Centralized Smart Home Framework Monitoring for Power Savings

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Abstract. Electrical energy has become a staple for humans. Almost all human activities always require electrical energy. To maintain the availability of electricity at any time, then it takes the process of global electricity savings. The electricity savings can be done in two ways, the first is the development of technology to make electric appliances that require low power for operation and the second is to improve human behavior in the use of electrical appliances (turning off electrical appliances when not in use). This research aims to create a centralized smart home that can help people to monitor the condition of electrical appliances in the house and turn off automatically when not being used. Besides this system could also be used in manual mode and be controlled remotely using a smartphone through the Internet. The system is made centrally so not only for the home but can be used for many homes. After application was implemented it can monitored which device is turned on or turned off.

Keywords: Smart Home, Monitoring and Power Savings

1   Introduction

Electricity has become basic necessities for humans. Almost all human activities require electrical energy. This electrical energy obtained from the power plant that converts a form of non-electric power or energy into electricity. There are many types of power plants that use various kinds of energy, such as hydro [1], wind [2], solar, geothermal [3] and others. However, there are also power plants that use coal so indirectly cause pollution and interfere with the comfort of human life.

In 2010, the consumption of electric energy in the United States approximately 41% was spent in housing / building. Of the total energy in housing / building about 74% is used for the electrical load in the housing, such as lights, air conditioners and other home devices. From 1980 to 2010 the growth of housing increased by 79% [4]. On

these data of electrical energy consumption in the residential sector is enormous and increasing every year. Given the amount of electrical energy consumption in daily life and limited sources of electrical energy generation, to ensure the availability of electricity at any time it is necessary strategic steps to support the global electrical energy savings, optimal and affordable [5]. This electrical energy savings can also reduce the pollution caused by power generation processes that use fuels such as diesel, coal and others [6].

Basically, in order to save electric energy can be done in two ways. The first way is engineered on the power load [7]. The purpose of engineering in electrical load is to develop technology that can make the electrical load working on the same performance but with lower power consumption [8]. Examples of engineering have been done on the power load is the energy saving lamp. The second-way electrical energy savings can be made through customs and human behavior in the use of electricity. Habits and human behavior that only uses electricity when needed, the electricity savings made would be optimal but in fact, sometimes people often forget to turn off electrical appliances when they're finished using. It required an intelligent system that is able to help people in energy savings. Based on these reasons, this study was undertaken in a system " Centralized Smart Home Framework Monitoring for Power Savings ".

This system would be able to monitor the condition of electrical equipment (on / off) that exist in every room in the house or building. The system would also able to detect the presence of the people in each room. This system can be operated automatically with the rules defined by the user, so that the system can turn off unused electrical load automatically. The system can also be operated manually via smartphone. Users can know the status of any electrical equipment (on / off) and also the status of each room (there are / are not) in the home via a mobile application created in this system. Users would also able to turn off and turn on electrical appliances using smartphones. Process monitoring and control could also access remotely via the Internet or GSM network in the smartphone. To find out how much power has been used, the system will be equipped with a flow sensor capable of measuring the power consumption on any equipment used. Thus, the power usage of each device in the home can also be monitored. If this system is applied globally to every house or other building, then this will be an effective measure that can be applied to energy savings.

This research will be conducted in three phases, with an initial aim to design the application framework of the system. Applications are expected to turn on and turn off electrical loads that exist and can monitor the status of the electrical load is turn on or off. Then the application can also be used for monitoring the power usage of each electrical load and on the server can be used to limit the power consumption in every home.

2   System Design

The overall research aims to design Centralized Smart Home. The future target of this research to create of a Smart Home system Centralized both in the hardware and software that can perform power saving can be seen in **Fig. 1**. At that figure Smart

Home Center is used to monitor every device that connected which has an information that give information about device status. Not only monitoring, but Smart Home Center can use to controlling that device. Internet is only used to connecting Smart Home and Smart Home Centre. The protocol of the internet not conducted in this research. And Smart Home used to place the device. At this research object which focused is conducted by Lamp. Lamp is represent by a node which has an microcontroller and sensor.
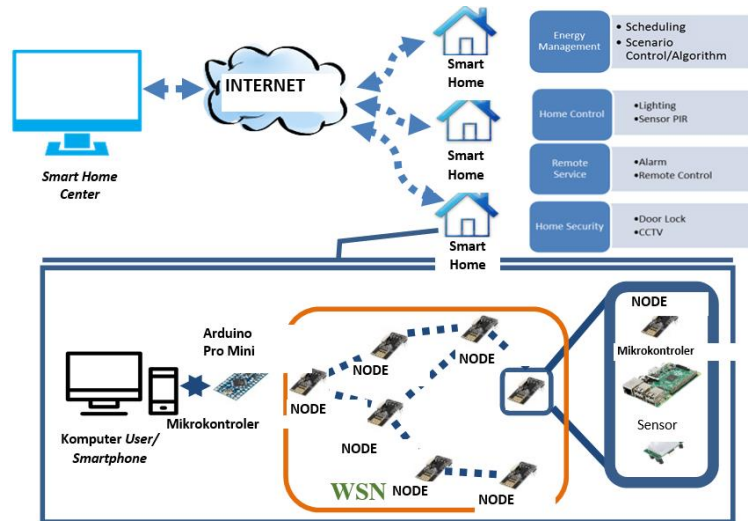

Fig. 1. Smart Home Centralized System

In this paper an early stage of research to design application framework from designing Centralized Smart Home. Applications used later can be placed in the Smart Home Center or computer user / client. This research is focused on application which user can be controlling and monitoring that device in Smart Home in Smart Home Centre.

2.1   Application Design

Application design begins with the design of the use case diagram. Use case diagrams are used to understand the needs of the user. User separated by 3 user, first is Admin who develop the systems. Admin can be controlling all feature that provides by systems. Systems provides the hardware ability to perform in order to Smart Home functional needed by Lamp. User defined by one only people that can monitoring and controlling the systems.
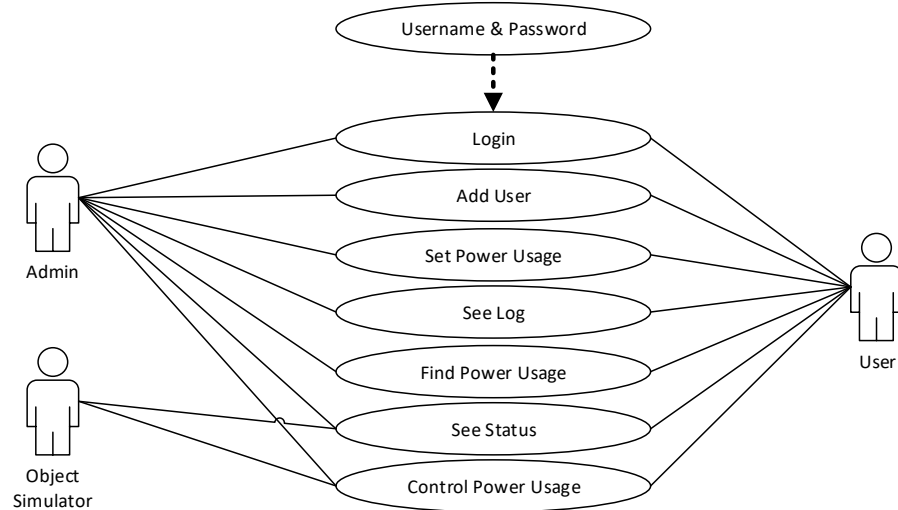
Fig. 2. Application Use Case Diagram

Object Simulator used to simulated Lamp, so it provide the functional scenario that conducted by Lamp. So it can tell the user the lamp condition, it turned on or off, so Lamp can be turned off when it not needed and saving the power that consumed. The design uses case diagram is used as a framework for developing, planning and documentation of systems centralize smart home. The design of use case diagram of this research can be seen in **Fig. 2**.

2.2 Testing Design Scenario

System testing will be conducted by examining the smart home applications on the computer centers and computer user. System testing conducted on this application required the application object simulator as a virtual load that is in the house. Testing the application system shown in **Fig. 3**.
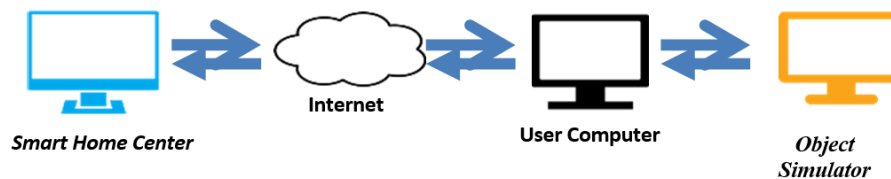

Fig. 3. System Testing Scenario

A smart home center such as an application that essentially serves to replace the object in the form of hardware in order to speed the application development process Smart Home. This app will turn on or off the object (virtual) when receiving data from the smart home applications. Object simulator is the object which we control, we can define it yourself with flexible. Given ID and name of each object that can we can set it by yourself.
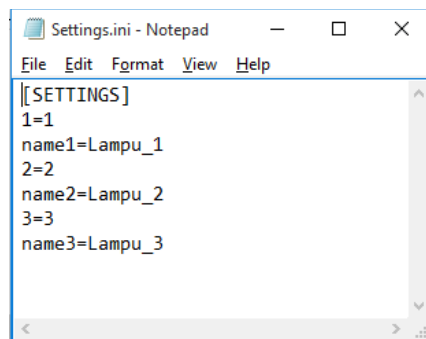
The communication process occurs when an application gives the command to turn on or turn off an object, or when an object sends the data condition. For the future development of the system can use an object with the original hardware because it takes a lot of time for configuration and troubleshooting. So this research is focused on procurement framework configuration. Based on that reason in this research also made an Object Simulator application that serves as a virtual object that can communicate with smart home applications.

3   System Configuration and Testing

Based on **Fig. 3**, the test will be done in three ways, the first overall and centralized testing performed by object simulator, this test is expected to provide the configuration of the host device to be simulated. The second was monitoring power usage on the object so it will be seen or monitored on the use of the power possessed by each device. The latter was power restrictions on the user with a view to limiting the use of excessive power on the device home.

3.1   Centralized System Configuration and Testing with Application Simulator Object

In order to set the number, ID and name of the object in Object Simulator was used with the extension .ini file setting. In the file number, ID and object name were written. How to write the number, ID and name of the object shown in **Fig. 4**. Writing the setting starting from line 2. Number 1 before the equal sign indicates the number of the object whereas the number 1 after the equals sign indicates the object ID.

Fig. 4. Writing configuration settings in the .ini file

In the 3rd row, the words "name1" indicating variable that will store the name for the object number 1, while the words "Lampu_1" is the name given to the object 1 (the name is in accordance with the desire the user). This rule applies equally to the next line. The number of objects that you want to simulate objects can be seen from the last number. In **Fig. 4** the number of objects is simulated 3 objects. If the Object Simulator

application is run with the settings file as shown in Figure 4, the results of application Object Simulator can be seen in **Fig. 5**.

Fig. 5. Object Simulator Application

In **Fig. 5** can be seen that the number, ID and name of the object in accordance with what is written in the file settings. There are three objects with the number 1 to 3 and with the same ID from 1 to 3. The name of each object are also in accordance with what is written in the file settings.

The next test is to control each object in the Object Simulator uses Smart Home applications. Tests will be performed by turning on and off a few objects that other objects as shown in.

Fig. 6. Testing Object controlling the Simulator via Smart Home Applications

Based on **Fig. 6** it can be seen that the lampu_1 and lampu_2 ON and lampu_3 Object Simulator Applications is turned off. The outcome of this process is shown in **Error! Reference source not found.**.
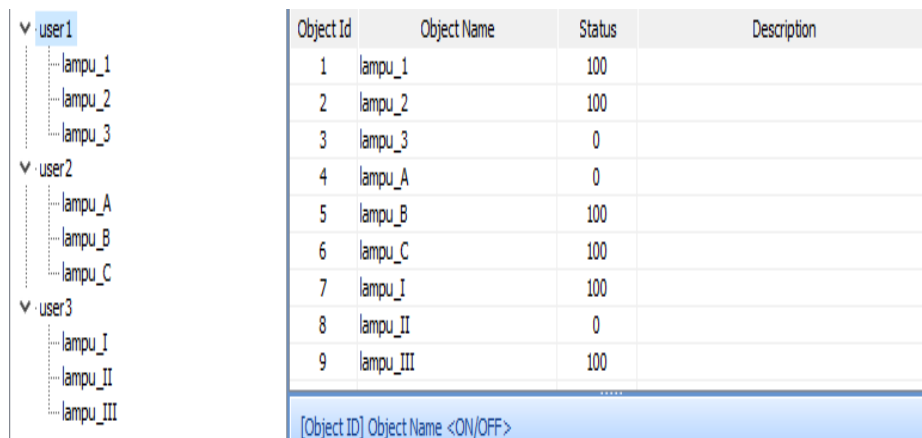

Fig. 7. The test results in Simulator through the Application Object controlling Smart Home

In **Fig. 7** it can be seen that the test results in accordance with the data entered in Smart Home Application, which is lampu_1 and lampu_2 lit while lampu_3 die. If the test

was conducted by user1, then the same test will be done to another user in order to know that the system can be monitored centrally.

Based on the first test can be done adding to user-2 with the name user2 and user 3 with user3 name, with the same process conducted by making the simulator by changing or adding ObjectID and ObjectName so going out to different user space.

To determine whether all of the data entered user1, user2 and user3 can be accessed centrally by Smart Home Application, the user must log in as an administrator in the Smart Home Application. When logged in as an administrator, then the user can see all users and objects that controlled each user. The results of this test are shown in **Error! Reference source not found.**. Based on Figure 8 it can be seen that there are three user, which is user1, user2 and user 3. Each individual user control objects with different ID. In **Error! Reference source not found.** can also be seen that the status of each object of each user is the same as the status of each user. Thus it can be said that this system can be accessed centrally.

Object Id	Object Name	Status	Description
1	lampu_1	100	
2	lampu_2	100	
3	lampu_3	0	
4	lampu_A	0	
5	lampu_B	100	
6	lampu_C	100	
7	lampu_I	100	
8	lampu_II	0	
9	lampu_III	100	

∨ user1
　lampu_1
　lampu_2
　lampu_3
∨ user2
　lampu_A
　lampu_B
　lampu_C
∨ user3
　lampu_I
　lampu_II
　lampu_III

[Object ID] Object Name <ON/OFF>

Fig. 8. Centralized Controlling Systems

3.2   Object Power Consumption Monitoring.

Monitoring power usage of each object / the electrical load in the home can be made on the application server and the user. The use of object / electrical load of every user can be viewed at any time and the amount of power used for that object. The results of the monitoring on the application server and the user is shown in **Fig. 9**.
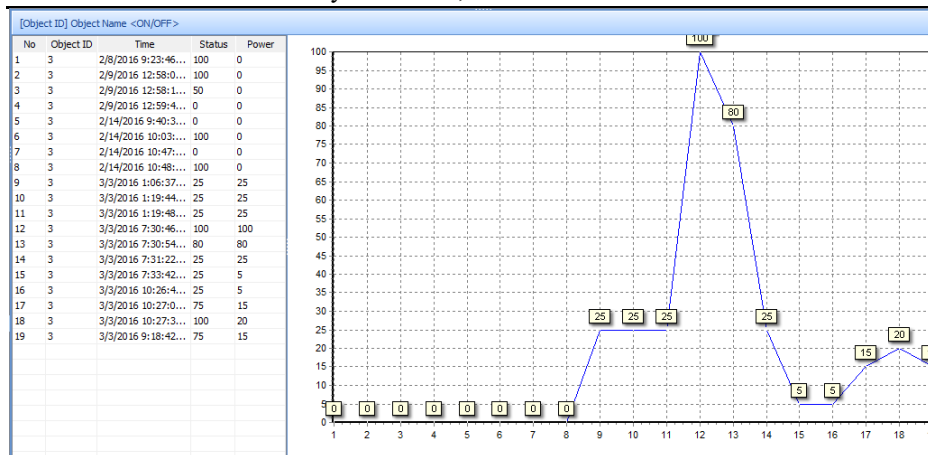
Fig. 9. Monitoring Power Consumption On The Object

In **Fig. 9**, there is two important part that is on the left represents the history of the use of objects at home and the right portion is shown in graphical form. In the history shows that the use of the object based on the time and the amount of power used each time. On the chart shows the power consumption of the objects displayed in graphical form every time.

3.3 User Power Restriction

Power restrictions on the object can only be done on the application server. Power restrictions made at the request of the user to limit the power consumption of the existing object of his house. Power restriction is done with the intention that a user can limit the total power usage at home for the purpose of saving power. How do the power restrictions on the application that is through the Settings menu - Usage Limit. Display power restrictions are shown in **Fig. 10**.
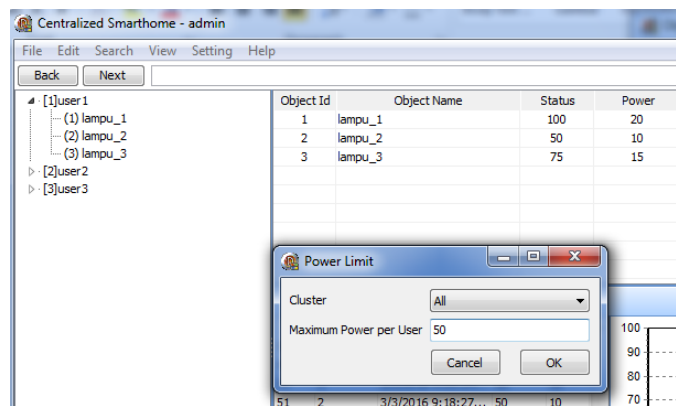

Fig. 10. User Power Restriction at Smart Home Application

On the menu, there are power restrictions "Cluster" and "Maximum Power" per User. "Clusters" are used to the user because the user needs to use power at home may be different. If the "Cluster" is selected All this limits the power consumption of all users on the system are created equal, and "Maximum Power" is used to limiting the maximum power that used to all user. For example in Figure 10, the power consumption of each user is restricted to a maximum of 50 watts. Then in **Fig. 10** can also be seen that the power consumption of the user first, to lampu_1 is a 20 watt, 10 watts and lampu_2 is lampu_3 is 15 watts, so the total power consumption is 45 watts.

On the display can be seen that for the first user on the object lampu_2 its use is still 50% of the maximum power of the device's existing, if made up to 100% then power on lampu_2 be 20 watts, so the total power at the user 1 will be 55 watts. On the menu power restrictions, previously had done that every user uses its power limited to 50 watts so that there is an excess of 5 watts on user1. Because there is excess power on user1, then the system application can't run a command to increase the lampu_2. Rejection of the system is shown in**Fig. 11**.
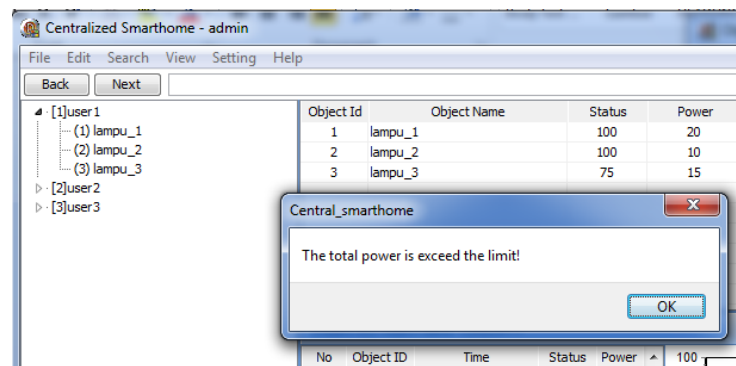

Fig. 11. The Occurrence Excess Power

From the test results on the user power restrictions, it can be seen that the smart home application can be used to limit the power to each user. This power restriction hopes can be used as a tool for monitoring the power consumption by the user and can help to reduce their power on home.

4   Conclusion and Future Works

Based on the results of the design until the test can be concluded if the application to set the on-off object devices can be created and set. Applications can receive data from each piece of equipment is turned on or off. Smart Home Application can monitor power usage on any object at any time, as well as a centralized system can be accessed by logging in as an administrator on the Smart Home Application.

For future works can be implemented by a microcontroller along with wireless communication modules. The system can be integrated with a few enhancements, for example, monitoring can be implemented on the mobile or the web, and cloud storage is implemented on the server. As well as to do the design and testing of usability, scalability up to learnability system. So that the system can be implemented and accepted by various stakeholders.

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