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IOT BASED SMART LAMP FOR EFFICIENT USAGE OF ELECTRICAL ENERGY

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Abstract. The government is proclaiming the electrical energy saving campaign in order to raise the people's awareness of its importance. The Ministry of Energy and Mineral Resources (ESDM Ministry) of the Republic of Indonesia stated that a year of energy saving equals to the amount of saving Rp43.000.000.000.000,00 (forty three trillion rupiah) of money, which is also equal to a construction of electric steam power plant with the capacity of 3.500 megawatts (MW). One of the programs that has been encouraged by the government is the 'turn off the light' campaign. Turning off lights is a simple but often neglected thing. Apart from the limited awareness to save the energy for a better future, people are often too busy to do it. In 2015, Taruna built an Arduino Micro-controller based light control system using Android smartphone to provide ease, specifically for physically disabled and elderly. The shortcomings of this system are that the lights cannot be turned on and off automatically (smart) with timer and it can only be controlled at close range (bluetooth). Development of technology with the internet guide can easily help human, and thus, this research aims to improve the system with the time control (timer) and close range control (bluetooth) as well as the long range using SMS and internet. The system is built with the prototype model that incude the communication, fast planning, fast prototype designing and building, system submission and feedback. The result of this system building is that the light can be controlled using bluetooth and also provide a faster response time; less than a second (as well as the timer). The light can also be controlled from a long range using the internet connection, giving a response time between 14 to 17 seconds. When a light control command occurs, the SMS notification is sent to the cell phone of the user. Using this system, the light can be controlled correctly in order to conveniently give the user effectivity and efficiency in electrical energy usage.

Keywords : Android, Arduino, IoT, Smart, Web.

1. INTRODUCTION

The (Indonesian) government has been doing various innovations in order to save energy in Indonesia. In 2016, they launched an energy conservation program, using a jargon "Let's cut 10 percent" that invites people to conserve the usage of electrical power. This conservation program was proclaimed simultaneously in 20 major cities in 11 provinces. The minister of ESDM (Energy and Mineral Resources) at that time claimed that 10 percent of energy savings per year actually equals to Rp43.000.000.000.000,00 (forty three trillion rupiah) of money, and also equals to a construction of electric steam power plant with the capacity of 3.500 megawatts (MW). The Minister of ESDM added that there were three ways that the people could do in an effort to make an electrical energy saving from now on: First, turn off the lights and remove electronic equipment that is not being used and

remove the switch; second, hold the Air Conditioner (AC) temperature at 25 degrees; and third, to live an energy efficient lifestyle [1].

The Ministry of ESDM succesfully organized the Earth Hour program in 2012. The campaign to turn off electricity for one hour from 20:30 to 21:30 saved electricity in Jakarta by 214 megawatts. Along with the activity entitled "This Is My Action, Where's Yours?", the ministry also gave 100 solar lights to the merchants around Central Park that were turned on simultaneously when the blackout was carried out. The objective of this campaign is none other than to save electricity, which also contributes to mitigating climate change [2].

Technology develops rapidly and unstoppably, producing new innovations in various line of human life, one of which is Smart Home. Smart Home is a branch of ubiquitos and pervasive computing, and also closely related to artificial intelligence that is used to increase the comfort factor, security, and energy savings in a house [3]. The internet is one of vital components in the development of Smart Home and the concept that has recently developed is the Internet of Things (IoT).

IoT can be described as the connector of everyday objects such as smartphones, internet television, sensors and controllers to the internet in which the intelligent devices are linked together to enable new forms of communication between people and those electronic devices [4]. Iot is a concept that aims to expand the benefits of internet connectivity that is continuously connected. As for the capabilities such as data sharing, remote control, etc., including objects in the real world such as food, electronics, any equipment, including living things, all of which are connected to local and global networks through sensors that are embedded and always active.

Taruna developed a Smart Home system, a home light control system based on the Arduino Microcontroller using an Android Smartphone. The developed system was able to provide convenience to residents, especially to those with disabilities who have moving limitation and the elderly. This system has the ability to turn on or off the lights using an Android Smartphone via Bluetooth media [5]. Andrianto and Arief developed the similar Smart Home system which is home lighting controllers, only difference is that theirs have remote control capabilities using Web media (internet) [6]. Astiyana, on the other hand, developed the same Smart Home system, namely remote home lighting controllers that uses SMS media [7].

Based on previous studies, there are still shortcomings that wmust be refined, one of which is combining 3 (three) media namely Bluetooth, Web / internet and SMS in 1 (one) system, so that the new system has more choices in its use. This study aims to combine the 3 (three) media above and add the ability to set the timer for automatic control of the lights, so that the lights can be turned on and off according to the specified time. With this system, the lights will not be turned on at an unnecessary time, especially when the user is too busy or forget to turn the light off and thus, will also help and support the energy-saving program by the government.

2. METHODS

Data collection in this study was carried out by literature study and interviews. Literature studies is all about studying the literature related to research topics, which is about how to build the system with various methods in order to support the research. The literature is obtained from various sources including scientific journals, research reports, magazines and books. The interviews are conducted by asking several questions to people who have sources of information and responsibilities needed in this study. Some people who are the users of electricity is also interviewed.

Prototype models are used in system development in this study. The development process of this system begins with the communication with prospective users, followed by rapid planning in the form of design modeling, then the building of prototypes, the next step is delivering the system to the user to obtain feedback, if the system is perfectly match with the needs of the user then the process is finished, otherwise if it is still not suitable then the process will continue to the initial stage and so on continuously.

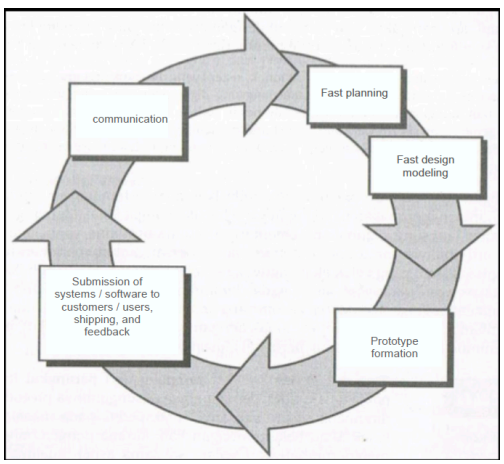

Figure 1. Prototype Model

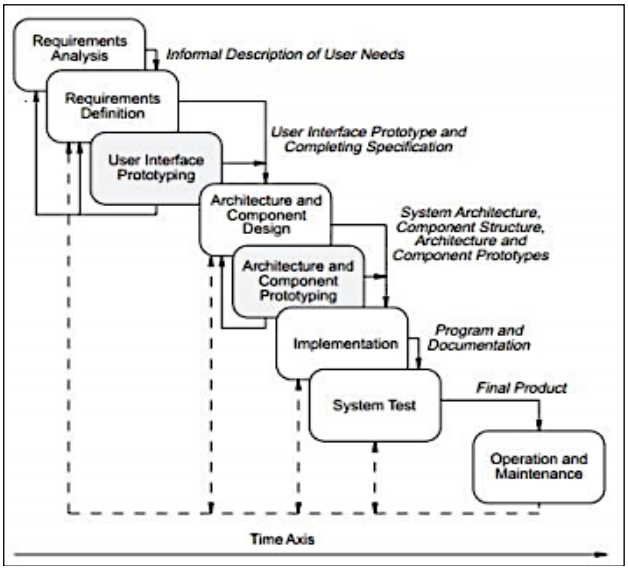

Figure 2. Prototype Model Flow Process
Source: Khosrow & Pour [8]

The implementation of the prototype model to the system built includes the design of the display that interprets the functions from each of the menu presented on the system and then displayed to several respondents to get feedback. Some designs can be seen in the following picture:

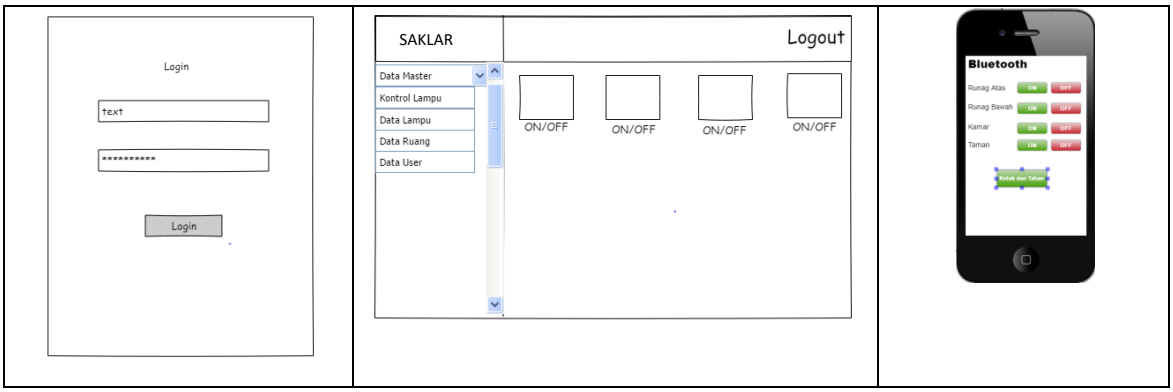

Figure 3. System Display Process

The building of system flow process in the prototype is also described as a flowchart to facilitate prospective users in understanding the system workflow functionality and in the form of Data Flow Diagrams (DFD) to describe the access rights of users. One of the control flowcharts via bluetooth and DFD can be seen in the following picture:

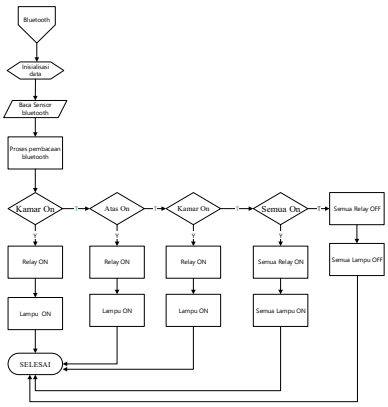

Figure 4. Prototype Flowchart Control

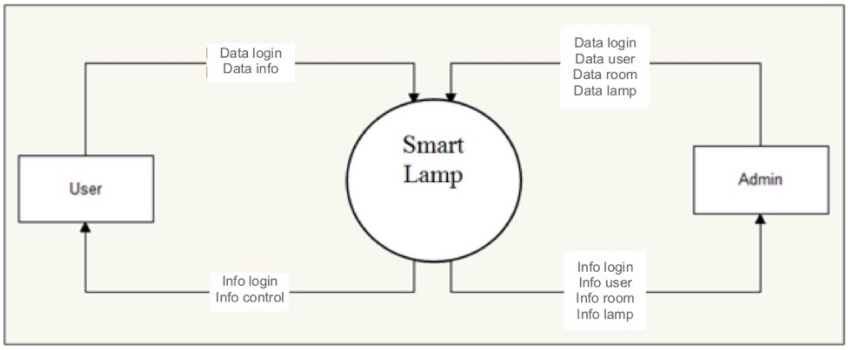

Figure 5. Prototype Flowchart Control

3. RESULTS AND DISCUSSION

The system built provides an alternative for the user to control the lights, including the access to control by time (timer) and with direct control (using bluetooth, web, sms). The illustration of system proposed can be seen in Picture 6:

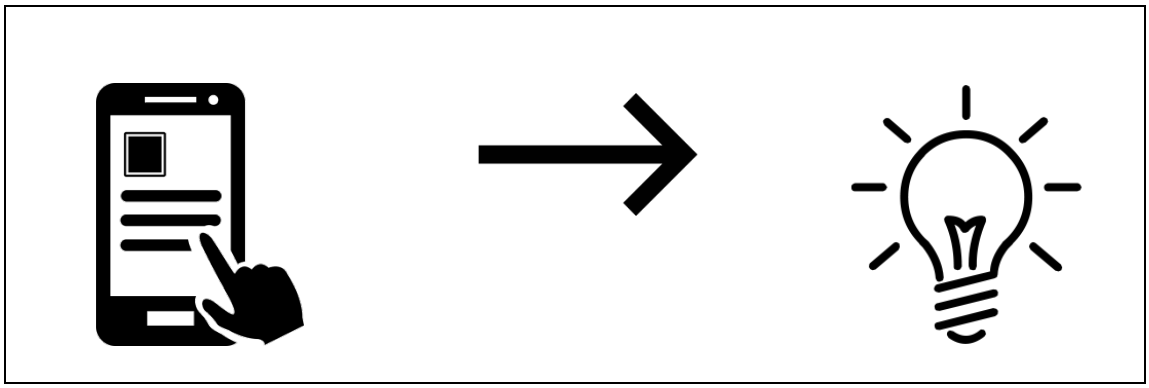

Figure 6. System Performance Building

The system architecture built consists of a sensor unit, sender, and output unit. The sensor unit consists of GSM, Bluetooth, and RTC which are directly connected to Arduino. The sender (unit) consists of Wemos, Modem Router, Android Smartphone, and internet network which will later be used in order to send data. While the output unit consists of relays and lights.

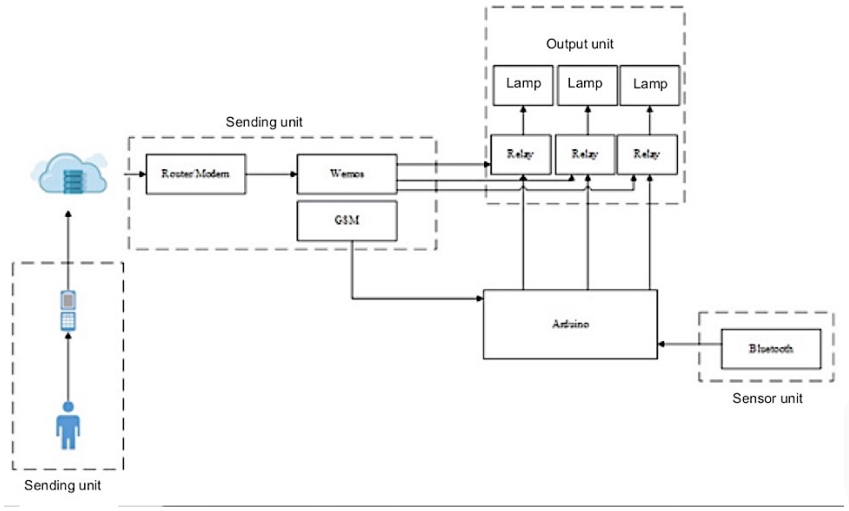

Figure 7. System Architecture Design

Context Diagram describes the role of users in general towards the system built. The system built has 2 (two) user levels, namely Admin and User. Each user has their own access rights, namely: Admin has access to manage data on space, lights and users and also able to operate or control the lights. While the users are limited to the operation or control of the lights only. Admin is the only one who can create a new User that is able to operate or control the lights.

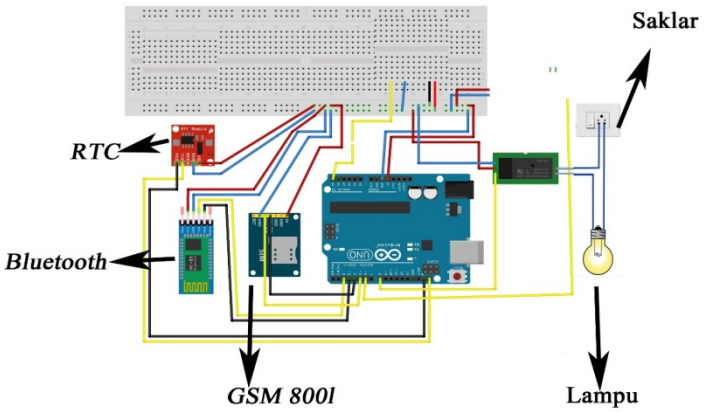

Figure 8. Hardware Schematic Design

Hardware Schematic Design describes the overall hardware circuit until the process ends at the light control. The LDR sensor is connected to Arduino using 2 jumper cables namely GND sensor to GND Arduino, and VCC sensor to VCC Arduino. The Bluetooth HC-05 module is connected to Arduino using 4 jumper cables namely GND Bluetooth to Arduino GND, VCC Bluetooth to Arduino VCC, RX Bluetooth to RX Arduino and TX Bluetooth to Arduino TX. The GSM module is connected to Arduino using 4 jumper cables namely GND GSM to Arduino GND, VCC GSM to VCC Arduino, RX GSM to RX Arduino and GSM TX to Arduino TX. IR is connected to Arduino using 3 jumper cables, namely GND sensor to Arduino GND, VCC sensor to Arduino VCC, and AO sensor to pin 3 on Arduino. 3 pieces of Relay are connected to Arduino through 9 jumper cables, namely GND relay to GND Arduino, VCC relay to VCC Arduino and IN relay to pins 7.8, and 9 Arduino.

Front View

Rear View

Right Side View

Left Side View

Figure 9. Hardware Implementation

The hardware implementation miniature can be seen in the picture above. The trial was conducted on 4 (four) lights which were divided into living room light, upper room light, bedroom light and garden light. Miniature hardware construction is located on the lower floor and can also be seen in the picture with the description "Rear View".

Software as an interface for Admin and User is built mainly by web-based with the PHP programming language and MySQL as its database. Through this web, Smart Lamp will be controlled by the User in order to turn the lights on or off. Implementation of the software can be seen in Figure 10:

Admin Page User Page

Figure 10. Software Implementation

The tests carried out on the system that has been built are carried out on each control component which includes bluetooth, timer, web and SMS notifications. The test results can be seen in Table 1.

Table 1. Control Component Testing

Control	Information
Bluetooth	Successful
Timer	Successful
Web	Successful
SMS	Successful

The tests are carried out in parallel, meaning that 1 (one) lamp can be controlled by 5 (five) components above and provide a notification in the form of SMS to each activity carried out by the User.

The control response to the lights by using Bluetooth media is relatively fast, which ranges from <1 second (less than one second). Besides that the response of the control to the Timer (RTC) is also quite fast according to the time set by the User. However, different results are shown by controls via the Web, which is above 10 (ten) seconds, or relatively slow. The response to the Web can be seen in Table 2:

Table 2 Response to the Web

Object	Second(s)	Average (second)
Living Room Light	11	14,6
	17	
	16	
Upper Room Light	18	16,3
	14	
	17	
Bedroom Light	17	21
	21	
	25	
Garden Light	11	14,6
	18	
	15	

This test is done by inserting a script on the Web to calculate the time like a Stopwatch tool. Each test is conducted 3 (three) times through the User. Based on the temporary analysis, this condition is influenced by the internet connection or availability of internet networks in the User environment, and thus affecting the fast or slow response of the lights.

According to the test result, the system built can run well and also give a positive impact in an effort to support the government to save the electricity usage. As a simple calculation, if the homeowner forgets or unable to turn off a 15-watt fluorescent lamp on their front yard for 1 hour per day in 1 month, the calculation can be assumed as follows:

0,015 kW * 1 hour * 30 = 0,45 kWh

Rp. 996,74/kWh * 0,45 kWh = Rp. 448,53

From the calculation above, there is actually a misuse of electricity of Rp. 448.53 when the homeowner neglects to turn off a lamp on his front yard for 1 hour per day in 1 month. The amount will certainly go up and be directly proportional if there are more lights that are neglected/not turned off in several houses. Using a system that is built according to this research, the condition above will not be happen and the users can actually save more electricity and energy for things that are useful.

4. CONCLUSION

Based on the results and tests of the system built, it can be concluded that the lights can be controlled at close range via bluetooth and can also be controlled remotely via the Web. User can also control or turn the lights on/off through the timer as desired by the user. Every activity carried out by one of the users will bring up the status notification light (on/off) in the form of an SMS to all Users registered by the admin. One light can be controlled by all media controls that have been built into this system. The system that has been built is able to help the electricity energy usage become more effective and efficient and able to contribute to energy-saving programs promoted by the government.

5. REFERENCES

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