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Web Based Raspberry Monitoring System Solar Energy Power Plant

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Abstract. In conducting the monitoring of current and voltage change towards temperature change and humidity at the output of Solar Power Plant (SPP), the researcher used to conduct measurement manually which was by using multi meter until the measurement obtained depends on the researcher/the operator itself to do the measurement. In this research, the researcher looked for the solution to replace the human roles as the operator of the measurement tool with raspberry pi-based monitoring system and RTC DS3231 to monitor the current, the voltage, the temperature, and the humidity on the surface of PTS to know the current that flows and the change of voltage towards the temperature and the humidity that occur in 24 hours. Based on the result of the research conducted, raspberry pi-based SPP monitoring system and RTC DS3231 could record the current, the voltage, the temperature, and the humidity in real time towards the performance result of SPP into CSV file with recording time once in 10 seconds into Micro SD and the result of that measurement can be accessed through website/internet where Raspberry Pi is functioned as the web server connected to the campus network system.

Keywords – Measurement, SPP, raspberry, logger data, web monitoring

1. Introduction

Indonesia that is located in the equator obtains good sunlight until the intensity of the abundant sunlight can be utilized to be the source of energy in which the average annual irradiation is 4 to 5.5 kWh/m^2 per day (1 kWh=1MJ/3600*1000) [1], [2]. Mid-day irradiation approximately 1 kW of energy on every m^2 of ground surface [3], [4]. Solar Power Plant (SPP) is the tool to convert the sunlight to be electrical energy, big and small power produced is influenced by the changes of some conditions such as the temperature & humidity, the direction of the sunlight, the strength of the sunlight, and so on [5].

The direct measurement by using multi meter and the temperature measurement tool and the humidity to observe the current change and the voltage at SPP is felt not optimal yet, in which the measurement still counts on the operator to assure the multi meter and the temperature and humidity measuring tool work well, frequently the multi meter experienced standby or not reading in a couple of minutes or low battery and so on. The SPP monitoring system that places the voltage sensor, current sensor, and temperature sensor and humidity to read the voltage change and current towards the

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temperature and the humidity that can be monitored and controlled from far distance can be in the form of micro-controller connected to computer device to save the data read by micro-controller at the web page in which the computer can function as web server connected to internet network or intranet, or micro-controller that can work like mini-computer in which Micro SD functions as the hard disc and works by using operating system installed into that micro SD like Raspberry Pi [6][7].

There are some operating systems that can be installed at Raspberry Pi, one of them is Raspbian. Raspbian is the operational system with Linux-based, to install the functional system into micro SD can use freeware, Rufus. After the operating system works, some applications and functions are ready to be installed and used. In this research, the researcher installed the web server and PHP my admin as the web server to display the report and information the results of the research. GPIO obtained at Raspberry Pi functions as pin input/output to read sensors will be used. The sensor used for SPP monitoring system is the voltage sensor, the current sensor such as ACS712 and temperature sensor and humidity DHT11 that mostly sold at the electronics store or online store. In order, Raspberry Pi can read the sensor based on the time and date of the measurement, real-time clock (RTC) is used because raspberry is not yet completed with time and clock system like the computer in general. The result of sensor reading based on the time and date are saved into one file or called as logger data in the form of CSV file. Next, the web page that has been built will read the CSV data until the web display result will show the reading that has been saved into CSV file in which the reading system is conducted once in 10 seconds.

2. Research Methodology

The monitoring system of SPP at Faculty of Engineering Lancang Kuning University was started from the study of literature, then data collection, the working performance analysis, and the design then functioning web-based monitoring system.

2.1. A. Reading The Data of The Time and The Clock

Raspberry Pi does not have update time system except through two ways, they are Raspberry Pi connected to the internet until the local automatically synchronized to internet time or using Real Time Clock (RTC). RTC is chip IC that has time started from second, minute, hour, day, date, month, until year accurately which are provided at RTC module with power supply source itself which is the clock battery.
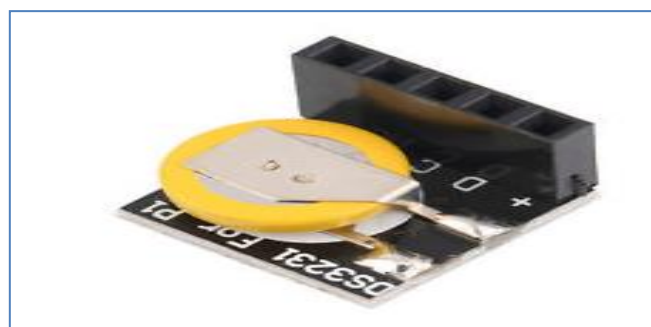

Figure 1. RTC3231

To read RTC3231 in Raspberry Pi, we can do instruction below step by step:
```
sudo apt-get update
sudo apt-get -y upgrade
sudo nano /etc/modules
```

At the display of the bottom page, add rtc-ds3231 with the example as follows:
```
snd-bcm2835
i2c-bcm2835
i2c-dev
rtc-ds3231
```

2.2. Read The Voltage Data

The sensor used to measure the voltage is the sensor with voltage DC 0-25 V, this module worked based on resistive divider principle, made the voltage that will be detected decreased 5 times, until the output voltage from sensor 0-5 V and the maximum voltage detected was 5 x 5 V = 25 V. From the result of the voltage system test at raspberry during the reading was 3,7978875v until the maximum voltage detected was 5 x 3.7978875 V = 18.9894375 V. Because this output voltage from maximum solar panel 38 V or 2 times from the reading then added with divider resistive sequences before entering the sensor which was 2 resistors connected series with the sequences.

IC MCP3008 is the IC converter from the analog which is in the form of measured value changed into the digital value, IC MCP3008 has 8 channels analog reader and 4 legs that will be connected to Raspberry Pi and Vcc to 3,3 V and the ground.

In which the first column is the date and time, the second column is voltage reading 1, the third column is the voltage reading 2, the fourth column is the voltage reading 3, and the fifth column is the voltage reading 4. Next, this CSV file will be read by webpage at the discussion below.

2.3. Read The Current Data

The sensor used to read the current output of the solar panel was ACS712, ACS712 is the module that functions censing the current at certain sequence, module variant ACS712 is divided in 3, they are the reach of current measurement maximal 5 A with sensitivity 185 mV/A, maximal 20 A with sensitivity 100 mV/A and maximal 30 A with sensitivity 66 mV/A. In this research, the writer used ACS712ELCTR-30 A that can sense the maximal current 30 A. The following is the sequence:
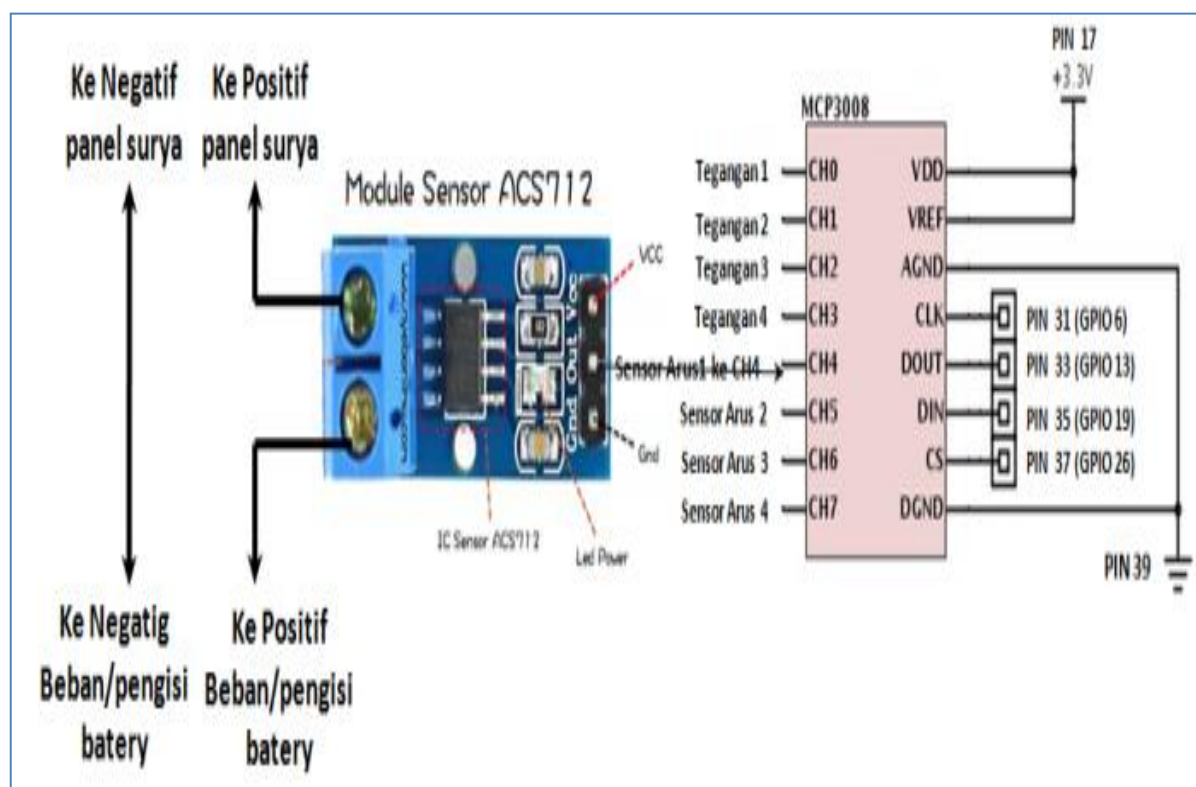

Figure 2. The Sequences of Current Sensor ACS712

Like the censor of the voltage using channel 0 until channel 3 to read voltage 1 until voltage 4 from a solar panel, channel 4 until channel 7 read 4 sensors of current 1 until the censors of current 4 that are connected to 4 solar panels.

Next the instruction of saving the data into the CSV file and setting the reading time the same with the voltage reading above in which the voltage data and the saved current into the same file which was datatgg.csv and the data collection was conducted once in every 10 seconds.

```
# the location of CSV file the same with the program location in the same folder, then:
data = open ('data.csv', 'a')
```

The data that will be read becomes 4 data again, they are currently 1, current 2, current 3, and current 4, then the reading instruction becomes:

```
data.write ('{}    {}    {}    {}    {}    {}    {}    {}    {}\n'.
format(waktu, voltage1, voltage2, voltage3, voltage4, arus1, arus2, arus3, arus4))
# the reading instruction every 10 seconds made under the data writing instruction:
time.sleep(10)
```

2.4. Read The Temperature Data and The Humidity

To measure the temperature and the humidity, the DHT11 sensor was used. DHT11 is the sensor module that functions to sensing the temperature object and the humidity that has the analog voltage that can be processed further at Raspberry Pi. The sequences are as follows:
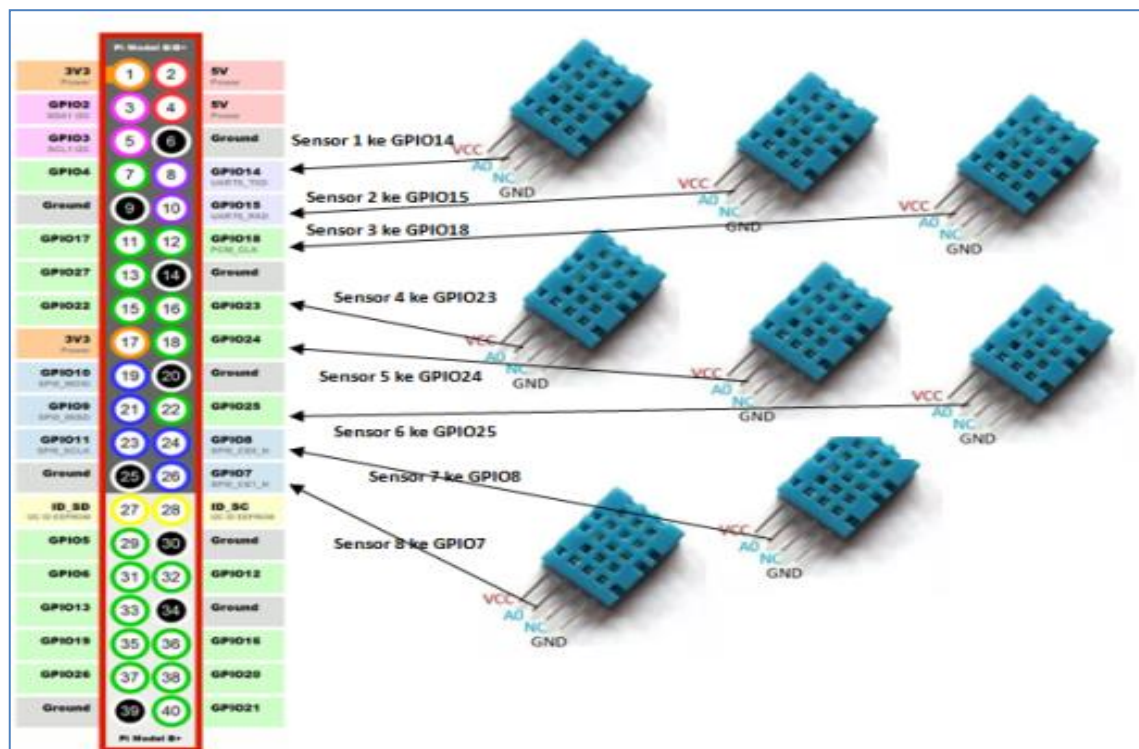

Figure 3. DHT11 and GPIO Raspberry Pi

Two DH11 censors were installed at the solar panel, resistor 10 k ohm was connected to A0 and VCC for the reading accuracy. In this research, there was 4 solar panel then 8 censors of DHT11 will be installed in which 2 DHT11 sensors are installed at each solar panel. To read DHT11 at raspberry pi, it can be done by using the library that can be downloaded from the internet or installing the application Adafruit_Python_DHT11 through the following ways:

```
sudo apt-get update
sudo apt-get install build-essential python-dev python-openssl git
git clone https://github.com/adafruit/Adafruit_Python_DHT. git && cd Adafruit_Python_DHT
sudo python setup.py install
```

After it is done, the instruction at the example can be used. With the file capital at the file AdafruitDHT.py existed in the example folder, we can add from 1 example censor used to be 8 DHT11 censors . The following is the data result saved into datasuhu.csv:

Figure 4. Data of Logger Censor The Temperature and The Humidity

At the figure, it can be seen that each data is separated by the tab in which the first column the date and the time, the second column humidity of sensor 1, the third column was the temperature data at sensor 1, and so on until sensor 8.

3. Raspberry PI Web Monitoring

Raspberry Pi is a small single board computer, wich performanced like any desktop, laptop, or server [8], [9]. It also called the microcontroller [10] or microcomputer based or minicomputer, in which Micro SD functions as the hard disc at the computer in general in which the operating system is saved. The operating system used in this research is wheezy-raspbian.

3.1. Installing Wheezy-Raspbian

This operating system can be downloaded at page http://www.raspberrypi.org/downloads/ and application Rufus to install raspbian into Micro SD by using Micro SD card reader.

3.2. Installing Web server

After the operating system works at Raspberry, next we install apache that functions as the web server application. The way to install this Apache is very easy; run the instruction `sudo apt-get update`, afterward run `sudo apt-get install apache2 -y`. When done, then the raspberry has been installed with web server (visit http://localhost/).

If the upgrade is necessary to support to format php, run the instruction `sudo apt-get install php libapache2-mod-php -y`, after that delete file index.html and make the new file with name `index.php` and fill in "`<?php phpinfo(); ?>`" into `index.php` and raspberry has already supported php format.

3.3. Displaying The Web of Temperature Data and Humidity

The writer made one folder under www with folder name "research", at that folder, the writer created the new file with name "`data-suhu.php`", the following is the script that displays the temperature data and the humidity

3.4 Displaying The Web of Voltage Data and The Current
The same with the data web of the temperature and the humidity, the writer made the new file under the research folder named "`data-tegangan.php`" with a script and the following is the data web display of the voltage and the current:

4. The Analysis and The Discussion

Beside it can display the data at the web page, the instruction of show the chart for the needs of analysis can be done based on the logger data of the temperature and the logger of the voltage and the current. The following is the analysis and the discussion by the writer:

4.1. The Comparison Between The Voltage Towards The Temperature

The chart display at web raspberry page, showing the chart of the voltage and the current towards the change of temperature above the surface of SPP, the temperature used was the average of the temperature sensor 1 and the temperature sensor 2 installed on the surface of 4 SPP. Then it can be seen that the temperature can influence the voltage output PV even though it is very small.

4.2. The Comparison Between Voltage Towards Humidity

The chart of the voltage and the current towards the humidity change. The humidity almost did not influence the output voltage at the PV.

4.3. The Comparison Between Voltage Towards PV A, B, C, and D

At the web page, it also shows the voltage output of PV comparison, among PV A, B, C, and D. PV A and PV C direct to the east and PV B and D direct to the west, from the chart it can be seen that the voltage in the morning at PV A and C was bigger compared to PV B and C, however in the afternoon the output voltage of PV B and D was bigger than at PV A and C. When the thunder occurred, it could be seen there was voltage output from PV.

5. Conclusion

The monitoring system of SPP web-based can be developed further, either from the parameter side that will be measured or the chart display or the comparison needed. In order to be accessed from outside of the campus, IP Address that can only be accessed in campus LAN is changed to IP Public that can be obtained from the internet provider. Another development can be done at weighting control in which the contractor as the connector between the inverter and the loads can be disconnected or connected with the setting at raspberry pi or the menu provided at the webpage itself until it can be monitored and managed so that the battery does not run out quickly.

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