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Android Smartphone Application to Control Home Lights Based on ESP8266 and IoT

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Abstract – *A house often lived in due to someone going to work all day or even on holiday outside the city. There must be a special strategy to activate the lights at night and deactivate the lights during the day. A smart device that can help as a position to turn on and turn off the house lights. Home lights can be controlled remotely using an Android smartphone and IoT internet network. The system is designed on a prototype scale; there are four AC-powered lamps, namely two lamps, each installed inside and outside the house. The ESP8266 microcontroller is a data processing medium for communication from Android smartphones to lighting devices. Utilizing the IoT system to connect the smartphone to the Internet and the ESP8266 forms a system that can be accessed remotely. The Android application on the smartphone has four buttons, namely from light-1 to light-4. All lights can turn on and off on command. When testing a system connected to Firebase, the system can respond well and from a long distance while connected to the Internet. The system response in turning the lights on and off is ±4 seconds, and the longest distance is ±10 km. All control buttons in this system application can function properly according to their function to control home lights by sending data in the form of logic high or logic low to Firebase. This Android-based home light control uses the Internet network, making it easier to turn on or off the house lights while connected to the Internet network.*

Keywords – *ESP8266; House lights; Internet of Things; Smartphone; AC Powered lamps.*

I. Introduction

HUMAN activities work in various sectors, such as industry, offices, and business. The consequences that arise are houses that are often lived in, even for long periods. Residents who often come home late at night have an effect on the lighting in the house and too often neglect it, causing theft problems. The house was quiet, and there was no one to turn the lights on and off, so some people thought the house was empty. Digital and embedded technology development plays a role in helping human activities. Electronic equipment can generally be connected to a network and controlled remotely. Electronic and digital systems can be processed using microprocessors or microcontrollers [1, 2]. The microcontroller technology that is often used is the Arduino family because the programming support is easy to apply [1, 3].

In situations where turning on and off the lights was previously done manually or with a switch, this can be done with an infrared-based remote control at close range [4]. On the other hand, a smartphone can be integrated into the Arduino for communication purposes, sending signals or data [5, 6]. Several related studies have carried out timer-based automatic light control [7, 8], SMS or telegram-based data sending [9, 10], and voice recognition to control electronic equipment and lights [11, 12]. This research is still within reach for controlling electronic equipment over relatively short distances. Smartphone communication with Arduino generally uses Bluetooth, a media transceiver module, and radio frequency. The range that Bluetooth can achieve is relatively close. Transceiver and radio frequency modules are all used for medium range. Therefore, implementing the Internet of Things (IoT) system for long-distance communications requires network media and WiFi devices to be connected to the Internet [10, 13]. IoT systems require physical devices such as sensors, microcontrollers integrated with WiFi modules, and actuators [14]. The application of an Android smartphone makes it easy to create applications as command buttons for controlling IoT-based electronic equipment. Several researchers have utilized the

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Arduino model ESP8266 facilities because the module contains WiFi and can be programmed on the Arduino platform [10, 14, 15]. In this research, we developed an IoT-based system to control electronic equipment, such as lights, from a long distance. The Android application in the smartphone is used as a replacement for a switch, where the smartphone is previously connected to the internet network, and the ESP8266 module is also connected to the Internet. The motivation for designing this system is based on the ease of using technology, supporting the development of Internet of Things technology.

II. Research Methods

The home light control system based on Android smartphones and IoT comprises hardware and software. The hardware for this system is ESP8266 as a data processor, LM2596 as a step-down, relay module, and power supply. The software part is the App Inventor program for smartphone applications, the Firebase application, and the Arduino or ESP8266 microcontroller program. Figure 1 illustrates a smartphone and IoT-based home lighting control system.

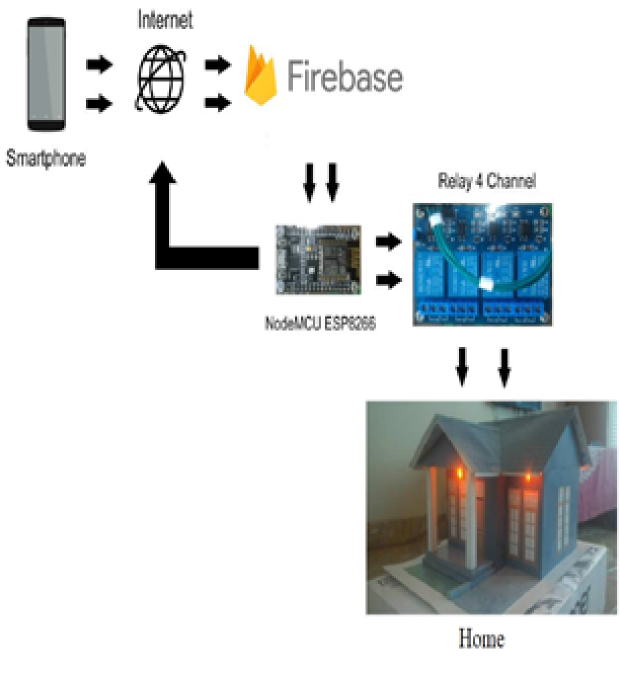

Figure 1: Illustration of a smartphone and IoT-based home light control system

Based on the illustration in Figure 1, smartphones are used as input to replace virtual buttons in giving commands. The Android smartphone is connected to the Internet, and the data is stored in the Firebase system [5]. On the other hand, the ESP8266 module is also connected to the Internet; data from Firebase is compared with the ESP8266 to adjust the relay channel in turning the house lights on and off. Firebase functions as a container for data received based on input from the Android display and is tasked with channelling this data to ESP8266 [16]. The relay module is a four-channel relay because four lights are controlled. Two lights are outside, and two are inside the house.

i. Power supply

The power supply circuit used is a full wave rectifier circuit (conversion of AC voltage to DC voltage) and the use of the LM2596 step-down module. The LM2596 module is a DC voltage reduction circuit, and the voltage value can be adjusted. The power supply circuit can be seen in Figure 2. There are two LM2596 step-down modules to separate the current flow, namely, one for the ESP8266 and another for the relay module. The aim of separating the current is to maintain current stability and not disrupt the process in the ESP8266 micro.

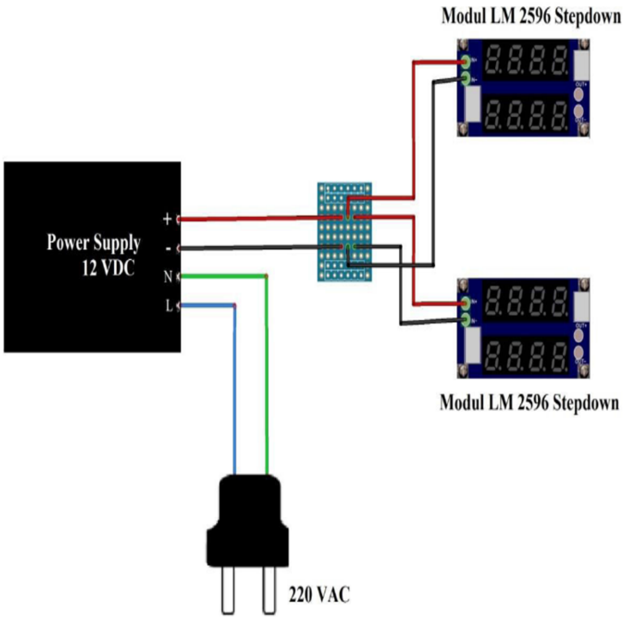

Figure 2: Power supply circuit for a home lighting control system

ii. ESP8266

An Arduino microcontroller type ESP8266 is used in this project. Esp8266 is integrated with a WiFi module and can be connected to the Internet [17, 18]. The ESP8266 also supports input-output or GPIO ports. The output port is used to control four relay channels, namely D1, D3, D5 and D7. The Esp8266 micro gets input from smartphone command signals and data. This data is processed by the ESP8266 and adjusted according to the logic for selecting four relay channels. The relay is active if it is given a logic high so that the relay switch is connected and the light turns on, and vice versa. Figure 3 shows the electrical schematic of the home lighting control system.

iii. Smartphone and Firebase application design

At the Android-based application design stage on smartphones, we used the free version of the App Inventor application. App Inventor is a tool that makes it easy to create Android applications, and this tool has been implemented in various mobile applications [19–21]. Figure 4 shows the design of an Android-based system application. In the application display, four buttons represent each light switch. When the button is pressed, the output from the application is black (logic high), and when pressed again, it becomes white (logic low).

The high and low logical data from the Android application is sent to the Firebase application. Firebase is a database tool developed by Google, and this application provides a solution for easy mobile application development [16]. In this project, Firebase functions to accommodate data received via mobile applications [22]. The data from Firebase will then be sent to the ESP8266 micro, all of which must be connected to the Internet network. Figure 5 shows the channel page on Firebase that has been created. If the data in Firebase for lamp-1 has a logic high, then lamp-1 is on; conversely, if it is a logic low, then lamp-1 is off. This rule also applies to lamp-2, lamp-3 and lamp-4.

III. Results and Discussion

In this project, testing was carried out in stages, namely testing the power supply circuit, testing the Android application for four buttons, and testing the smartphone and IoT-based home lighting control system. Test the power supply and step-down circuit to find out whether the module is functioning properly or not. The output displayed by the step-down display is between 1.2 volts to 11.8 volts. Select the voltage value by turning the potentiometer to the left or right on the LM2596 step-down. Figure 6 shows the voltage display that can be used for digital system modules.

At the application testing stage, four buttons can be seen in Figure 7. Figure 7(a) shows the condition of the buttons when the operator has not pressed them. Figure 7(b) shows the button display that the operator has clicked. There is a difference in color when the button is pressed, namely black (meaning logic high), and if not, then it is white (logic low). Based on these experiments, all buttons can function properly, match the logic illustration, and display color.

Testing continued by combining applications in the home lighting control system. Applications on Android are connected to the Internet, and the ESP8266 micro is also connected to the Internet. The system as a whole is connected to the Internet and the Firebase application. The test of the house light control system can be seen in Figure 8. Figure 8(a) shows the condition of the house when it is off, and the button has not been pressed. Figure 8(b) shows the condition of the light when the operator clicks the button. When the button is clicked, the Android application sends logic-high data to Firebase; this data is visible on the real-time database page, namely in FB1, FB2, FB3 and FB4. The FB symbol stands for Firebase. When the button is clicked again by the operator, the button changes to white, and the data in Firebase becomes logically low. The ESP8266 microcontroller adjusts the logic low and high on Firebase; if the value is logic high, then the micro sends a high signal to the relay, and the light turns on. Conversely, if the ESP8266 reads a logic low, then a low signal is sent to the relay, and the light goes out. Testing continues to determine the length of time or response required by the system to turn on and turn off the house lights. The house lights are turned on and off during the day and at night. Table 1 shows the response time of the system in turning on and off house lights in the Internet network. The system response time for turning on and off the lights is ±3.47 seconds; this is for daytime conditions. In night conditions, the response time is shown at ±4.26 seconds. This condition can occur because traffic on the Internet is different during the day and at night.

Table 1: Time response of the system in turning on and off smartphone and IoT-based house lights

Lamp	Daytime (second)		Night (second)		Info
	On	Off	On	Off	
1	4.2	3.5	3.5	4.5	Success
2	4.1	2.5	4.5	4.4	Success
3	3.6	3.3	4.5	4.2	Success
4	3.5	3.1	5.5	3	Success

Traffic during the day is generally faster than at night. The experimental results show that the system can be connected to the Internet and the Firebase application, and house lights can be turned on and off based on smartphones and IoT. Tests on this project were also measured to ensure the distance between the house and the smartphone application was ±10 km.

IV. Conclusion

In this project, a home light control system has been designed using a mobile application connected to the Internet and Firebase. This system uses an ESP8266

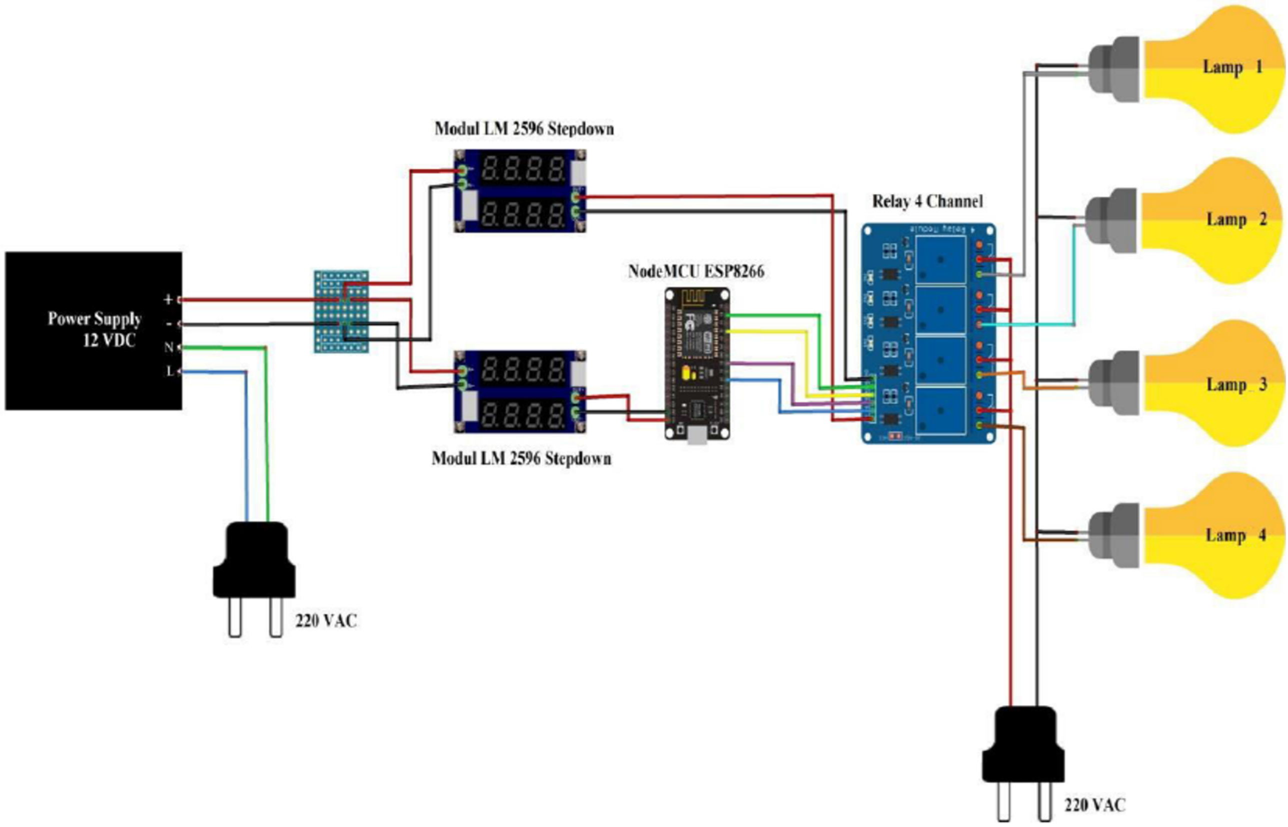

Figure 3: Electrical schematic of a home light control system

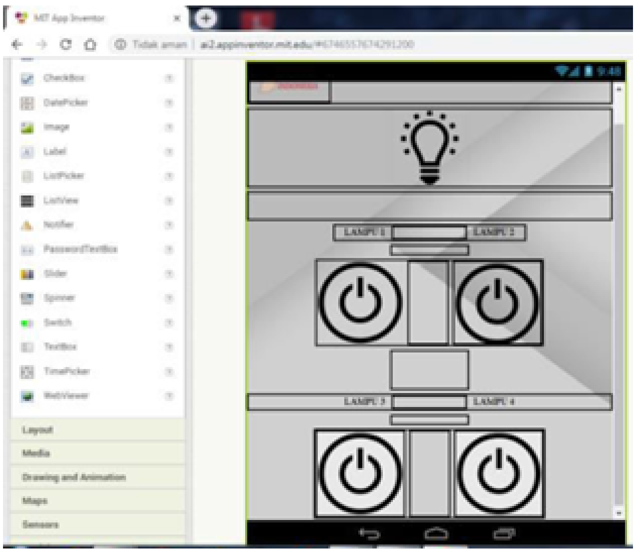

Figure 4: Design an Android-based application to control home lights

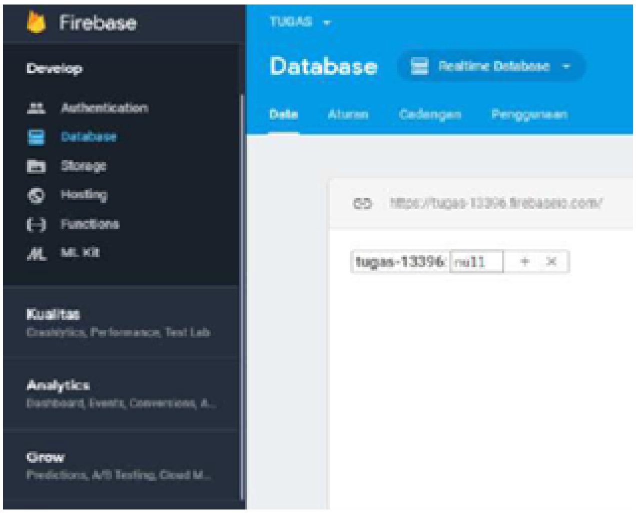

Figure 5: Created Firebase channel page

microcontroller, a power supply module, a four-channel relay module and four house lights. In the experiments that have been carried out, it shows that the system can be connected well. The mobile application sends data to Firebase, and the ESP8266 micro matches the logical data in Firebase. House lights can be turned on or off via a smartphone connected to the Internet. The response time of the system in turning on or off the lights is ±4 seconds over a long distance of ±10 km.

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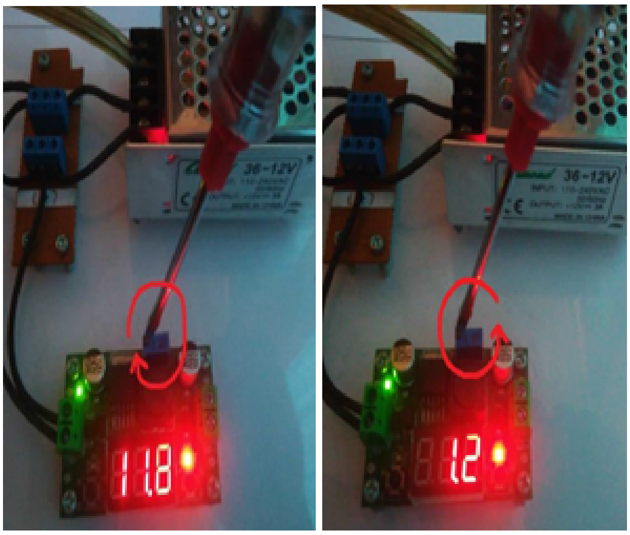
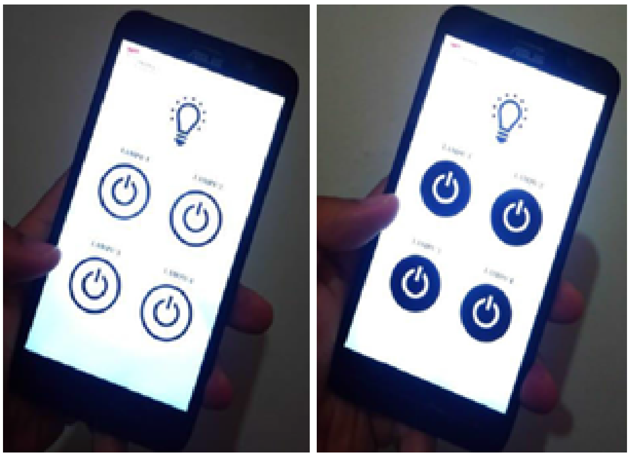


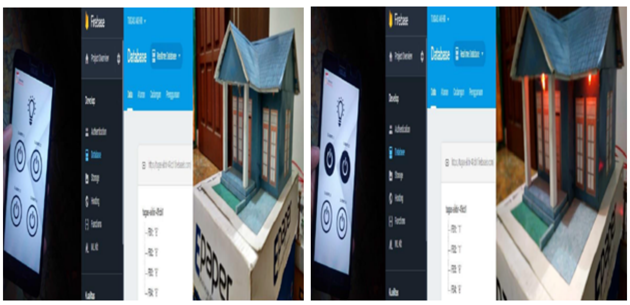
(a) **(b)**

Figure 6: Voltage testing on the power supply. (a) rotate to the right, and (b) to the left



(a) **(b)**

Figure 7: Testing buttons in Android applications. (a) logic low, and (b) logic high



(a) **(b)**

Figure 8: Testing buttons in Android applications. (a) logic low, and (b) logic high

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