

Android-Based On-Off Airfield Lighting System Operating Control Design at International Airport in Indonesia

Adhitya Octavianie*¹, Muh. Dirga Alfikri², Ahmad Rossydi³

Lecturer, at Aviation Polytechnic of Makassar, Indonesia

Corresponding Author: Adhitya Octavianie*

Email: adhityaoctavianie@gmail.com*¹, muhdirgaalfikri@gmail.com², a.rossydi@gmail.com³

Abstract: This research aims to determine the usefulness of control components in operating Android-based Airfield Lighting System equipment with ON/OFF conditions and how to design android-based ON/OFF Airfield Lighting System operating controls. In the process of designing control Airfield Lighting System, this study carried out several stages, namely research identification, a research plan as a process of observation of data, analysis as the first step of collecting and preparing data, design as a stage of development after conducting analysis, and implementation as a result of research that has been designed that will conduct testing. The study results on the design of ON/OFF Operation Control Airfield Lighting System Based on Android at Sultan Aji Muhammad Sulaiman Sepinggan Balikpapan Airport have been tested at CCR SAMS Sepinggan Balikpapan Airport by using NodeMCU components as the microcontrollers and connection links with Android as ON/OFF control. This study concludes that the device has been designed as an alternative control in case of control problems in ATC and MPH at Wireless Access Point that result in the manual operation of the control that makes the technician must direct activate to CCR.

Keywords: Control, NodeMCU, Airfield Lighting System

Date of Submission: 14-12-2021

Date of Acceptance: 28-12-2021

I. INTRODUCTION

Generally, the international airport in Indonesia has Airfield Lighting System (AFL) facilities. AFL is a visual landing aid that serves and serves aircraft during takeoff, landing, and taxi to move efficiently and safely. Each AFL lamp has a Constant Current Regulator (CCR), helping stabilize the current heading to each AFL light. During on the job training at International Airport in Indonesia, there was a problem that caused damage to the wireless access point (WAP/AP) in the network amplifier system that led to the breakup of the network that entered the Fiber Optic cable (FO), which impacted the AFL control system located in the ATC tower. MPH 1 also did not work, and the manual operation of the control made the technician have to activate the CCR directly.

Airfield Lighting System

Airport lighting systems (ALS) give visible information to the aircraft. The airfield lighting system is designed to meet the latest International Civil Aviation Organization (ICAO) and Federal Aviation Authority (FAA) recommendations to guarantee the safety of airport operations. The airport usually uses switching devices to control the airfield lighting systems [1]. This system consists of aircraft luminaires during the approach, landing, and taxiing operations [2].

The Airfield Lighting System is a visual landing aid that helps and serves aircraft that take off land and taxi to move efficiently and safely. The facility consists of unique lights that visually signal and inform the airmen, especially when the flight will make a landing or takeoff. These cues and visuals are provided by adjusting the special lights' color configuration and light intensity [3].

Android

Android is one of the most essential and highly used operating systems [4]. Android is a mobile operating system based on modified versions of the Linux kernel and other open-source devices. Android is designed for mobile devices especially touch screens such as smartphones and tablets. Android is also free software with open source, in the sense that Google allows users to develop the operating system. Android also has an app store called Google Play Store [5].

NodeMCU ESP 8266

NodeMCU is an Opensource IoT platform. Consisting of hardware in the form of System of ESP 8266 from the ESP series made by Espressif Systems, the firmware used is the Lua scripting programming language. By default, NodeMCU refers to the firmware used rather than the hardware development kit, and NodeMCU can also be interpreted as the Arduino board ESP 8266. In addition to the Lua NodeMCU language also supports the Arduino IDE software by making slight changes to the board manager in the Arduino IDE software, namely by adding a URL to download a special NodeMCU board on the board manager [6].

Resistor

The letter R denotes the electrical prisoner in delivery, and the prisoner is a component designed to have a specific prisoner size. As the name implies, resistor functions are resistive and belong to one of the electronic components in passive components. The unit or resistance value of a resistor is called Ohm and is denoted by the symbol Omega (Ω) [7].

Light Emitting Diode (LED)

LEDs are electronic components that can emit monochromatic light when given forward voltage. LEDs are a family of diodes made of semiconductor materials. The colors of light emitted by LEDs depend on the semiconductor material [8].

Arduino Relay

Relay is an electronic component that can function to perform logic switching. A relay is a switch that is operated electromagnetically through an electrical signal. The relays based on Contact Point are Normally Closed (NC) and Normally Open (NO). In the design of this tool, they usually close used in the power supply reserve and normally open connected to state electricity company (PLN) source. Relay is logically controlled through Arduino to perform alignment according to the desired conditions in the program [9]. The controlling remote light with NodeMCU uses Blynk to operate the ON/OFF lamp remotely (10).

The lamp control using NodeMCU-based voice commands to activate the lamp using NodeMCU as a microcontroller [11]. In this study, there are several differences and similarities with the research conducted by [10]. This study is the language of the programs made and the burdens used. This study also has similarities with the previous study conducted by [10] namely microcontrollers used in research and control tools and applications used. This study also has similarities with research conducted [11], including NodeMCU ESP 8266 as a microcontroller and Arduino relay module as a breaker from the microcontroller to load while the difference is the programming language created and the load used.

II. METHOD

Research design

In the process of designing control Airfield Lighting System carried out several stages as in Figure 1.

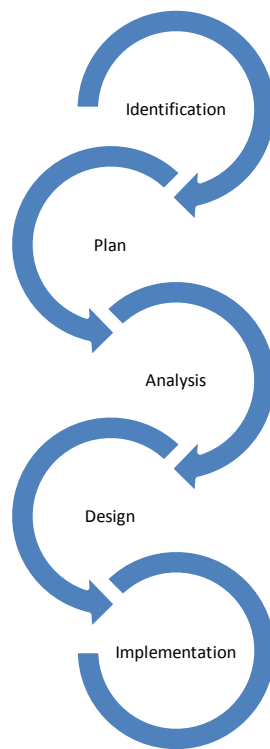


Figure 1. Research Stages

Tool design

In this process, there is hardware and software that will be used. The device can be seen in Figure 2.

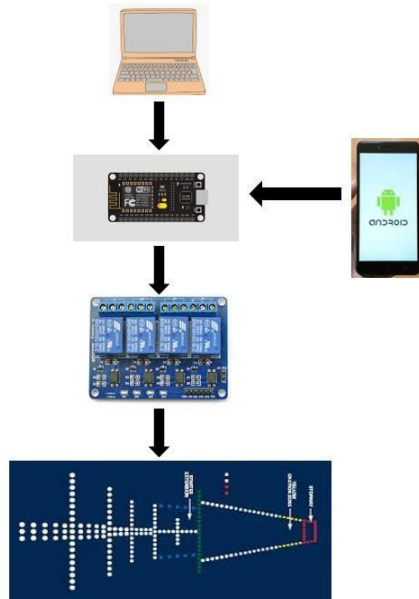


Figure 2. Tool Design

How tools work

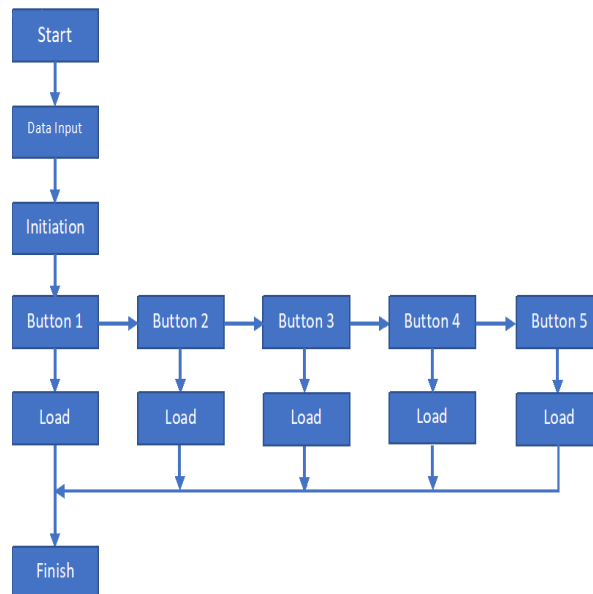


Figure 3. Flowchart System

In designing android-based ON/OFF Airfield Lighting System operating controls, there are several working steps as follows:

- 1). Create a programming language on a PC/laptop using the Arduino IDE application after creating the programming language and then uploading it to NodeMCU.
- 2). After the programming language is uploaded, connect NodeMCU with WIFI, whose IP is the same as the programming language that has been created.
- 3). Next, connect the output Pin from NodeMCU to the input pin of the Arduino Relay.
- 4). Then, design a mock-up of the Airfield Lighting System with the components that already have.
- 5). If the mock-up design is finished, connect it with the output pin of the Arduino Relay.
- 6). Then connect Android with NodeMCU.
- 7). Last, the Airfield Lighting System mock-up can be controlled by operating ON/OFF via Android.

Testing techniques

The testing technique is a technique that is done to ensure all components have been installed under normal conditions or vice versa. In addition, this is done to find out whether or not the performance of the operating control tool when in ON/OFF conditions for the AFL. There are 2 stages to test this tool, namely by measuring the current and voltage.

Data Analysis Techniques

After designing ON/OFF operating controls on the Android-based Airfield Lightning System, the author conducted a data analysis at the location, conducted by asking directly to the technician at the airport and analyzing directly in the field. The data analysis technique used in writing this final task is qualitative descriptive analysis, i.e., the author observes facts or events that have occurred in the field and compares them with existing documents or procedures. This study uses the qualitative descriptive analysis method to analyze, describe, and summarize various conditions and situations from various data collected in interview results or observations about the problems studied that occur in the field [12].

III. RESULT

The system research phase is carried out to know the results of the design that has been made. System testing consists of several stages, ranging from testing each supporting part of the system to testing the system as a whole. From the test results, it can be analyzed the performance of each part of the system that interacts with each other so that the ON/OFF AFL operating control system is formed. Testing the entire system is useful for knowing how the performance and success rate of the system.

Hardware

The hardware that has been successfully created in this study is a prototype of the android-based ON/OFF AFL operating control system. The hardware in this study consists of NodeMCU, Arduino Relay, Resistor, and 5 Watt LED. The workings of the hardware created i.e. NodeMCU sends data to the Arduino Relay where the data is transmitted by the connected Phone, after relay gets the data then relay which as on / off control will give its output to the resistor as an obstacle before the inflow to the LED as a device load on the hardware.



Figure 4. Hardware outside View

NodeMCU ESP 8266

In this study, the microcontroller used is NodeMCU. The role of microcontrollers here is as a controller of electronic components. Arduino is an open-source electronic circuit with hardware and software that is easy to use and a control link for Android with a microcontroller that serves to send data entered in software applications located on android phones.

Arduino Relay

In designing this tool, a relay is paired that serves as a switch that regulates the microcontroller's output that sends data to the 5 V LED load.

Resistor

The use of resistors in this design so that the LED used is not broken due to excessive incoming current and can cause the LED to be damaged.

LED

In the design of this tool, LED as an indicator of AFL lights attached to the design that gets the voltage regulated by the relay.

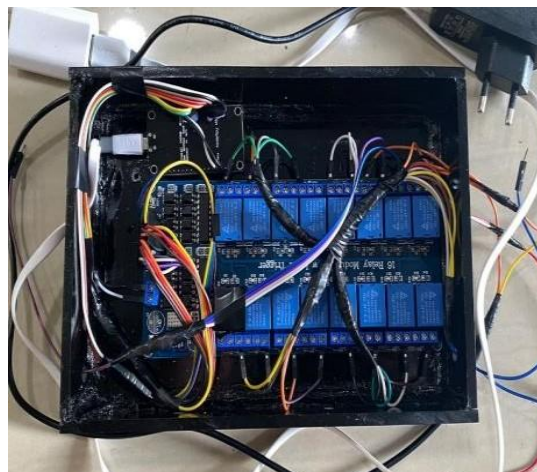


Figure 5. Hardware Component Assembly

1). Soft Ware

The software used in this design is the Blynk application that can be downloaded in the Playstore. The function of the application as a control used on Android later sends data to NodeMCU. Then also used Arduino IDE as an application to create a programming language that will be entered into NodeMCU as a microcontroller that will get commands from Android and send data to the relay to enable LEDs.



```
AFL_BPN_NODEMUCU | Arduino 1.8.15
File Edit Sketch Tools Help
AFL_BPN_NODEMUCU
Download latest Blynk library here:
https://github.com/blynkkk/blynk-library/releases/latest

Blynk is a platform with iOS and Android apps to control
Arduino, Raspberry Pi and the likes over the Internet.
You can easily build graphic interfaces for all your
projects by simply dragging and dropping widgets.

Downloads, docs, tutorials: http://www.blynk.cc
Sketch generator: http://examples.blynk.cc
Blynk community: http://community.blynk.cc
Follow us: http://www.fb.com/blynkapp
http://twitter.com/blynk_app

Blynk library is licensed under MIT license
This example code is in public domain.

This example runs directly on NodeMCU.

Note: This requires ESP8266 support package:
https://github.com/esp8266/Arduino

Please be sure to select the right NodeMCU module
in the Tools -> Board menu!

For advanced settings please follow ESP examples :
- ESP8266_Standalone_Manual_IP.ino
- ESP8266_Standalone_SmartConfig.ino
- ESP8266_Standalone_SSL.ino

Change WiFi ssid, pass, and Blynk auth token to run !
Feel free to apply it to any other example. It's simple!
*****

/* Comment this out to disable prints and save space */
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// You should get Auth Token in the Blynk App.

Please be sure to select the right NodeMCU module
in the Tools -> Board menu!

For advanced settings please follow ESP examples :
- ESP8266_Standalone_Manual_IP.ino
- ESP8266_Standalone_SmartConfig.ino
- ESP8266_Standalone_SSL.ino

Change WiFi ssid, pass, and Blynk auth token to run !
Feel free to apply it to any other example. It's simple!
*****

/* Comment this out to disable prints and save space */
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "BK1jXKn0lgbALROENky50ha4Htpu5Tr9";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Lainnya.";
char pass[] = "00000000";

void setup()
{
  // Debug console
  Serial.begin(9600);

  // You can also specify server:
  Blynk.begin(auth, ssid, pass, "blynk-cloud.com", 8080);
}

void loop()
{
  Blynk.run();
}
```

Figure 6. Programming Language

IV. DISCUSSION

From the results of the research that has been explained, the results of testing this tool are done by testing using a multimeter measuring instrument.

NodeMCU testing

Testing on NodeMCU microcontrollers is done by taking measurements on NodeMCU pins that will be used as inputs and outputs to run the system on AFL On / Off operating control. Input and output testing is done by checking on NodeMCU pins using digital multimeters. In the design of the ON/OFF AFL operating control tool, there are several pins that are used as inputs and outputs.

Arduino Relay Testing

Testing on this relay is done by taking measurements using a multimeter on the NO and NC relay that will be used as the output of the relay that will run the system on the AFL ON/OFF operating control.

Resistor Testing

Resistor testing is done by using a multimeter using ohm/resistance units using the x1 scale, which is connected to a red and black probe with both ends of the resistor.

LED testing

Testing on LEDs is done using a multimeter with ohm/resistance units. Positive feet on LEDs are connected with positive probes, and LED negative feet are connected to negative probes on multimeters.

Testing Tools on CCR at SAMS Sepinggan Airport

In the test, the tool that has been designed is done direct testing to the AFL load located international airport in Indonesia which is done in the CCR substation T4 room. The tool that has been designed is connected to the control module located in the CCR, by connecting the CCR control voltage to the NC relay then COM from the relay connected to the CCR control relay, after connecting then the connection between the phone and the tool that has been designed using the Blynk application after connecting can be done AFL control operation using Android.



Figure7. Testing of tools on CCR

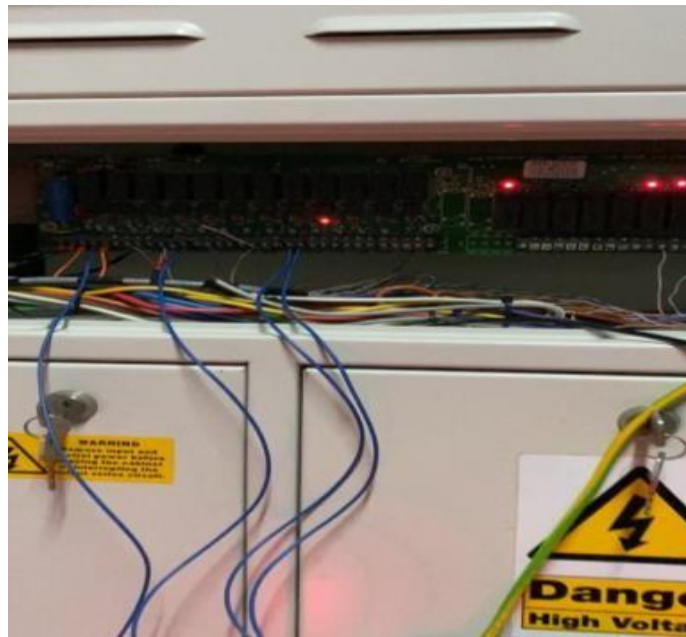


Figure 8. Placement of cables on CCR control



Figure 9. Test results on CCR display

Table1. CCR Test Results

No.	oftware and Hardware	Function	Not Working
1	NodeMCU	☐	-
2	Relay Arduino	☐	-
3	Relay CCR	☐	-
4	Application Android	☐	-

Testing Tools on Prototypes

In this test, the tool that has been designed is tested to the prototype that has been made using LED loads as an AFL indicator. After the tool components are designed, then the output of each relay goes to the LED as the AFL control. If all has been connected, it can be connected to Android, which has a Blynk application with

Ip code that has been created before after the application is downloaded then, it can be operated by contacting a NodeMCU. If it is connected, then so AFL control operation can be performed using Android.



Figure 10. Test Results of Tools on Prototypes

Table 1. Test Results on the Prototype

No.	Software and Hardware	Function	Not Working
1	NodeMCU	☐	-
2	Arduino Relay	☐	-
3	Resistor	☐	-
4	LED	☐	-
5	Application Android	☐	-

V. CONCLUSION

This study showed the usefulness of control components in operating Android-based Airfield Lighting System equipment with ON/OFF conditions and how to design android-based ON/OFF Airfield Lighting System operating controls. The design of the tool has been made can work properly. It is expected to be able to become the solution to existing problems. The android system can be used effectively to design control tools as simple as the AFL's ON/OFF control tool.

References

- [1] Bumiller, G., and Pirschel, N., 2003. Airfield ground lighting automation system realized with power line communication. In *Proc. 8th Int. Symp. Power Line Commun. Appl* (pp. 16-20).
- [2] Sudjoko, R. I., and Hariyadi, S., 2021. Design and Simulation of Airfield Lighting System Using 8 Luminaire in Airfield Lighting Laboratory at Politeknik Penerbangan Surabaya. In *Journal of Physics: Conference Series* (Vol. 1845, No. 1, p. 012034). IOP Publishing.
- [3] Decree of the Director General of Transportation Number SKEP/114/VI/2002 concerning Standard Drawings for Airport Lighting Installations (Airfield Lighting System). Retrieved August 24, 2021, at 10.15 am.
- [4] Almomani, I. M., & Al Khayer, A. (2020). A comprehensive analysis of the android permissions system. *IEEE Access*, 8, 216671-216688.
- [5] Sadiq, S., Umer, M., Ullah, S., Mirjalili, S., Rupapara, V., and Nappi, M. 2021. Discrepancy detection between actual user reviews and numeric ratings of Google App store using deep learning. *Expert Systems with Applications*, 181, 115111.
- [6] Efendi., Chandra. 2019. Implementation of Internet of Things on Home Lighting Control System using Telegram Messenger Bot and NodeMCU Esp 8266. Retrieved September 11, 2021 at 8:29 p.m.
- [7] Susanti and Fitri, 2018. Design and Manufacturing of Basic Electronics Practicum Modules. <https://eprints.umm.ac.id/42927/3/BAB%202.pdf>. Last accessed on August 21, 2021 at 12:26 PM.
- [8] Sagittarius. 2015. Application of RGB LED on Arduino Uno based Color Sorter Robot Arm. <http://eprints.polsri.ac.id/1810/3/BAB%20II.pdf>. (Last accessed on August 25, 2021 at 09:25 WITA. Retrieved August 21, 2021 at 5:56 p.m).
- [9] Aprilianti, D. 2019. Design and build of Automatic Transfer Switch (ATS) as a Connector of Backup Electrical Resources using a Web-based Arduino Uno ATMEGA328. (Doctoral dissertation, Sriwijaya State Polytechnic).
- [10] Tamba, S. P., Nasution, A. H. M., Indriani, S., Fadhilah, N., and Arifin, C. 2019. Remote light control with nodemcu using blynk. *Journal of Tekinkom (Information and Computer Engineering)*, 2(1), 93-98.
- [11] Mubarak, M. S. A. 2018. Light Control using NodeMCU-based Voice Commands. (Doctoral dissertation, STMIK Widya Cipta Dharma).
- [12] Made Wiratha, I. 2006. Guidelines for Writing Research Proposals, Thesis and Thesis.