The Prototype of Solar-Powered Building Lighting IoT

Tri P Handayani\textsuperscript{1}, Stephan A Hulukati\textsuperscript{2}, Risman Jaya\textsuperscript{3}, Yuant Tiandho\textsuperscript{4} and Riska Abdullah\textsuperscript{5}

\textsuperscript{1}Information System, Universitas Muhammadiyah Gorontalo, Indonesia
\textsuperscript{2}Electrical Engineering, Universitas Ichsan Gorontalo, Indonesia
\textsuperscript{3}Geography, Universitas Muhammadiyah Gorontalo, Indonesia
\textsuperscript{4}Electrical Engineering, Universitas Bangka Belitung, Indonesia
\textsuperscript{5}Electrical Engineering, Universitas Ichsan Gorontalo, Indonesia

Corresponding author: stephanhulukati17@gmail.com

Abstract. The aim of this research is to build a prototype of remote device that uses TCP/IP that could connect to a local network through a web server. The prototype has two features, firstly the prototype can toggle single specific lamp and turn off and turn on the lamps in an entire building. It is controlled through a web application which can also be operated through smartphones and computers. The experiment result shows that the prototype needed 500 seconds delay to activate the lamp and fan relays through the web server.

Keywords IoT (Internet of Things), Embedded, Node mcu, and Control.

1. Introduction

The aim of this research is to develop a prototype of building lighting remote control system. It has the capability to monitor and control the lighting remotely though a web application. This remote control system makes it easy for users to control building lights to save electricity [1].

A remote control using sound recognition as a controller of electrical equipment was developed. We Arduino UNO and the EasyVR module were combined as a voice recognition module. Sound sampling was done twice with relatively the same pronunciation variations in each words, this is adjusted in order to increase the ability of EasyVR which cannot accept the pronunciation of the second sound, if it is different from the variation in the pronunciation of the first sound. The EasyVR module on electrical equipment used relay as a switch and it used a wireless microphone in order to recognize the sound remotely [2].

An Arduino-based smart home remote control system that is controlled through an Android smartphone was designed. This system is equipped with an on and off button on the software that will be embedded in an Android smartphone. This is to control four electrical devices so that users do not need to switch on the electrical device directly [3].

A module that control electronic device using Raspberry Pi as an online web server was also developed. This module can be controlled by using a PC or Smartphone. Utilization of Raspberry Pi Mini PC as a web can decrease 25% of power consumption [4].

Previous research commonly used Arduino as the microcontroller, whilst this research used NodeMcu as the microcontroller, since it is capable of connecting to Wi-Fi directly. The size of NodeMcu is also smaller than Arduino so it used smaller electrical consumption compared to other microcontrollers [5], is shown in Figure 1.
2. System Design
The schematic design of the prototype is shown in Figure 2. It consists of a NodeMcu microcontroller, Local area network, laptop as the main controller, relay that connects to the light and relay that connects to the fan. Based on Node Mcu ESP8266, the control system allows the user to switch lamps from a distance.
Figure 3. Electrical circuit diagram of the prototype

Figure 2 shows that if Relay 1 is off and relay 2 is off, the light do not turn on. If relay 1 is on and relay 2 is off then the lights turn on, and when relay 1 is on and relay 2 is on then the lights is also turn on. The tools and materials used are shown in Table 1.

Table 1. The materials used.

| No | Component                      | Qty  | Function                                           |
|----|--------------------------------|------|---------------------------------------------------|
| 1  | NodeMcu Esp 8266               | 1    | Control system                                    |
| 2  | LED                            | 3    | Indicator                                         |
| 3  | Relay 5 VDC                    | 3    | Electrical Switch on/off                          |
| 4  | Jumper                         | 1 Set| Connect the Arduino pins with the relay circuit   |
| 5  | Panel Box                      | 1    | Placement of components and tools                 |
| 6  | Power cable                    | 1 m  | The power cable from the AC voltage to the lamp socket |
| 7  | USB cable                      | 1 Set| Connect to Arduino power supply to DC source      |
| 8  | Solar panels, Inverter and Solar Control Charge | 1 Set | A device consisting of solar cells that convert light into electricity for lamp and fan. |

The flowchart of the system is shown in Figure 4.
3 Result and Discussion
Coil is electrified when receiving a signal from NodeMcu, then Normally Open (NO), will be closed when the relay is voltage then Normally Closed (NC) will open as well as vice versa.

Figure 4. The flowchart of the system
Figure 5. The circuits of building lamp controller

Figure 5 shows that each cable is connected to NodeMCU. The cable that has been connected to the Usb 2rel to NodeMCU, the orange cable connect to Vcc, the blue cable is connected to Digital1, the white colored cable is connected to Digital 2 and connected to Ground. If everything is connected correctly, the program is ready to run on a computer that is already programmed using Arduino IDE.

Figure 6. The developed prototype

Figure 6 shows the final prototype before installing it in the building. The prototype was tested before installation. The prototype used single light and 1 fan. The test begins by turning on the lights. Testing is done by running a web application and accessing it via smartphones and computers. The testing result of the prototype is shown in Table 2.

Table 2. Tool Testing.

| NO | Hardware  | Condition | Time  |
|----|-----------|-----------|-------|
| 1  | Computer  | Ok        | 500 s |
| 2  | Smartphone| Ok        | 500 s |

The table shows that computer and smartphone needs 5 seconds processing time before the light is turned on.

Figure 7 shows the connection of the lighting prototype to a Wi-Fi access point, which is used by the smartphone to connect. The testing ran well using a web application.
Figure 7. Connection of lighting to a Wi-Fi access point

Figure 8 shows the testing result of voltage and current usage of the prototype. It shows that the voltage produced is 200 Volt and the flowing current was 131.3 mA.

Figure 8. Testing result of voltage and current of the system

4. Conclusions
- The prototype needs processing time of 500 seconds to turn on or off the light when toggled from both smartphone and local network connected to Wi-Fi.
- Both smartphone and local network that connected to the Wi-Fi can control the lighting and the fan.

Acknowledgment
We gratefully acknowledge the funding from USAID thorough SHERA program - Centre for Development of Sustainable Region (CDSR). In year 2017-2021 CDSR is led by Center for Energy Studies – UGM.

References
[1] Afilusuf, R. (2016). Web Based Smarthome Automatic Lighting, 22–26.
[2] Saputri, Z. N. (2014). Voice Recognition Application as Controller of Electrical Equipment Based on Arduino Uno. Voice Recognition Application as Controller of Electrical Equipment Based on Arduino Uno, 1, 8.
[3] Fiqri, S., & W, F. T. P. (2015). Designing a Remote Home Control System Using an Android Cellular Phone. Tanjungpura University, 1–80.
[4] Kunarso, L. (2015). Design Of Web-Based Electric Control System Using Mini Pc Online Server, 1–80.
[5] Kahimpong, R.L., Umboh, M., & Maluegha, B. (2013). Automatic Based on Arduino Uno Atmega328, 6, 69-81.