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An experimental setup to seek for maximum power point tracking of photovoltaic panels

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Energy is a very important issue nowadays. In the last years a lot of researchers have dedicated their studies to looking for new energy sources. In Brazil, we have the privilege to have an amount of sunlight per year - very high all over the country. This fact motivated this research. In this work we present an experimental approach for achieving maximum power point tracking of photovoltaic panels. To do so, we assemble an experiment composed by a small photovoltaic panel which is attached to a step motor shaft and can turn, controlled by the step motor, from a 2πrd angle. The idea is to use the photovoltaic panel as sensor of solar energy. The step motor turns and exposes the panel to the sunlight. The voltage produced by the panel is acquired with a data acquisition board and its maximum value is chosen as the best point and associate to the number of steps needed to reach this point. The number of steps indicates the best panel position. The experimental setup was tested and preliminary results show that the best position of the panel is always reached and the automated process is quite reliable.

Key words: Photovoltaic panel, solar energy, step motor, LabVIEW.

INTRODUCTION

Renewable energy has been the subject of studies worldwide. Solar energy, in particular, is a type of energy in abundance in our country with tropical climate. Searches contemplating the use of such energies are encouraging industry production of photovoltaic panels, responsible for the transformation of solar energy into electricity Tiba (2000). In literature some authors demonstrate their preoccupation with obtaining the optimum working of photovoltaic panels. Works such as Carvalho (2012) propose an algorithm that calculates the best position of the photovoltaic panel according to the area of use; Chapman and Esram (2007) discusses various techniques for obtaining the maximum power point for photovoltaic panels; and Dolara et al. (2009) present a comparative study between seven widely used algorithms to obtain the MPPT (Maximum Power Point Tracking). A rapid method used to track the maximum power point photovoltaic panels is presented and compared with experimental results in Esram et al. (2006). With respect to the practical application panel, one can cite the work of Barin (2012) that analyzes the performance of a bike pump powered by solar energy from a photovoltaic panel, in order to use it for irrigation product horticulture in small farms. In Camargo et al. (2012), the authors propose use of the energy lost when a photovoltaic panel heats up when exposed to sunlight. The lost energy is converted into thermal energy directly by means of the Seebeck effect. With a more

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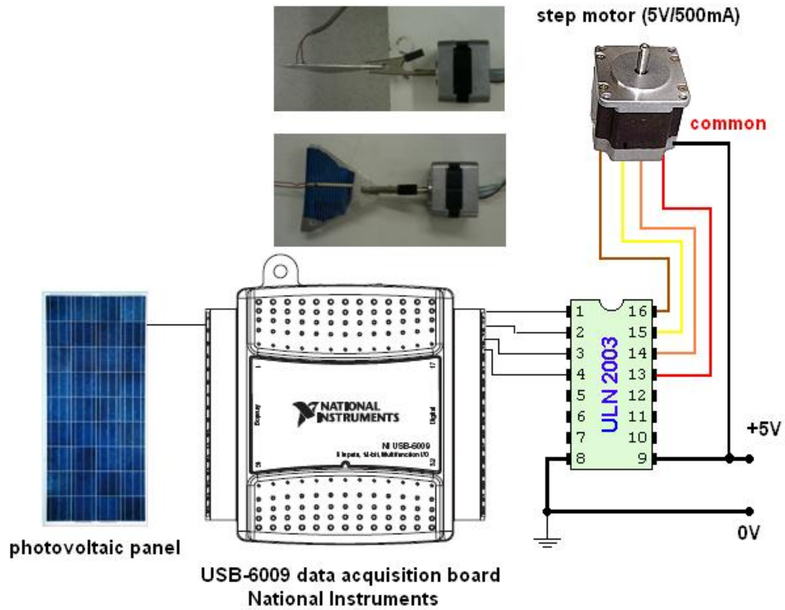

Figure 1. The experimental setup.

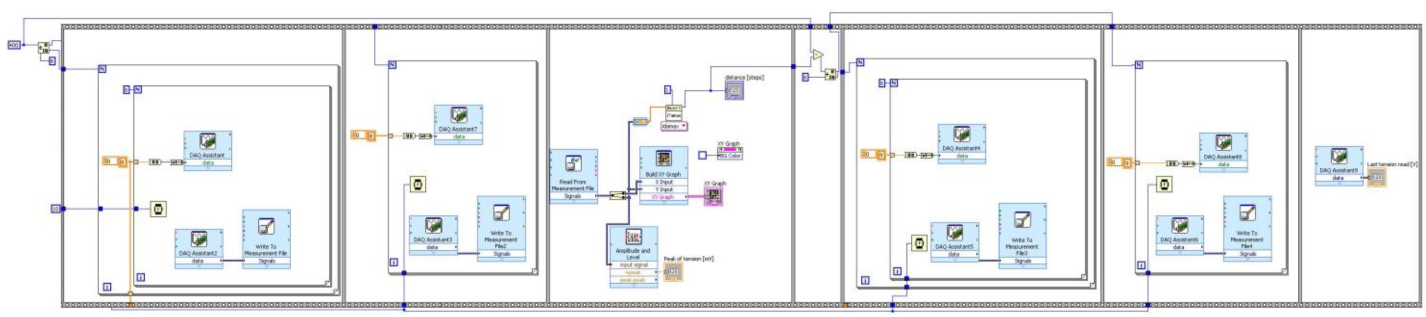

Figure 2. Block diagram of the LabView application.

experimental approach, Ribeiro et al. (2013) presents an experimental setup that uses LDR (Light Dependent Resistors) as sensors in order to obtain a best position of the photovoltaic panel. In this work, we propose to use the photovoltaic panel as a sensor of solar energy in order to seek for the best attitude of the panel with the sun. In fact, the application is set up to initially turn about 2πrd. So it reaches the point of maximum solar incidence. In the next steps, it just add few more steps to the actual motor position improving the solar incidence once the sun is moving itself. We intend to use the results in a bigger panel which could use this experiment as a slave to calculate the best position and feedback of the bigger panel with this information.

THE EXPERIMENTAL SOLAR TRACKING

In order to obtain the maximum power point, an experimental setup was assembled. A scheme of the experimental setup proposed in this work is shown in Figure 1. It is composed by a step motor with 200 steps of precision (1.8°/step), a power amplifier, ULN-2003 that amplifies the current that feeds the motor and a piece of a photovoltaic panel (with 2093.32 mm^2 of area) that lies on a plate linked to the step motor shaft. The voltage produced by the photovoltaic panel and the power amplifier are linked to a data acquisition board USB-6009. The board's role is to command the step motor and acquire the voltage produced by the panel.

All this setup was integrated into a LabVIEW application, whose block diagram is shown in Figure 2. In order to improve the motor position precision we worked with half step in the step motor, increasing the number of steps to 400 (0.9°/step).

In the application, depicted in Figure 2, we start with a sweeping of 2πrd (400 steps) of the step motor that carries the photovoltaic panel and exposes it to the solar energy. The acquisition board acquires the voltage produced by the photovoltaic panel and chooses the maximum value of this data. The maximum value is, then, associated with the number of steps given by the step motor. With this result, the motor turns the photovoltaic panel to the best position. In the next steps the application keep acquiring data from

Figure 3. Photovoltaic panels to power an air conditioning system.

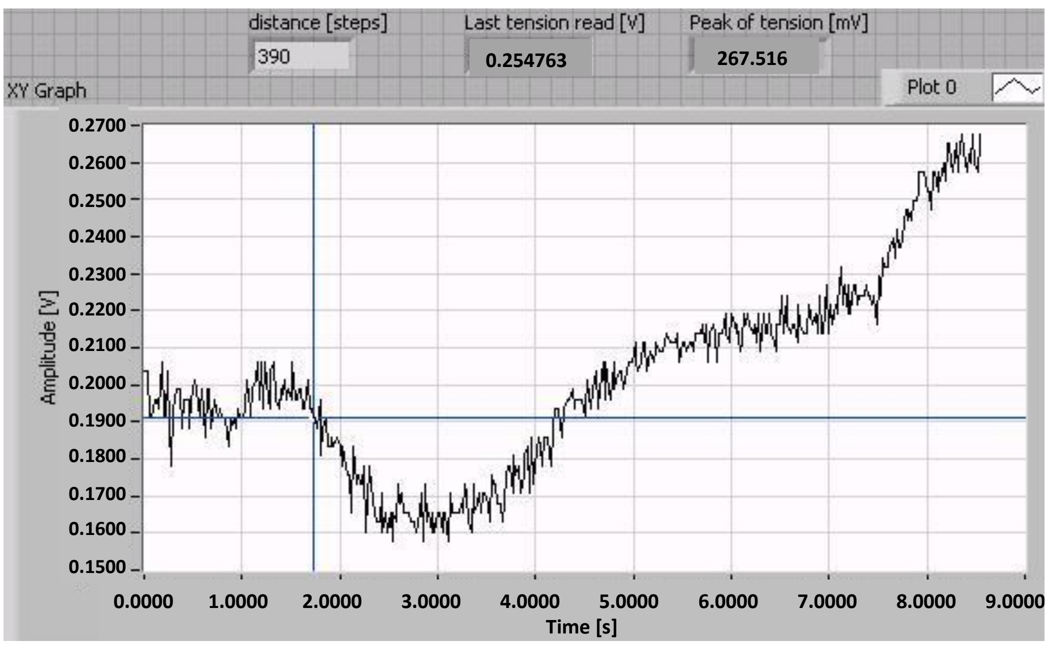

Figure 4. Preliminaries results.

voltage and, once it changes (increase or decrease) by 10% of the maximum value, the system execute another search in order to re-establish a new position to the solar panel, keeping the voltage acquired as maximum as possible. Once we calculate this position, we can feedback the panels illustrated in Figure 3. The panels in Figure 3 are used to power an air conditioning system and the unused energy is stored into batteries. The system performs a constant trajectory during the day, which is not ideal for performance optimization. We propose to interfere in this trajectory, in order to feedback the panels and keep it perpendicular to the sunlight.

RESULTS AND FURTHER WORK

In Figure 4 we show a print of a LabVIEW screen. In the figure, the graph shows the photovoltaic panel voltage

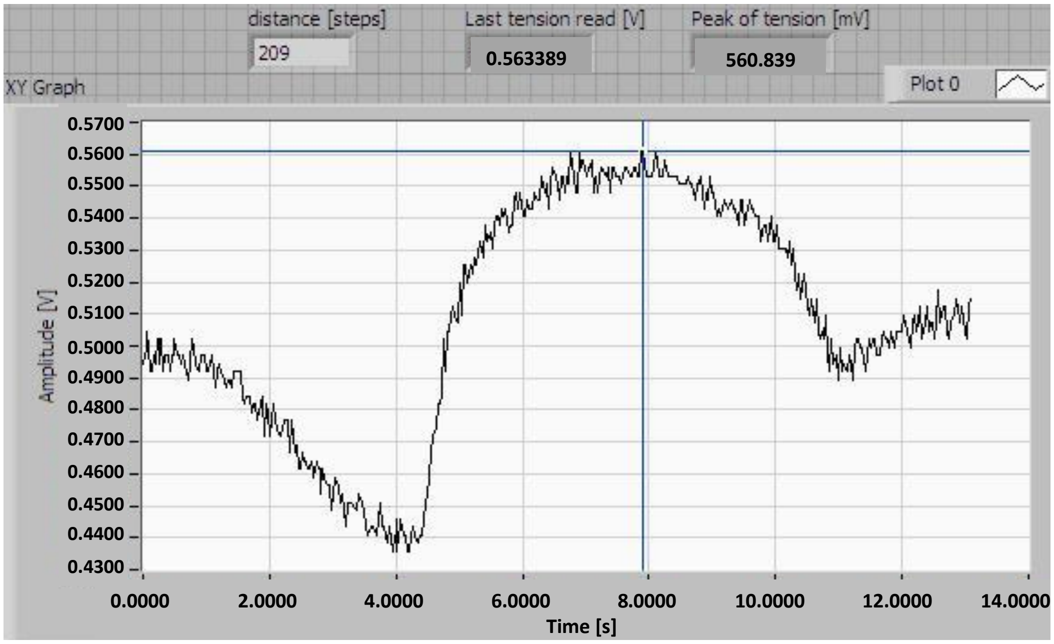

Figure 5. Results in sunlight.

against time.

The test, whose results are displayed in Figure 4, was carried out indoor, with a flashlight turned on in order to test the application developed. As we can see the motor counts 400 steps and finds that in step 390 the maximum power in the solar panel was reached. This value, for this specific case, means 0.267516 V, which is the tension peak. So the motor turns back to this position (390) and the last tension was read with the value 0.254763 V. This test was carried out indoor because the tension values are so low. In Figure 5 we present the results with the experiment carried out in the sunlight.

In this result, the tension is much bigger and the application shows 0.560839 V of peak, reached with 209 steps.

Conclusions

In this work we address the problem of seeking for maximum power point tracking of photovoltaic panels. The idea is to feedback a bigger photovoltaic panel with the information of best position obtained by this reduced experiment. So the reduced experiment uses the photovoltaic panel itself as a sensor to indicate in which position the bigger tension is achieved. The reduced panel is exposed to the sun, attached to the shaft of a step motor which, initially, turns the panel of an angle of 2πrd. With the identification of the position of maximum energy and the automation of large fields of energy generation, it will be possible to increase production of electrical energy, generating a higher level of clean energy and less environmental damage. With that, we estimate considerable increase in daily energy generation, since the efficiency of the panels will increase significantly.

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