



Improvement of the MPPT by applying the “Perturb and Observe” method

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ABSTRACT

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In this work, we analyse the modelling and simulation of the electrical operation of a photovoltaic (PV) system with a numerical control 'perturb and observe' function to ensure tracking of the maximum power provided by the PV generator. Our analysis proposes a system comprising a PV panel, a boost converter and a 'perturb and observe' command. The panel provides a maximum power output of 60 W. Simulation results using Matlab/Simulink demonstrate the system's ability to maintain the panel's maximum power output to the load in the event of temperature, irradiation or load variations.

1. INTRODUCTION

This Most of the electrical energy produced in the world comes from the use of fossil fuels such as oil, coal, natural gas and nuclear energy.

These resources are becoming increasingly scarce, while the energy demands of the world are constantly rising. [1-2]

Given that this form of energy covers a large part of current energy production, it is necessary to find another alternative; the constraint imposed is to use an economical and low-polluting source of energy because the protection of the environment has become an important point. [3-4]

There are several renewable energy sources, hydroelectric energy, geothermal energy, biomass energy, wind energy and photovoltaic energy. The main advantage of these energies is that their use does not pollute the atmosphere and they do not produce greenhouse gases, which warm the earth. [5-6]

Photovoltaic energy is a possibility of efficient and sustainable development, which is why scientific research is developing in the direction of generalizing, improving and optimizing the operation of photovoltaic systems. [7-8-9]

The optimization of photovoltaic systems is based on sizing criteria and maximization of the power generated to have a good yield

For a photovoltaic installation, the variation of the illumination or the load induces a variation of the power supplied by the photovoltaic generator; in addition the latter does not supply the optimum power. [10-11-12]

In this context, research is committed to inventing systems to always recover the maximum amount of energy, this is the principle called 'Maximum Power Point Tracker' (MPPT). [13-14-15]

We are interested in the study and optimization of the operation of a photovoltaic system by the 'Perturb and Observe' method, widely used for their simplicity of integration and their efficiency. [16-17]

2. Proposed GPV photovoltaic system

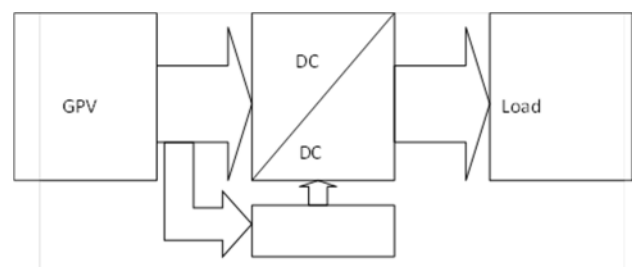


Fig 1. Block diagram of a photovoltaic system GPV, converter (DC/DC), control (MPPT).

The block diagram in Fig 1 shows a typical GPV system, it includes:

- The PV generator consists of 36 elementary photovoltaic cells.

It can deliver an optimal power of 60 W ($I_{opt}=3.5A$, $V_{opt}=17.1V$).

- The adaptation stage is a 'boost' type DC-DC converter.

- The MPPT control (Maximum Power Point Tracking), is the control block of the PV system which makes it possible to seek the optimal operating point of the PV generator, this point depends on the weather conditions and the variation of the load. Its operating principle is based on the automatic variation of the cyclic ratio α of the chopper so as to continuously have the maximum power at the output of the PV panel.

3. System simulation (GPV, converter, MPPT, load) AND results

For the photovoltaic generator to provide its optimal power, it must be equipped with an adaptation stage which has the role of seeking automatically and continuously the maximum power point (PPM) of the PV generator and this weather conditions (sunshine, temperature) or load variation

The current generated by the GPV unit is injected into the converter which supplies the load.

The voltage and current of the GPV are measured by the MPPT block to deduce the duty cycle which drives the switch (Transistor IGBT).

The electrical circuit parameters are as follows:

$C_e=2mF$; $R_L=2\Omega$; $L=10mH$; $C_s=3mF$; $R_{ch}=40\Omega$; $T=4ms$

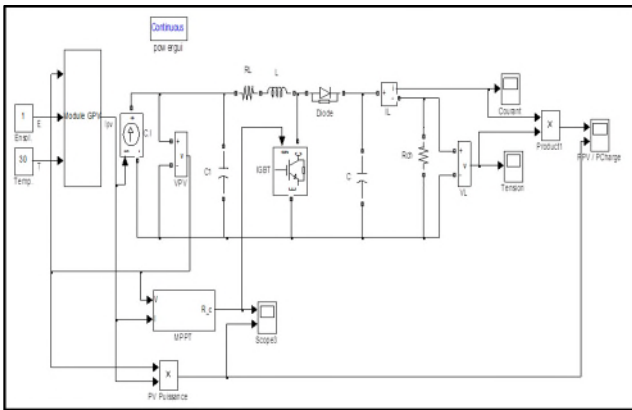


Fig 2. GPV System Simulation, Boost Converter, MPPT, Charge

4. SIMULATION RESULTS

The following figures present the simulation results in different cases.

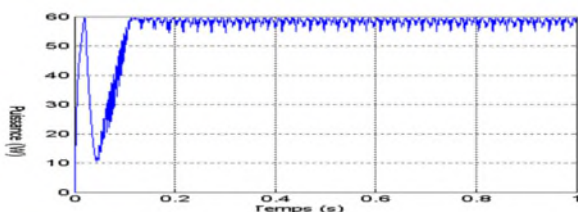


Fig 3: Power GPV (W)

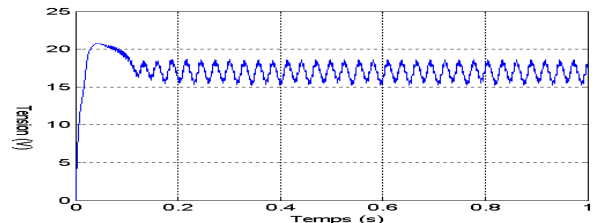


Fig 4 : Voltage GPV(V)

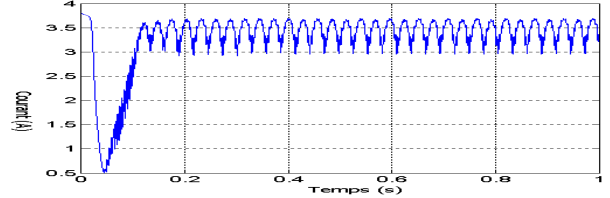


Fig 5: Current GPV (I)

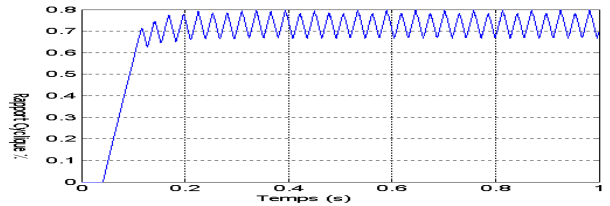


Fig 6: Duty cycle from MPPT

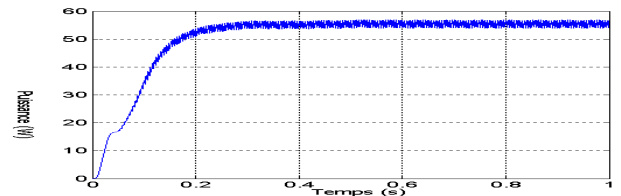


Fig 7 : Load power.

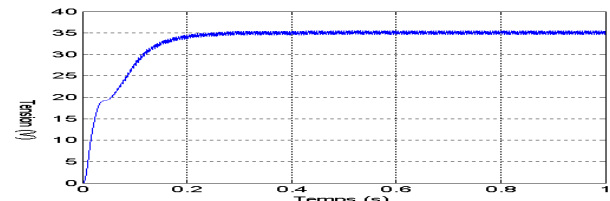


Fig 8 : load voltage.

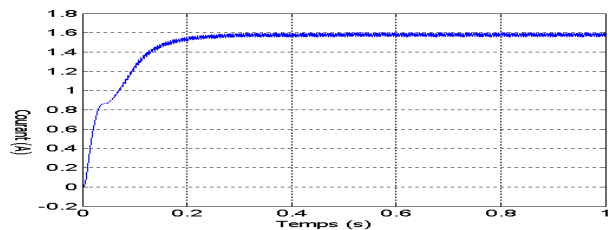


Fig 9 : Load current

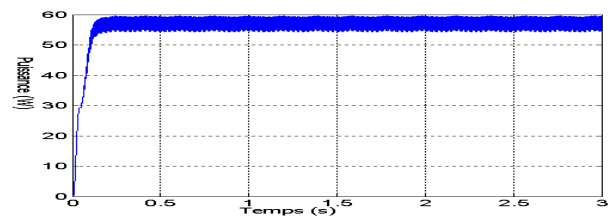


Fig 10: Output power for 20Ω load

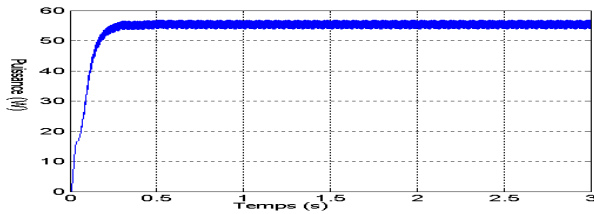


Fig 11: Output power for 40Ω load

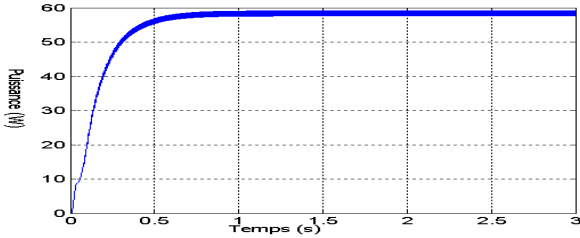


Fig 12: Output power for 80Ω load

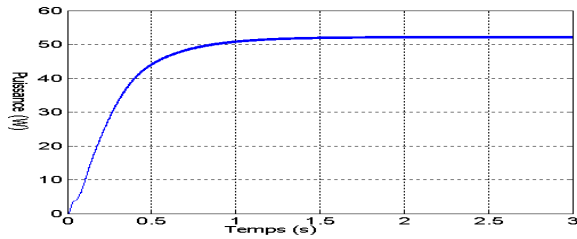


Fig 13: Output power for 200Ω load.

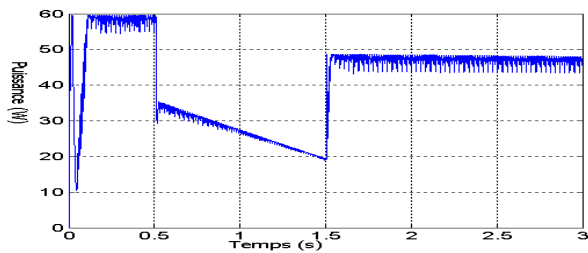


Fig 14 : GPV power for variable luminance.

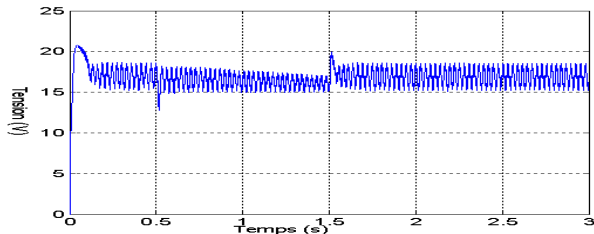


Fig 15 : GPV voltage for variable luminance.

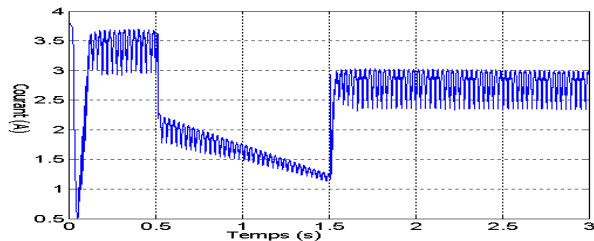


Fig 16: GPV current for variable luminance

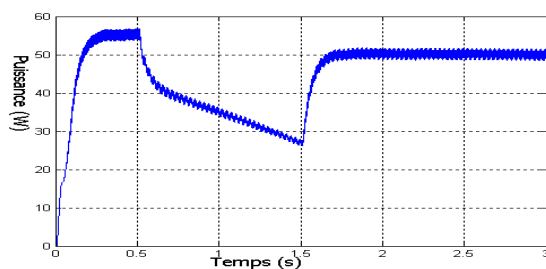


Fig 17: Power of the Load for variable luminance

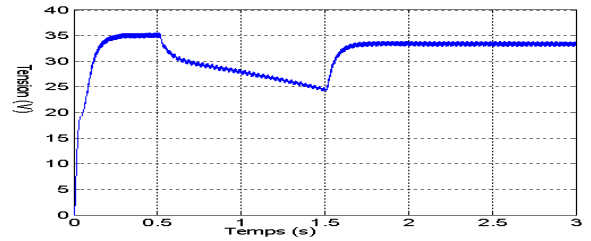


Fig 18: Load voltage for variable luminance.

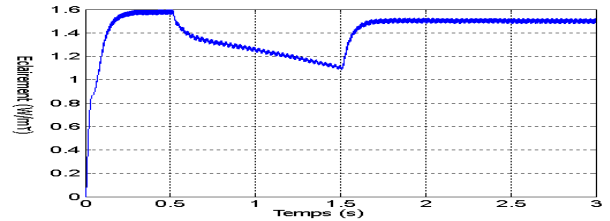


Fig 19: Load current for variable illumination.

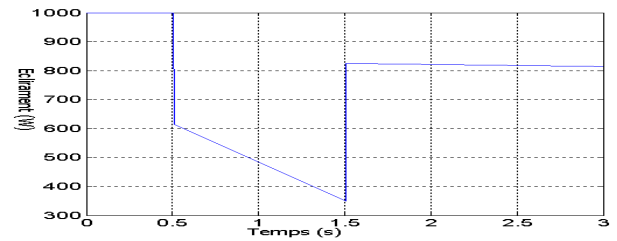


Fig 20: Variation of proposed illumination

5. ANALYSIS AND DISCUSSION OF RESULTS

It appears that the various electrical quantities (powers, voltages and currents) stabilize after a transient state of duration 0.2s, on the graph appear oscillations around the optimal operating point MPP, it is the effect of the continuous disturbance of the operating voltage of the system to follow the MPP point, (major problem of this technique 'perturb & observe').

The power supplied by the PV generator stabilizes around 60 W and that supplied to the load around 57W, at the output of the panel, the voltage and the current stabilize respectively around 17V and 3.4 A, At the level of the load, the voltage and the current stabilize respectively around 35V and 1.6A.

The power difference between the output of the panel and that supplied to the load is due to losses in the electrical circuit: by switching and by conduction in the IGBT transistor, in the diode, The duty cycle of the PWM control increases from 0 to stabilized at 70%.

- For a load variation of a value of 20Ω then 40Ω passing through 80Ω and finally 200Ω, the output power of the converter remains stable and this is ensured by the MPPT control which transfers the maximum power supplied by the source to the load.

- The variation in illumination as shown in the Figs above generates a variation in the power of the GPV.

It is noted that the voltage of the GPV remains a little near constant but the current of the GPV undergoes linear variation according to the illumination, and as the MPP is variable according to the illumination the power supplied to the load varies with the variation of the MPP.

6. CONCLUSIONS

In this work we presented the simulation of a GPV system with and without MPPT and it were found that the energy conversion system, consisting of a GPV, and a boost converter controlled by the MPPT method of Perturb and Observe leads to optimal operation of the system.

The search for the maximum power point is done in a stable and robust way over a wide variation of the load.

The results obtained show that the system converges towards the optimal conditions independently of the meteorological conditions and the variation of the load.

These results, very interesting, show that the use of the MPPT control allows improving in a considerable way the output of the photovoltaic installations.

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