Design of Power Monitoring Application

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Abstract. the usage of electrical energy has increased significantly. Awareness of increasing electricity consumption has motivated many researchers to create various kinds of innovations to help reduce the energy crisis in Indonesia. So, it is necessary to consider educating the civilization to monitor the intensity of energy consumption as a good culture to monitor electricity consumption efficiently. This research aims to design an Android-based application based on the Internet of Things (IoT) that can monitor electricity consumption and trace the history of electricity consumption data. The monitoring application can calculate both the power used per hour and the estimated costs incurred. Application was made to monitor kWh meters using IoT, electronic design by using ACS 712 current sensor and NodeMCU 8260. Based on the experiments conducted, it was concluded that the Design of Monitoring Kwh Meter Monitoring Application with ACS712 Current Sensor Using Ubidots IoT Platform successfully worked to control the monitoring of the amount of electrical energy usage through IoT, which has only 0.35 % error.

1. Introduction

Nowadays the usage of electrical energy has increased significantly. Based on data from the Central Statistics Agency, Badan Pusat Statistic (BPS), the State Electricity Company, Perusahaan Listrik Negara (PLN) customers in 2015 had reached 61,214,562 which in 2010 the number of PLN customers was 42,438,860. The increase in the number of PLN customers is also accompanied by an increase in electricity consumption per capita [1]. Awareness of increasing electricity consumption has motivated many researchers to create various kinds of innovations to help reduce the energy crisis in Indonesia. However, besides helping to solve the energy crisis problem, in Indonesia it is necessary to evaluate the use or consumption of electricity. Make social culture of electricity consumption efficiently in accordance to one of the themes raised by the National Energy Council, Dewan Energi Nasional, is the achievement of energy efficiency and conservation [2]. So, it is necessary to consider educating the civilization to monitor the intensity of energy consumption as a good culture to monitor electricity consumption efficiently.

Considering to the data, it is very necessary to design a tool and application that is capable of monitoring electrical energy consumption. Therefore, this research aims to design an Android-based application based on the Internet of Things (IoT) that can monitor electricity consumption and retake electricity consumption data. The monitoring application can calculate both the power used per hour and the estimated costs incurred. Application was made to monitor. This application calculates the electric power by multiplying between drawn current by loads and voltage across the load. Additional for this application, the application calculates value of energy, kW, to be multiplied by the price of electricity per kWh in order to get an estimated cost to be paid by the consumer. By utilizing advances
in technology, an idea emerged to design a system that monitors the amount of electricity used through IoT.

By utilizing these technological developments, an application was made to monitor kWh meters, electronic based IoT circuit consists of a current sensor, ACS712 and nodeMCU8260 as main processor. The android based application developed provides information of current, voltage, power and estimated cost incurred. With this application, the energy consumption can be monitored, thereby encouraging more efficient use of electrical energy for energy sovereignty.

2. Related Work

Research that refers to making energy monitoring applications has been conducted in several studies. Researcher [3] made an application that could monitor energy consumption at home. The research based on WSN (Wireless Sensor Network) research designed ABASH, an android application for smart home.

Research [4] designed an android-based power management application. Energy consumption analyzed was obtained from the Current Transformer (CT) sensor air conditioner, and data were processed from a webserver connected to Arduino and could be accessed via an android application, the value can be displayed using graphical interface. This application already built using IoT, thus the user can trace the history of power consumption. The measurements that can be tracing are current status, room, statistic and history.

Research [5] makes application of monitoring domestic household electrical energy. The application was built to be accessed in real-time using an android application. Monitors the data in the form of power consumption, voltage, and current in household electricity. In research [6] made an android application that can measure the electrical charge on household energy consumption and is able to calculate the costs that must be incurred based on the consumption of electrical energy.

3. Design of System

Design of system android application using Internet of Things is illustrated in Fig 1,

Figure 1. Illustration of System.

Figure 1 shows that the user uses the android application to access data stored on the server. The server section is connected by using Arduino to be able to access energy consumption in kWh meters connected to various household electricity loads. Figure 2. shows the relationship between kWh meter and load. In the kWh meter information on electricity consumption is obtained.
The resulting signal will be accessed and computed using Arduino to get the current and voltage data used. After the data is obtained the user can find out the electrical energy consumption and the price incurred per kWh meter. Figure 3. presents an illustration of the use of android applications, that users can access electricity consumption and costs incurred in order to build user awareness to be able to cultivate efficiency in electricity consumption.

The design of the device consists of electronic design and IoT data design. The electronic design is created using the MCU Node ESP8266 as a communication module between Arduino and a database which is an IoT (Internet of Things). Here is an electronic circuit to create a kWh Meter Monitoring Application with ACS 712 Current Sensor, Figure 4 shows electronic wiring of the system,
The wiring of electronic circuit is shown in the Fig 4, the ACS 712 output sensor is connected to the load and switch, while the input is connected to NodeMCU 8260 for communication on the Ubidots Iot Platform and Arduino Uno.

After the electronic design is complete, continue to develop the database design. The database was created using the IoT Platform from Ubidots. Ubidots is an Internet of Things platform from the United States. Fig 5. Shows application Development from Ubidots

The initial step in using Ubidots is to log in. These Ubidots can be created using the Arduino IDE program. After creating a program on the Arduino IDE, data can be entered such as the NodeMCU board, port and enter the Ubidots library and then connected to the electronic circuit that was created with the help of NodeMCU 8260. To display the token, select the dashboard menu and select the devices that are already connected to Ubidots. Then upload the sketch that was made on the Arduino IDE. Then open the serial monitor with 115200 baudrate. Then return to the dashboard menu to display the results.

Using Android Studio, Ubidots platform can be accesses directly from android smartphone. From this platform user can monitor these measurements, current, energy, and cost of electricity. We assume, the voltage remains constant at 220V. IoT makes the user can trace the history of these measurements.

4. Implementation and discussion

To display the results of the current reading, we make an IoT-based application where the application can later be used to monitor the current flowing depending on how much we use electricity in our homes. As explained in the application design method, it receives current reading data with the

Figure 4. Electronic Circuit.

Figure 5. Application Development of Ubidots
help of the ACS 712 sensor sent by the circuit using NodeMCU 8260. The application is Ubidots. Dashboard of user interface is shown in Fig 6.

![User Interface](image)

**Figure 6. User Interface**

For the implementation electronic design is connected to the load, two lamps that have power value are 60 W and 40 W. will be displayed in table I,

**Table 1. Current Value**

| No | Time (m) | Current (A) |
|----|----------|-------------|
| 1. | 5        | 0.23        |
| 2. | 15       | 0.31        |
| 3. | 20       | 0.02        |
| 4. | 25       | 0.07        |
| 5. | 30       | 0.35        |
| 6. | 35       | 0.38        |

Based on Table 1, It can be seen that the current value in this test is small because the load measured is only two incandescent lamps. ACS 712 sensor successfully works to measure the current.

**Table 2. Power**

| No | Time (m) | Power (Watt) |
|----|----------|--------------|
| 1. | 1        | 70.09        |
| 2. | 2        | 79.28        |
| 3. | 3        | 80.80        |
| 4. | 4        | 96.94        |
| 5. | 5        | 84.77        |
| 6. | 6        | 90.13        |
| 7. | 7        | 77.43        |
| 8. | 8        | 108.83       |
| 9. | 9        | 61.42        |
| 10.| 10       | 103.96       |

From Table 2, It can be seen that the power value in this test is also increased due to the current data. Graphical display of the measurement is shown in Fig 7-Fig 10.
Figure 7. Cost of Electricity for 1 Minutes

| Date          | Value |
|---------------|-------|
| 2019-05-30 23:56:00 -07:00 | 109.96 |
| 2019-05-30 23:57:00 -07:00 | 81.42 |
| 2019-05-30 23:58:00 -07:00 | 100.03 |
| 2019-05-30 23:59:00 -07:00 | 77.45 |
| 2019-06-01 00:00:00 -07:00 | 80.19 |
| 2019-06-01 00:01:00 -07:00 | 84.77 |
| 2019-06-01 00:02:00 -07:00 | 80.94 |
| 2019-06-01 00:03:00 -07:00 | 80.60 |
| 2019-06-01 00:04:00 -07:00 | 79.28 |
| 2019-06-01 00:05:00 -07:00 | 70.06 |

Figure 8. Power Value

Figure 9. Graphic of Power
In Figure 10, is a graph of current after 5 minutes. This application measures an average current of 0.55 A and power value, $P_m$, 121.43 W. For the validation, we calculate current and voltage, $I = 0.55$ A, $V = 220$ V, to obtain power value of calculation ($P_c$). The calculation using equation (1) as follow,

$$P_c = V \times I_m$$

Where, $P_c$ is power calculation value (W), $V$ is voltage (V), $I_m$ is measurement current value (A). The calculation using equation (1) has a value $P_c = 121$ W. Which has only 0.35 % error compare to value of $P_m$. From $P_m$ value, we can estimate the cost of electricity, first we get kWh of the electricity is 0.04. The price for electricity per hour is Rp. 1000, - thus we obtain the cost is Rp4,-. The graphic value of electricity cost is shown in Fig 11.

5. Conclusion

Based on the experiments conducted, it was concluded that the Design of Monitoring Kwh Meter Monitoring Application with ACS712 Current Sensor Using Ubidots IoT Platform successfully worked to monitor the amount of electrical energy usage through IoT, which has only 0.35 % error. The advantage of this tool is that it has simple packaging, is relatively cheaper, and time efficient.
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