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Implementation of wireless monitoring system for analyzing solar photovoltaic panel

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ABSTRACT – This paper aims to explain the implementation of a low cost wireless monitoring and communication system for an individual solar photovoltaic panel. The proposed system continuously records information and data at an individual solar photovoltaic panel to observe the performance and operation. Each solar photovoltaic panel is installed with a voltage-current sensor and thermocouple sensor as a system, which is integrated with low-powered Raspberry Pi Zero Wireless to perform information and data sending to the cloud database system. The solar photovoltaic panel information and data is send to Google cloud database system for recording and enable customer to monitor the performance and operational of installed solar photovoltaic panel. Hence, this paper briefly present the operational results to evaluate the system.

1. INTRODUCTION

Solar Photovoltaic is known as one of the most promising technology, which have the greatest future to accommodate the present increasing energy demand. Therefore, the coordination of sensed and measured data or information is very important for an effective management using the wireless communication system. In [1], ZigBee technology is integrated to remotely monitor and distribute the controlling of smart photovoltaic system. In [2][3], proposed a ZigBee technology based monitoring and supervising system. The current and voltage originated from the photovoltaic plant is monitored, in addition, the inverter and battery temperature and humidity is also considered. Similar monitoring and control is proposed in [4] using Labview software and microcontroller interfacing. In another research paper, wireless sensor network is adapted for individual panels to monitor the respective photovoltaic panel's status [5]. This research uses wireless sensor network to identify the efficiency, failure and weaknesses occurs during system operation. This system uses the Bluetooth technology to communicate with the main controller for information sending. In [5], smart mechanism using wireless sensor network technology is integrated to proficiently monitor the solar system performances. Application of IoT is used to detect the faulty solar panels in the solar system. Having reviewed these research paper, wireless sensor network especially Bluetooth technology is seen as one of the promising technology used in solar system monitoring and controlling.

Therefore, this paper explains the findings of a wireless monitoring system for analyzing solar photovoltaic panel condition. The following of this paper is organized as follows: Section 2 presents the performance results. Conclusion is presented in Section 4.

2. SYSTEM DESIGN AND IMPLEMENTATION

Figure 1 and Table 1 shows the complete specification of the proposed system.

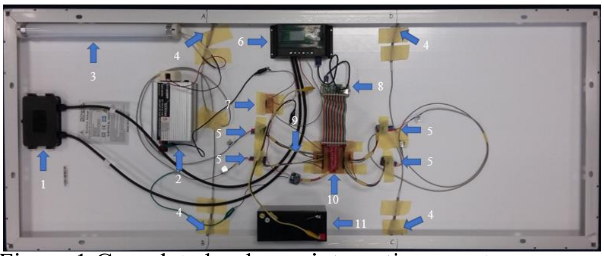

Figure 1 Complete hardware integration - system.

Table 1 Component's Hardware Number – Figure 1

Component's Number	Hardware
1	Solar Panel
2	Solar Power Inverter DC 12V to AC 220V
3	Lamp
4	Thermocouple K-Type (A, B, C, D)
5	Thermocouple Amplifier (MAX31855)
6	Solar Charger
7	PCB Current Divider
8	Raspberry Pi Zero Wireless
9	Voltage/Current Sensor (INA219)
10	PCB GPIO 40 Pins
11	12 Volt Rechargeable Battery

3. RESULTS AND DISCUSSION

This section presents the sensed and measured results for voltage/current sensor – INA219 and thermocouple K-Type. The readings in Tables 2 and 3 are taken starting at 11am when the sun start rising and stops at 6pm in the evening during the sunset.

(a) Thermocouple K-Type Sensed and Measured Reading

Table 2 Thermocouples sensed and measured readings

Hours	Degree Celsius, °C			
	TC A	TC B	TC C	TC D
1	28	27	29	27
2	27	27.5	27	28
3	26	26.5	28	27
4	27	26.5	27.5	27.5
5	27.5	27.5	27	28
6	29.75	30	30.5	30
7	28	29	29	29.5

According to the recorded reading, the temperature at the solar photovoltaic panel rises when the heat from the sun rises.

(b) Current, Voltage and Power

Table 3 Current, voltage and power measurement

Hours	Voltage (V)	Current (A)	Power (W)
1	11.2	0.93	10.29
2	11.5	0.85	9.86
3	11.42	0.9	10.2
4	11.58	0.85	9.88
5	11.6	0.85	9.86
6	11.55	0.88	10.07
7	11.62	0.84	9.87

Table 3 shows the sensed and measure current, voltage and calculated output power at each of the solar photovoltaic panel**.** The output power indicates small increment but eventually remain constant because of increment in the environment temperature, which affects the generated output power.

(c) Google Cloud - Current, Voltage and Temperature

Figures 2 and 3 shows the recorded current, voltage and temperature data transferred to Google Cloud from the Raspberry Pi Zero Wireless (Figure 1). This data is stored into the SD Card at the Raspberry Pi Zero Wireless, and then is pushed into the Google Cloud, which is setup in the Google Drive.

4. CONCLUSIONS

The results and discussion presented in Section 3 validates the methodology used to design and implement the proposed system for analysing solar photovoltaic panel, which is presented in Figure 1.

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```
Python 2.7.13 (default, Jan 19 2017, 14:48:08)
[GCC 6.3.0 20170124] on linux2
Type "copyright", "credits" or "license()" for mo
>>>
================= RESTART: /home/pi/Desktop/ina21
Voltage: 11.56V
Current: 874.09mA
Power: 10106.10mW
Voltage: 11.54V
Current: 876.40mA
Power: 10102.44mW
Voltage: 11.47V
Current: 894.51mA
Power: 10234.15mW
Voltage: 10.01V
Current: 988.96mA
Power: 10878.05mW
Voltage: 11.50V
Current: 870.49mA
Power: 9984.15mW
Voltage: 11.49V
Current: 871.40mA
Power: 10010.98mW
Voltage: 11.50V
Current: 857.62mA
Power: 9850.00mW
```

Figure 2 Current, voltage and power.

```
Python 3.5.3 (default, Jan 19 2017, 14:11:04)
[GCC 6.3.0 20170124] on linux
Type "copyright", "credits" or "license()" for more
>>>
================= RESTART: /home/pi/Desktop/4x ther
Press Ctrl-C to quit.
Thermocouple Temperature 1: 24.000*C / 75.200*F
Thermocouple Temperature 2: 33.000*C / 91.400*F
Thermocouple Temperature 3: 27.750*C / 81.950*F
Thermocouple Temperature 4: 27.250*C / 81.050*F
Thermocouple Temperature 1: 24.000*C / 75.200*F
Thermocouple Temperature 2: 33.500*C / 92.300*F
Thermocouple Temperature 3: 27.750*C / 81.950*F
Thermocouple Temperature 4: 27.750*C / 81.950*F
Thermocouple Temperature 1: 24.000*C / 75.200*F
Thermocouple Temperature 2: 33.500*C / 92.300*F
Thermocouple Temperature 3: 27.750*C / 81.950*F
Thermocouple Temperature 4: 27.750*C / 81.950*F
Thermocouple Temperature 1: 24.000*C / 75.200*F
Thermocouple Temperature 2: 33.500*C / 92.300*F
Thermocouple Temperature 3: 27.750*C / 81.950*F
Thermocouple Temperature 4: 27.750*C / 81.950*F
Thermocouple Temperature 1: 24.000*C / 75.200*F
Thermocouple Temperature 2: 33.500*C / 92.300*F
Thermocouple Temperature 3: 28.000*C / 82.400*F
Thermocouple Temperature 4: 27.750*C / 81.950*F
Thermocouple Temperature 1: 24.000*C / 75.200*F
```

Figure 3 Four-thermocouple temperature reading.

REFERENCES

[1] X. Xiaoli and Q. Daoe (2011). Remote monitoring and control of photovoltaic system using wireless sensor network. *2011 Int. Conf. Electr. Inf. Control Eng.*, 633–638.

[2] F. Shariff, N. A. Rahim, and W. P. Hew (2015). Zigbee-Based Data Acquisition System for Online Monitoring of Grid-Connected Photovoltaic System. *Expert Syst. Appl.*, 42(3), 1730–1742.

[3] L. Saraiva, A. Alcaso, P. Vieira, C. F. Ramos, and A. M. Cardoso (2016). Development of a Cloud-Based System for Remote Monitoring of a PVT Panel. *Open Eng.* 6(1), 291–297.

[4] P. Padmaja and M. U. Shamili (2015). Design and Implementation of photovoltaic System Control Based on GSM Remote Monitoring. *Int. J. Sci. Eng. Technol. Res.* 4(24), 4663–4667.

[5] M. J. Prieto, A. M. Pernía, F. Nuño, J. Díaz, and P. J. Villegas (2014). Development of a Wireless Sensor Network for Individual Monitoring of Panels in a Photovoltaic Plant. *Sensors (Switzerland)* 14(2), 2379–2396.