G-Tech : Jurnal Teknologi Terapan
Volume 7, No. 3, Juli 2023, hal. 807-815
E-ISSN: 2623-064x | P-ISSN: 2580-8737

Web based Environment Monitoring System (Case Sudy: Laboratory of Universitas Multimedia Nusantara)

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Informasi Artikel

Riwayat Artikel

Diserahkan : 14-04-2023
Direvisi : 20-04-2023
Diterima : 29-04-2023

ABSTRAK

Bangunan hijau adalah suatu konsep merancang, membangun, mengoperasikan dan memelihara bangunan yang memperhatikan aspek-aspek penggunaan sumber daya alam, kualitas udara dalam ruangan serta memperhatikan kesehatan penghuninya. Untuk memantau kondisi lingkungan bangunan hijau ini dibutuhkan sistem sensor agar kondisi lingkungannya tetap terjaga sesuai standar. Penelitian ini bertujuan untuk merancang sistem sensor untuk memantau kondisi lingkungan Universitas Multimedia Nusantara. Untuk mempertahankan kondisi lingkungan bangunan tersebut, dibutuhkan sistem pemantauan secara realtime. Hasil penelitian adalah berhasil dirancang sistem sensor pemantauan lingkungan bangunan hijau khususnya ruang kelas berbasis web secara realtime dengan menggunakan NodeMCU ESP8266, Sensor DHT22, dan Sensor LDR. Selisih pembacaan antara sistem sensor pemantauan dan Environment meter untuk tingkat pencahayaan, temperatur, dan kelembaban secara berturut-turut adalah 0.67 lux, 0.9°C, dan 5.8%RH.

Kata Kunci:

Bangunan hijau, Sistem sensor, Real-time, WEB, Nodemcu ESP8266

Keywords **:**

Green building, Sensor system, Real-time, WEB, Nodemcu ESP8266

ABSTRACT

Green building is the concept of designing, building, operating, and maintaining buildings that pay attention to the use of natural resources, indoor air quality, and the health of the occupants. This green building is the choice in responding to the issue of limited non-renewable energy. To monitor the environmental conditions of green buildings, a sensor system is needed to maintain environmental conditions according to standards. This study aims to design a sensor system to monitor environmental conditions in Universitas Multimedia Nusantara. A real-time monitoring system is needed to maintain the green building environment's condition. The results of the study succeeded in designing a real-time monitoring system for green building environmental sensors, especially web-based classrooms using the NodeMCU ESP8266, DHT22 Sensor, and LDR Sensor. The difference in readings between the monitoring sensor system and the environment meter for lighting levels, temperature, and humidity respectively is 0.67 lux, 0.9°C, and 5.8%RH.

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INTRODUCTION

A green building is a building that applies the concepts of design, construction, operation, and management (Zhou, 2020) by taking into account aspects of the use of natural resources, indoor air quality, and paying attention to the health of its occupants. This green building is the choice in responding to the issue of limited non-renewable energy. A sensor system is needed to monitor environmental conditions (Andhare, M. S., Pal, T. L., Jayaram, V., Sreelekshmy Pillai, G., Tripathi, V., Krishnaraj & & Abhilash, 2022). The sensor's environmental conditions data is used to compare with the Indonesian National Standards or SNI document.

Universitas Multimedia Nusantara is one of the buildings that has implemented the green concept. This can be demonstrated by the achievements that have been obtained, including receiving an award as an Energy Efficient Building at the 2014 ASEAN Energy Award, namely the New Media Tower Building (Chininta Rizka Angelia, 2019). To prove and maintain green environmental conditions, a sensor system is needed to monitor building environmental conditions in real-time so that the information is provided. It is expected that the information provided can be accessed via the web so that building occupants can find information related to the environmental conditions of the building being inhabited.

This study aims to design a sensor system to monitor environmental conditions in Universitas Multimedia Nusantara. The environmental parameters to be monitored are temperature, humidity, and lighting levels in the room. The study was conducted by using the NodeMCU ESP8266, DHT22 Sensor, and LDR Sensor. After data was collected by the sensor, the data will be compared with the SNI document. To compare the level lighting parameter using SNI 6197:2020 (BSN, 2021), then to compare the temperature and humidity parameters using SNI 6390:2011 (Badan Standarisasi Nasional (BSN), 2011).

Research related to the design of sensor systems for monitoring has been carried out by previous researchers as listed in table 1 and table 2. The current research has several differences from previous studies including the use of different hardware, the stimulus used for research, and also the location of the research.

Tabel 1. Previously Research related to the Study

Author (Year)	Aims	Research Method	Results
(Saputri & Dhaneswari, 2022)	To design a monitoring building based on the Blynk application	The method is using DHT22 sensor, BH1750 sensor, KY-038 sensor, WeMos D1 Mini, mobile phone, and Blynk	The accuracy of the temperature sensor is 94.41%, the humidity sensor is 93.53%, the light sensor is 91.26%, and the sound sensor is 97.13%
(Fahmy Rinanda Saputri, 2021)	To measure the level of lighting in campus laboratory rooms	The system uses an LDR sensor and for calibrating uses Environment Meter DT-8820	The average accuracy of the lighting monitoring system is 88.926% and 89.130% for the average precision rate
(Dong1 et al., 2019)	To review the effect of indoor sensors on energy management, thermal comfort, visual comfort, and air quality in the environment	Comparing several studies related to sensor type and use, analysis related to sensor applications and their effects in several environments	Results of comparison between articles related to intelligent building sensor systems for building control

Tabel 2. Previously Research related to the Study

Author (Year)	Aims	Research Method	Results
(Noureddine Lasla, Messaoud Doudou, Djamel Djenouri, Abdelraouf Ouadjaout, 2019)	Create a wireless monitoring system with passive infrared sensors (PIRs)	Create a pervasive system integrated with the building without cable installation. The system is battery-operated for easy installation	The system can be demonstrated for more than 6 years without any battery change
(Behnam Mobaraki, Seyedmilad Komarizadehasl, Francisco Javier Castilla Pascual, 2022)	To design a low-cost sensor for ambient temperature monitoring	The method is using Arduino Mega, BMP280, BMP180, DHT22, SHT21. SHT35	The measurement difference decreased with increasing number of sensors, as the maximum standard deviation of 10 sensors (0.42) decreased to 0.32 and 0.27 for groups of 20 and 30 sensors, respectively.

RESEARCH METHODS

This system consists of a combination of microcontrollers, sensors, and other electronic components. The system is then designed to be an electronic circuit that can measure and monitor environmental variables, such as lighting levels, temperature, and humidity. The components that make up the system are NodeMCU ESP8266, DHT22 Sensor, LDR Sensor, LM2596 DC-DC step down, 1602 Liquid Crystal Display (LCD) screen, LM2596 DC-DC step down, switch, and 18650 Battery, 1500 mAh rechargeable.

Sensor measurement results can be displayed on the LCD screen and website in real-time. Programming is done using the Arduino IDE software on a computer/laptop. With the Arduino IDE software, sensor reading results can also be connected to the ThingsBoard server, namely things board. Cloud to design dashboards by selecting the type of display of sensor reading data visualizations, such as in graphs or tables.

When the system is run through the activation of the switch, the input from the LDR and DHT 22 sensor readings will be processed by the NodeMCU ESP8266 microcontroller which is then connected to the LCD 1602 and the battery as a voltage source. The voltage from the battery is lowered first using the DC-DC step-down LM2596 to provide power to the circuit. The output will be displayed on the 1602 LCD and a website that can be accessed on a computer/laptop via a Wi-Fi network.

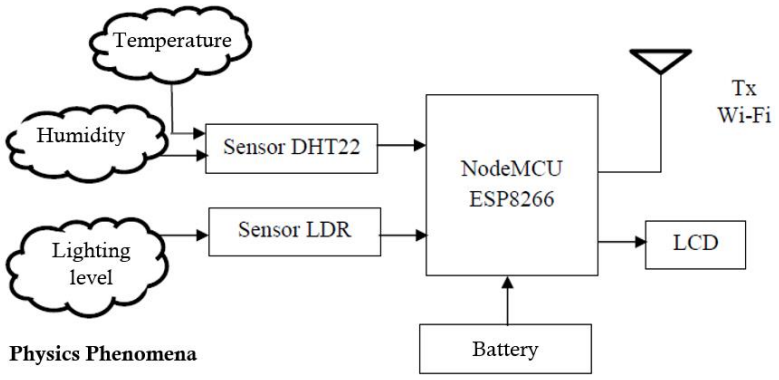

Figure 1. Block Diagram of Web-based Environmental Monitoring Sensor System (Transmitter)

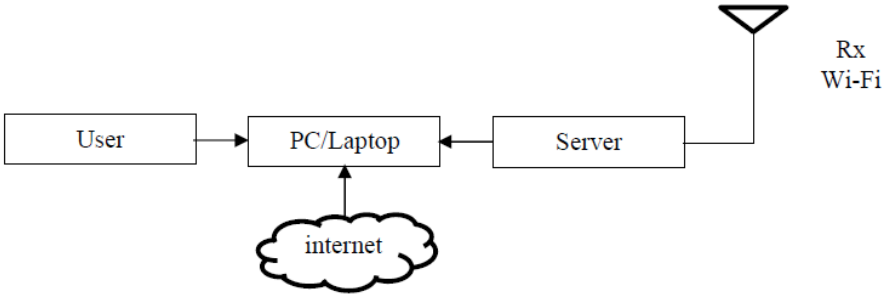

Figure 2. Block Diagram of Web-based Environmental Monitoring Sensor System (Receiver)

In monitoring the environmental parameters of green buildings, sensors system is needed that can sense according to the wishes of researchers. This system is controlled by a microcontroller that has been selected by researchers according to adequate capacity. If the sensor system can work, then the next step is calibration with the DT-8820 Environment Meter measuring instrument. Systems that already work well are integrated using software to be able to display web-based environmental monitoring information. Figure 1 and 2 is an overview of how a web-based monitoring system works. The system will send a signal that is perceived by the sensor as seen in Figure 1. Then the system will receive the signal and be displayed to the web on a PC or laptop as shown in Figure 2.

RESULTS AND DISCUSSION

The Results

The test location of the monitoring system that has been designed is one of the class members of Multimedia Nusantara University. This classroom functions as a laboratory, namely room B518, shown in Figure 3. The trial time is on Wednesday, September 29, 2021, from 15.30 – 16.05 WIB. The situation of the classroom environment when testing data collection using a system that has been designed, namely a small window on the door is closed using black cardboard, both large windows in room B518 are already closed with curtains, and all lights are on (36 lights in total), but there are two lights that have been damaged (flashing), does not turn on the air conditioner but there are two ventilation fans (also does not turn on), and the room is occupied by only 1 person.

Figure 3. System Testing location

Testing is carried out to determine the success of the monitoring system in reading physical phenomena contained in the test site. Figure 4, 5, and 6 are the results of consecutive measurements of lighting, temperature, and humidity levels. The results show that the sensor system has successfully read physical phenomena in the form of lighting, temperature, and room humidity. In addition to being displayed on the LCD screen, the readings can also be displayed on the website.

Figure 4. The Results of Measuring Physical Phenomena is Displayed on the Website (Light Level Parameter)

Figure 5. The Results of Measuring Physical Phenomena is Displayed on the Website (Temperature Parameter)

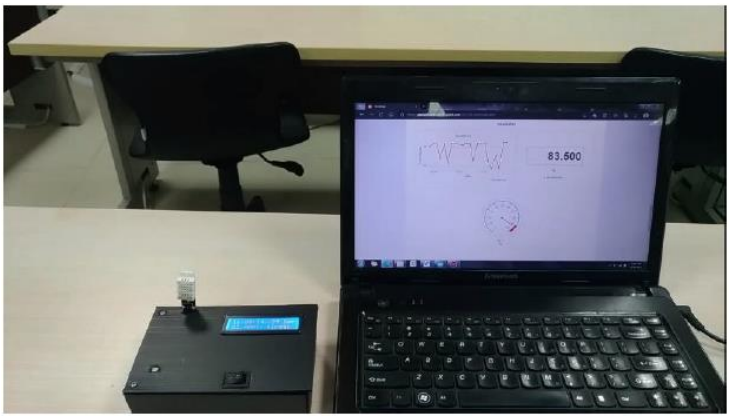

Figure 6. The Results of Measuring Physical Phenomena is Displayed on the Website (Humidity Parameter)

Figure 7, 8, and 9 are comparisons of readings between the successfully designed monitoring system and the Environment Meter. Based on the results, it can be seen that the difference in the readings of lighting, temperature, and humidity levels is 0.67 lux, 0.9°C, and 5.8%RH, respectively.

Figure 7. Comparison of Sensor System Readings and Environment Meter (Light Level Parameter)

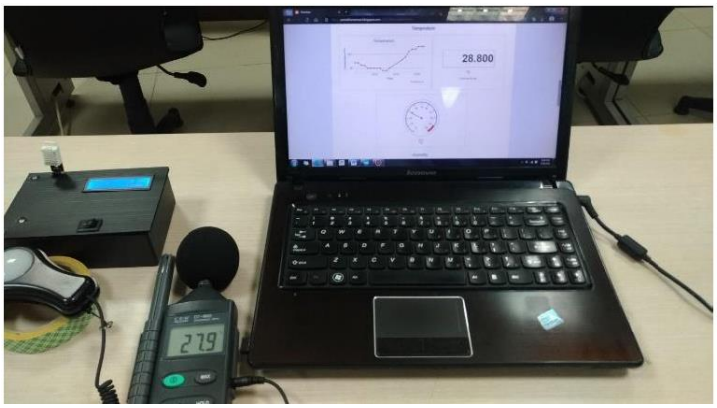

Figure 8. Comparison of Sensor System Readings and Environment Meter (Temperature Parameter)

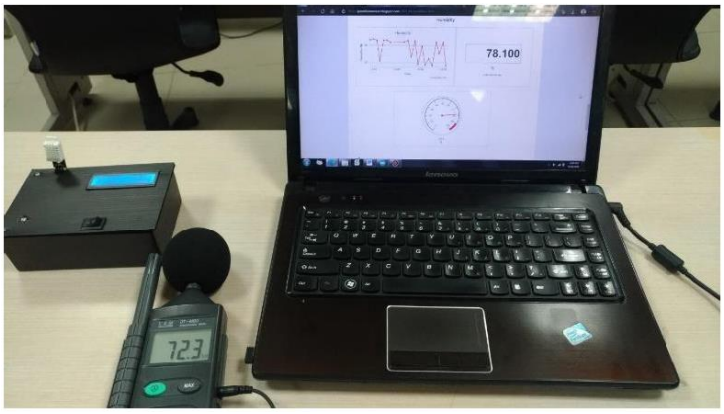

Figure 9. Comparison of Sensor System Readings and Environment Meter (Humidity Level Parameter)

The Discussion

The closed environmental monitoring system is shown in Figure 10. This consists of several parts seen in Figure 11 namely: 1) NodeMCU ESP8266; 2) DHT22 sensor; 3) DC-DC Step Down; 4) LDR sensor; 5) LCD1602; 6) Switches; 7) Rechargeable battery 1500 mAh; An LDR sensor is a resistor composed of semiconductor material. When an LDR sensor receives light that is an electronic wave, electrons break away from the atoms of the semiconductor material and conduct an electrical charge. The lighter energy absorbed, the electric voltage will increase while the resistance will decrease.

Meanwhile, the DHT22 sensor consists of a Thermistor with NTC type and humidity sensor components to receive/feel changes in air temperature and humidity. If there is an increase in temperature or humidity in the air, the resistance value of the sensor will decrease. Signal conditioners function to convert signals from sensors and convert them into voltage and current signals, through a microcontroller into measurement quantities, such as lux (lighting level), °C (temperature), and %RH (humidity). Signal processors are used to filtering out signal noise. Data presentation to display output, where in this task the data presentation elements used are LCD1602 and Thingspeak in Blogger as shown in Figure 12.

Figure 10. Monitoring System with Cover

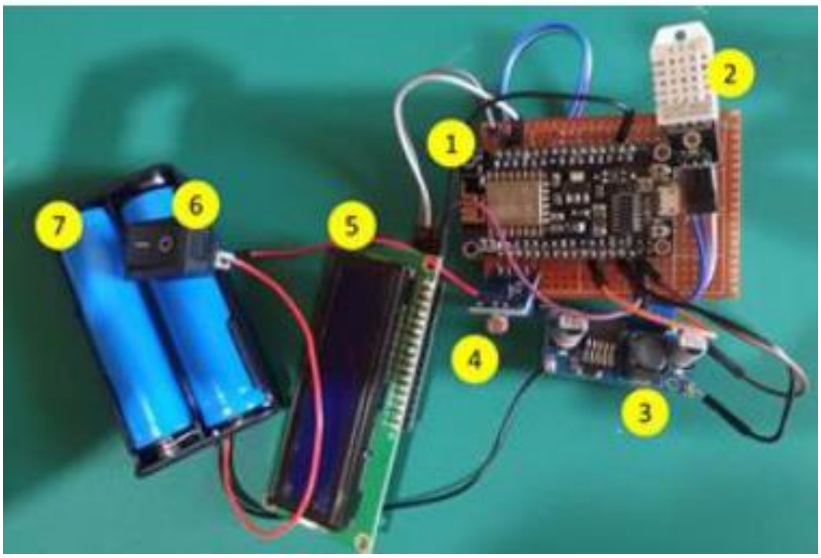

Figure 11. The Circuit of Monitoring System

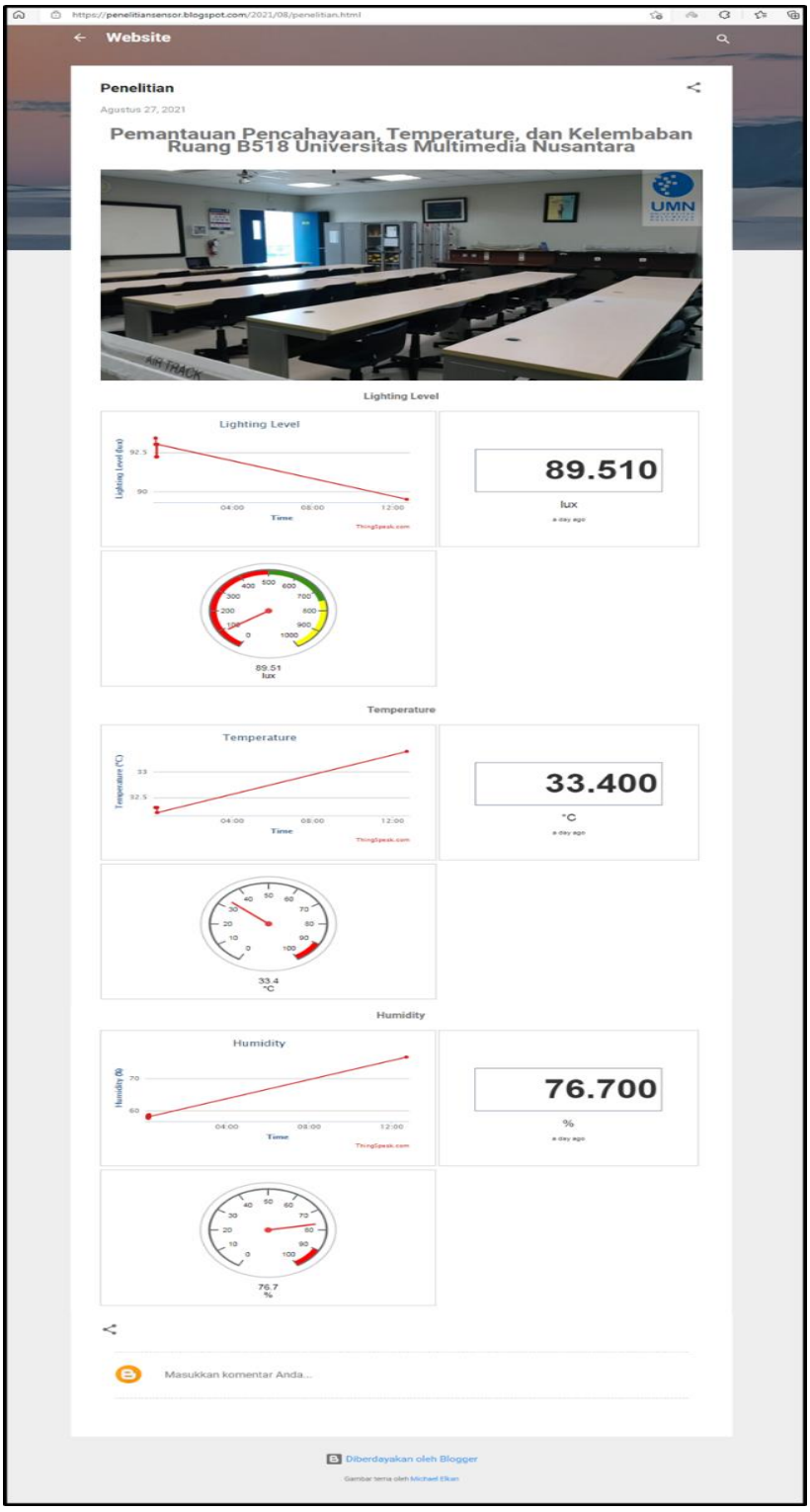

Figure 12. Website-based Monitoring System

CONCLUSION AND SUGGESTION

Conclusion

Based on the research that has been done, the conclusions are drawn that it has successfully designed a sensor system for monitoring the environment of green buildings, especially web-based classrooms in real-time using NodeMCU ESP8266, DHT22 Sensor, and LDR Sensor. The

difference in readings between the monitoring sensor system and the Environment meter for lighting, temperature, and humidity levels was 0.67 lux, 0.90C, and 5.8%RH, respectively.

Suggestion

It takes data collection several times in different locations, especially within Multimedia Nusantara University in order to find out the performance of the system that has been built.

ACKNOWLEDGMENT

We would like to thank Universitas Multimedia Nusantara for supporting the facilities and finances for this research activity.

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