DEVELOPMENT OF IOT-BASED HUMAN MACHINE INTERFACE FOR OPERATIONAL CONTROL AT MUTIARA SIS AL JUFRI PALU AIRPORT

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ABSTRACT

The results of a literature study at Palu's Mutiara Sis Al Jufri Airport are that daily electrical power monitoring has not been carried out optimally. So expenditure on electrical power is still very high. Therefore, the research objectives were (1) to understand how to design and build an IoT-based Airfield Lightning System control and monitoring, (2) to know how to operate an Internet of Things-based Airfield Lightning System control and monitoring. The research method used for this research is research and development, namely developing existing research and adding additional features that are not yet available. The testing technique used is the black box technique. The results of this research are that it can control IoT-based Airfield Lightning Systems such as CCR systems at airports. This research can also monitor the Dimmer output voltage and current which has been adjusted at each step. The circuit used is a parallel circuit. For programming it comes from the Arduino IDE application and for monitoring it uses the Thinger.io platform. The Airfield Lightning System areas designed are lights on the Runway, Taxiway, Apron and PAPI. The components used are the NodeMCU ESP8266 microcontroller, Relay, PZEM-004T, Dimmer, and Terminal Block. The advantage of this design is that it can monitor current and voltage without needing to go directly to the runway, thereby saving technician time and energy. The weakness of this research is that it cannot work interlocked for each step change, it must be done manually and it cannot monitor the output of each load. And to be able to monitor the output voltage one by one by adding PZEM-004T for each load output and NodeMCU ESP8266. With these suggestions, it is hoped that they can be developed for further research

Keywords: Airfield Lightning System, Internet of Things, black box, *Thinger.io*

1. INTRODUCTION

Control is a process of maintaining or controlling something so that it remains orderly as it should be. Meanwhile, monitoring is an activity that aims to monitor or observe something (Apriani et al., 2019). Control of the AFL at Mutiara Sis Al Jufri Airport was initially carried out using a manual control desk, where all forms of control and monitoring actions on the AFL were still carried out manually, while the monitoring process was not yet available. So the airport has not been able to monitor the power issued/required for the operation of the AFL. Apart from going out, technicians have to take time and energy to carry out these control and monitoring actions. In the industrial era 4.0, all actions are carried out automatically, for example by using machines, programming, robots, even AI. So a Human Interface Control Desk Airfield Lightning System Design Based on the Internet of Things was created at Mutiara Sis Al-Jufri Airport in Palu to make it easier for technicians to carry out control and monitoring in the form of HMI (Human Machine Interface).

The Airfield Lightning System which will be designed will only consist of 4 parts, namely Runway, Taxiway, Apron and PAPI. A runway is a defined rectangular area on a land aerodrome prepared for the landing and takeoff of aircraft. (ICAO, 2022) for the length of the runway at Mutiara Sis Al Jufri Airport in Palu, namely 2500. According to (ICAO, 2022) Taxiway is a certain path at an airport on land which is intended for aircraft to taxi and is intended to be a connection between one part of the airport air with others. According to Annex 14, an apron is a designated area at an aerodrome which is given to regulate the activities and movements of aircraft in raising or lowering passengers, passengers, post or cargo, parking or maintenance. (ICAO, 2022). Precision Approach Path Indicator (PAPI) is a visual landing tool that functions to guide an aircraft about to land by providing the aircraft with the correct landing angle (Purbo et al., 2023).

According to Burange and Misalkar, the Internet of Things (IOT) is a structure in which objects, people are provided with exclusive identities and the ability to move data over a network without the need for two-way human-to-human i.e. source to destination or human-to-computer interaction (Agung Raharjo & Sabur, 2020). By using the Internet of Things system, technicians are expected to be able to control and monitor the Airfield Lightning System from a distance. The component used is a microcontroller, namely NodeMCU

ESP8266. NodeMCU ESP8266 is an open source IoT platform. Which consists of System On Chip ESP8266 hardware from the ESP 8266 made by Espressif Systems. The firmware uses the Lua scripting programming language. By default, the term NodeMCU actually refers to the firmware used rather than the development kit hardware (Fauzan et al., 2022). For monitoring, use the PZEM-004T. The PZEM-004T sensor is a multifunctional sensor module which functions to measure voltage, current, power, power factor and energy contained in an electric current. This module is equipped with an integrated voltage sensor and current sensor (CT). In its use, this tool is specifically for indoor use and the installed load is not allowed to exceed the specified power (Nursamsi Adiwiranto & Budi Waluyo, 2021). To set the steps yourself, use a Dimmer. A dimmer is a series of electronic components from an input AC signal, then the signal is processed into a forward phase AC signal from the input AC signal which reduces the power (Watts). It can be concluded that the dimmer is useful for reducing the power (watts) so that the heat can be controlled by the heater. In Dimmer there are 4 Levels 1 (Low), 2-3 (Middle) and 4 (High) (Lukman Aditya, 2021). Which is operated via Relay. A relay is a switch that is operated electrically and is an electromechanical component which consists of 2 main parts, namely an electromagnet (coil) and a mechanical (a set of switch/switch contacts). Relays use electromagnetic principles to move switch contacts so that with a small electric current (low power) they can conduct higher voltage electricity (Aliyudin, 2017).

2. METHOD

The research method is a series of activities in seeking the truth of a research study, which begins with a thought that forms a problem formulation to give rise to an initial hypothesis, with the help and perception of previous research, so that the research can be processed and analyzed which ultimately forms a conclusion (Sahir, 2022). The research method used by the author is the research and development research method. Research and Development (R&D) research method is a research method used to produce certain products and test the effectiveness of these products (Sugiyono, 2013). The following are ten stages that must be considered when carrying out research and development research methods.

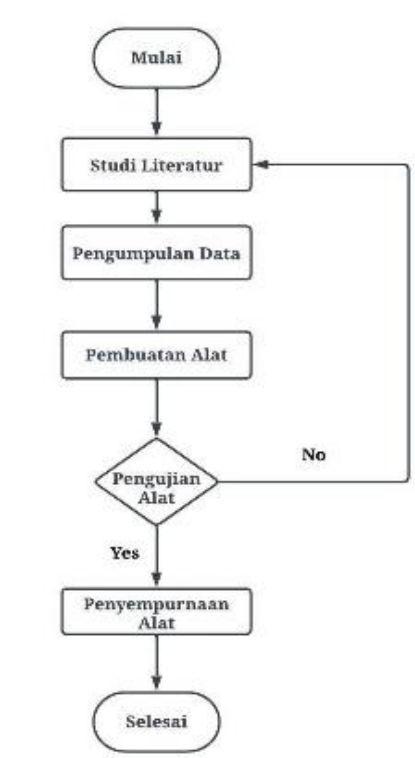

Figure 1. Flowchart of the Application

The author carried out tool testing techniques using the black box method. The definition of Black Box Testing is only testing functionality and interfaces without knowing the detailed process and only knowing the input and output. The aim of Black Box Testing according to Maharani and Merlina is to prove the operating function of the software, whether the output is running as expected and whether the information stored is always kept up to date (Ambarsari et al., 2021). The first stage that researchers will carry out in Black Box testing is to test the components that have been prepared one by one and read the indicators correctly to indicate whether the components can be used or not.

3. RESULTS AND DISCUSSION

From the results of this literature study, the author can conclude the formulation of the problem raised for the author's research. The author found a deficiency in the control desk of the CCR Airfield Lightning System, namely that it could not monitor the incoming and outgoing current and voltage, so that the electrical unit had difficulty monitoring output. Therefore, the author wants to provide a development idea in the form of a simple simulation regarding the control and monitoring of an IoT-based Airfield Lightning System.

Figure 2. Mutiara Sis Al Jufri Palu Airport Airfield Lightning System

Initially the author was going to use a transformer as a voltage regulator, but because the output voltage limit of the transformer was very small and not enough to turn on the lights that could be read by PZEM. Therefore, the author replaced it with Dimmer. The author uses relays as regulators of on, off, and load steps. The author uses a 12 Watt lamp as a load. The author uses a terminal block as an isolator from the power source.

Control testing is carried out by looking at the response of the lights to commands given via the NodeMCU ESP8266 to the Relay to be forwarded to the Dimmer whose voltage has been determined for each Dimmer. The push button is an important component because it acts as a conduit from command to action. The test results presented are of two types, namely a circuit in the on state or condition I and a circuit in the off state or condition O.

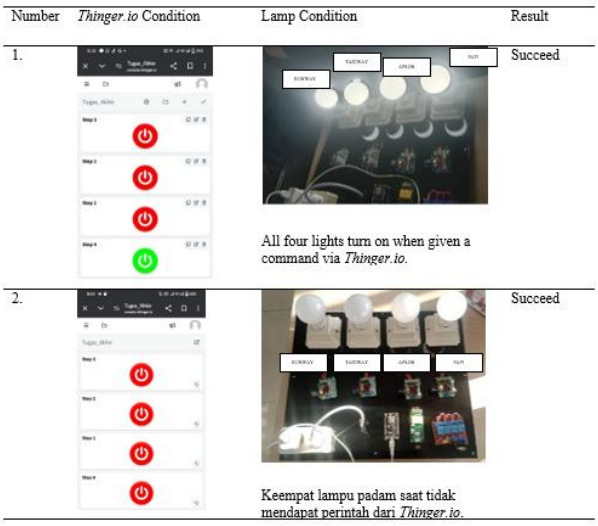

Figure 3. Control Test Result

The second test is the Step Brightness test, which is the level or brightness level of the lights. Step testing is carried out to find out whether the brightness of the lamp can follow the step command given. Researchers simulated Runway, Taxiway, Apron and PAPI lights using step brightness in the form of a Dimmer as a mini CCR.

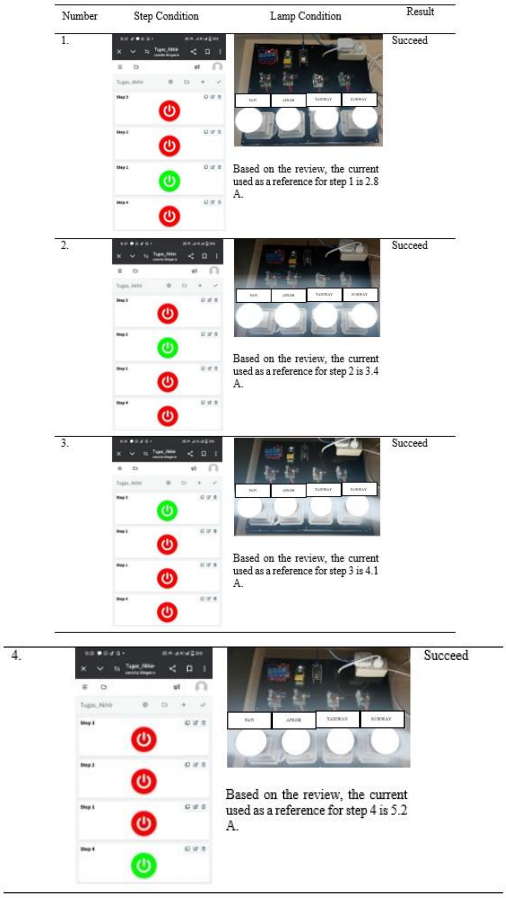

Figure 4. Step Brightness Control Test Result

Monitoring testing is carried out by comparing the voltage and current on the monitor with the measurements measured using a measuring instrument. In this test, researchers will compare the results displayed on the Thinger.io monitor with the results read on the Clamp Meter.

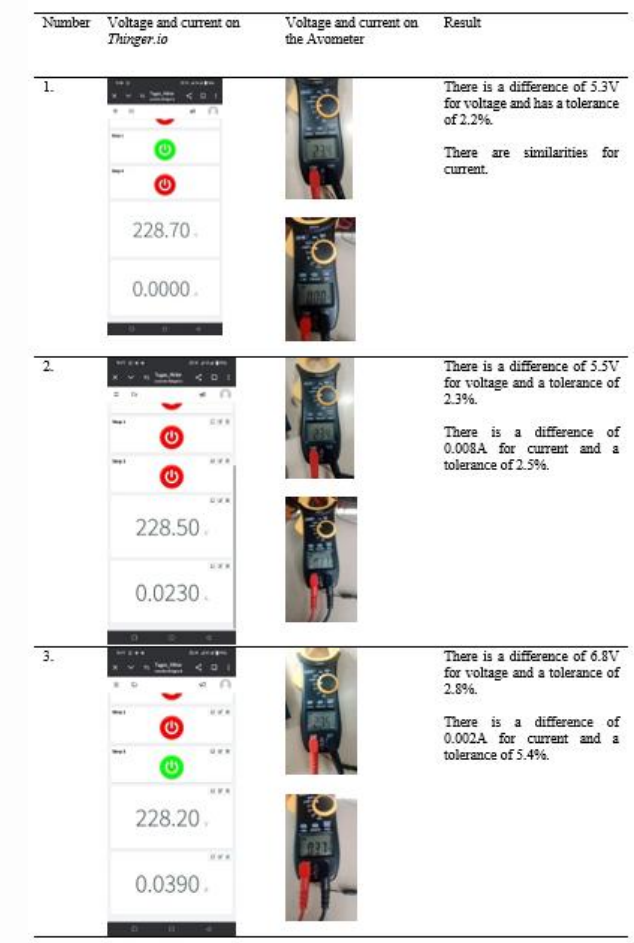

Figure 5. Monitoring Test Result

N-Gain Score Test, The N-Gain Score Test aims to determine the effectiveness of WBL learning with the Intact Group Comparison method or the experimental method and control class as follows.

Table 1. N-Gain Score Test

No	Kelas Eksperimen	No	Kelas Kontrol
	N_Gain Score (%)		N_Gain Score (%)
1	65.79	1	7.89
2	76.09	2	4.26
3	60.53	3	.00
4	68.09	4	3.03
5	81.63	5	8.33
6	84.85	6	6.06
7	82.93	7	6.38
8	89.74	8	2.17
9	94.29	9	8.57
10	81.82	10	6.52
11	62.50	11	5.17
12	60.00	12	5.36
13	48.65	13	35.19
14	58.33	14	5.66
15	63.83	15	25.00
16	73.81	16	6.52
17	81.25	17	5.26
18	86.79	18	35.19
19	91.38	19	5.66
20	78.72	20	43.75
21	75.76	21	5.77
22	75.00	22	5.17
23	71.05	23	6.52
24	69.39	24	5.17
Rata-rata	74.258	Rata-rata	10.359
Minimal	48.65	Minimal	0
Maksimal	94.29	Maksimal	43.75

Based on Table 4 shows the results of the N-Gain Score test calculation, the average N-Gain Score value for the experimental class is 74.258 or 74.2%, so it is stated to be included in the fairly effective category with a minimum N-Gain Score value of 48.65% and a maximum of 94.29%. While the average N-Gain Score for the conventional method control class is 10.35 or 10.3%, so it is stated to be included in the ineffective category for a minimum N-gain score value of 0% and a maximum of 43.75%.

4. CONCLUSION

With this research, readers are expected to be able to understand how to use Internet of Things-based Airfield Lightning System control and monitoring. The control tests carried out are control tests for on and off, as well as step brightness control tests. Readers can monitor tolerance from the results of monitoring that has been carried out. Based on the tests carried out, the monitoring that has been carried out has a low tolerance value. The author hopes that in the future this research can be developed for features that are not yet available, such as interlock and monitoring features for each load output. So that this research can later become research that is close to perfect.

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