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Control System UV-C Lamp and Room Temperature Based Internet of Things

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ABSTRACT

In 2020, the world was shocked by the emergence of a new virus, called Coronavirus Disease 2019 (COVID-19). One of the efforts to overcome the transmission of COVID-19 is by sterilizing the room. This research designs an automatic room sterilization device using UV-C lamps that can be controlled using the Blynk application. There are 2 working principles of this tool. First, the lamp will turn on according to a predetermined setpoint. Second, the lamp can turn on like a normal lamp. This research has 3 tests, the first is testing the lamp automation system where the UV-C lamp response is in accordance with the notification in the Blynk application. The second test is a human detection system with a PIR sensor where the sensor can detect a maximum radius of 5m. The third test of room temperature monitoring system with DHT11 sensor with digital thermometer comparison tool. The average error value is 0.88% with the accuracy of the DHT11 sensor of 99.12%.

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1. INTRODUCTION

At the beginning of 2020, the world was shocked by the emergence of a new virus, namely Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-nCoV-2) and the name of the disease is Coronavirus Disease 2019 (COVID-19). The COVID-19 disease was first discovered at the end of December 2019 in Wuhan, the capital city of Hubei Province, China [1]–[4]. The World Health Organization (WHO) has designated COVID-19 as a global pandemic because it has spread from day to day to all corners of the world. COVID-19 is a new disease in humans that has never been identified before. Common symptoms of COVID-19 are acute respiratory distress, fever, cough, and shortness of breath [5]–[7]. Under current conditions, COVID-19 is not a disease outbreak that can be simply ignored. If you look at the symptoms, maybe ordinary people will think of it as an ordinary fever, but for medical analysis, this virus is very dangerous and deadly [8], [9]. COVID-19 was first reported in Indonesia on March 2, 2020, with 2 cases identified. According to data from the Ministry of Health of the Republic of Indonesia as of January 21, 2022, the number of confirmed positive for COVID-19 was 4,280,248 with 144,201 deaths and 4,121,928 recovered [10], [11]. The spread of cases of transmission of COVID-19 in Indonesia mostly occurs due to direct transmission from human to human, or indirectly through touching objects that have been contaminated with the SARS-CoV-2 virus [12]. To tackle the transmission of COVID-19 is by keeping a distance of at least 2 meters from other humans, using a mask, washing hands after touching objects, staying away from crowds, eating nutritious food, exercising regularly, carrying out vaccinations, and improving and improving air quality. indoors to be free from VBKJP (viruses, bacteria, germs, fungi, and pollution). One of the efforts to tackle the transmission of COVID-19 is by sterilizing a room by spraying liquid disinfectant throughout the room. However, this method is less effective because it is done manually, and the objects exposed to the liquid disinfectant get wet [13].

Based on the background above, "Design and build control of UV-C light and room temperature based on IoT. A UV-C lamp is a tool that can sterilize a room and can kill viruses [14], [15]. UV-C lamps have a wavelength of 100-280 nm [16]. There are 2 working principles of this tool, namely automatic, the light will turn on according to a predetermined setpoint and manually, the light will turn on manually like a normal light.

2. METHOD

In designing an IoT-based [17][18] UV-C light and room temperature control system, we will use the methodology and literature from several previous studies, with a flow chart as shown in Figure 2 which explains the flow of this final project. In designing a UV light control system -C and room temperature based on IoT [19] will use the methodology and literature from several previous studies, with a flowchart like in Figure 1 which explains the flow of this final project.

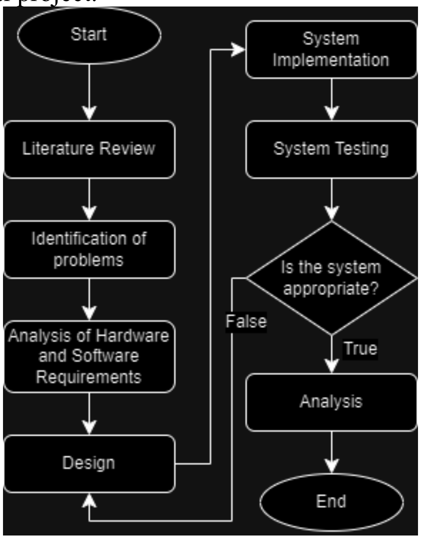

Figure 1. Flowchart Research Method

The first is to look for literature studies related to this research. Next, identify the problems that exist in this study. Next, analyze the hardware and software requirements needed. Hardware requirements are NodeMCU ESP8266, Relay, PIR sensor, DHT11 sensor, UV-C lamp, and Smartphone. Software requirements are the Arduino IDE and the Blynk application. Next is the tool design process. The design of the tool can be seen in Figure 2.

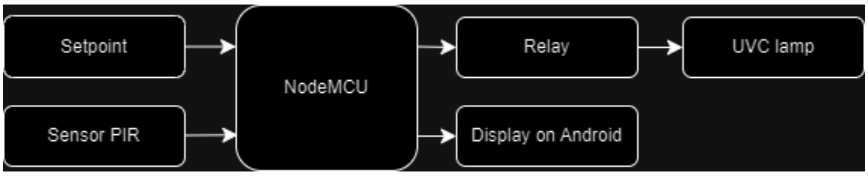

Figure 2. Tool Design

In this design, there are 2 modes, namely automatic mode, and manual mode. In automatic mode, the working principle is that it will light up once every 15 minutes if there are no people in the room. In manual mode, the working principle is that it will turn on by pressing the power button on the device and does not depend on the schedule from the Blynk application. If someone is detected, the light will turn off automatically. Based on the circuit above, the setpoint will be input via the Blynk application on Android. The input will go to the NodeMCU microcontroller. The PIR sensor connected to NodeMCU will detect the room, whether there are people in the room or not. If there are no people, NodeMCU will run according to the setpoint that has been set, and if there are people, NodeMCU will forcibly turn off the UV-C lamp. The DHT11 sensor here functions to monitor the temperature and humidity of the room [20]–[22]. On the Android display, the device is displayed whether it is on or not, whether there are people in the room or not, and the temperature and humidity values of the room [23].

The next process is system implementation, namely hardware and software implementation. Next is system testing, there are 3 system tests, namely human detection system testing, UV-C lamp automation system testing, and temperature monitoring system testing. The last process is the analysis of the tests that have been carried out in this study.

3. RESEARCH AND DISCUSSION

3.1. Hardware and Software Design

Hardware design consists of sensor design in the form of motion sensors and temperature sensors. In the hardware system, there are 3 systems, namely a UV-C lamp automation system, a temperature monitoring system, and a human detection system. The hardware design will consist of 3 circuits and be connected to the NodeMCU ESP8266 as a data processor from the results that have been obtained. As in Figure 3

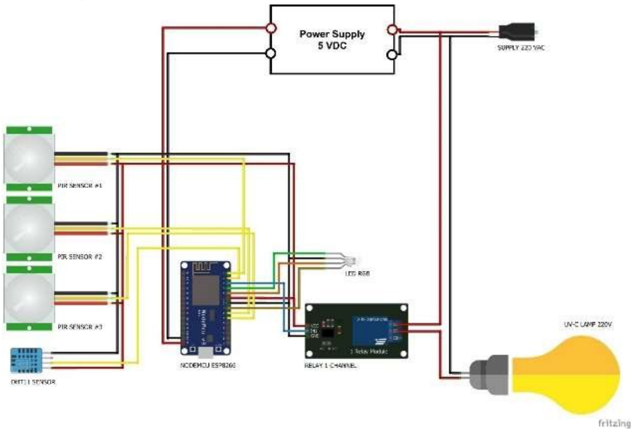

Figure 3. Design of an IoT-based UV-C lamp and room temperature control system

Hardware design also functions as the application of a system created to carry out instructions from software design. Each component used has certain specifications, the component specifications are in Table 1.

Table 1. Component specification table

Component	Specification
NodeMCU ESP 8266	Working Voltage 3.3V, Input Voltage 5V, 11 Digital I/O Pins
PIR Sensor	Working Voltage DC 4.5– 20V, Output High 3.3V, Low 0V, Diameter 23mm
Relays 1 Channel	Working Voltage 5V ADC, Resolution 10-bit, Analog and Digital Outputs
TEMPERATURE	Working Voltage 3.3-5V Humidity range 20 % - 95 %, Accuracy ± 5%
SENSOR	Temperature range 0° C – 50° C, Accuracy 0.5'C
UV-C Lamp	Working Voltage 220V 38W power, Frequency 50/60 Hz Wavelength 185 – 254 NM

3.1.1. UV-C Lamp Automation System Design

This design aims to set a schedule that is adjusted and can be controlled remotely. Starting from the NodeMCU ESP8266 which is connected to a 5V voltage, the relay is connected to the microcontroller, which is used to turn on and turn off the lights by closing and opening contacts by providing a relay. The relay is connected to the UV- C lamp.

The way the light automation system works is when the scheduling has been determined in the Blynk application which is already connected to the internet, the relay connected to the light will be active. If it has been running for 15 minutes, the light will turn off and the relay will be deactivated. As in Figure 4.

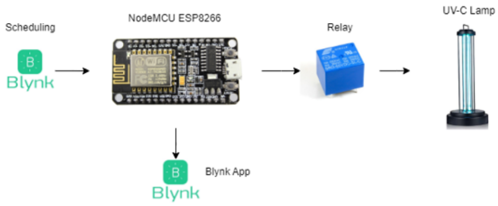

Figure 4. Lighting automation system design

3.1.2. Human Detection System Design

This design aims to detect humans if they enter a room, the lights will be automatically deactivated. Starting from the NodeMCU ESP8266 which is connected to a 5V voltage, the PIR sensor, which is connected to the NodeMCU ESP 8266, the relay, which is connected to the microcontroller, is useful for turning on and off the lights by closing and opening contacts by providing a relay. The relay is connected to the UV-C lamp.

The way the person detection system works is when the PIR sensor detects people in a room at a certain distance, the lights will automatically stop working and a notification will appear on the Blynk application that a person has been detected. If no people are detected in the room, the lights will be reactivated according to a predetermined schedule. As in Figure 5.

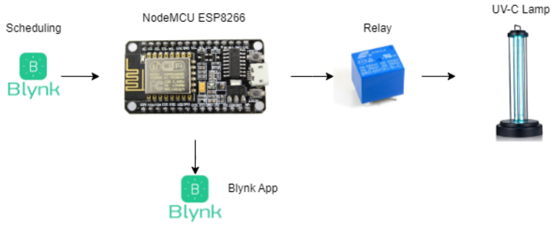

Figure 5. Human detection system design

3.1.3. Temperature Monitoring System Design

This design aims to monitor the temperature in a room. Starting from the NodeMCU ESP8266 which is connected to a 5V voltage, the DHT11 sensor is connected to the NodeMCU ESP 8266 [24], [25]. The way the temperature monitoring system works is when the tool is run, the NodeMCU ESP8266 will provide command to read the temperature value on the DHT11 sensor, then the value will be displayed in the Blynk application. As in Figure 6.

Figure 6. Temperature Monitoring System Design

3.1.4. Software Design

After hardware design is done, software design is then carried out which includes pin and sensor initialization on the NodeMCU ESP8266, WIFI initialization, and Blynk application initialization. The flow chart can be seen in Figure 7.

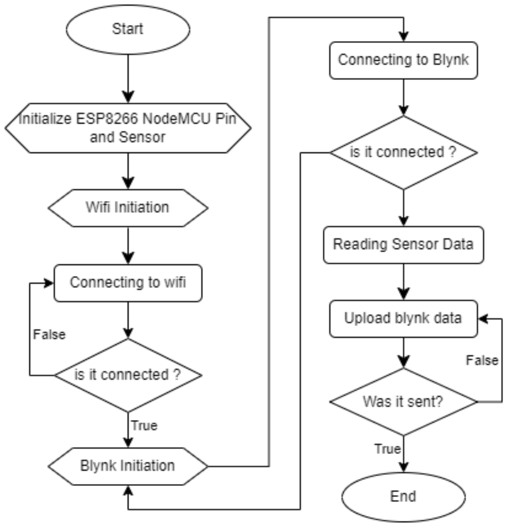

Figure 7. Software design flowchart

The first stage is to initialize the pins and sensors on the NodeMCU ESP8266. The next stage is initializing WIFI, then connecting to WIFI. If the WIFI is not connected, then you must repeat from the initializing WIFI stage, but if it is already connected, then continue to initialize Blynk then connect to Blynk. If it is not connected, then you must repeat from the Blynk initialization stage, but if it is already connected then continue reading sensor data and uploading it to Blynk. If the sensor data is not sent, it must repeat from uploading data to Blynk, but if the data has been sent then it's finished.

3.2. TESTING AND ANALYSIS

3.2.1. UV-C Lamp Automation System Testing

This test is carried out by analyzing whether the response of the lamp matches that of the Blynk application. Data collection was carried out on a schedule from 22:15 WIB to 00:30 WIB with an interval of 15 minutes. The results of this test can be seen in Table 2.

Table 2 The test results of the UV-C lamp automation system

No.	Time	UV-C Lamp Response	The Blynk app
1	22:15	Light On	UV-C Light On
2	22:30	Light Off	UV-C Light Off
3	22:45	Light On	UV-C Light On
4	23:00	Light Off	UV-C Light Off
5	23:15	Light On	UV-C Light On
6	23:30	Light Off	UV-C Light Off
7	23:45	Light On	UV-C Light On
8	24:00	Light Off	UV-C Light Off
9	00:15	Light On	UV-C Light On
10	00:30	Light Off	UV-C Light Off

From Table 2, 10 data were obtained in the form of UV-C lamp responses with notifications on the Blynk application. From the test above, it was found that the response of the UV-C lamp was in accordance with the notification on the Blynk application.

3.2.2. Human Detection System Testing

This test is carried out by varying the human distance from the distance of the PIR sensor connected to a UV-C lamp in a room. Data collection was carried out by varying the distance from 0 m – 9 m and the distance from 5.1 m – 6 m. The test results can be seen in Table 3 for distances of 0 m – 9 m and Table 4 for variations of distances of 5.1 m – 6 m.

Table 3. Human detection system test results (0 m – 9 m)

Trial to-	Range (m)	Information
1	0	Human Detected
2	1	Human Detected
3	2	Human Detected
4	3	Human Detected
5	4	Human Detected
6	5	Human Detected
7	6	No Human Detected
8	7	No Human Detected
9	8	No Human Detected
10	9	No Human Detected

Table 4. Human detection system test results (5,1 m – 6 m)

Trial to-	Range (m)	Information
1	5,1	No Human Detected
2	5,2	No Human Detected
3	5,3	No Human Detected
4	5,4	No Human Detected
5	5,5	No Human Detected
6	5,6	No Human Detected
7	5,7	No Human Detected
8	5,8	No Human Detected

Trial to-	Range (m)	Information
9	5,9	No Human Detected
10	6	No Human Detected

Based on Table 3 and Table 4, the results of testing data for the human detection system using the PIR sensor are obtained. From the test above it was found that the PIR sensor can only detect humans a maximum of 5 meters.

3.2.3. Testing of the Temperature Monitoring System

Testing the temperature sensor monitoring system is carried out by collecting temperature data in the room using the DHT11 temperature sensor and compared with a digital thermometer. Temperature data collection was carried out at different hours, which was carried out 10 times and the test results can be seen in Table 5.

Table 5. Test results of the temperature monitoring system

No	DHT11 Sensor (°C)	Digital Thermometer (°C)	Difference (°C)	Error (%)
1	27	26,7	0,3	0,60
2	27	27,2	0,2	0,40
3	28	27,5	0,5	1,00
4	28	28	0	0,00
5	27	27,6	0,6	1,20
6	26	26,8	0,8	1,60
7	25	25,6	0,6	1,20
8	25	25,6	0,6	1,20
9	26	26,4	0,4	0,80
10	27	27,4	0,4	0,80
Average			0,44	0,88

From Table 5, the last 10 data are obtained in the form of an average value as a comparison value between conventional tools and the DHT11 sensor. The difference in value is a few digits smaller and larger than with conventional tools, then the percentage error value obtained from the calculation (experimental value – theoretical value)/measurement range x 100%, then the average is calculated. The DHT11 sensor error value is 0.88%.

3.2.4. Analysis

The analysis sub-chapter is the result of the analysis after testing the IoT-based UV-C light and room temperature control system. The purpose of the analysis is to find out the conditions that occur when the test is carried out, this analysis is carried out for each test.

Based on Table 2 are the results of testing the UV-C lamp automation system. The response of the UV-C lamp matches that shown in the Blynk application. Table 3 and Table 4 show the results of testing the human detection system using the PIR sensor by varying the distance between the human and the PIR sensor from 0 m to 9 m and from 5.1 m to 6 m. The PIR sensor can detect humans at a maximum distance of 5 m, more than the PIR sensor cannot detect humans. The weakness of the PIR sensor used is that it cannot detect humans if there is no significant movement.

Table 5. is the result of testing the DHT11 temperature monitoring system. This is done by comparing the DHT11 sensor with a digital thermometer to find out whether the sensor used has a high level of accuracy and is feasible to use. Based on the test results, the value of the DHT11 sensor and digital thermometer is obtained with an average difference of 0.44°C or if it is reduced to 0.88%, which means it has an accuracy rate of 99.12%, and this can prove that the DHT11 sensor is good condition and fit for use.

4. CONCLUSION

After designing a UV-C light control system and room temperature based on the Internet of Things, it can be concluded as follows:

- The design of a UV-C light and room temperature control system based on the Internet of Things has been successfully created, using the NodeMCU ESP8266 microcontroller and 2 sensors, a PIR sensor and a DHT11 sensor. The PIR sensor is used to detect humans and the DHT11 sensor is used to monitor room temperature. This tool also has a function to schedule UV-C lamps according to the user's wishes through the Blynk application, and the Blynk application can monitor the system.

- This IoT-based UV-C light and room temperature control system can work according to the design made. There are 3 tests, the first is testing the lamp automation system where the response of the UV-C lamp is in accordance with the notification on the Blynk application. Testing the two human detection systems with the PIR sensor where the sensor can detect with a maximum radius of 5 m, more than that the PIR sensor cannot detect humans. Testing the three-room temperature monitoring systems with the DHT11 sensor with a digital thermometer comparison tool. The average error value is 0.88% with a DHT11 sensor accuracy of 99.12%.

REFERENCES

[1] Y. Yuliana, "Corona virus diseases (Covid-19): Sebuah tinjauan literatur," *Wellness Heal. Mag.*, vol. 2, no. 1, pp. 187–192, Mar. 2020.
[2] Q. Gao, Y. Hu, Z. Dai, F. Xiao, J. Wang, and J. Wu, "The Epidemiological Characteristics of 2019 Novel Coronavirus Diseases (COVID-19) in Jingmen, China," *SSRN Electron. J.*, vol. 2, no. 8, pp. 113–122, 2020.
[3] B. Mohan and N. Vinod, "COVID-19: An Insight into SARS-CoV2 Pandemic Originated at Wuhan City in Hubei Province of China," *J. Infect. Dis. Epidemiol.*, vol. 6, no. 4, Jul. 2020.
[4] H. W. Z. W. Y. D. R. C. C. X. Y. S. Z. L. T. M. S. J. H. Y. W. G. X. T. S. X. Z. Y. Cai, "Phase-adjusted estimation of the number of Coronavirus Disease 2019 cases in Wuhan, China," *Cell Discov.*, vol. 6, no. 10, 2020.
[5] M. A. Shereen, S. Khan, A. Kazmi, N. Bashir, and R. Siddique, "COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses," *Journal of Advanced Research*, vol. 24. Elsevier B.V., pp. 91–98, 01-Jul-2020.
[6] T. Dzieciatkowski, L. Szarpak, K. J. Filipiak, M. Jaguszewski, J. R. Ladny, and J. Smereka, "COVID-19 challenge for modern medicine," *Cardiol. J.*, vol. 27, no. 2, pp. 175–183, May 2020.
[7] K. J. Goh *et al.*, "Rapid Progression to Acute Respiratory Distress Syndrome: Review of Current Understanding of Critical Illness from Coronavirus Disease 2019 (COVID-19) Infection," *Ann. Acad. Med. Singapore*, 2020.
[8] Y. Sumarni, "Pandemi Covid-19: Tantangan Ekonomi dan Bisnis," *Al-Intaj J. Ekon. dan Perbank. Syariah*, vol. 6, no. 2, p. 46, Sep. 2020.
[9] R. Ali Naqvi *et al.*, "Coronavirus: A 'Mild' Virus Turned Deadly Infection," *Comput. Mater. Contin.*, vol. 67, no. 2, pp. 2631–2646, 2021.
[10] Z. Nabila, A. R. Isnain, Permata, and Z. Abidin, "Analisis Data Mining Untuk Clustering Kasus Covid-19 Di Provinsi Lampung Dengan Algoritma K-Means," *J. Teknol. dan Sist. Inf.*, vol. 2, no. 2, p. 100, 2021.
[11] P. Wardani, S. Sutisna, and M. Supriyatno, "Leadership Strategies for Facing Threats Non-Military; In The Middle of the Deep Covid-19 Pandemic Non-Military Defense," *Citiz. J. Ilm. Multidisiplin Indones.*, vol. 2, no. 1, 2022.
[12] J. Prayitno, R. A. Darmawan, J. P. Susanto, and R. Nugroho, "Tinjauan Teknologi Inaktivasi Virus Untuk Penanggulangan Pandemi Covid-19," *J. Bioteknol. Biosains Indones.*, vol. 8, no. 1, pp. 137–154, Jun. 2021.
[13] S. Ngudiwaluyo *et al.*, "Healthy Workspace Design in a New Habit Era with Covid Buster Technology in Accordance with the Minister of Health Regulation PMK 1077- 2011," 2011.
[14] F. Memarzadeh, "A Review of Recent Evidence for Utilizing Ultraviolet Irradiation Technology to Disinfect Both Indoor Air and Surfaces," *Appl. Biosaf.*, vol. 26, no. 1, pp. 52–56, Mar. 2021.
[15] T. dos Santos and Lívia Furquim de Castro, "Evaluation of a portable Ultraviolet C (UV-C) device for hospital surface decontamination," *Photodiagnosis Photodyn. Ther.*, vol. 33, 2021.
[16] A. Z. N. Azza, D. F. Amal, F. R. Pinestiti, N. N. Alfian, S. Safiinatunnajah, and D. J. Suroso, "Smart Sterilization System pada Ruang Kelas Berbasis UVC," *J. Inform. Polinema*, vol. 7, no. 3, pp. 43–52, Jun. 2021.
[17] Y. Efendi, "Internet Of Things (Iot) Sistem Pengendalian Lampu Menggunakan Raspberry Pi Berbasis Mobile," *J. Ilm. ILMU Komput.*, vol. 4, no. 1, pp. 19–26, Apr. 2018.
[18] B. Artono and R. G. Putra, "Penerapan Internet Of Things (IoT) Untuk Kontrol Lampu Menggunakan Arduino Berbasis Web," *J. Teknol. Inf. dan Terap.*, vol. 5, no. 1, pp. 9–16, Apr. 2019.
[19] D. Setiadi and M. N. Abdul Muhaemin, "PENERAPAN INTERNET OF THINGS (IoT) PADA SISTEM MONITORING IRIGASI (SMART IRIGASI)," *Infotronik J. Teknol. Inf. dan Elektron.*, vol. 3, no. 2, p. 95, Dec. 2018.
[20] M. T. A. S. M. N. A. M. K. Ishak, "Monitoring Temperature, Humidity and Controlling System in Industrial Fixed Room Storage Based on IoT," *J. Eng. Sci. Technol.*, vol. 15, no. 6, 2020.
[21] T. Adiono, M. Y. Fathany, S. Fuada, I. G. Purwanda, and S. F. Anindya, "A portable node of humidity

and temperature sensor for indoor environment monitoring," in *2018 3rd International Conference on Intelligent Green Building and Smart Grid (IGBSG)*, 2018, pp. 1–5.

[22] M. A. A. Razali, M. Kassim, N. A. Sulaiman, and S. Saaidin, "A ThingSpeak IoT on Real Time Room Condition Monitoring System," in *2020 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS)*, 2020, pp. 206–211.

[23] A. P. Susanto, M. Rivai, and T. Tasripan, "Autonomous Docking System untuk Mobile Robot Berbasis Citra pada Stasiun Pengisian Daya Nirkabel," *J. Tek. ITS*, vol. 7, no. 2, Feb. 2019.

[24] A. M. Avi, M. S. Rana, M. B. Bedar, and M. A. Talukder, "An android application and speech recognition-based IoT-enabled deployment using NodeMCU for elderly individuals," *Bull. Electr. Eng. Informatics*, vol. 12, no. 5, pp. 2763–2776, Oct. 2023.

[25] T. Suryana, "Automation and Remote Control of Electronic Equipment Using the Internet with NODEMCU ESP8266 Interface and Apache MYSQL Web Server," Indonesian Computer University, 2021.