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Implementation of acquisition card for meteorological parameters of a photovoltaic system in a southern region

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***Abstract*— The southern regions of Algeria are characterized by a very significant solar energy reservoir, which qualifies them for the extensive use of photovoltaic conversion systems throughout the year. the efficiency of photovoltaic systems in these regions is largely linked to their performance, which evolves according to the climatic conditions. the collection of climatic data, such as temperature, humidity, atmospheric pressure, wind speed, has become essential nowadays, for estimating solar isolation or improving control command such as the command of maximum power point tracking MPPT. the aim of this work is firstly, to design by simulation an acquisition cart based on a microcontroller to collect meteorological data to get the performance of photovoltaic module and then the implementation of this design in real time.**

Keywords— **PIC16F877A, Temperature sensor, Acquisition, I-V Curve**

I. Introduction

The continued increase in global energy demand, as well as growing concerns about the effects of global warming and the negative environmental consequences of using traditional energy sources such as fossil fuels [1] (oil and its derivatives), are prompting governments and organisations to explore alternatives to the use of energy sources. Among these alternative resources, photovoltaic power generation is a favoured option in Algeria due to its unique advantages such as ease of installation and low maintenance costs [2],[3]. In addition to the abundance of these resources, especially in the desert region of North Africa, our country is known to have the most sunshine, with an annual average of 3,500 hours of sunshine per year. Photovoltaic (PV) systems are increasingly used for the production of renewable energy. The effectiveness of these systems depends on various weather parameters such as sunshine, room temperature, humidity, and wind speed [4-6]. To optimize the performance of PV systems, it is crucial to monitor and acquire these parameters in real time. This article focuses on the study and simulation of an acquisition map dedicated to the collection of meteorological data for a photovoltaic system.

The main objectives of this work are

- Develop an acquisition map capable of measuring and collecting critical meteorological parameters.
- Simulate the operation of the board to ensure accuracy and reliability.
- Integrate the acquisition board with a PV system to analyze data and optimize power generation.
- Design of the Acquisition Board.

In this paper a simulation of a meteorological parameter acquisition card for a photovoltaic system is presented. Then design and implementation of the proposed card is done, after that the data are collected experimentally and sketched to show the PV characteristics.

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II. Design of the Acquisition Card

The design of the acquisition card is based on the integration of specific sensors for real-time measurement of relevant meteorological parameters. The sensors selected must be accurate, robust and compatible with the outdoor environment. In addition, the acquisition card is equipped with a communication interface to transmit the collected data to a centralized monitoring system..

III. Simulation and Validation

Once the design is complete, simulations are carried out to evaluate the performance of the acquisition board under different weather conditions. Computer models are used to reproduce realistic scenarios, taking into account seasonal and diurnal variations. Simulation results are then compared with real meteorological data to validate the accuracy and reliability of the acquisition card.

A. SIMULATION LCD 16X2

We have used a 16x2 LCD display in order to show the characteristics of the proposed system, as shown in figure 1.

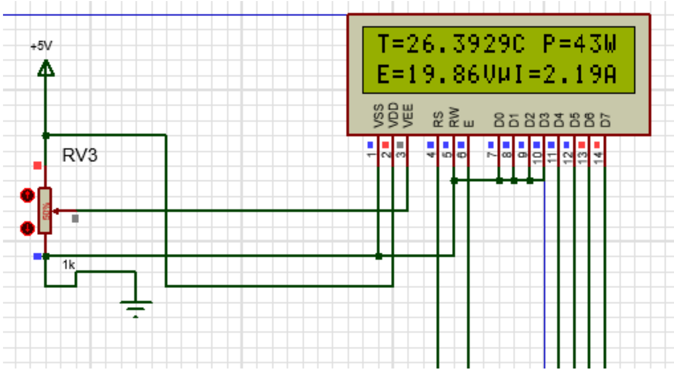

Fig. 1 Connection of 16x2 LCD display

B. Equivalent scheme of PV generator

Figure 2 represent the PV generator used in our simulation

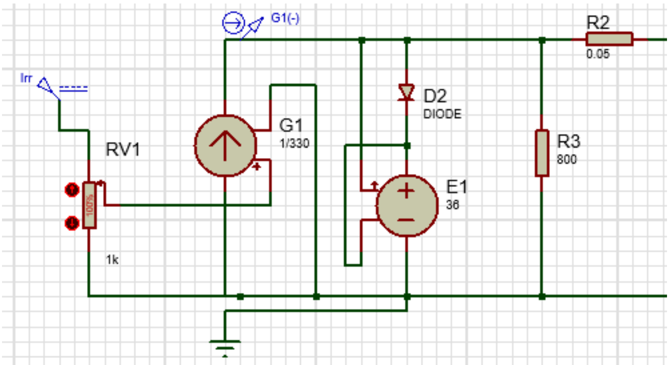

Fig. 2 Equivalent circuit of PV generator

C. Current sensor

The current sensor used in our simulation is ACS712, which measure the current of PV generator see figure 3

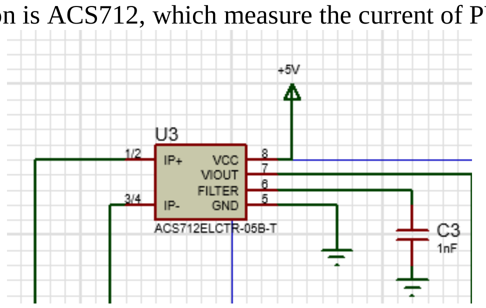

Fig. 3 ACS712 current sensor

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D. Voltage sensor (Voltage divider)

In order to read the voltage value, a bridge of voltage divider is employed, which shown in figure 4

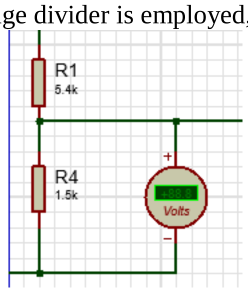

Fig. 4 Voltage divider

E. Temperature sensor

For the temperature measurement, we have used the well-known LM35 temperature sensor (see figure 5)

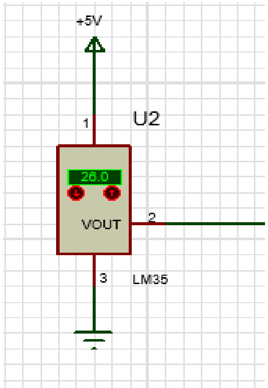

Fig. 5 LM35 temperature sensor

F. Microcontroller 16F887A

The proposed system is monitored by the microcontroller 16F877A (figure 6), to show all measured data

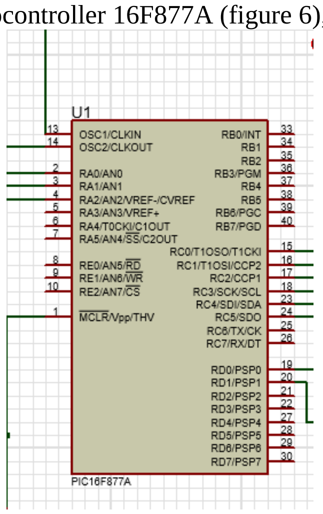

Fig. 6 The microcontroller PIC16F877A

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G. The simulation of the proposed system

Using the previous components, we have done simulation in PROTEUS of the proposed meteorological acquisition card, shown in the figure 7, and based on the software design presented in figure 8

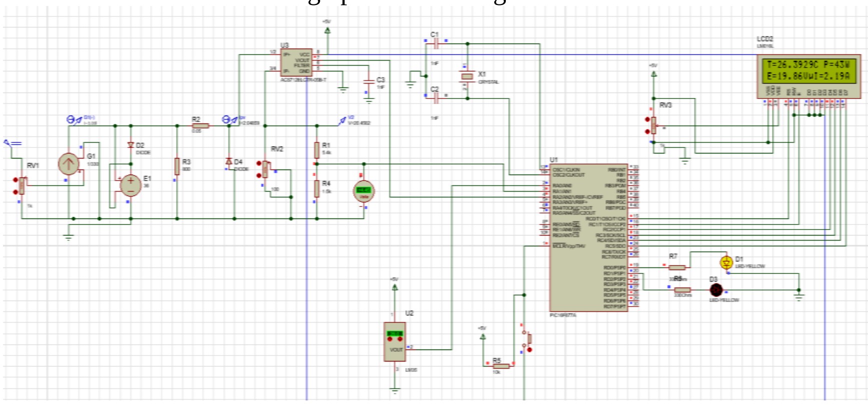

Fig. 7 Simulation of the proposed system

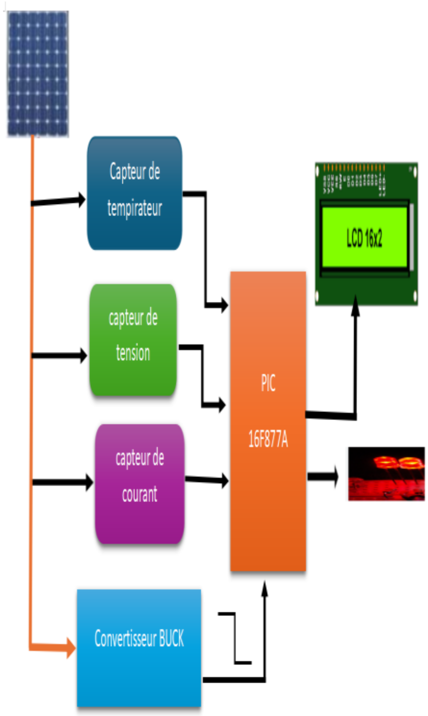

Fig. 8 The software design of the proposed card

Figure 9 represents the flowshart of the program implemented on PIC16F877A using MikroC environnement.

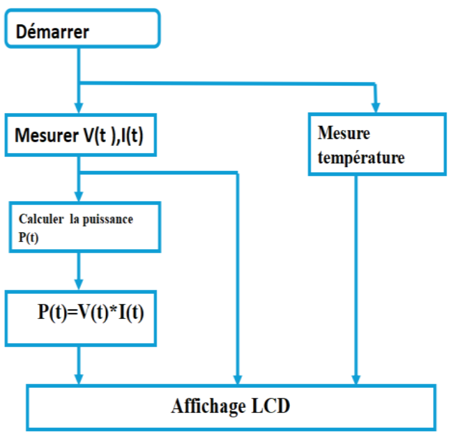

Fig. 9 The flowshart of the program

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IV. IMPLEMENTATION OF THE METEOROLOGICAL CARD

Figure 10 shows the implementation of our meteorological card, with is installed behind the PV panel in order to extract the real time data.

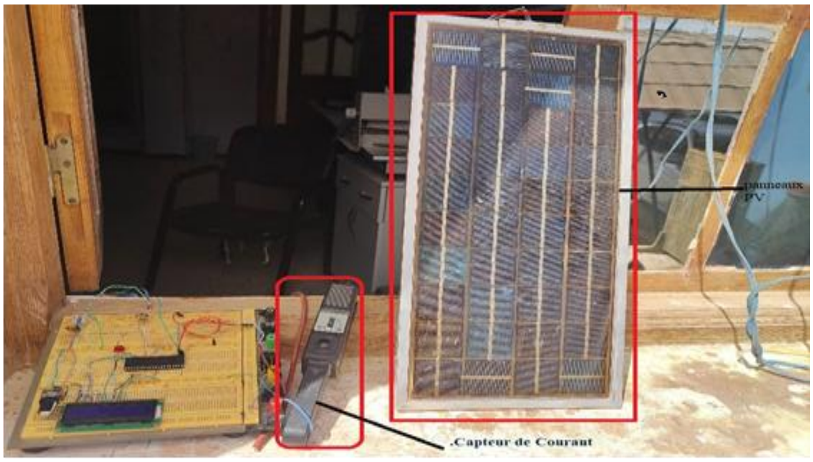

Fig. 10 Real time implementation of the system.

Once validated, the acquisition card is integrated into the photovoltaic system. It enables continuous monitoring of meteorological parameters, providing crucial information for optimizing solar power generation. In the event of adverse weather conditions, the system can automatically adjust its operating parameters to maximize yield and ensure efficient use of available solar energy.

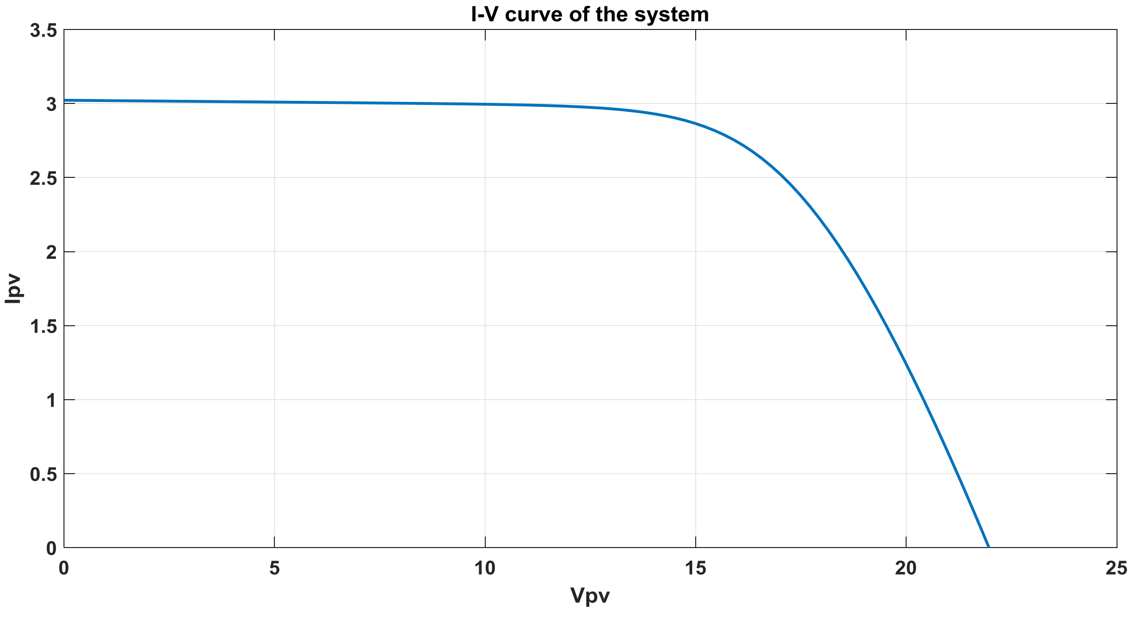

Fig. 11 I-V curve extracted from the system.

The curve shown in figure 11 is the I-V curve of solar panels that illustrates how a solar cell reacts to current (I) and voltage (V) when exposed to solar radiation. It consists of linear (photosynthetic saturation), maximum (maximum power), and non-linear (tension saturation). Understanding these curves is crucial for evaluating solar panel performance and optimizing efficiency, as it helps determine optimal operating conditions for maximum efficiency. This curve is essential for determining optimal solar panel performance.

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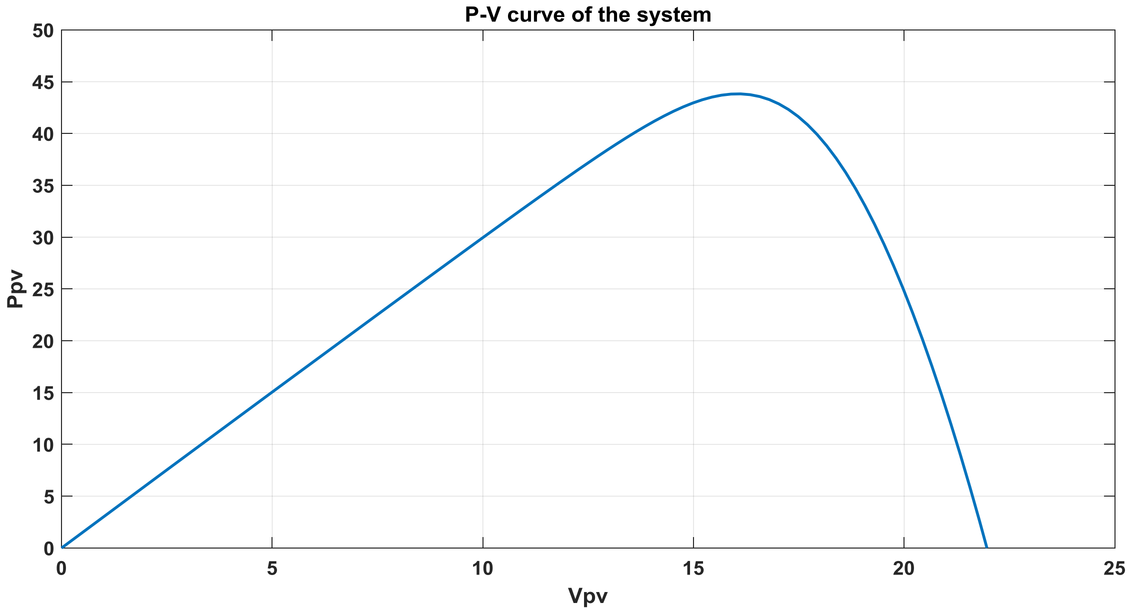

Fig. 12 Ppv Vs Vpv curve extracted from the system.

The power curve Ppv(Vpv) of a solar panel illustrated in figure 12, represents the power output (Ppv) of a panel when exposed to solar radiation under certain conditions. It is determined by the Maximum Power Point (MPP), the internal cell's shape, and the losses in the solar system. The MPP is the point where the solar cell reaches its maximum power output, where it must operate for maximum efficiency. Understanding the MPP helps determine optimal solar panel operating conditions for maximum efficiency and performance.

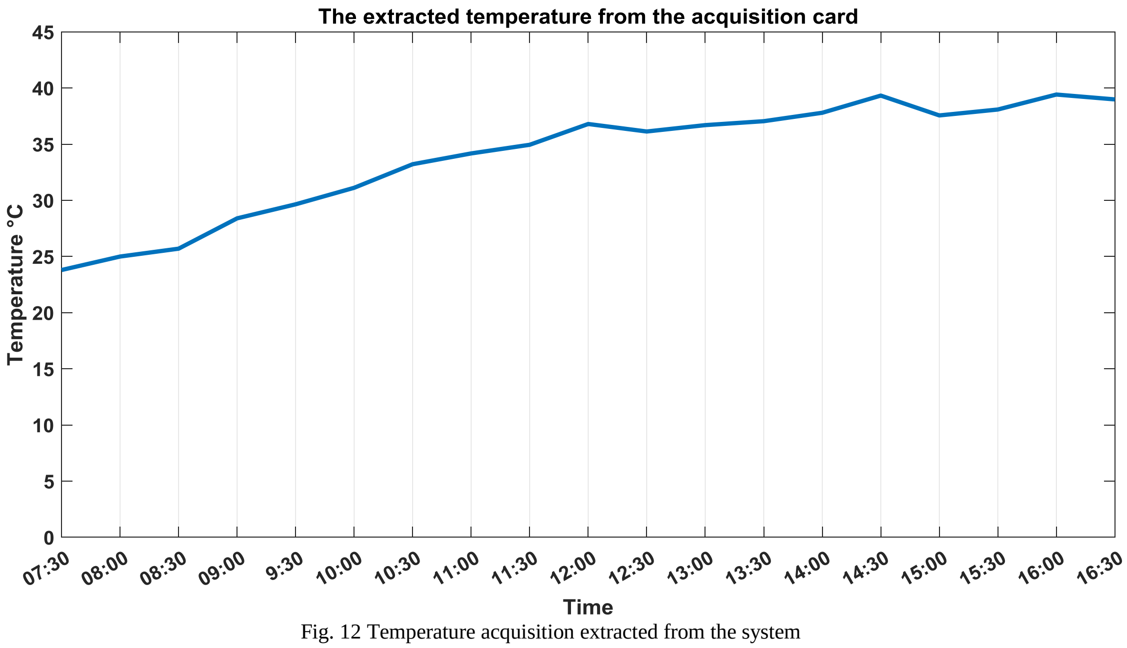

Fig. 12 Temperature acquisition extracted from the system

The data of Fig.12 is collected on 05th May, 2024 in Adrar city situated in sahara region of Algeria, at regular intervals (e.g. every half hour) and shows the variation in solar panel temperature over the course of the day and over several days. This information is essential for understanding the impact of weather conditions on photovoltaic system performance.

V. Conclusion

The implementation of meteorological parameter acquisition for photovoltaic (PV) systems is essential to optimize energy production and ensure efficient operation of these systems. Further advances in sensor technology, data analysis and simulation models are needed to improve the accuracy and reliability of meteorological parameter acquisition. We also need to address the

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integration of these technologies into smart grid systems for real-time energy management and distribution. Our research highlights several key findings:

The use of sophisticated simulation models allows a detailed analysis of the performance of photovoltaic systems in different weather scenarios. These models help to understand the potential energy production and identify any potential problems related to weather fluctuations. We simulated a weather parameter acquisition card, then after validation by simulation we made a prototype that gave good results, a real-time data reading through a 16F877A microcontroller.

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