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# Design and Analysis of Fuzzy Logic Controller Based Solar PV System with Boost Converter

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**ABSTRACT**
In this project, another approach is anticipated for examination of tie-line management of grid connected solar system. Anticipated method depends on the management of power in tie-line. Presented method gives low stress on operation of custom-made topology for control. The working principle of described method is that the grid is developed by the solar system for the distribution of energy and tie-line control is developed with the help of two parameters viz. frequency and power. Usage of a boost converter (BC) for controlling the power of photovoltaic (PV) by Maximum power point technique (MPPT) is presented is presented here. Firstly the PV network is evaluated through simulink for the principle point and then the BC is deployed next to a MPP control device. The Maximum power point technique is accountable for finding the utmost power from the PV and give it, by using BC, to the load which in turn increase the voltage to the desired level. Different types of MPPT techniques like P&O which is a conventional method is implemented. To overcome the issues obtained by implementing P & O based MPPT, this paper has proposes Fuzzy Logic Controller based MPPT technique. The key factor is to track the utmost point of power of the PV module with the objective to obtain supreme plausible power. The simulation results of this proposed system can be evaluated by using Matlab/Simulink Software.
Keywords: Boost converter, MPPT, Photovoltaic, grid, fuzzy logic controller, and Perturb & Observe control.

## I. INTRODUCTION

The most important sustainable power source is solar energy. Energy from the sun is ideal compared to common non-sustainable resources like fuel, coal, and so on free and without bounds. The popularity of photovoltaic systems (PV) is growing as the price of crude oil rises and the global market becomes more volatile. Additionally, as the green peace movement and awareness of humanity have grown in relation to effective power vitality, PV—which is typically derived from solar energy—could be a solution for cleaner and better energy. The PV provides one of the most effective ways to generate energy with a realistic perspective taking into account the actual situation of the dated resources of power. Typically, a photovoltaic system that is connected directly to the load only occasionally operates at MPP. In order to connect the DC source to the DC Converter at the PV, which produces the point of maximum power, the photovoltaic cluster directs the DC source that needs to be properly trained. This allows for the discovery of the maximum power available for a particular protection level.

The mppt is used to transfer the maximum amount of power from the solar PV module to the load. Dc-dc converters are used to connect loads to power because they efficiently transfer the most power from PV solar modules to the load. The dc-dc converter acts as a barrier between the load and the PV system, shifting and coordinating the duty cycle of the load's impedance as seen by the source in order to transmit the maximum amount of power. In order to get the most power out of a photovoltaic system, mppt strategy is required. In the PV framework, maximum power point tracking is used to increase the PV cluster power output, which is independent of temperature, radiation conditions, and dc-dc converter configurations.

The remaining paper is organised as follows. The system description is described in section II, proposed system of the project is described in section III, results and discussion is described in section IV, conclusion and references are described in section V and VI.

## II. SYSTEM DESCRIPTION

The rest of the document is structured as follows. Section II provides a description of the system, Section III provides a description of the project's proposed system, Section IV provides a description of the results and discussion, and Sections V and VI provide a description of the conclusion and references.

$$I = I_{ph} - I_o \left[ e^{q\left(V + I.\frac{Rs}{\alpha kT}\right)} \right] - \left( \frac{V + I.Rs}{Rp} \right) \quad (1)$$

Here:

- V and I are PV voltage and current.
- $R_s$ and Rp are the cell series and parallel resistances.
- q Is the charge on electron.
- $I_{ph}$ is the current developed from light
- The reverse saturation current is Io and is a constant.
- K is the Boltzman constant, and $T_k$ is the temperature in $_o$K.

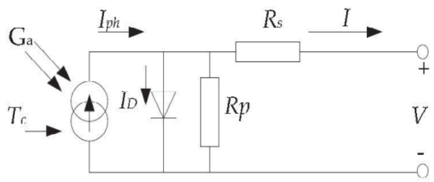


Fig. 1. PV array equivalent network

In simulations, expression (1) is used to derive the characteristics of the solar cell output, as shown in Fig. 2. This curve unequivocally demonstrates the non-linear output characteristics of a solar cell and their significant dependence on solar radiation, temperature, and load conditions [2, 5]. Each curve has a MPP where the solar array performs at its best.

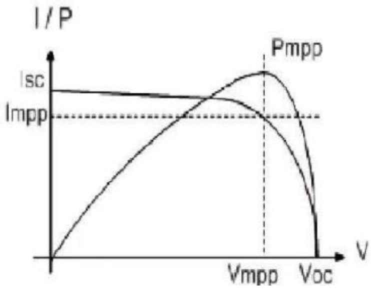


Fig. 2. I/P-V solar cell characteristic

### A. STEP-UP CONVERTER

The step-up type converter is a DCDC power converter that lowers current while increasing input voltage. It is a type of switched-mode power supply (SMPS) that includes two semiconductor devices and either a capacitor, inductor, or a combination of the two as an energy storage element. Capacitive filters are typically added to the supply side input filter and converter output to reduce voltage swell.

As power increases, it signals that the MPP is now the area of operation; as a result, the working voltage must also be adjusted in the same direction. Otherwise, if the PV cluster's output is reduced, the working point and MPP will be further away, necessitating a change in operating voltage [6].

The solar voltage is occasionally increased or decreased by the MPP hunter. If a particular perturbation causes the photovoltaic system's power output to increase (decrease), the ensuing perturbation will then be produced in the opposite (opposite) direction.

## III. Proposed system

Fuzzy logic controllers are used in a variety of renewable energy applications (FLC). Because of its ease of use, FLC has gained in popularity over the previous decade. FLC also handles bad input, removing the requirement for the controller to use a precise mathematical model. In order to acquire the greatest power from PV modules, FLC can simply manage nonlinearity problems. It can function in any weather, with any temperature or irradiance variation.

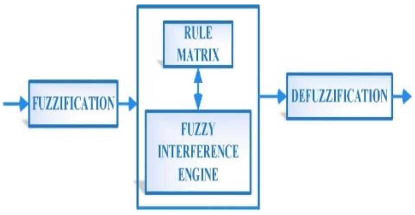


Fig.3. the Stages of Fuzzy Logic controller

There are three types of fuzzy logic controller processes:

1. Fuzzification
2. Rule Evaluation
3. Defuzzification

The first form of fuzzification allows crisp input, such as fluctuations in input voltage values. It uses the stored membership function to convert Crisp Input to Fuzzy Input. When the fuzzy values are designed, the first stage of FLC, fuzzification, occurs.

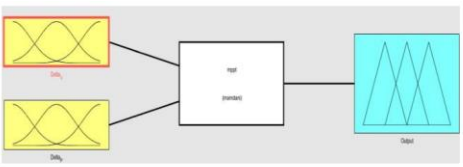

Fig.4. the FLC

The second type of Fuzzy logic controller is rule evaluation. During rule evaluation, the fuzzy processor is utilised to determine the controlling action that occurs during the response delivered to the set of input values. The Rule Evaluation gives a fuzzy output for each action. The last category in the fuzzy logic controller process is the Defuzzification Technique. The fuzzy value is turned to a crisp value during defuzzification. The crisp value from the fuzzy set is always the intended value of the output. Each fuzzy output variable in relation to the output membership function for each input set is effectively modified by the FLC Process. The centre of gravity (COG) methodology, often known as the centroid method, is the most commonly used defuzzification procedure. The Fuzzy logic controller is employed in the MPPT controller in this project, which is related to the P&O algorithm. FLC involvement in MPPT increases output voltage, and creating a Fuzzy Logic Controller that does not require much awareness of the model's specific requirements is relatively straightforward. The rule must only be assigned to each set of the membership function.

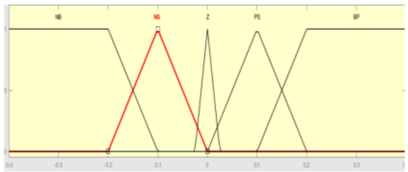

Fig.5. Membership function of input Variable Delta_P

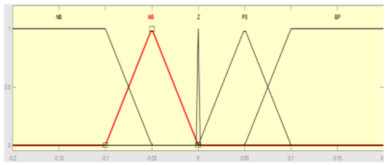

Fig.6. Membership function of input Variable Delta_V

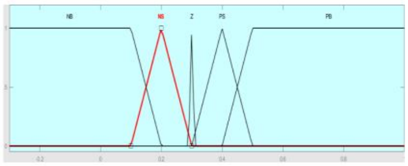

Fig.7. Membership function of Output Variable Delta_Y

| ΔV \ ΔP | NB | NS | Z | PS | PB |
|---|---|---|---|---|---|
| NB | PB | PS | NB | NS | NS |
| NS | PS | PS | NB | NS | NS |
| Z | NS | NS | NS | PB | PB |
| PS | NS | PB | PS | NB | PB |
| PB | NB | NB | PB | PS | PB |

Table-1 Rule based in FLC

This paper introduces a novel method for constructing an MPPT for a PV module under unknown conditions. After implementing this method, the fluctuation around the Maximum PowerPoint is decreased. This technique outperforms the straightforward P&O algorithm Approach. Variations in PV module voltage (Delta V) and changes in PV module power are sent into the Fuzzy logic controller (Delta P). The fuzzy logic controller's output is delta Y. The fuzzy logic controller's output is delta Y. The output of the Fuzzy logic controller is fed into the sampling signal, which is altered and sent to the boost converter, which provides the switching pulses.

## IV. Simulation results and discussion

**Simulation results by using P&O MPPT Controller**

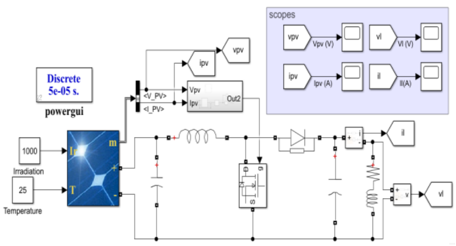


**Fig. 8.Schematic diagram**

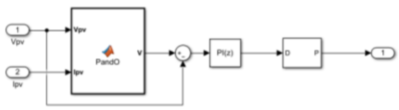


**Fig.9. Controller**

**At input Vpv=400V rating based**

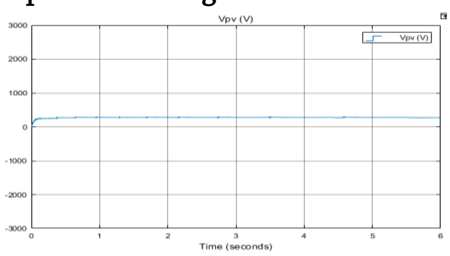


**Fig.10. PV voltage**

The above figure depicts the voltage of photovoltaic array by using P&O MPPT controller at the input of 400V.

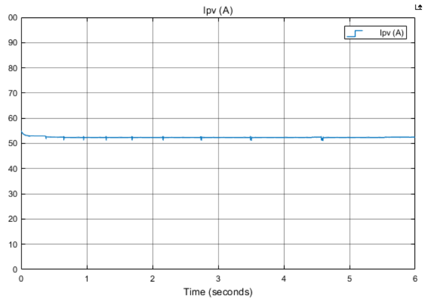


**Fig.11. PV current**

The above figure depicts the current of photovoltaic array by using P&O MPPT controller at the input of 400V.

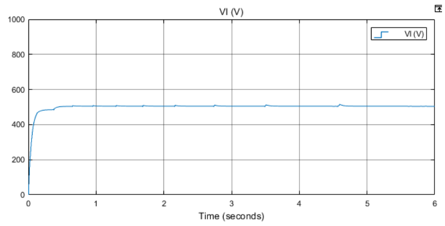


**Fig.12. Load voltage or DC voltage**

The above figure depicts the load voltage by using P&O MPPT controller

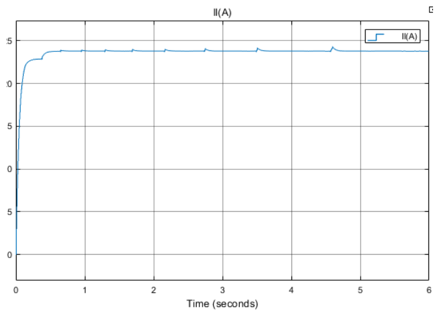


**Fig.13.Load current or DC current**

The above figure depicts the load current by using P&O MPPT controller

**At input Vpv=450V rating based**

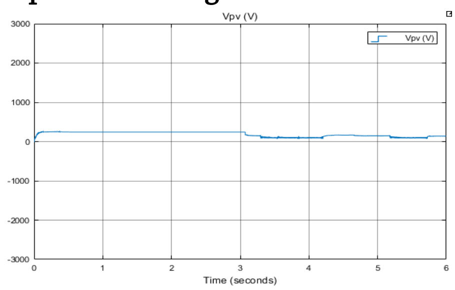


**FIG.14. PV voltage**

The above figure depicts the voltage of photovoltaic array at the input of 450V by using P&O MPPT controller

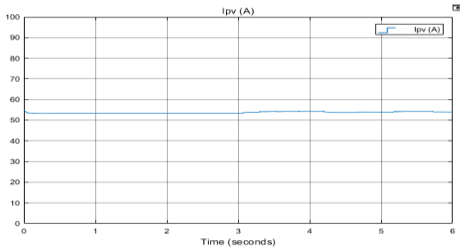


**Fig.15. PV current**

The above figure depicts the current of photovoltaic array at the input of 450V by using P&O MPPT controller

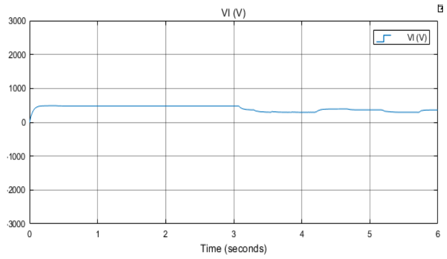


**Fig.16. Load voltage or DC voltage**

The above figure depicts the load voltage by using P&O MPPT controller

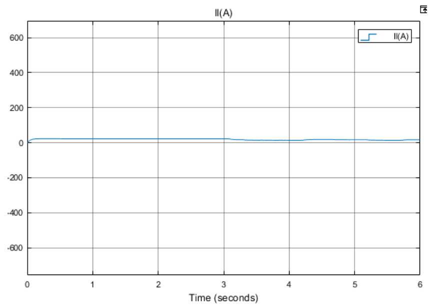


**Fig.17. Load current or DC current**

The above figure depicts the load Voltage by using P&O MPPT controller

**Simulation results by using FLC Controller:**

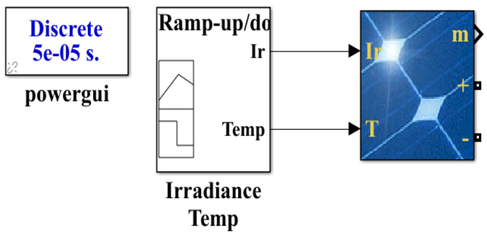


**Fig.18. Schematic diagram**

**Irradiation at 1000**

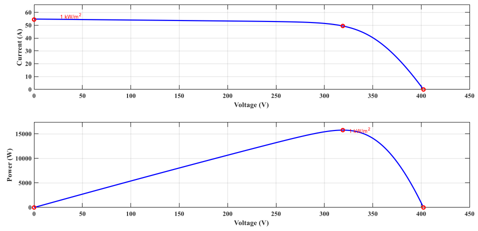


**Fig.19. I-V curve and Power-Voltage graph**

The above Figure shows the I-V and P-V characteristics of the maximum power point of the single cell at 1000 irradiation

**Irradiation at 800**

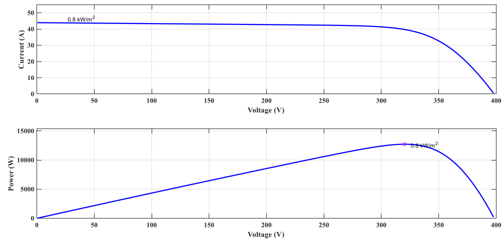


**Fig.20. I-V curve and Power-Voltage graph**

The above Figure shows the I-V and P-V characteristics of the maximum power point of the single cell at 800 irradiation

**Irradiation at 600**

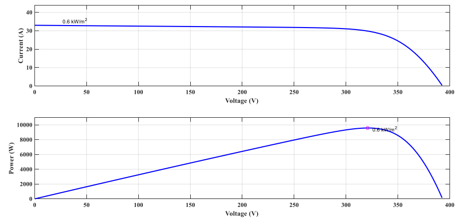

**Fig.21. I-V curve and Power-Voltage graph**

The above Figure shows the I-V and P-V characteristics of the maximum power point of the single cell at 600 irradiation

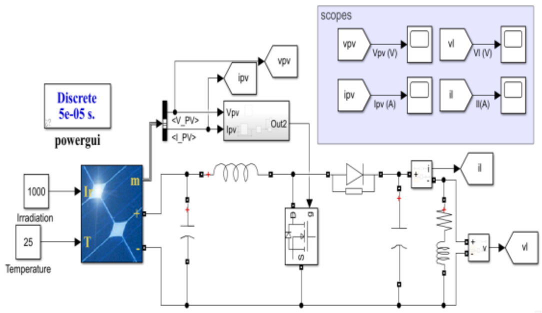


**Fig.22. Schematic diagram**

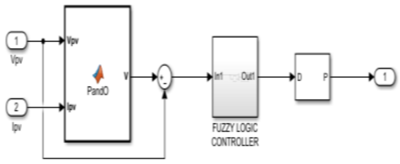


**Fig.23. Controller**

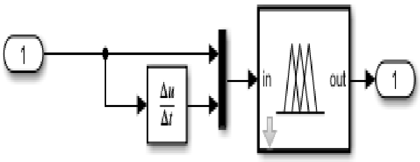


**Fig.24. Fuzzy logic controller**

**At input Vpv=400V rating based**

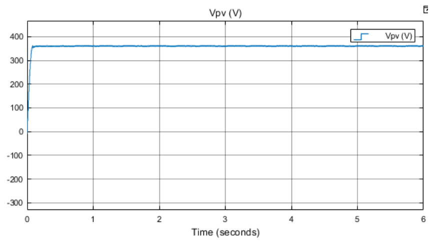


**Fig.25. PV voltage**

The above figure depicts the voltage of photovoltaic array by using fuzzy logic controller at 400V of input voltage

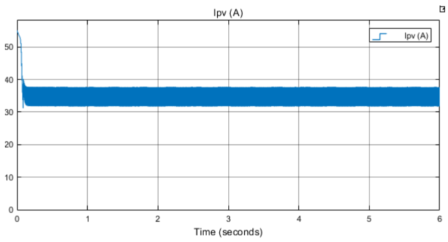


**Fig.26.PV current**

The above figure depicts the current of photovoltaic array by using fuzzy logic controller at 400V of input voltage

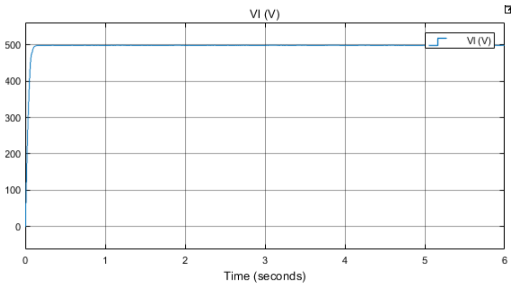


**Fig.27. Load voltage or DC voltage**

The above figure depicts load voltage by using fuzzy logic controller

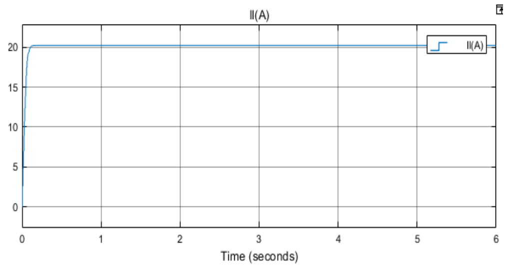


**Fig.28. Load current or DC current**

The above figure depicts load voltage by using fuzzy logic controller

**At input Vpv=450V rating based**

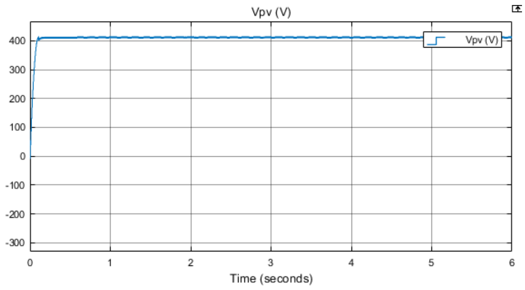


**Fig.29. PV voltage**

The above figure depicts the voltage of photovoltaic array by using fuzzy logic controller at 450V of input voltage

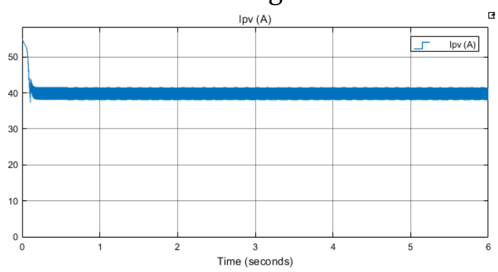


**Fig.30. PV current**

The above figure depicts the voltage of photovoltaic array by using fuzzy logic controller at 400V of input voltage

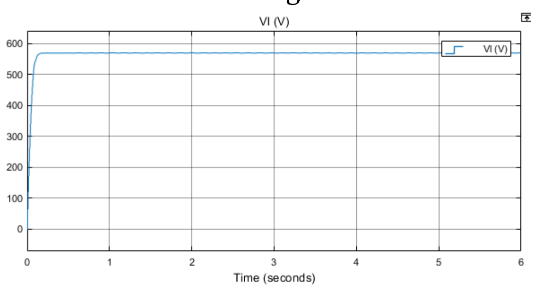


**Fig.31. Load voltage or DC voltage**

The above figure shows the load voltage by using fuzzy logic controller

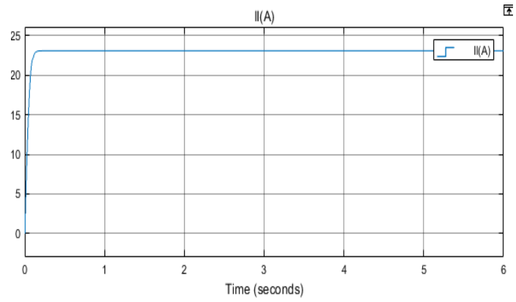


**Fig.32. Load current or DC current**

The above figure shows the load current by using fuzzy logic controller

## V. Conclusion

This paper has proposes Fuzzy Logic Controller based MPPT technique has been done. From the PV hypothesis, a mathematical representation of the Photovoltaic is introduced. Thereafter, the PV structure with resistive load, DC-DC converter and MPP controller have been implemented. At last, the simulation of network has been done with MATLAB. Firstly, the simulation of panels of PV indicates that the models simulated were precise to decide the attributes of voltage current on the grounds that the current voltage qualities are equivalent to the qualities revealed in the information sheet. Also, while the sunlight or else its temperature fluctuates, the Photovoltaic voltage and current output changes. At that point, the simulation indicates that P&O calculation can follow the fuzzy logic based MPPT of the PV as it generally runs at utmost power regardless of the condition of operation. The outcomes indicated that the P&O calculation gives a precision of nearly 100% in consistent state.

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