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SYSTEM FOR DATA ACQUISITION ON PHOTOVOLTAIC PANEL

Gabriel Meceneiro[1]
meceneiro@pos.ft.unicamp.br

Talía Simões dos Santos[1]
talia@ft.unicamp.br

Pedro Henrique de Souza Pozelli[1]
p175772@dac.unicamp.br

[1]FT-UNICAMP
[1]Limeira, São Paulo 13484-332

***Abstract* — This article presents a real-time monitoring system for the photovoltaic panels based on an Atmega328P microcontroller. The proposed system is simple and low cost. It is explained step-by-step how to collect data voltage, current, power and temperature from photovoltaic panels. It presents a solution to access the database via web, with generation of graphs for visualization.**

Keywords* — *Monitoring Data Acquisition; photovoltaic panel; database; microcontroller.

I. INTRODUCTION

In the past years, the electric energy provided by photovoltaic panel increased significantly. It is well known that the main factors which affect the energy production, in a photovoltaic system, are solar irradiance on the photovoltaic cells and in its work temperature [1]. Furthermore, the single module can be submitted to partial shading, which increases the loss of photovoltaic energy [2].

The implementation of a monitoring system able to measure the main electrical quantities which affect the energy production, may be a possible solution to minimize the loss [3], [4]. Moreover, this system carries out diagnostic activities to detect and locate possible failures and to simplify the operator intervention [5]. However, the implementation of a monitoring system increases the global cost of the photovoltaic installation, which can be economically unsustainable for small scale projects.

There are several commercial systems to carry out the data acquisition, both in field applications and laboratories, but generally they are relatively expensive. The purpose of this paper consists in the conception and fulfillment of system which is open source, simple, low cost and whose performance can be similar to those commercial monitoring systems. The proposed device contains a set of sensors connected to an internet interface.

II. MATERIAL AND METHOD

The project proposes the building of a tool to support the data acquisition in solar panels. An Arduino UNO [6], a shield Ethernet board [7], an ACS712 current sensor [8] and a solar panel were used [9].

A. Solar Panel

Polycrystalline photovoltaic panel with 10W power was used in this project. Table 1 shows the main technical specifications [6].

Table 1. Technical specifications of the module used

Panel Name	JS 10
Maximum Power	10W
Maximum Power Voltage	17.10 V
Short Circuit Current (Isc)	0.65 A
Cell Type	Polycrystalline

B. Voltage Reading

For the voltage reading of the photovoltaic panel, a resistive element of high impedance was attached to the charge. Through it, the reading with partial voltage was possible with the use of a microcontroller analog digital port (A/D). Figure 1 shows the connection diagram.

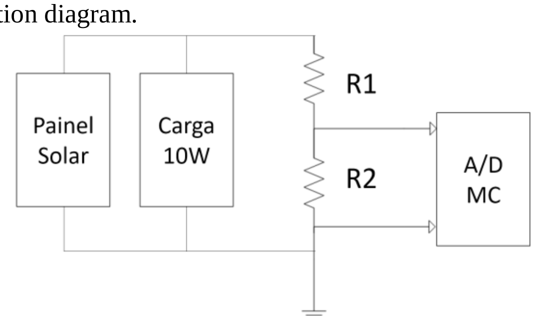


Figure 1. Measuring System.

The resistors were chosen according to the ohm's law. The R2 resistor is of 1KΩ. Knowing that the maximum input voltage of the microcontroller is 5 Volts, and that the maximum voltage produced by the charged panel is 17.1 Volts, it is possible to calculate the R1.

$$V_{R2} = (R_2 * V_{in}/(R_{2+} R_1)) \rightarrow 5 = (1K\Omega * 17{,}1/ R_1)$$
$$R_1 = 2{,}42K\Omega$$

The chosen values for the resistors were R1= 2,4KΩ and R2= 1KΩ. High precision resistor with variation of more or less

1% was used. The system calibration was done with an 8808A bench multimeter with a 5-digit accuracy after point.

The reading is done through a voltage drop on the resistor R2. The reading value of A/D is multiplied by the equation: (17.1/1023). The results are given in Volts.

C. Current Reading

In order to measure the current, a current sensor ACS712 -30A was used (Figure 2). This sensor conducts the reading in a non-invasive by hall effect. The sensor has three pins: GND, VCC and the output. The output pin has voltage results which correspond to the level of current applied, the tension ranges from 0 to 5V, its relation is linear, defined as 66 mV for each Ampere applied.

Figure 2. Current Sensor.

D. Temperature Reading

In order to read the temperature, a sensor LM35 was used. (Figure 3). It is a precision sensor with an analog output voltage. It has a range from -55 ºC to +150 ºC, with ± 0,5 ºC accuracy. The output voltage is 10mV / ºC [3]. The LM35 output is connected to a port A/D-04 of the microcontroller. The outcome value on the AD is multiplied by the equation: (5/(1023))/0.01). The results are given in ºC.

Figure 3. Temperature Sensor [3].

E. Communication Server and Database

The server used was the one at Faculdade de Tecnologia (FT-UNICAMP). *PHP-MySQL* was the interface used, which is responsible for receiving data, running calculation and storing information. The *MySQL* database was chosen because it is free to use and also has a good integration with *PHP* language.

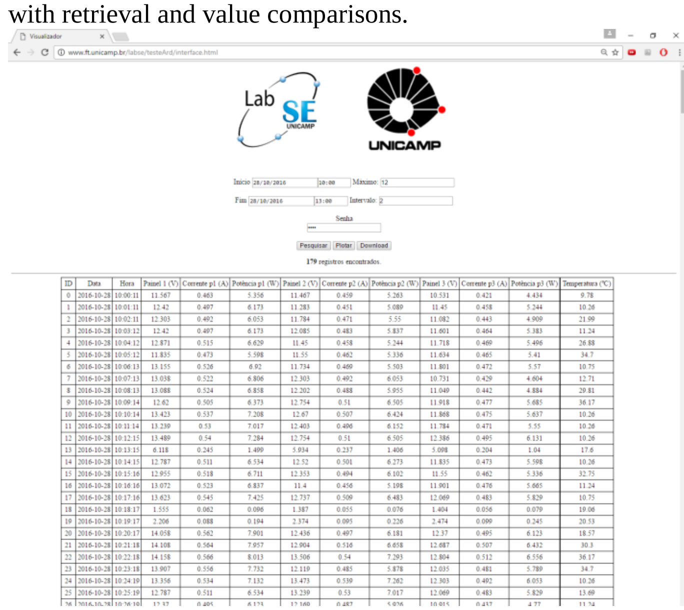
The display interface was developed using the *PHP* with *Javascript* programming languages. It offers search options (separated by date and time) from the collections accomplished. The page has a button to download the data from the chosen date in *CSV* (*Comma-separated values*) spreadsheet. There is an icon to generate graphs which show the power of the panels along the day, with the help of "*CanvasJS*" library [10].

The plot option retrieves the table values generating the graphs which use the *canvas* element of the *HTML5*. The plotted data can be visualized separately.

The access to the interface is available at: http://www.ft.unicamp.br/labse/Ard/interface.html.

III. RESULTS

Figure 4 shows the search screen with the date and time fields. After choosing date and time, a table with the voltage, current, power and temperature is retrieved. It is necessary to present the data this way in order to identify possible failures with retrieval and value comparisons.



ID	Data	Hora	Painel 1 (V)	Corrente p1 (A)	Potência p1 (W)	Painel 2 (V)	Corrente p2 (A)	Potência p2 (W)	Painel 3 (V)	Corrente p3 (A)	Potência p3 (W)	Temperatura (ºC)
0	2016-10-28	10:00:11	11.567	0.463	5.356	11.467	0.459	5.263	10.531	0.421	4.434	9.78
1	2016-10-28	10:01:11	12.42	0.497	6.173	11.283	0.451	5.089	11.45	0.458	5.244	10.26
2	2016-10-28	10:02:11	12.303	0.492	6.053	11.784	0.471	5.55	11.082	0.443	4.909	21.99
3	2016-10-28	10:03:12	12.42	0.497	6.173	12.085	0.483	5.837	11.601	0.464	5.383	11.24
4	2016-10-28	10:04:12	12.871	0.515	6.629	11.45	0.458	5.244	11.718	0.469	5.496	26.88
5	2016-10-28	10:05:12	11.835	0.473	5.598	11.55	0.462	5.336	11.634	0.465	5.41	34.7
6	2016-10-28	10:06:13	13.155	0.526	6.92	11.734	0.469	5.503	11.801	0.472	5.57	10.75
7	2016-10-28	10:07:13	13.038	0.522	6.806	12.303	0.492	6.053	10.731	0.429	4.604	12.71
8	2016-10-28	10:08:13	13.088	0.524	6.858	12.202	0.488	5.955	11.049	0.442	4.884	29.81
9	2016-10-28	10:09:14	12.62	0.505	6.373	12.754	0.51	6.505	11.918	0.477	5.685	36.17
10	2016-10-28	10:10:14	13.423	0.537	7.208	12.67	0.507	6.424	11.868	0.475	5.637	10.26
11	2016-10-28	10:11:14	13.239	0.53	7.017	12.403	0.496	6.152	11.784	0.471	5.55	10.26
12	2016-10-28	10:12:15	13.489	0.54	7.284	12.754	0.51	6.505	12.386	0.495	6.131	10.26
13	2016-10-28	10:13:15	6.118	0.245	1.499	5.934	0.237	1.406	5.098	0.204	1.04	17.6
14	2016-10-28	10:14:15	12.787	0.511	6.534	12.52	0.501	6.273	11.835	0.473	5.598	10.26
15	2016-10-28	10:15:16	12.955	0.518	6.711	12.353	0.494	6.102	11.55	0.462	5.336	32.75
16	2016-10-28	10:16:16	13.072	0.523	6.837	11.4	0.456	5.198	11.901	0.476	5.665	11.24
17	2016-10-28	10:17:16	13.623	0.545	7.425	12.737	0.509	6.483	12.069	0.483	5.829	10.75
18	2016-10-28	10:18:17	1.555	0.062	0.096	1.387	0.055	0.076	1.404	0.056	0.079	19.06
19	2016-10-28	10:19:17	2.206	0.088	0.194	2.374	0.095	0.226	2.474	0.099	0.245	20.53
20	2016-10-28	10:20:17	14.058	0.562	7.901	12.436	0.497	6.181	12.37	0.495	6.123	18.57
21	2016-10-28	10:21:18	14.108	0.564	7.957	12.904	0.516	6.658	12.687	0.507	6.432	30.3
22	2016-10-28	10:22:18	14.158	0.566	8.013	13.506	0.54	7.293	12.804	0.512	6.556	36.17
23	2016-10-28	10:23:18	13.907	0.556	7.732	12.119	0.485	5.878	12.035	0.481	5.789	34.7
24	2016-10-28	10:24:19	13.356	0.534	7.132	13.473	0.539	7.262	12.303	0.492	6.053	10.26
25	2016-10-28	10:25:19	12.787	0.511	6.534	13.239	0.53	7.017	12.069	0.483	5.829	13.69
26	2016-10-28	10:26:19	12.37	0.495	6.123	12.169	0.487	5.926	10.915	0.437	4.77	11.24

Figure 4. Web page with monitoring values.

Figure 5 shows, in a graph, the power values along one day. It is possible to identify the hours with higher attenuation index. Moreover, it is also possible to identify some kind of failure in the panel.

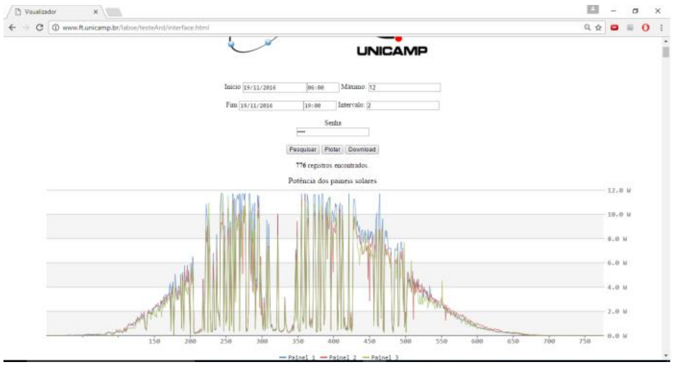


Figure 5. Slope in one-day measurement.

Figure 6 represents the curve of a 6-day measurement. The graph helps identify the scenarios faced during these 6 days.

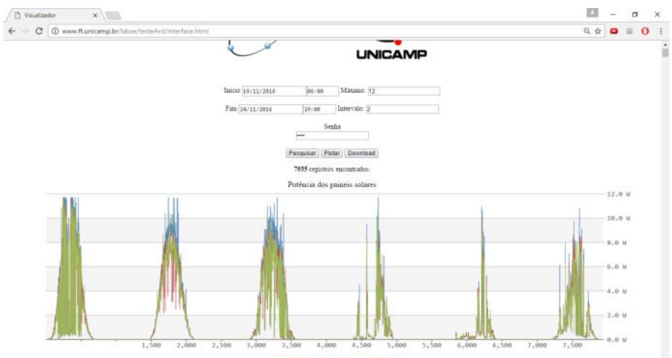


Figure 6. Curve in 6-day measurement.

IV. CONCLUSION

The results showed that the technique used was enough to build a system of data acquisition in real time for photovoltaic panels. The system was built using easy to access components.

The remote access is one of the advantages of the web, because it can be accessed from anywhere. Finally, the process carried out by the system also generates reports, crucial resource in tasks for predictive maintenance of the solar panels.

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