Modeling And Simulation In Matlab\Simulink Of The Chain Supply DC-DC Load In Solar Power PV.

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Summary-
   The theoretical study of the solar cell is based on a representation of the solar cell diode.

The effects of light and temperature on the solar cell are studied, especially on parameters such as the short -circuit current Isc and open circuit voltage Voc. According to the characteristics of the DC load, which is an engine and operating conditions (light and temperature), we can find a very large difference between the maximum power of the PV generator (GPV) and that actually transferred to the load. To extract each time the maximum power available at the terminals of GPV composed of a boost converter controlled by a pulse width modulation (MLI), we use an algorithm of perturb and Observe (P and O) .

Modeling and simulation system (photovoltaic generator, boost converter, the MPPT algorithm) is then performed in Matlab Simulink.

Keywords- photovoltaic generator, a DC motor, Boost converter, MPPT.

I. INTRODUCTION

The rapid increase in demand for electricity and the recent changes in environmental conditions such as global warming led to the need for a new source of energy that is cheaper and sustainable with less carbon emissions.

Solar energy has offered promising results in the quest to finding the solution to this problem. The harnessing of solar energy using PV modules comes with its own problems that arise from the change in insulation conditions. These changes in the insulation conditions severely affect the efficiency and output power of photovoltaic modules [1-2].

A great deal of research has been done to improve the efficiency of the photovoltaic modules. A number of methods of how to track the maximum power point of a PV module have been proposed to solve this problem.

As the market is now flooded with varieties of these MPPT that are meant to improve the efficiency of PV modules under various insulation conditions it is not known how many of these can really deliver on their promise under a variety of field conditions. This research then looks at how different type of converter affects the output power of the module and also investigates if the MPPT that are said to be highly efficient and do track the maximum power

point under the various conditions [1].

A MPPT is used for extract the maximum power from the solar PV module and transferring that power to the load [3,4], we chose to use the technology research MPPT maximum power point [5,6] based the algorithm-Perturb and Observed (P & O).

A DC-DC converter serves the purpose of transferring maximum power from the solar PV module to the load; it acts as an interface between the load and the PV generator [7].

Modeling in Matlab / Simulink different parts of the system is proposed.

II. SYSTEM MODELING

Studied the system consists of a PV generator, DC-DC converter and the load. The DC-DC converter is controlled by a signal modulated pulse width, with a research strategy point of MPPT maximum power.

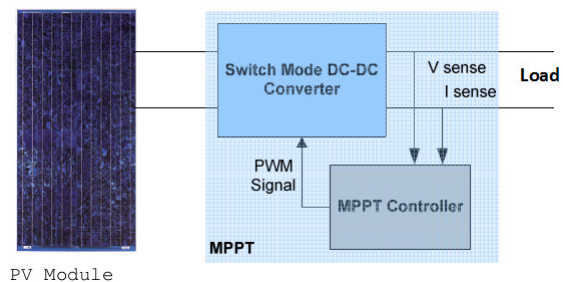The figure below shows the block diagram of the entire system:

Fig. 1 Block diagram of typical MPPT system

The MPPT controller provides appropriate control action to follow the maximum power point in every moment. This control, in the case of a DC load acts directly on the duty cycle of the DC-DC converter [8].

A. Modeling of the photovoltaic generator:

A solar panel cell is essentially a semiconductor PN junction.
When exposed to light, a DC current is generated. The generated current varies linearly with the solar irradiance [7]. The equivalent electrical circuit of an ideal solar cell can be treated as a current source parallel with the diode shown in Figure 2.
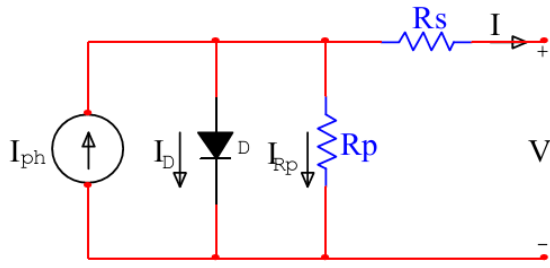
Fig. 2 Model of a solar cell

The basic PV cell is a generator of very low power for the needs of most domestic and industrial applications [1], they are formed by a series or parallel connection of PV cell that performs the conversion of solar energy photovoltaic electricity. The model for a diode is the most classic and most commonly used model; it involves a current generator for modeling the incident light flux and a diode for the phenomenon of polarization of the cell. To account for physical phenomena cell level, the model is completed by two series and shunt resistors R_s and R_p respectively [3].

The series resistance is due to the contribution of the base resistors, the front of the junction and contact front and rear The shunt resistance characterizes the leakage current of the junction along the cell periphery;. It is reduced to the following the penetration of metallic impurities in the junction (especially if it is deep) during deposition of the metal grid or making contacts on the face of the broadcast cellule. We neglect R_p

because it is very small compared with R_s .

Kirchhoff's law allows us to write the following equation:

$$I = I_{ph} - I_D \tag{1}$$

Where

- I is the current supplied by the cell
- I_{ph} is the photocurrent is proportional to ψ illumination, it also corresponds to the short circuit current I_{sc} defined as follows:

$$I_{ph} = I_{CC}\left(\frac{\psi}{1000}\right) \tag{2}$$

- I_D is the bias current of one diode is given by [3]:

$$I_D = I_S\left(e^{\frac{(V+R_S I)}{V_T}} - 1\right) \tag{3}$$

With:
I_s: dependent of the temperature T and technological electrical parameters of the junction.
V_T: thermodynamic potential defined by [3]:

$$V_T = \frac{AKT}{q} \tag{4}$$

T: effective cell temperature in Kelvin.
From relation, we obtain the expression of the characteristic I (V) of the chosen model:

$$I = I_{cc}\left(\frac{\psi}{1000}\right) - I_S\left(e^{\frac{(V+R_S I)}{V_T}} - 1\right) \tag{5}$$

From equation (5), we set the Simulink model of the PV generator given by the following figure:
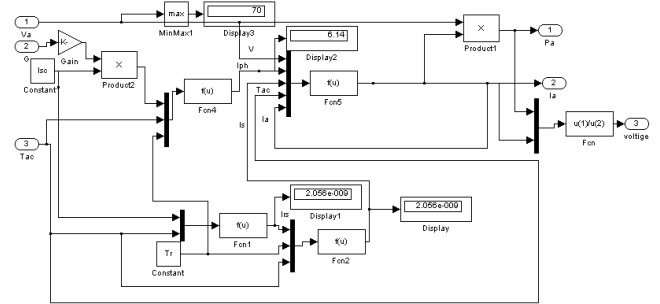

Fig.3 Simulink model of the photovoltaic generator

1) Influence of temperature:

The temperature is an important parameter in PV cells behavior; we below the I-V characteristic of a photovoltaic module for fixed illumination and different temperatures [5].
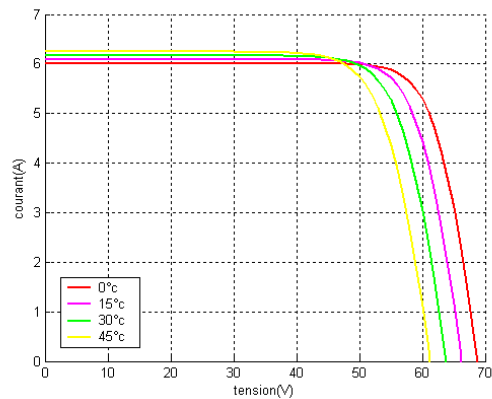

Fig. 4 Current-voltage characteristics for different temperatures

We note that the temperature increases the current increases, for against the open circuit voltage decreases. This causes a decrease in the maximum power available.

2) Influence of light:

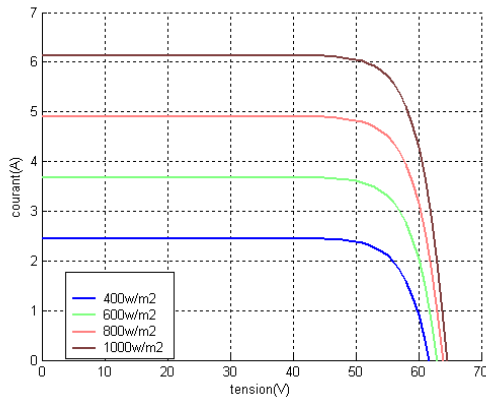We varied the irradiance G and plot the I-V characteristics associated:

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Fig. 5 Current-voltage characteristics for different illumination

We note that the current is directly proportional to the levels of illumination.

B. Modeling the control algorithm (P & O):

Method P & O operates by periodically perturbing voltage V_{PV} panel with small amplitude about its initial value (ΔV), and the resulting P_{pv} power variation is observed [9].

Thus, we can deduce that if a positive increment of voltage V_{pv} generates increased power P_{pv} is to say pressure differential> 0, as shown in Figure 6, the voltage disturbance moves the operating point to closer to the MPP (maximum power point) point and continues to disrupt the voltage in the same direction, this will move the operating point to reach the MPP [9, 10].

If, however, the power decreases ΔP<0, the operating point moves away from the MPP. So we must disturb the tension with algebraic sign contrary to previous sign to move the operating point up to reach the MPP.

From these various analyzed on the impact of a change in the voltage on the characteristic P_{pv} (V_{pv}), it is easy to locate the operating point from the MPP, and converge it to the maximum power through a suitable control sequence [11].

In summary, if following a disturbance voltage, PV power increases the direction of disturbance is maintained. Otherwise, it is reversed to take the convergence to the new MPP.
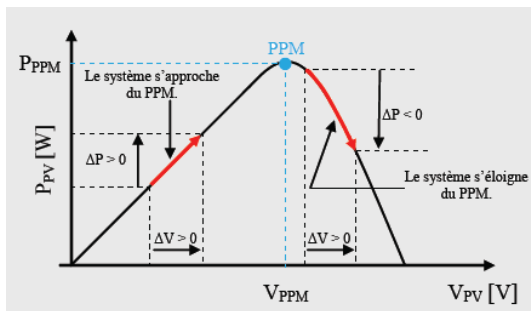

Fig. 6 Application of the algorithm P & O on the characteristic P_{pv} (V_{pv}) [11]

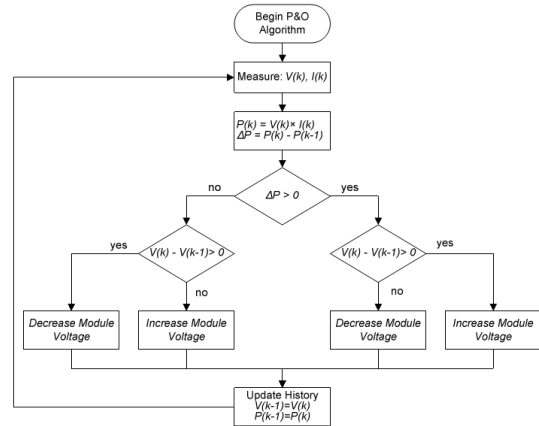The following figure shows the flowchart of the algorithm (P & O).

Fig. 7 Flowchart of the algorithm Perturb and observation (P & O)

The model developed in Matlab/Simulink is shown in Fig. 8 and it is shown that the voltage value is the value of the maximum power, the voltage (V = 54.7V) feeds the DC-DC converter.
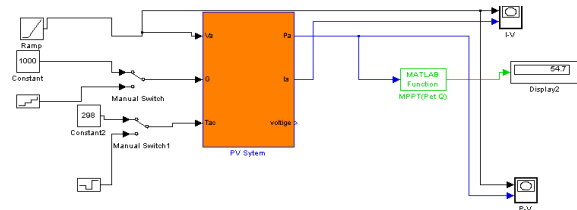

Fig. 8 Model Matlab/Simulink MPPT (P & O) studied

C. Modelling boost converter:

This type of power converter converts a DC voltage into another DC voltage higher value. His transformation ratio is called α, the duty cycle (ratio of time during which the transistor is closed, the period hash):

$$\frac{V_s}{V} = \frac{1}{1-\alpha} \qquad \text{with } \alpha < 1$$
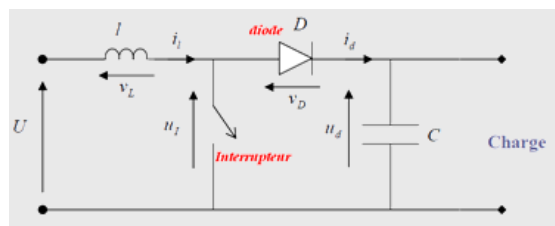
Its simplest form is presented as a result:

Fig. 9 Equivalent circuit of a boost converter

The control circuit of the converter studied consists of the main elements necessary to ensure the control of the switch; the command used is

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intersective MLI.

The purpose of the control circuit is twofold:
- launch orders switching GTO.
- control the output converter voltage V_{dc}.
It is a technique used for energy conversion.
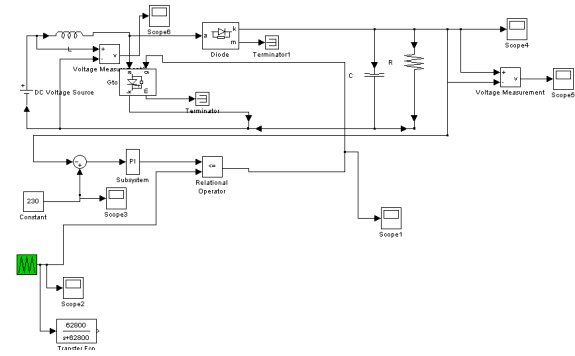In MATLAB/Simulink, the model and the converter circuit is realized as shown in Figure 10.

Fig. 10 Model of the converter and control circuit

The model developed in Matlab/Simulink is shown of Figure 11, the entire conversion chain (GPV, MPPT and Boost converter).
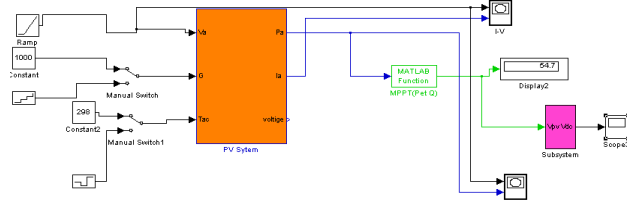
Fig. 11 The whole conversion chain

According to the results, we note that there is a transitional regime 0.01s early conversion. Then, the voltage stabilizes its value 270V. V_{dc} voltage is well regulated and varies between 250V and 300V, thus obtaining an increase in the voltage 54.7V to 270V using the boost converter.
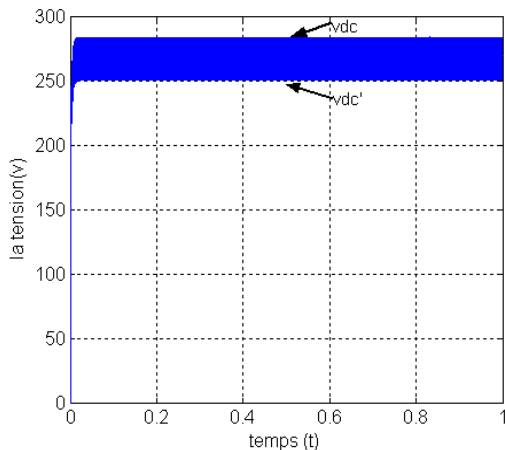
Fig. 12 The output voltage of the converter hovering around its reference

D. Modeling continuous load:

Based on modeling of the whole conversion chain Matlab/Simulink, we modeled the DC-DC load.
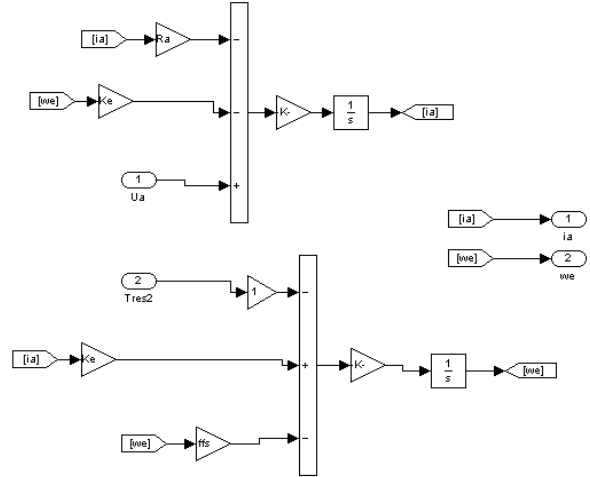We set the Simulink model of DC motor (DC-DC) given by the following figure:

Fig. 13 The model of the DC motor

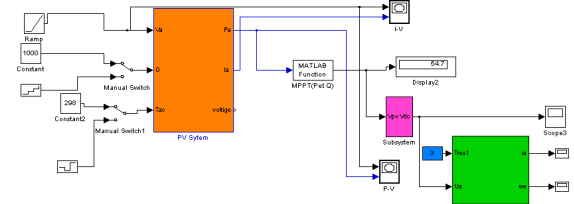The overall system model established in our article Matlab / Simulink is shown in Fig 14.

Fig. 14 Overall scheme of the PV system

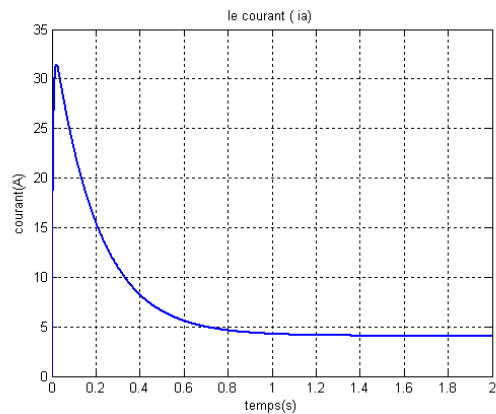The characteristic of the DC motor is studied in the following figures shown:
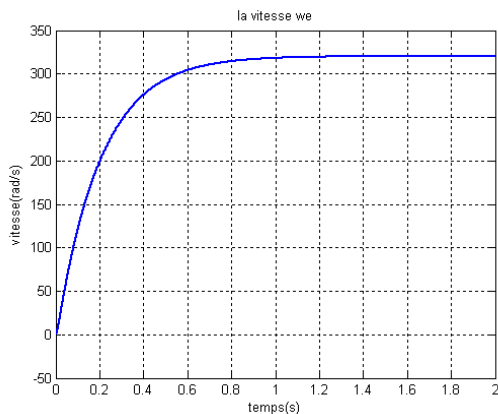
Fig. 14-a Motor current

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Fig. 14-b Engine speed

Fig. 14 Characteristics of the DC motor powered by PV

III. CONCLUSION

To have the best power output from the photovoltaic generator (GPV) and the load, we modeled the entire conversion chain in Matlab and then search algorithm of maximum power point tracking (MPPT) was designed and simulated. It forces the generator to work GPV in its maximum power point (MPP), leading to an overall improvement in system performance power conversion.

Although satisfactory in relation to direct GPV-load connection, improved P & O algorithm may be necessary in the case of sudden loading temperature and illumination.

IV. REFERENCES

[1] R. S. Lewis, " Antartic Research and Relevant of Science", *in Bulletin of the Atomic Scientists*, Vol. 26, 1970, pp. 2.

[2] S. Mekhilef, "Performance of grid connected inverted with maximum power tracker and power factor control", *International Journal of Power Electronics*, vol. 1, pp. 49-62, 2008.

[3] M.E. Ahmad and S. Mekhilef, "Design and Implementation of a Multi Level Three-Phase Inverter with Less Switches and Low Output Voltage Dissertation ", *Journal of Power Electrical*, vol.9,pp.594-604, 2009.

[4] S. Chin, J. Gadson, and K. Nordstrom, "Maximum Power Point Tracker", *Tufts University Department of Electrical Engineering and Computer Science*, pp.98, 2005.

[5] M. Djarallah "Contribution à l'étude des Systèmes photovoltaïques résidentiels couplés au réseau électrique", *Thèse de Doctorat, Université de Batna, Algérie*, 2008.

[6] Akihiro Oi "Design And Simulation Of Photovoltaic Water Pumping System" , *In Partial Fulfillement Of The Degree Of Master Of Science In Electrical Engineering, Faculty Of California. Polytechnic State University, san Luis Obispo*, 2005.

[7] R. Chenni, M. Makhlouf et al" A detailed modeling method for photovoltaic cells", Science Direct Energy, 32. 2007.

[8] G. Walker "Evaluating MPPT Converter Topologies Using A Matlab PV Model", *Dept of Computer Science and Electrical Engineering, University of Queensland, Australia*, 2010.

[9] M. Azab. "A New Maximum Power Point Tracking for Photovoltaic Systems", *in waste.org*, vol.34, pp.571-547, 2008.

[10] H. Knopf. "Analysis Simulation And Evaluation Of Maximum Power Point Tracking (MPPT) Methods For A Solar Power Vehicle", *in Electrical and Computer Engineering*, vol. Masterof Science in Electrical and Computer Engineering. Portland State University, pp.77, 1999.

[11] B. S. Energy "What is Maximum Power Point Tracking (MPPT)", vol.2009.