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Performance Enhancement by Maximum Power-Point Tracking Techniques With MATLAB/Simulink of Solar Photovoltaic model

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***Abstract*- In this work we present the characteristics of a solar module. The results show that the maximum power generated depends on the intensity of the sun and the temperature radiation. The module provides the maximum available power must constantly adapt to the load with the PV generator. This adaptation can be achieved by inserting a DC-DC converter controlled by a tracking mechanism "Maximum Power Point Tracking" (MPPT). We also present a study on the DC-DC converters and MPPT control to find the point where the power of the PV generator is maximum. In this paper, we presented briefly some techniques of MPPT control as the increment of inductance algorithm, perturbation observation, neural networks, fuzzy and the neuro fuzzy logic and the control by a microcontroller.**

Keywords: Photovoltaic Energy, MPPT, Boost converter , (P & O) controller, Matlab simulink.

I. Introduction

Renewable energy, and in particular power generation from solar energy using Photovoltaic (PV) has emerged in last decades since it has the aforesaid advantages and less maintenance, no wear and tear. The main applications of PV systems are in either stand-alone systems such as water pumping, domestic and street lighting, electric vehicles, military and space applications [2-3] or grid-connected configurations like hybrid systems and power plants [4].

A. *Deferent Types Of Photovoltaic Systems*

PV systems are classified into two broad categories according to the way energy is used:
- Systems connected to the grid.
- Isolated and autonomous systems.

1. The grid Photovoltaic power systems

Photovoltaic generator connected to the network does not need energy storage and eliminates a standalone installation the most problematic link (and more expensive). This is actually the whole network that serves energy reservoir. Two energy meters are needed: a counter counts the purchased provider of energy and other energy meter energy returned to the grid when production exceeds consumption measurement [9] [11].
A third counter is added in the case where the energy produced is injected into the network in entirety (non-consumption meter). [1]

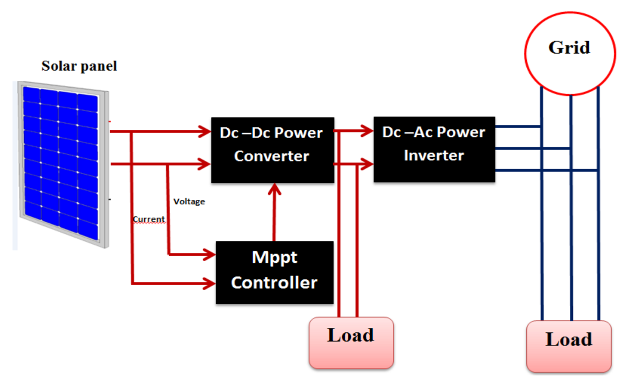

Fig 1. Components of a typical on-grid PV system

2. *Autonomous photovoltaic electrical installations*

Photovoltaic panel (1) can provide the necessary electrical energy directly to the receivers (lighting and household equipment) function. A control system (2) and a battery (3) to allow batteries to store electrical energy which is used in the sun are absent. The batteries are used to store electrical energy in chemical form. They restore the electric power needed by its characteristics. The charge controller (2) is primarily to protect the battery against overload and deep discharge function. It is essential for the life of the battery. In isolated, one can also use receivers operating on alternating current (6). In this case, the facility will include a UPS (4). We can give some examples of autonomous systems, such as beacons at sea, urban streetlights, solar pumping and houses isolated sites.

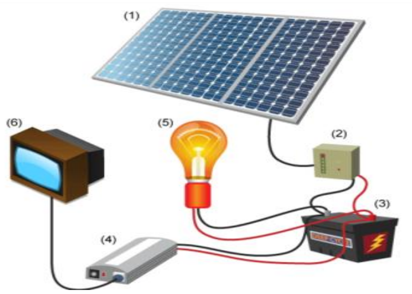

Fig 2. Installations off isolate, photovoltaic

2. The inverter

- It converts direct current into alternating current,
- It is to find the circuit breaker which cuts power to the ERDF network, only the AC part.

3. Solar charge controller

The controller is an essential complement to the solar system for automatically controlling the battery and avoids overcharging. The connection is made between the solar panels and batteries.

4. Battery

The battery clamp to store energy. There are three types of batteries:

- Lead-acid batteries, the most economical, they require regular maintenance (approximately every 6 months).
- The GEL Batteries, They have the advantage of avoiding any risk of discharge, they need less maintenance.
- The AGM batteries, they have slightly higher maximum intensities to GEL batteries. Its performance will be slightly better. In addition, they are more tolerant to errors.

5. PV-panels

A photovoltaic panel is a device for using sunlight to generate electricity.

6. breaker

Circuit breakers are used to protect the system from short circuits and power surges. They are placed in front of the facility and the differential switch, which is designed to protect people.

B. DC / DC converter

The most important parameter of the buck-boost converter is its chopping ratio Y that depends on the duty ratio D through a nonlinear relation given by:

$$Y = \frac{D}{1-D}$$

This converter is inserted between the PV generator and the DC motor to match the PV generator output characteristics to the DC motor input characteristics.

Assuming the converter is ideal, then its input and output powers are equal resulting in the following relation [5][6]:

$$\frac{E_a}{V_{gm}} = \frac{I_{gm}}{I_a} = \frac{D}{1-D}$$

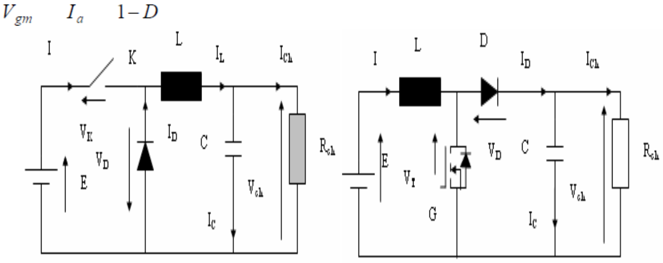

Fig 3. DC/DC Converter (Buck and boost Type)

C. MPPT Control Algorithm

Many MPPT techniques have been proposed in the literature; examples are the Perturb and Observe (P&O), Incremental Conductance (IC), Fuzzy Logic, and so forth. The P&O algorithm is very popular and simple [10].

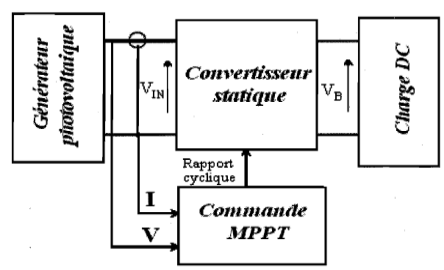

Fig 4. PV System with Power Converter and MPPT Control

1. Incremental inductance algorithm

In that the derivative of the output power of the panel is calculated algorithm otherwise. It is calculated based on the voltage difference dV and V and current I and dI difference. This derivative is zero at the maximum power point, positive left point MPP and negative right [4, 8].

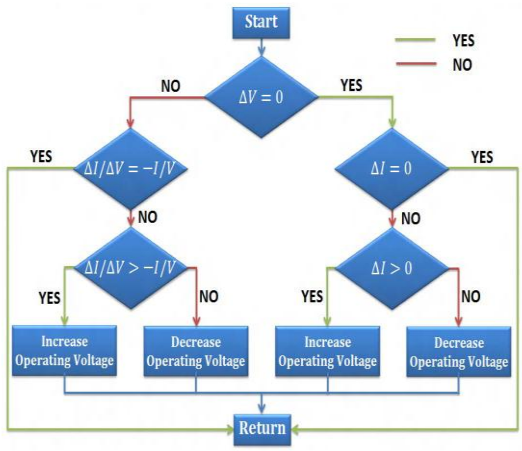

Fig 5. : Organigram of Incremental inductance algorithm

1. Perturbation and observation (P & O)

In this algorithm a slight perturbation is introduced to the system. Due to this perturbation the power of the module changes. If the power increases due to the perturbation then the perturbation is continued in that direction. After the peak power is reached the power at the next instant decreases and hence after that the perturbation reverses. When the steady state is reached the algorithm oscillates around the peak point. In order to keep the power variation small the perturbation size is kept very small as shown in fig. 11 [13], [14], [15]

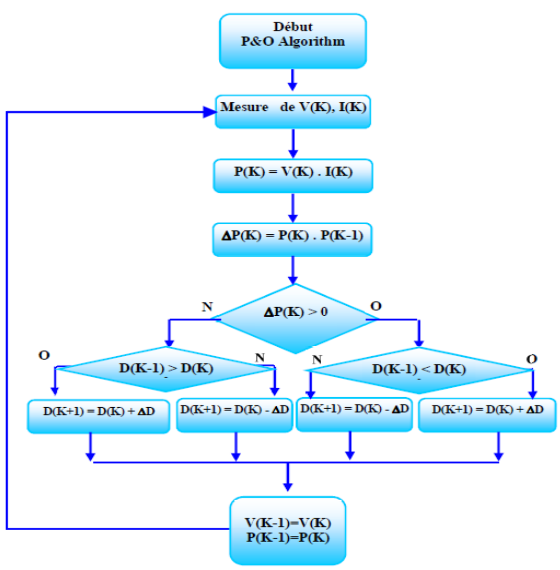

Fig 6. Organigramme of perturbation and observation method

2. MPPT control by neuronal networks:

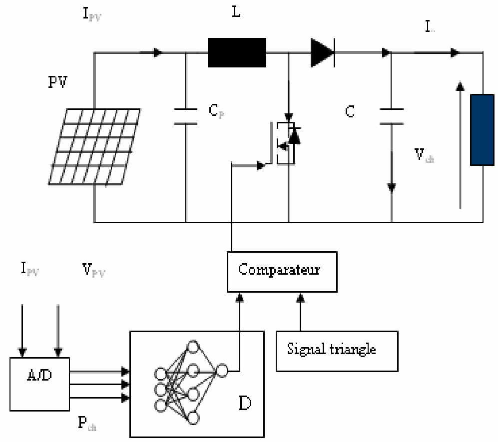

Fig 7. Architecture of neural networks control

3. MPPT control by fuzzy logic

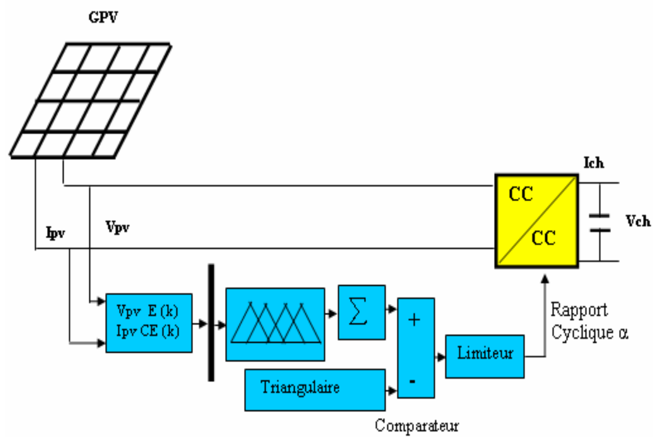

Fig 8. Architecture of fuzzy logic control

4. MPPT control by neuro fuzzy logic method:

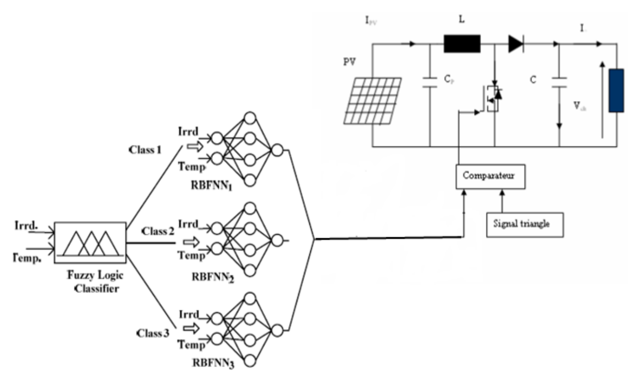

Fig 9. Architecture of the Neuro–fuzzy network

5. *Mppt control by Microcontroller (PIC)*

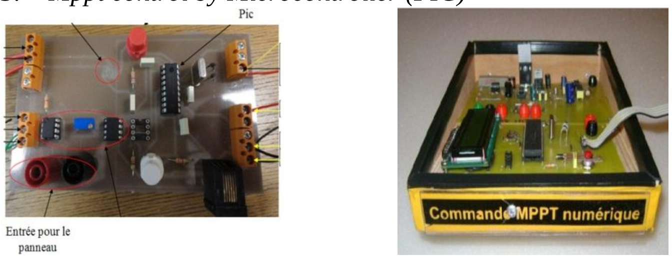

Fig 10. Mppt control by Microcontroller (PIC)

D. *photovoltaic module:*

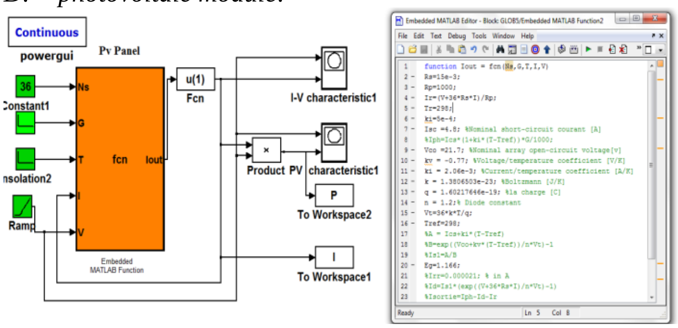

Fig 11. PV Module Model in Simulink

Parameter	Value
Maximum Power	**60W**
Tension at Pmax	**17.1 V**
Current at Pmax	**3.5A**
Open Circuit Voltage Voc	**21.1V**
Short Circuit Current Isc	**3.8A**

Table I. The parameters of a single solar cell

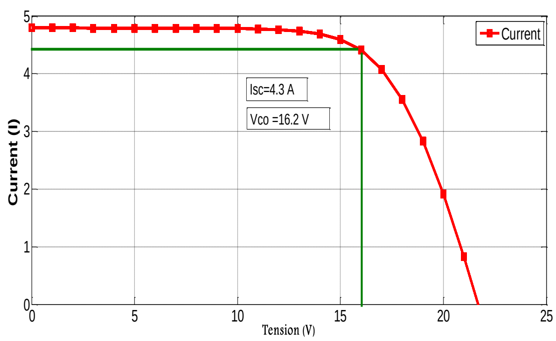

Fig 12. V-I characteristic curve of PV array simulation

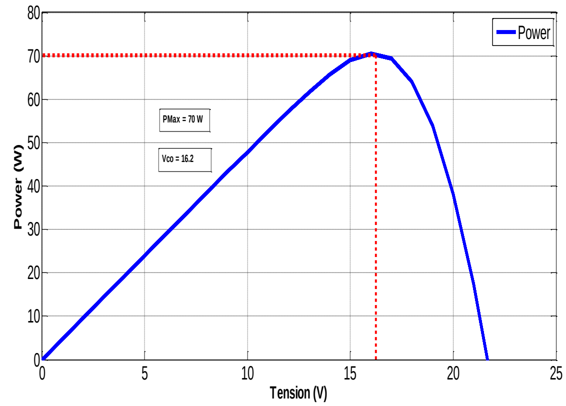

Fig 13. P-V characteristic curve of PV array simulation

1. *Effect Of Variation Of Solar Irradiation*

The P-V and I-V curves of a solar cell are highly dependent on the solar irradiation values. The solar irradiation as a result of the environmental changes keeps on fluctuating, but control mechanisms are available that can track this change and can alter the working of the solar cell to meet the required load demands. Higher is the solar irradiation, higher would be the solar input to the solar cell and hence power magnitude would increase for the same voltage value. With increase in the solar irradiation the open circuit voltage increases. This is due to the fact that, when more sunlight incidents on to the solar cell, the electrons are supplied with higher excitation energy, thereby increasing the electron mobility and thus more power is generated [7] and [10].

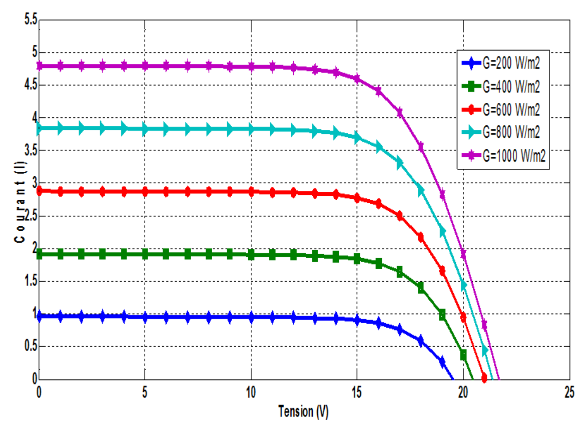

Fig.14. V-I Characteristics of a PV cell at constant temperature (25°C) and various irradiation levels

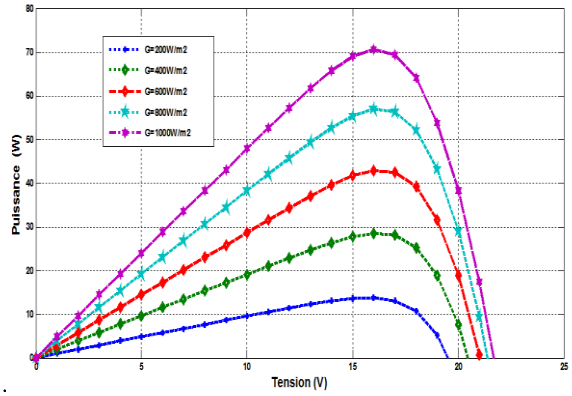

Fig.15. V-P Characteristics of a PV cell at constant temperature (25°C) and various irradiation levels.

2. Effect of variation of temperature

On the contrary the temperature increase around the solar cell has a negative impact on the power generation capability. Increase in temperature is accompanied by a decrease in the open circuit voltage value. Increase in temperature causes increase in the band gap of the material and thus more energy is required to cross this barrier. Thus the efficiency of the solar cell is reduced [7] and [10].

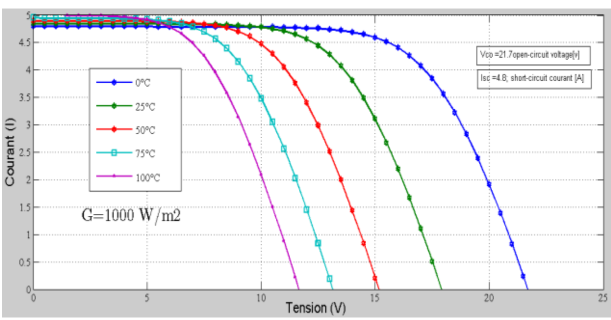

Fig.16. V-I Characteristics of a PV cell at constant irradiation level and various temperatures.

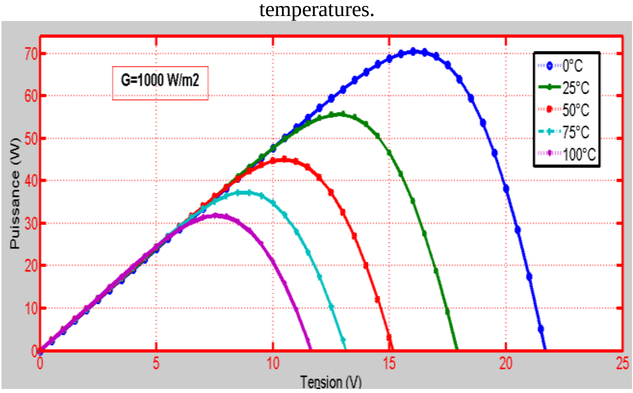

Fig.17. V-P Characteristics of a PV cell at constant irradiation level and various temperatures.

II. Simulation Results

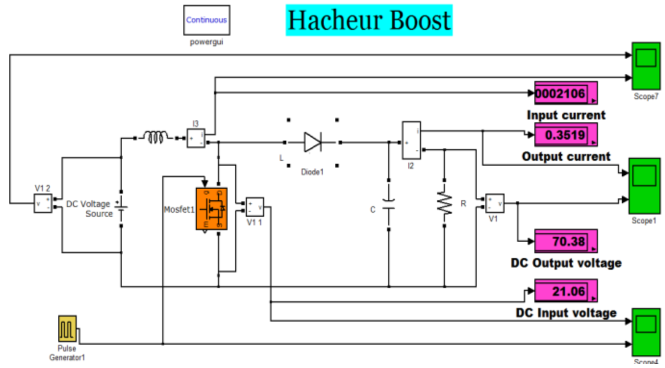

Fig 18. Block Simulink of Hacheur Boost

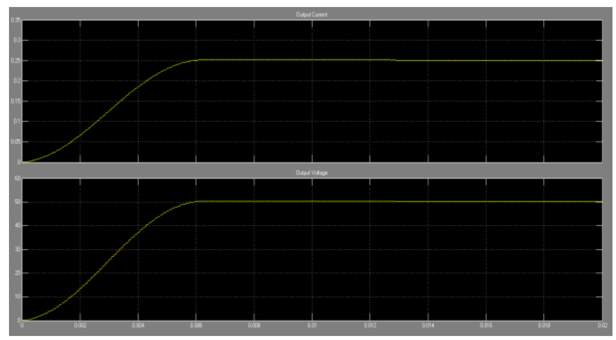

Fig 19. Simulation Results for Output current and Output Voltage

1. Overall system (GPV inverter – MPPT - load)

Fig.27 shows the block diagram Simulink PV system adapted by the MPPT "perturbation and observation" command.

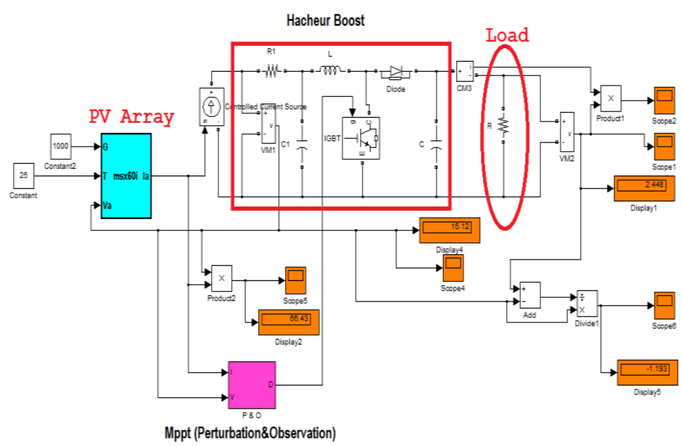

Fig 20. Model with P&O algorithm

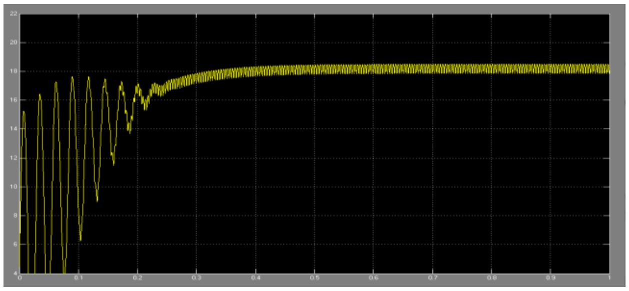

Fig 21. Simulation Results for input Voltage

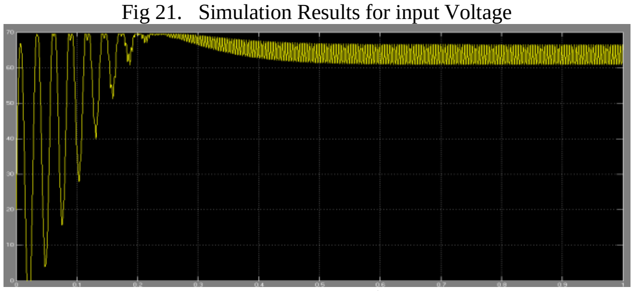

Fig 22. Simulation Results for input Power

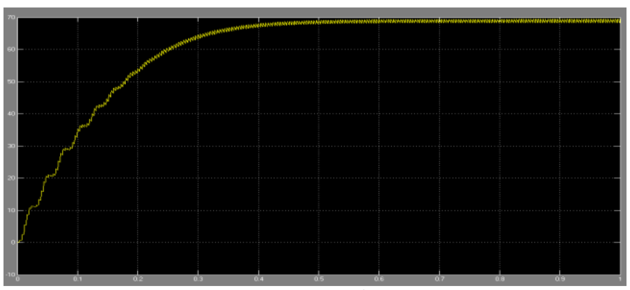

Fig 23. Simulation Results for output Voltage

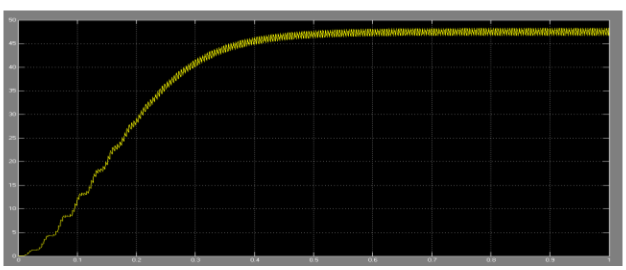

Fig 24. Simulation Results for output Power

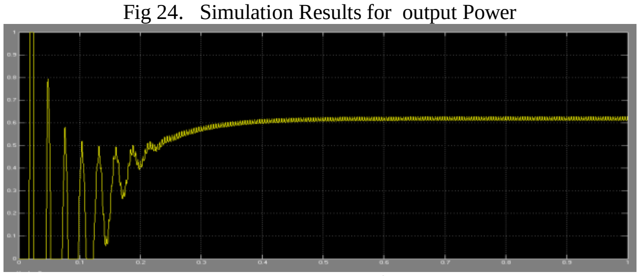

Fig 25. Simulation Results for Duty cycle

III. CONCLUSION

The work we presented focuses on the analysis of modeling and simulation of electrical operation of a photovoltaic (PV) system adapted by a digital command (MPPT) ensuring the continuation of the maximum power supplied by the PV generator. PV generator performance degrades with increasing temperature, the decrease in light intensity and load variations. The performances of the PV generator are evaluated using standard conditions: temperature 25 ° C. Illumination Artificial intelligence techniques such as fuzzy logic, neural networks and neuro-fuzzy for the converter control networks.

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