Implementation of cart Algorithm for Monitoring System and Prediction of Electric Power use of IOT-Based Household Equipment

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Abstract. PLN customer power consumption from the household sector is quite large, originating from the use of household appliances, such as refrigerators, televisions, dispensers, lamps and air conditioners. When users feel that their electricity usage is wasteful, they do not know in detail which household electrical appliances consume the most electricity. At this time customers still find it difficult to monitor the power usage of every household electrical appliance. So it is not known which equipment consumes large amounts of electrical energy. For this reason, a monitoring system for household electrical power usage is needed. This system can be used by PLN household sector customers to find out which household appliances use large power, so customers can manage the use of household appliances. To do this monitoring, a wattmeter device is needed that is able to measure the power use of household electronic equipment. The results of this measurement are measured current data through the current sensor. So that monitoring can be done through the system in real time, the measurement data is sent to the monitoring system database server via the internet of things (IoT) devices. Data generated from the monitoring system can be analyzed using prediction techniques, to obtain information about the length of time the availability of electrical energy has been purchased by the customer. One algorithm that can be used to predict the use of household electrical power is the CART algorithm. This research aims to build a monitoring system for power usage for each IoT-based household appliances. This research aims to build a monitoring system for power usage for each IoT-based household appliances. The second objective of this research is to apply CART algorithm to predict the power usage of household appliances.

1. Introduction

PLN customer power consumption from the household sector is quite large. Based on the 2016 Electricity Statistics Record issued by the Directorate General of Electricity of the Ministry of Energy and Mineral Resources, the number of PLN customers in the household sector in 2016 was 59,243,672. The results of electricity sales for a number of these customers was 93,634.63 GWh. Where the consumption of electrical energy comes from the use of household appliances, such as refrigerators, televisions, dispensers, lights and air conditioners.

Household sector electricity users do not know in detail which household electrical equipment consumes electricity. So that users feel the use of electricity is wasteful. Customers do not know which electrical equipment uses the most electricity. The amount of electricity used is influenced by a load of electrical equipment and the length of use of electrical equipment. It may be that equipment with a small power load with long usage consumes more power than equipment with a large power load but uses it for a short time. Also, electricity users cannot know the period for the availability of electricity that has been purchased. To estimate the length of time the electricity is available, a prediction is calculated based on the power load of household appliances. As a result, customers will get prediction information for the length of time the availability of electricity. This will be important information for customers to save electricity.

Internet of Things (IoT) refers to the use of information technology, internet network connectivity and sensors that allow devices that are not computers to be connected to each other through the internet network. This device can produce data, send, receive, collect and exchange data. IoT can be used to support water level monitoring systems (Perumal et al, 2015). IoT is used to send water level data to the server in real time. The prototype monitoring system for the use of three-phase electric energy in real time can be supported by using IoT (Lestari et al, 2017). The IoT used in this study was used to collect data on the power usage of each household electrical appliance. Data on the power usage of each of these household electrical appliances can be used to obtain information on which equipment uses a large amount of power as well as information on the length of time the equipment is used.

At this time customers still find it difficult to monitor the power usage of every household electrical appliance. So it is not known which equipment consumes large amounts of electrical energy. In addition, there is also no system that can be used to estimate the length of time for the availability of electrical energy based on the length of use of household electrical appliances.

For this reason, a monitoring system for household electrical power usage is needed. This system can be used by PLN household sector customers to find out which household appliances use large power, so customers can manage the use of household appliances. Data generated from the monitoring system can be analyzed using prediction techniques, to obtain information about the length of time the availability of electrical energy has been purchased by the customer. One algorithm that can be used to predict the use of household electrical power is the CART algorithm.

A study that proposed an IoT-based water monitoring system that measures water levels in real-time. The water level sensor is used to detect the height of the water level based on the desired parameters, if the water level reaches the parameter, the data signal will be sent in real-time. A cloud server is used to store data. The measurement results of the water level are displayed on the dashboard of the prototype application remotely [1].

Research that has proposed an IoT technology solution for web-based real-time monitoring systems aimed at monitoring temperature and humidity in the drying process in the agricultural sector. The focus of this research is how the mechanism for delivering data from sensors to end user devices uses the MQTT (Message Queuing Telemetry Transport) protocol. The system architecture is described as a three-tier client-server architecture with three separate layers, namely presentation, application and database layer [2].

Research that produced a prototype of an electrical energy monitoring system in the G4 building at the State University of Malang using the IoT system. This system prototype has enabled real time measurement for users and can be accessed anytime. Overall system accuracy is carried out on the measurement of three-phase voltage, three-phase current and neutral current with an accuracy of 95.5% with an average error of 4.5% [3].

2. Research Method

In this research, there are several stages that can be seen in the Figure 1 below.

Figure 1. Research Flow Stage

2.1. Make IoT Controller

Making the IoT Controller is the stage to design and make hardware from the system to be built. The device made is a wattmeter. This wattmeter serves to measure the power used by household electronic equipment such as televisions, air conditioners, refrigerators, irons, fans, lights, and so on. Through the IoT Controller module installed on the wattmeter, the measured electronic equipment power data on the wattmeter will be sent to the database server.

2.2. Monitoring

The monitoring phase uses data that has been collected in the previous stage. At this stage, the information obtained from the processing of the two data will be displayed. The information displayed is the length of time each electronic device is on and the total power used by each household electronic device. The length of time information of each electronic device turns on is obtained from the difference in data of the time the electronic equipment turns on and off. While the total power information used by each household electronic equipment is obtained from the multiplication of electronic equipment power data with the length of time for each electronic equipment.

2.3. Data collection

At this stage, data will be collected from the system that has been made. There are 2 types of data collected, namely the power data used by each household electronic equipment and the time the household electronic equipment is turned on and off. These data are obtained from the database. Both of these data will be used in the process of monitoring and prediction.

2.4. Prediction

There are several steps taken in the prediction stage which can be seen in the Figure below. The first step taken is to pre-process data from all data that has been obtained from the data collection stage. Where in this step the merging of the two types of data every day with the class used is the length of time the availability of electrical energy that has been purchased by the customer. Then the data is changed to a .arff extension. The training data is used in the training process by using the CART algorithm. The results of this data training process are prediction models that will be tested using test data. From the testing process will be obtained accuracy. If the accuracy obtained meets the threshold value, where the threshold value used in this study is 80%. This prediction model will be used to predict the length of time the availability of electrical energy based on electrical power that has been purchased by the customer.

3. Result

In making IoT Controller, there are 2 stages uses. First is making tools and then is making databases and system interfaces. Making this tool starts with measuring electric current and voltage. To be able to measure current and voltage parameters, current and voltage sensors are used. Figure 2 shows prototype IoT Controller.

Figure 2. Prototype IoT Controller

Electric current and voltage from every household appliance is sending to database. This research data have attribute electric current (arus), electric voltage (tegangan), electric power (daya), power in kilowatt (kw) and power per hours (kwh). After that, data electric current and voltage can be shown in monitoring system. Figure 3 below show the results of monitoring tools that are monitored using a graphical display.

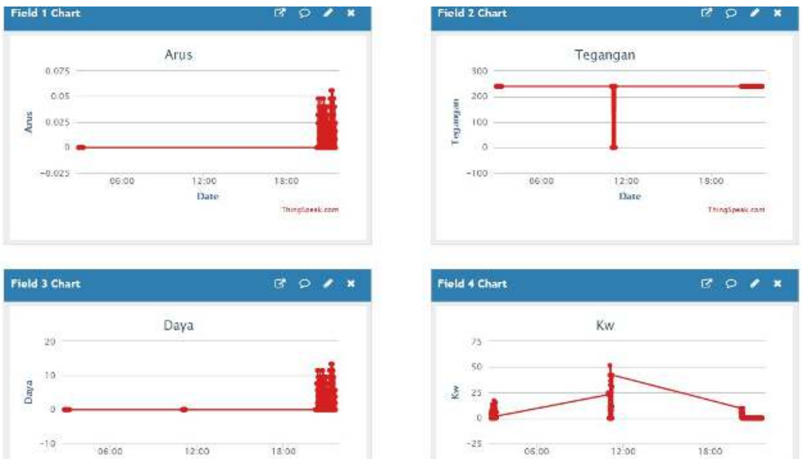

Figure 3. Monitoring

The data which are stored in database can be used to form electricity usage patterns. CART Algorithm used to form electricity usage pattern from electric current and voltage from household appliance. This pattern can be used to predict the electrical use of household appliances. We made data preprocessing before CART Algorithm applied to this research data. We choose three attribute from five attribute. The Attribute that we choose is current, voltage and power per hours. The class attribute is power per hours.

After the preprocessing stage, we applied CART Algorithm to the final research data. We used 10-cross validation for split data become learning data and testing data. The result from learning stage is linear regression equation. The linear regression equation is

$$power\ per\ hours = 0{,}2379 * current + 1.0298$$

This linear regression equation used in testing stage. Accuracy from this linear regression equation is 98%.

4. Conclusion

The result of this research is monitoring system for power usage for each IoT-based household appliances. The other result is CART algorithm can used to predict the power usage of household appliances with accuracy 98%.

References

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