooi Pinga, Jeyraj Selvaraja "Photovoltaic module modeling using simulink/matlab".

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 8, March 2018

[4]Trishan Esram and Patrick L. Chapman, ―Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques‖ *IEEE Transactions On Energy Conversion,* Vol. 22, No. 2, June 2007.

[5]Hohm D, Ropp M. ―Comparative study of maximum power point tracking algorithms. Progress in photovoltaics‖ *Research and Applications* 2003;

[6]S.K. Kollimalla and M.K. Mishra, "Adaptive perturb amp; observe MPPT algorithm for photovoltaic system," in *Power and Energy Conference at Illinois (PECI), 2013 IEEE*, Feb 2013, pp. 42-47.

[7]G. Walker, "Evaluating MPPT Converter Topologies Using a Matlab PV Model," *J. Electr. Electron.Eng*., vol. 21, no. 1, pp. 49–56, 2001.Topologies Using a Matlab PV Model," *J. Electr. Electron.Eng.*, vol. 21, no. 1,pp. 49–56, 2001