Solar Battery Charging Fuzzy Logic

Ajai Varghese[1], Mithun Madhukumar[1], Mariya Sebastian[1]

[1] UG STUDENT, EEE, AMAL JYOTHI COLLEGE OF ENGINEERING, KERALA, INDIA

ABSTRACT

The use of Photovoltaic systems has increased due to its clean and renewable nature of energy and the necessity for its need in future. But, many reasons lowers the efficiency of a solar panel due to factors like solar insolation, clouds and shading effect. During cloudy weather due to varying insolation levels the output of the panel keeps varying. A maximum power point tracking algorithm is required to increase the efficiency of the solar panel as it has been found that only 30 to 40% of energy incident is converted into electrical energy. The design of DC-DC converter (Buck converter) helps in regulating the output of the panel thus improving the efficiency and the output voltage using proper control technique. This paper deals with the development of a fuzzy logic control for MPPT to track the maximum power point and also compensate for fluctuating power during cloudy weather. The simulation study and hardware implementation of the proposed circuit is carried out. For simulating the circuit MATLAB Simulink is used

Keyword : - *DGs, optimization, Non-Dominated Genetic Sorting Algorithm II, Multi-Objective Probabilistic Approach*

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1. INTRODUCTION

Solar power generated by solar or photovoltaic (PV) cells depends on the environmental conditions such as irradiations, sunlight incident angle, cell temperature, and load conditions. Power converters would be typically inserted between the PV cells and the load to control the power flow from the PV cells to the load. Many PV systems also employ some form of maximum power point tracking (MPPT) to maximize power output, with the MPPT function achieved through continuously adjusting the duty ratio command of the power switch in the power converter.

MPPT algorithms maximize power output by gradually increasing or decreasing the duty ratio of the power converter according to the PV cell output power versus the voltage curve or the current versus voltage curve. Commonly used MPPT techniques include the perturbing and observing method and the incremental conductance method, both methods using fixed step size for the increment of the duty ratio command. If the step size is too small, the tracking process would be slowed. If the step size is too large, then the system may fluctuate about the maximum power point (MPP). In order to automatically adjust step sizes, variable step sizing algorithms based on adaptive and artificial intelligent techniques such as fuzzy logic and adaptive neuro-fuzzy system were assessed. Fuzzy logic controllers are characterized by their ability to imitate human thinking. Unlike traditional controllers, fuzzy controllers are able to use empirical methods or professional knowledge to design variable step size increments of duty ratio command for the power converter even without having an understanding of the mathematical model of the plant. Design considerations and effectiveness of the fuzzy MPPT algorithm depend on the input and output variables selected for the system. The output variable of the fuzzy MPPT algorithm would usually be the duty ratio command of the power switch for the power converter. However, there would be a number of different MPPT algorithm input variables to choose from based on the characteristics of the PV cells. The most commonly used input variables for the MPPT algorithms would be the slope of the I VERSUS V CHARACTERISTICS shown in Fig.1. Photovoltaic cells have a complex relationship between their operating environment and the maximum power they can produce. The fill factor, abbreviated FF, is a parameter which characterizes the non-linear electrical behaviour of the solar cell. Fill factor is defined as the ratio of the maximum power from the solar cell to the product of Open Circuit Voltage Voc and Short-Circuit Current Isc.

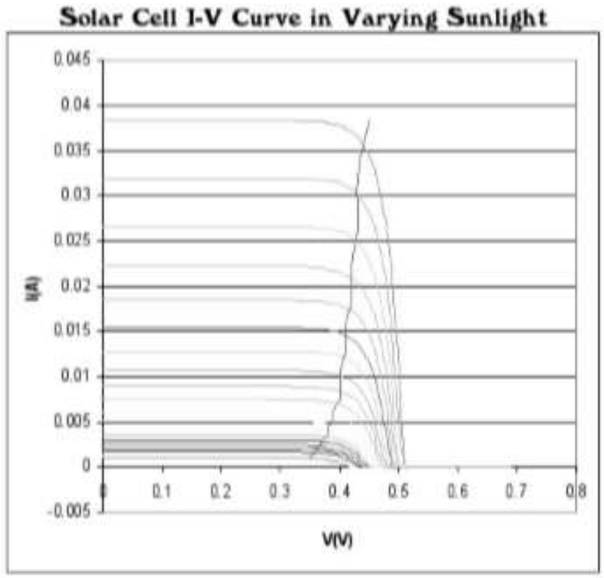

Fig.1 I-V Curve in varying sunlight

In tabulated data it is often used to estimate the maximum power that a cell can provide with an optimal load under given conditions, P=FF*Voc*Isc. (1) For most purposes, FF, Voc, and Isc are enough information to give a useful approximate model of the electrical behaviour of a photovoltaic cell under typical conditions. For any given set of operational conditions, cells have a single operating point where the values of the current (I) and Voltage (V) of the cell result in a maximum power output. These values correspond to a particular load resistance, which is equal to V / I as specified by Ohm's Law. The power P is given by P=V*I. (2) A photovoltaic cell, for the majority of its useful curve, acts as a constant current source. However, at a photovoltaic cell's MPP region, its curve has an approximately inverse exponential relationship between current and voltage. From basic circuit theory, the power delivered from or to a device is optimized where the derivative (graphically, the slope) dI/dV of the I-V curve is equal and opposite the I/V ratio (where dP/dV=0). This is known as the maximum power point (MPP) and corresponds to the "knee" of the curve. A load with resistance R=V/I equal to the reciprocal of this value draws the maximum power from the device. This is sometimes called the 'characteristic resistance' of the cell. This is a dynamic quantity which changes depending on the level of illumination, as well as other factors such as temperature and the age of the cell. If the resistance is lower or higher than this value, the power drawn will be less than the maximum available, and thus the cell will not be used as efficiently as it could be. Maximum power point trackers utilize different types of control circuit or logic to search for this point and thus to allow the converter circuit to extract the maximum power available from a cell.

2. MPPT IMPLEMENTATION

When a load is directly connected to the solar panel, the operating point of the panel will rarely be at peak power. The impedance seen by the panel derives the operating point of the solar panel. Thus by varying the impedance seen by the panel, the operating point can be moved towards peak power point. Since panels are DC devices, DC-DC converters must be utilized to transform the impedance of one circuit (source) to the other circuit (load). Changing the duty ratio of the DCDC converter results in an impedance change as seen by the panel. At a particular impedance (or duty ratio) the operating point will be at the peak power transfer point. The I-V curve of the panel can vary considerably with variation in atmospheric conditions such as radiance and temperature. Therefore it is not feasible to fix the duty ratio with such dynamically changing operating conditions. MPPT implementations utilize algorithms that frequently sample panel voltages and currents, then adjust the duty ratio as needed. Microcontrollers are employed to implement the algorithms. Modern implementations often utilize larger computers for analytics and load forecasting.

3. FUZZY LOGIC

Algorithm: P-V Slope and Variation of Slope as the Inputs

The fuzzy logic MPPT system used the slope of the -Voltage (P-V) curve (S (k)) and variation of slope (S (k)) as the fuzzy input variables. These variables were defined using the following equations:

S(k)=s(k)-s(k-1)

Figure 2 shows the database for fuzzy rules designed according to the fuzzy input variables. A five-term fuzzy set, positive big (PB), positive small (PS), zero (ZE), negative small (NS), and negative big (NB), is defined to describe each linguistic variable. Output from the fuzzy controller (duty ratio command of the buck converter) would change the output voltage and current of the PV cell. Once PV cell outputs change, it would affect the values of the next round of fuzzy input variables. The controller would then re-adjust the output commands accordingly. According to fuzzy logic, the selection of the domain of the inputs and outputs (universe of discourse) will also directly affect the results, so careful designs must be implemented. The general guidelines for determining the membership functions are: (1) defining the boundaries of the PB and NB regions first based the characteristics of the input variables; (2) the range of ZE is then determined based on the predetermined MPPT goal (efficiency criteria); (3) the boundaries of PM and NM are then determined following the selection of the boundaries of PB, NB, and ZE. Design iterations are usually required to reach a satisfactory result.

ΔS(K) \ S(K)	NB	NS	ZE	PS	PB
NB	ZB	NB	NS	ZE	PB
NS	NB	NS	ZE	ZE	PB
ZE	NB	NS	ZE	PS	PB
PS	NB	ZE	ZE	PS	PB
PB	NB	ZE	PS	PB	ZE

Fig.2 fuzzy rules

NB-negative big
NS-negative small
PB-positive big
PS-positive small

4. SIMULATION AND RESULTS

The simulations were done in the Matlab and the results were obtained.

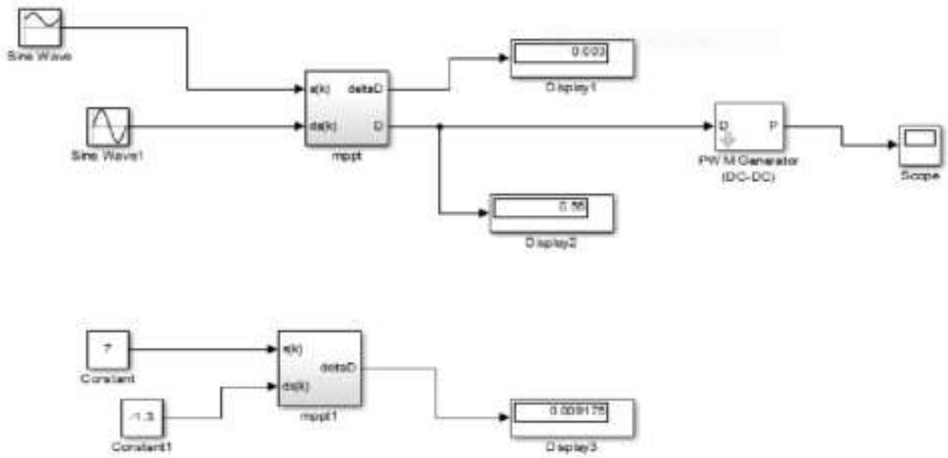

Fig5.1 Simulation using fuzzy

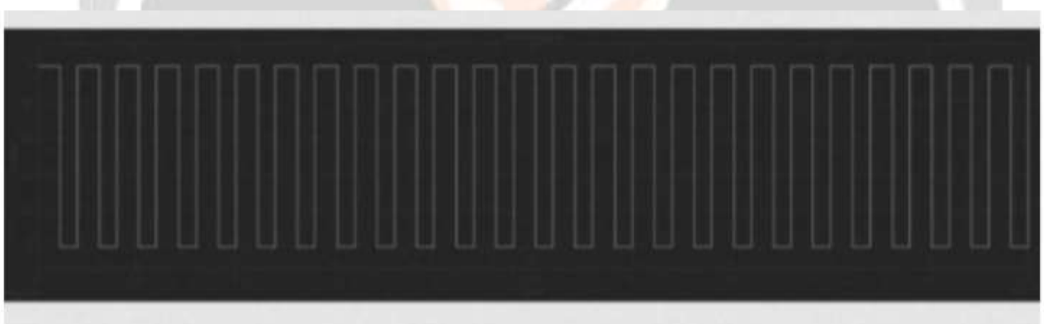

Fig5.3 PWM OUTPUT

5. CONCLUSIONS

This paper has presented the Fuzzy logic for controlling the MPPT of a PV system. The simulation results proves the system adapt to the Fuzzy parameters with fast response, good transient performance, insensitive to variations in external disturbances. In addition, the results of simulation and experiment have shown that MPPT controllers by using Fuzzy have provided more power than conventional. The speciality of the FLC is that the rule base is very simple which increases the speed of computation of the processor. Hence can track the MPPT very fast and accurately even if the environment abruptly.

6. REFERENCES

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