Smart Monitoring of e-Wakaf Solar System, FKEE UTHM using IoT

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1. Introduction

Solar energy is widely available throughout the world and can contribute to minimize the dependence on energy imports. In 90 minutes, sufficient sunlight strikes the earth to supply the energy needs 2of the whole planet for a year. A Solar Energy does not produce greenhouse gas (GHG) during operation and does not emit other pollutants. A Solar has many advantages, such as system-friendly deployment, improved operating strategies, advanced renewable energy forecasting and improved power plant scheduling. Additionally the solar energy is a flexible resources, including demand-side resources, electricity storage, grid infrastructure and flexible generation [1]. The photovoltaic panel (PV) consists of a series of photovoltaic cells mounted to convert solar radiation into electrical energy through a photoelectric effect. The Photovoltaic cells are made from silicon and extracted from the quartzite gravel raw material. In order to obtain silicon dioxide, the quartz is crushed during the process and the raw materials must be processed significantly before Photovoltaic cells can be made [2].

The monitoring systems of PV is very important for analysis the data, troubleshooting and decision-making [3]. Several monitoring systems have been developed using (IoT) to calculate solar panel quality parameters [4]. The Internet of Things (IoT) is a collection of interconnected computing devices, mechanical and virtual appliances, objects, people or animals with unique identifiers and the ability to transfer data over a network without needing communication between humans and computers [1].

This project is development of e-Wakaf Solar System Monitoring using IoT based on Arduino Uno as main controller of the system. This project using voltage sensor, current sensor and waterproof temperature sensor to monitor the performance of solar panel. A node MCU ESP8266 device is as an intermediary between device and ThingSpeak platform. Based on the results, the difference of manually and IoT system results of voltage, currents and power are 2.31%, 3.46% and 3.38%, respectively.

2. Methodology

The project used the Internet of Things (IoT) to monitor the performance of the solar system [5][6]. This project also divides into two parts: the software development and the hardware development. The software development is the programming of Proteus and Arduino was developed [7] [11] [12]. Secondly, the hardware development is a Prototype setup and a measurement circuit that consist of sensors and Arduino board so that the sensors data transfer and display to the connected PC. The

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Arduino then transfer data to the ThingSpeak platform using NodeMCU ESP8266 to display solar panel output [13][14].

The project consists of the following components: a solar panel [8][9][10], a charge controller circuit, a rechargeable battery, a DC / AC inverter, meter, temperature sensor, Arduino Uno, voltage sensor, current sensor and NodeMCU [15]. These are shows in the block diagram as shown in Figure 1.

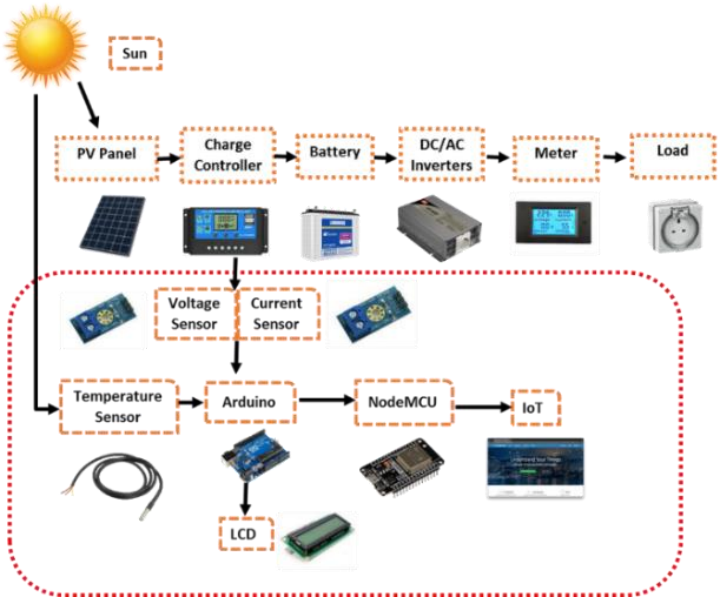

Figure 1: Process of PV panel using IoT

A photovoltaic panel are used to convert solar energy into electrical energy. The energy been stored inside the battery so that the supply of electrical energy at the night or on the rainy day. An electrical energy is saved at an immense level by using the solar to power the charge while the solar charger device is used to secure the charging battery from excess current. Then, the output of battery, which is DC will change to AC using DC/AC inverter for load (240V AC) such as socket and lamp. The Figure 2 shows the PV panel, which is located at G1, FKEE UTHM and Figure 3 shows the location of PV System at FKEE, UTHM.

Figure 2: PV panel at G1, FKEE, UTHM

Figure 3: Channel location

3. Results and Analysis

This section is discussed the results of e-Wakaf PV solar system performance. The comparison results between measurement in manually with ThingSpeak Platform of the PV panel system such as voltage, current, power and temperature are presented.

The temperature and solar panel provided the result, which in Celsius, voltage, current, and electricity, depending on the experiment that was performed. Besides that, reading from the solar panel, the parameter can be monitored from the Arduino IDE serial monitor. The data stream generated and saved in the ThingSpeak platform after a couple of seconds. The data that transmit to the ThingSpeak platform will saved in the data. All the data stored in the data stream will be compiled and show in graph. The Figure 4 to Figure 7 show the output from solar panel. Besides that, the data from ThingSpeak platform can be export to Excel and the results can be analyzed. In addition, ThingSpeak platform also able to show the location of the project by set a Latitude and Longitude. A graphs emphasize the main point, it make the data more convincing and provide users with a concise way to present information. Graphs are actually plots for current, voltage, power and energy value. These graphs are available from anywhere via the internet.

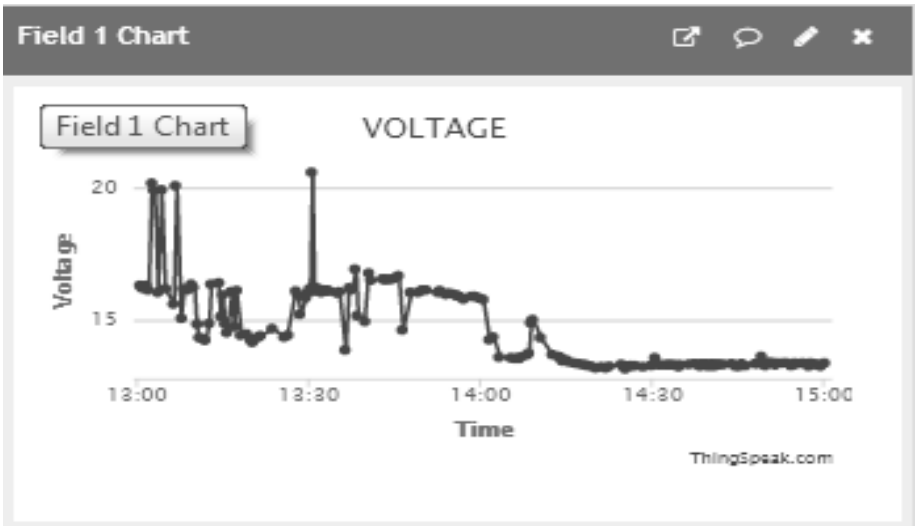

Figure 4: Graph of voltage vs time

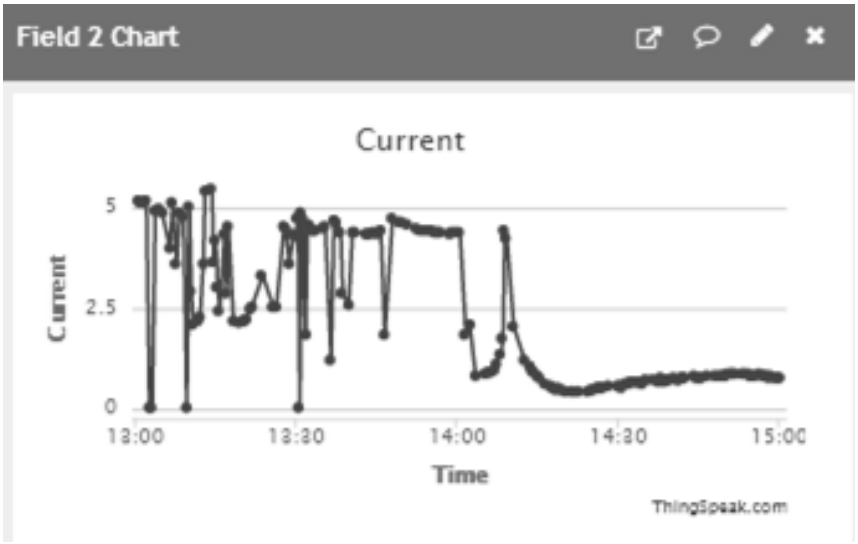

Figure 5: Graph of current vs time

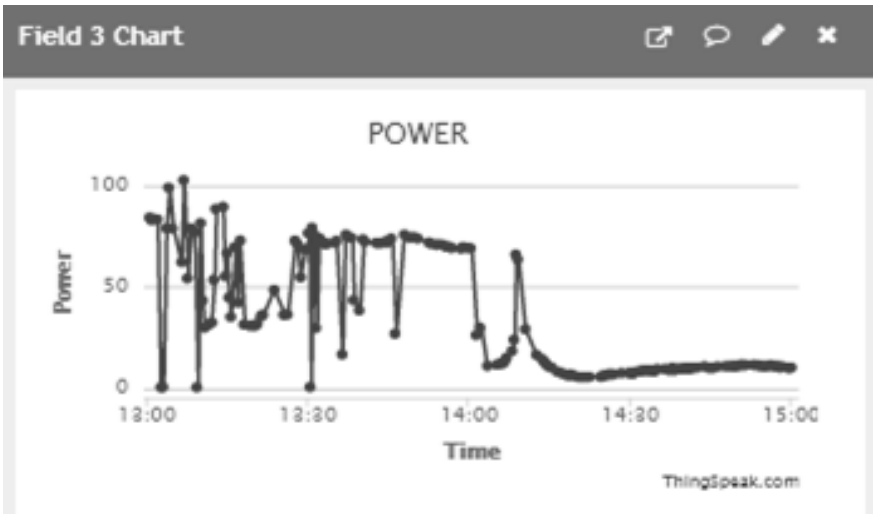

Figure 6: Graph of power vs time

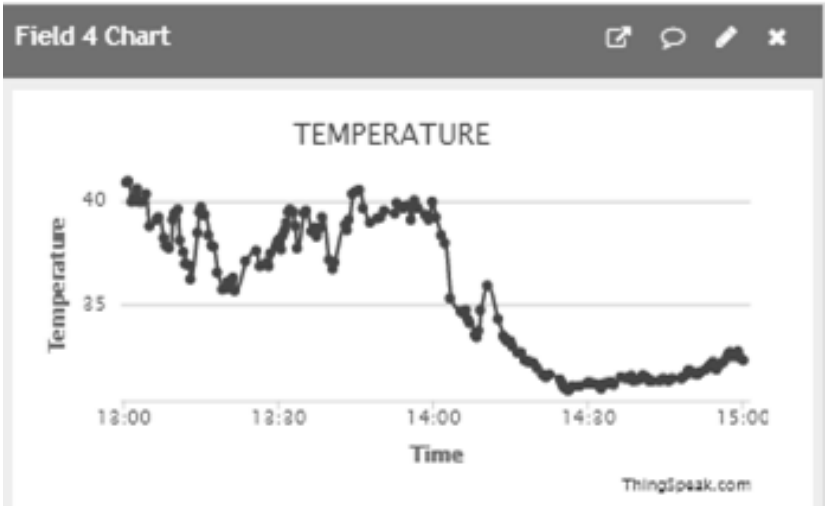

Figure 7: Graph of temperature vs time

3.1 Comparison of PV Panel Performance Monitoring

For this section discusses about the comparison of PV Panel performance based on the manually recorded and ThingSpeak platform at G1, UTHM area on 30 Nov 2019. The result is recorded every 30 minutes starting from 12.00 am until 3.00 pm. The objective is to collect the data of PV panel manually and through ThingSpeak platform which can monitor the performance of PV panel continuously using Internet of Thing (IoT) application to evaluate the data of PV panel system such as voltage, current, power and temperature. Table 1 tabulated the data has been collect from measurement and ThingSpeak platform.

Table 1: Results of measurement on 30 Nov 2019

Time (Hours)	Reading Data							
	Voltage (V)		Current (A)		Power (P)		Temperature (°C)	
	Manually	ThingSpeak	Manually	ThingSpeak	Manually	ThingSpeak	Manually	ThingSpeak
12.00 pm	13.81	13.85	1.44	1.49	19.89	20.65	33.16	33.25
12.30 pm	16.29	16.32	3.51	3.54	57.18	57.83	36.38	36.43
1.00 pm	20.03	16.32	5.25	3.64	84.25	59.43	40.12	40.31
1.30 pm	16.03	16.17	4.72	4.72	75.61	76.27	38.93	38.12
2.00 pm	15.64	15.76	4.28	4.37	66.89	68.94	39.37	39.18
2.30 pm	13.26	13.29	0.56	0.56	7.45	7.47	31.12	31.18
3.00 pm	13.36	13.36	0.76	0.76	10.12	10.12	32.25	32.25

The result was recorded from different methods in which first method is collect data manually and the second method is collect data from ThingSpeak platform. From the observation the higher percentage error is calculated on result at 1.00 pm, 30 November 19. By using the formula $[\frac{|\text{ThingSpeak Platform} - \text{Reading Data Manually}|}{|\text{Reading Data Manually}|} \times 100\%]$, based on the Table 2, the average percentage error of voltage, current and power from manually recorded data and IoT system are 2.31%, 3.46% and 3.38% respectively. It is because the possibility of human error and instrument error when human take a reading inaccurate. Therefore, it is because need the IoT approach to overcome this problem. While, Figure 8 until 11, shows the graphical results of the voltage, current, power output and temperature reading, respectively.

Table 2: Average percentage error

Time	% Error		
	Voltage	Current	Power
12.00 pm	0.29	3.47	3.82
12.30 pm	0.18	0.85	1.14
1.00 pm	18.52	30.67	29.46
1.30 pm	0.87	0.00	0.87
2.00 pm	0.77	2.10	3.06

2.30 pm	0.23	0.00	0.27
3.00 pm	0.00	0.00	0.00
Average	2.31	3.38	3.38

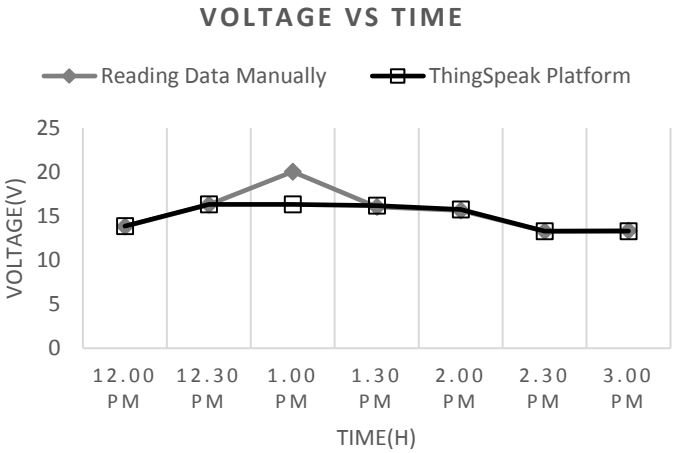

Figure 8: Graph of voltage vs time for 30 Nov 2019

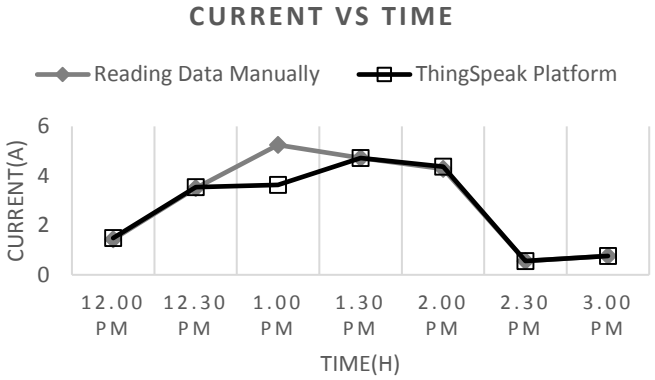

Figure 9: Graph of current vs time for 30 Nov 2019

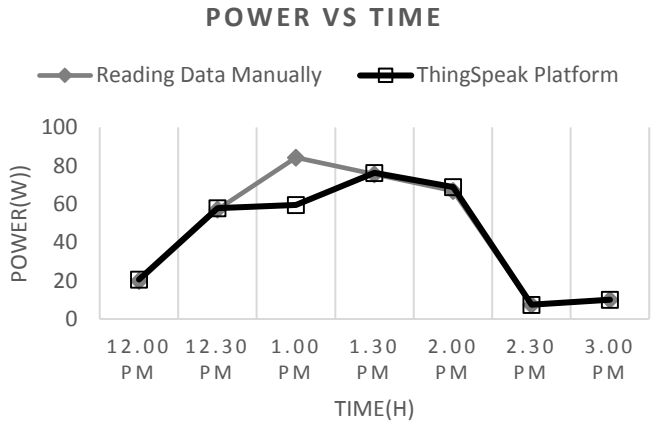

Figure 10: Graph of power vs time for 30 Nov 2019

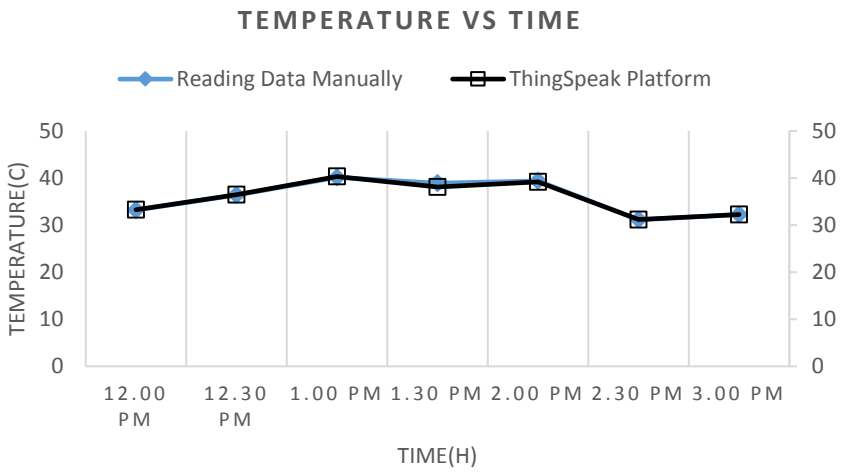

Figure 11: Graph of temperature vs time for 30 Nov 2019

4. Conclusion

As the conclusion, the e-Wakaf FKEE Solar System Monitoring Using IoT Application has been developed successfully. The objective has also been successfully achieved, which is who responsible to take care of the PV panel system is able to continuously collect the data through ThingSpeak platform. Besides that, the problem with wattmeter also can solve in which if wattmeter display blank, LCD able to replace and display the performance of Solar panel system. The monitoring system is equipped with NodeMCU ESP8266 to transmit data from the solar panel to the ThingSpeak platform. This system can work in one condition that the prototype will work within the WIFI coverage so that the user can connect the system to the NodeMCU ESP8266 and access the parameter of the solar panel via the ThingSpeak platform.

In order to determine the functionality of the system, a comparison of the reading of the data method has been made to determine either which one is more accurate. Therefore, the data more accurate is reading through ThingSpeak platform in which the probability of human error when reading data manually is higher. A performance parameter that can be enhanced in the IoT system in the future by improving or modifying the platform. Lastly, the good news is that we will see more IoT analytics demand in general. Organizations are under pressure to automate processes and services due to increased competitive pressure. IoT information itself is the key to finding opportunities for improvement and monitoring of changes. Using IoT increases knowledge of the operating parameters in real time. This allows to gain control over PV systems installed in remote areas, easily and rapidly to analyze fault diagnosis, maintenance, generation recording and quality data.

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