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Internet of Things (IoT) Based Temperature and Humidity Detector Prototype in the UHAMKA Data Center Room

[1]M. Asep Rizkiawan, [2]Harry Ramza, [3]Agus Sofwan
[1,3]Master of Program Electrical Engineering, National Institute of Science and Technology, Jakarta, Indonesia
[2]Department of Electrical Engineering, Faculty of Industrial Technology and Informatics,
University of Muhammadiyah Prof. DR. HAMKA, Jakarta, Indonesia
Email: [1]m_asep@uhamka.ac.id , [2]hramza@uhamka.ac.id , [3]asofwan@istn.ac.id

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ABSTRACT
Internet of Things (IoT) is a concept where an object or entity is imbued with technology such as sensors and software, aiming to communicate, control, connect, and exchange data with other devices as long as they remain connected to the internet. In this research, the developed IoT is employed to monitor and control the conditions of a data center space. The research methodology follows the system development life cycle, utilizing the Blynk application and a modified Arduino Uno with the esp8266 microcontroller, relay, and DHT-22 sensor for real-time temperature and humidity detection. The IoT development's outcomes were tested through black box and white box approaches. The research results demonstrate that the IoT network prototype functions effectively, enhancing the performance of the data center space. Temperature measurements were acquired from the DHT22 sensor, and alternative temperature measurements were taken without utilizing the DHT22 sensor, instead using a tool known as a thermometer, revealing measurement errors. Based on the calculation of the average percentage of temperature error on the DHT22 sensor, it can be concluded that the temperature error rate reaches 0.051%, while for humidity it reaches 0.064%, with an average delay time of 6.542 ms. Additionally, users have convenient access through both a website and mobile platform for seamless monitoring.

Corresponding Author:
M. Asep Rizkiawan,
Master of Program Electrical Engineering,
National Institute of Science and Technology, Jakarta, Indonesia
Jl. Moch. Kahfi II No.RT.13, RT.13/RW.9, Srengseng Sawah, Kec. Jagakarsa, Kota Jakarta Selatan,
Daerah Khusus Ibukota Jakarta 12630.
Email: m_asep@uhamka.ac.id
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1. INTRODUCTION

Nowadays, almost all companies or institutions tend to focus on client - server based applications [1]. This phenomenon shows how important it is to maintain the existence of servers as a crucial element in the business world [2]. Server rooms play a very significant role in a company, as company data is stored on server devices. Therefore, it is critical to adhere to server room safety standards, especially with regards to the humidity and temperature within it [3]. Temperature is a key factor that has a major impact on the smoothness and quality of the network and devices in the server room [4]. Factors such as temperature and humidity levels can affect the physical condition of computer servers and impact their health [5]. Therefore, maintaining its stability within the server room is very important [6].

High temperature and humidity levels inside the server room can have a negative impact on the performance of network devices, easily causing network device damage [7], In the network process, the worst case scenario could be an overheat condition [8], and potential short circuits in electrical systems [9].

According to [10] The recommended temperature range for server rooms is between 18°C to 27°C, with the ideal relative humidity ranging from 40%-60%. On the contrary, according to [11], The recommended standard temperature is within the range of 16°C to 19°C. Excessively high temperatures can cause damage to the hard disk [4]. while temperatures that are too low can slow down or even stop the mechanism from working [[12], while also increasing electricity consumption [13]. Humidity that is too high can cause a short circuit, while humidity that is too low can cause static electricity [14]. The server room, which functions as a shelter for servers, network devices such as routers and hubs, as well as various other devices related to the daily functioning of the system, such as UPS and air conditioners, requires careful calculation of the air humidity level and the efficiency of the cooling system inside [15]. In a server room environment, various factors need to be considered, including air humidity levels and cooling system efficiency [9]. Server conditions are strongly influenced by the surrounding temperature and humidity, which play an important role in improving the effectiveness of work in the room [16]. To ensure optimal server performance, it is important that the temperature and humidity of the server room are within normal limits [17], [18].

The implementation of a room temperature monitoring system can support object monitoring and optimize time in the monitoring process [19]. Room temperature monitoring usually involves manual data collection, which requires physical presence at the site [20]. Monitoring and adjusting temperature and humidity conditions cannot be done continuously manually due to limited human labor. Advances in technology and information are occurring rapidly, especially in various fields related to technology [21]. However, with the development of technology and information, more efficient solutions can be implemented. One such solution is the use of an Internet of Things (IoT)-based server room temperature monitoring system [8], [22], [23].

The IoT concept aims to maximize the benefits of internet connectivity to monitor physical conditions, share data, remote control, and so on through continuously connected sensors [24], IoT is here to simplify human interaction with surrounding devices [25][26], and IoT-based technologies are becoming tools that help humans in carrying out daily activities [27][28]. IoT connects various equipment [29], such as smartphones, internet TVs, sensors, lights, televisions, refrigerators, and even the door of the house to the internet constantly [30], [31]. All these devices can be monitored and controlled remotely through a smartphone connected to the internet network [32], [33]. In the context of access, IoT is often used as a substitute for humans to conduct surveillance in various sectors, including industry, environment, hospitals, public areas, security, and transportation [34]. For example, we implemented the IoT platform Blynk, which allows users to access the microcontroller from a Smartphone and integrate with it [35]. To maintain the temperature condition of the server room, IoT-based monitoring through the Blynk platform as an interface is required [23], by installing temperature and humidity sensors in the server room [36], The sensor is connected to a NodeMCU microcontroller that includes an esp8266 [37], [38], The NodeMCU sends the sensor readings to an IoT-based Service Provider, the Blynk Platform, to facilitate monitoring and controlling the temperature of the server room, even when the Administrator is not directly at the location.

In previous research [39] This research explores the use of the Internet of Things (IoT) in monitoring the temperature and humidity of data centers in real-time by using a simple monitoring system to determine the relationship and difference between temperature and humidity with respect to different measurement locations. The development of the temperature and humidity monitoring system was carried out using the proposed framework and has been deployed at the Muadzam Shah Polytechnic data center, where readings were recorded and sent to the AT&T M2X IoT platform for storage. The data was then retrieved and analyzed which showed that there were significant differences in the temperature and humidity measured at different locations. X The monitoring system also successfully detected extreme changes in temperature and humidity and automatically sent notifications to IT personnel via email, short message service (SMS), and mobile push notifications for further action. The detected data is uploaded to the cloud storage through the network and associated using an android application. The system uses Arduino UNO with Raspberry Pi, HTU 211D sensor device, and ESP8266 Wi-Fi module. The experimental results show the temperature and humidity of the surrounding environment and soil moisture of each plant using Arduino UNO with Raspberry Pi. Raspberry Pi is mainly used here to check the temperature and humidity through HTU 211D sensor element. This sensor is used to measure the temperature of the surrounding environment, storing the information that is displayed with different devices. Here, the ESP8266 Wi-Fi module has been used for data storage purposes [40]. This research is different from the research mentioned, the difference lies in the components or hardware needed in the research and also the object or place of research.

Currently, the data center at UHAMKA is not equipped with a temperature sensor to measure the temperature conditions inside. The existence of these sensors is very important because without them, administrators face difficulties in monitoring whether the temperature in the server room meets the standards set by the Telecommunication Industry Association (TIA). Based on this challenge and the results of several previous studies aimed at overcoming problems in the UHAMKA server room or data center, the idea arose to develop a temperature and humidity monitoring system that can be accessed via a web page. This research aims to be able to facilitate administrators in monitoring in realtime.

2. RESEARCH METHOD

The Internet of Things (IoT) can be explained as a concept where various devices can be interconnected and exchange data over the internet. IoT represents a level of technological advancement that utilizes the internet to control, collaborate, and communicate with various physical objects [41].

2.1. Component Internet of Things

Sensors are devices that collect data from an object, which can be instant information such as air temperature or more complex information such as video programs, Connectivity After obtaining the information, the next step is to send it to the cloud infrastructure for processing. To transfer data to the cloud, a connection or link is required, and the Internet of Things (IoT) provides various connection options such as cellular network, satellite, WiFi, wide area network (WAN), low power wide area network, and so on, Data processing Once the data is collected and sent to the cloud, the program will process it. Data processing can vary from simple tasks such as reading air temperature to more complex tasks such as image processing to detect objects in video footage, User Interface A point of view is required to process data so that users can read or interpret it. Nowadays, user interface (UI) is becoming a necessity. User interfaces are commonly seen on devices such as computers, laptops, tablets, cell phones, and various other devices. The function of the user interface is not only to display relevant information, but also to provide a way of interaction or control for Internet of Things (IoT) devices connected to the object [42].

2.2. Software Development Life Cycle (SDLC)

SDLC, which stands for Software Development Life Cycle, refers to the process of building or modifying a software system by following best practices or techniques that have proven effective in the previous development of similar software systems. Software Development Life Cycle (SDLC) is a process applied to design, manage, and implement information systems [43]. Software Development Life Cycle Stages (SDLC) [44]

1. Problem Identification, forms the basis for gathering the necessary sources of information in an effort to solve the problem.
2. Planning, Analyze the needs of users of the software system and formulate user requirements, and set goals to be achieved in the development.
3. Design, The system design document is focused on how to fulfill the required functions after converting the detailed requirements into complete requirements.
4. Development, Create a database, design test cases, prepare files, code, compile, make corrections, and clean up the program; and conduct a test run.
5. Implementation and Testing, Ensures that the software system meets the criteria of the functional requirements document. User and quality assurance team directed.
6. Application Development, Involves preparing for implementation, implementing the software in a production or user environment, and resolving issues that arise during the integration and testing phases.

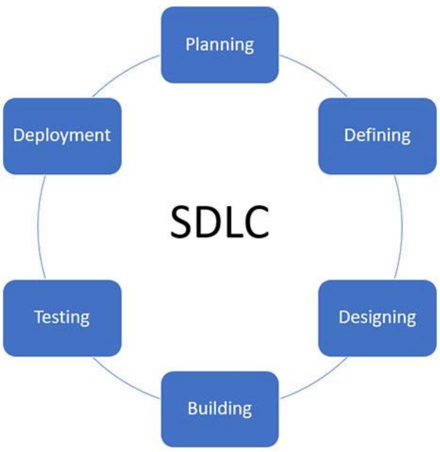

Figure 1. Software Development Life Cycle (SDLC)

2.3. Prototype Method

The Prototype Model is one of the approaches in software development that is very commonly used; by using the Prototype Method, developers and clients can actively communicate during the system building process. Clients often only need to provide an overview of the information required to be processed. On the other hand, the developer does not need to worry about the efficiency of the algorithm but rather focus on the interface and operating system that connects the user with the computer. During the system design stage, the Prototype model allows interaction between programmers and stakeholders to achieve a better understanding [45].

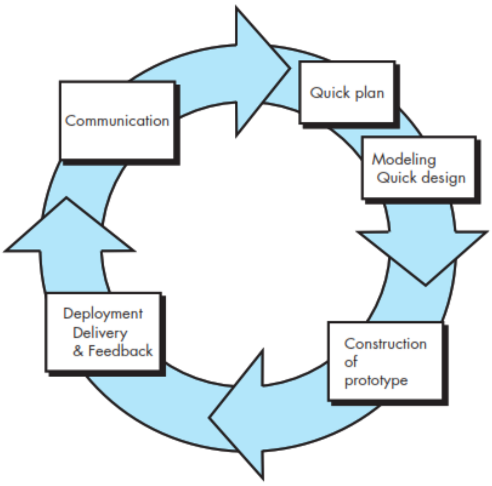

Figure 2. Prototype Model [46]

2.4. Block Diagram

In this system, Arduino will be connected to the DHT22 sensor as input to receive how much temperature is in the room, then Arduino is also connected to wifi as an internet source to be able to access BLYNK which is a place or interface to be able to see the room temperature with BLYNK, then a smartphone can access it all. There is also a catudaya as a source of electrical energy and an LCD as a hardware display.

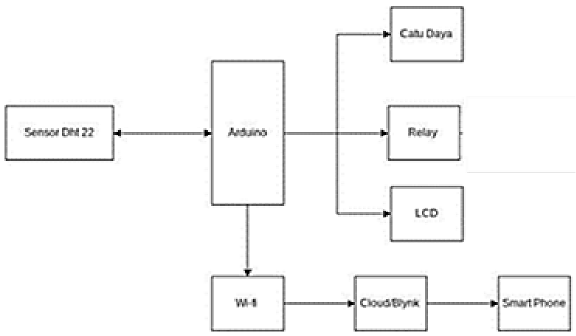

Figure 3. Block Diagram

2.5. Tool Design

This system uses male to female jumper cables to connect the circuit. The jumper cable is connected to the 2 Channel relay and connected to the NodeMCU ESP8266 device according to the color of the jumper cable used. This circuit is then connected to the smartphone via a wi-fi hotspot enabled on the Blynk app. When first registering an account on the Blynk app, a token has been provided for Blynk purposes.

2.6. Research Flowchart

The purpose of the research flowchart is to describe the mindset or steps taken by the designer in designing a system. By understanding the research flowchart, someone will more easily understand the mindset of the maker or the sequence of work processes of a system. This research flowchart can be seen in the picture below.

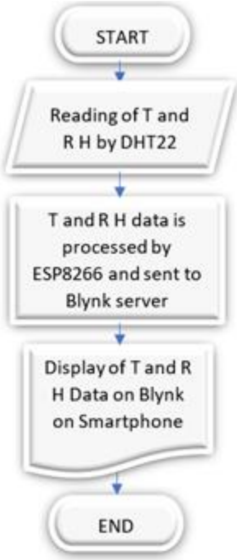

Figure 4. Research Flowchart

3. RESULTS AND ANALYSIS

3.1. Network Schematic

The Internet of Things-based temperature monitoring network design utilizes the STM32F103C Wi-Fi device. This device is responsible for processing data from the DHT22 sensor and receiving command input to activate the relay. The processed data is then transferred to the Blynk cloud server via a Wi-Fi router, and then forwarded to the ISP for internet access for data transmission. Temperature monitoring is done using an Android smartphone equipped with the Blynk app, and an internet connection is used to monitor the temperature.

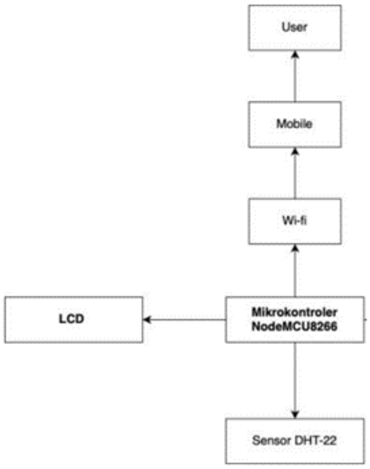

Figure 5. Network Schematic

3.2. Hardware Design Results

The hardware design starts by placing the NodeMCU ESP8266 on the Breadboard, then installing the DHT22 sensor on the Breadboard. Three male to male jumper cables are then installed, starting from the installation in the NodeMCU ESP8266 on PINs D5, GND, and 3V3, then connected to the DHT22 sensor by connecting 3V3 to (+), D5 to (OUT), and GND to (-). Next, the Arduino Robotdyn Type A Male Micro USB Data cable is attached from the NodeMCU ESP8266 to the Laptop to upload the program to the Arduino IDE, can be show in figure 6 and figure 7.

3.3. Hardware Testing Results

After all components are accurately assembled and all programs are successfully downloaded and installed, the next step is to test the function of the DHT22 sensor to determine whether it is operating properly or not. After ensuring that the sensor is functioning and can connect with the NodeMCU ESP8266, the next testing step is done by testing the temperature and humidity readings in the room. Based on the illustration above, it can be concluded that the DHT22 sensor and NodeMCU ESP8266 operate efficiently, enabling the transmission of temperature and humidity measurement data to the computer.

Figure 6. Hardware Design Results

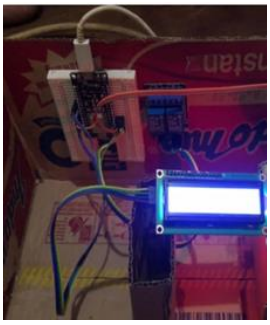

Figure 7. Hardware Design Results

3.4. Trial Results

The test data listed in the table 1 and table 2, it can be concluded that the temperature and humidity monitoring system in the room, which uses the NodeMCU ESP8266 module based on the Internet of Things, operates effectively.

Table 1. Black Box Testing Results

No	Testing	Input	Output	Result
1	Temperature sensor data input	Temperature changes	Display Temperature changes	Success
2	Sensor data input Humidity	Humidity change	Display Humidity Changed	Success

Table 2. White Box Testing Results

No	Testing	Description	Result
1	Connecting sensors with the blynk app	Temperature connects with the blynk app	Success
2	Supporting component testing Supporting component testing works	according to the expected function	Success
3	Algorithm Testing	The algorithm runs according to the goal	Success

3.5. Blynk App on Smartphones

Figure 12 shows the display of the results sent from the ESP8266 to the Blynk application on the user's mobile device, the Data Center staff. This allows the staff to know the temperature recorded in the server room.

Figure 12. Room Temperature Information Display

3.6. Testing the Temperature and Humidity Sensor (DHT22)

By doing 35 tests, we can calculate the average percentage of temperature and humidity errors based on Table 3 with the formula 1-4.

$$\text{Temperature error}(\%) = \frac{sum\ of\ temperature\ errors}{Total\ temperature\ Measurement\ Tool} \tag{1}$$

$$= \frac{16{,}3}{905{,}7} x100\% = 1{,}80\%$$

$$\text{Humidity error } (\%) = \frac{Total\ humidity\ error}{Total\ Humidity\ measuring\ instrument} \tag{2}$$

$$= \frac{16{,}3}{905{,}7} x100\% = 2{,}26\%$$

$$\text{Average temperature error } (\%) = \frac{temperature\ error(\%)}{Testing} \tag{3}$$

$$= \frac{1{,}80}{35} = 0{,}051\%$$

$$\text{Average error Humidity } (\%) = \frac{Humidity\ error(\%)}{Testing} \tag{4}$$

$$= \frac{2{,}26}{35} = 0{,}064\%$$

$$\text{Average delay(ms)} = \frac{Number\ of\ Delays(ms)}{Testing} \tag{5}$$

$$= \frac{229}{35} = 6{,}542\ ms$$

Table 3. Comparison Results of Temperature, Humidity DHT22 and measuring instruments

Testing	Time	Sensor DHT22		Measurement Tools		Error Temperature (%)	Error Humidity (%)	Delay (ms)
		Temperature (^{0}C)	Humidity (RH%)	Temperature (^{0}C)	Humidity (RH%)			
1	12:30:21	28,2	48,6	30,1	47,6	-1,9	1	0
2	12:30:28	28,5	49,6	30,1	47,8	-1,6	1,8	7
3	12:30:34	28,5	49,5	31,2	49,1	-2,7	0,4	6
4	12:30:41	26,6	59,7	28,4	59,3	-1,8	0,4	7
5	12:30:48	26,8	56,6	27,5	54,2	-0,7	2,4	7
6	12:30:54	26,8	54,7	26,8	54,1	0	0,6	7
7	12:31:01	27,2	54,8	27,7	54,4	-0,5	0,4	6
8	12:31:08	26,4	50,8	23,5	50,5	2,9	0,3	7
9	12:31:14	24,5	50,3	23,4	50,2	1,1	0,1	7
10	12:31:21	24,7	53,3	23,4	50,1	1,3	3,2	7
11	12:31:28	25,3	53,4	25,3	53,3	0	0,1	6
12	12:31:34	25,3	53,2	24,6	53,1	0,7	0,1	7
13	12:31:41	25,5	53,1	24,8	52,6	0,7	0,5	7
14	12:31:48	27,5	53,1	24,7	52,1	2,8	1	7
15	12:31:54	25,4	53,3	24,7	52,3	0,7	1	6
16	12:32:01	29,7	59,2	28,6	58,2	1,1	1	7
17	12:32:08	29,6	59,3	29,2	58,3	0,4	1	7
18	12:32:14	24,8	50,5	23,1	49,5	1,7	1	7
19	12:32:21	24,8	53,6	24,1	50,1	0,7	3,5	6
20	12:32:28	24,7	50,6	24,3	50,2	0,4	0,4	7
21	12:33:21	28,8	54,7	27,8	54,3	1	0,4	7
22	12:33:28	28,2	57,8	27,7	54,3	0,5	3,5	7
23	12:33:34	24,4	50,8	23,5	50,4	0,9	0,4	6
24	12:33:41	24,5	50,3	23,4	50,2	1,1	0,1	7
25	12:33:48	24,7	50,3	23,4	50,2	1,3	0,1	7
26	12:33:54	25,3	53,4	24,3	52,2	1	1,2	7
27	12:34:01	25,3	53,2	24,6	51,1	0,7	2,1	6
28	12:34:08	25,5	53,1	24,8	49,6	0,7	3,5	7
29	12:34:14	25,5	54,1	24,7	52,5	0,8	1,6	7
30	12:34:21	25,4	53,3	24,7	51,4	0,7	1,9	7
31	12:34:28	29,7	59,2	29,6	56,3	0,1	2,9	6
32	12:34:34	29,6	59,3	29,2	58,3	0,4	1	7
33	12:34:41	24,8	50,5	24,1	49,9	0,7	0,6	7
34	12:36:48	24,8	52,6	24,1	51,1	0,7	1,5	7
35	12:36:54	24,7	50,6	24,3	50,1	0,4	0,5	6

Testing	Time	Sensor DHT22		Measurement Tools		Error Temperature (%)	Error Humidity (%)	Delay (ms)
		Temperature (^{0}C)	Humidity (RH%)	Temperature (^{0}C)	Humidity (RH%)			
Total		922	2362,7	905,7	1828,9	16,3	41,5	229

Based on the calculation of the average percentage of temperature error on the DHT22 sensor, it can be concluded that the temperature error rate reaches 0.051%, while for humidity it reaches 0.064%, with an average delay time of 6.542 ms. Thus, the discussion and results have answered all the problems,

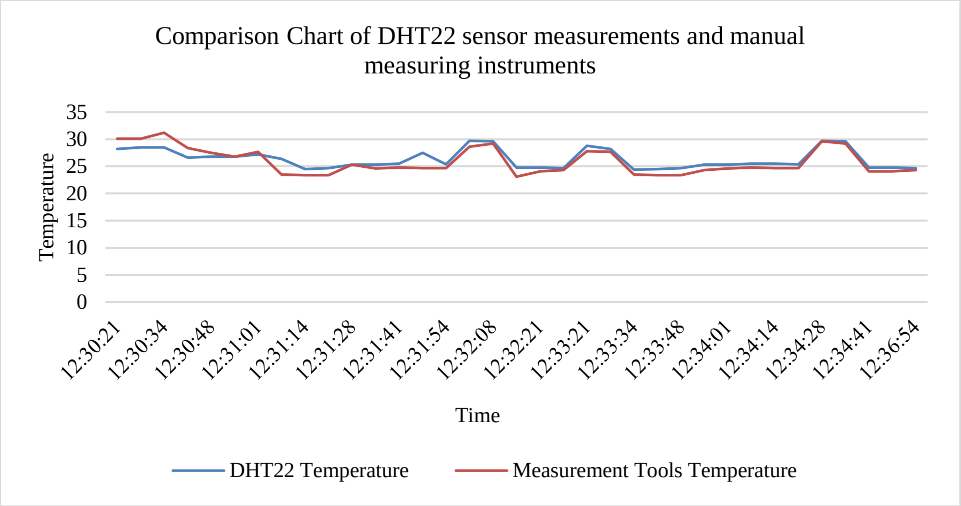

Figure 13. Comparison Chart of DHT22 sensor measurements and manual measuring instruments about temperature

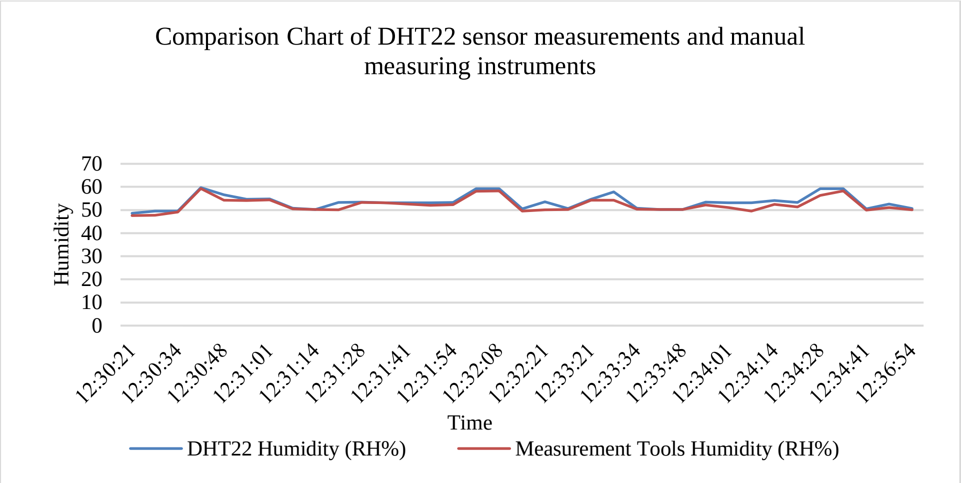

Figure 14. Comparison Chart of DHT22 sensor measurement and manual measuring instrument about humidity

4. CONCLUSION

Utilization of the IoT Network with the System Development Life Cycle method was effective in facilitating connectivity on the microcontroller network. The developed prototype system is able to design systems and devices according to the set criteria, increasing time efficiency. Based on the results of the tests carried out, it can be concluded that the Blynk application is effectively used to increase the utilization of the Internet of Things in monitoring the data center room at UHAMKA so that the administrator is greatly facilitated in the existence of a system that has been made so that he can monitor and monitor in real time, and get a value Based on the results of the calculation of the average percentage of temperature error with a value of 1,80%, Humidity Error with a value of 2,26%, temperature error on the DHT22 sensor, it can be concluded that the average level of temperature error reaches 0,051%, while for the average humidity error reaches 0,064%, with an average delay time of 6,542 ms.

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REFERENCES

[1] R. S. Anwar, “PERANCANGAN ALAT PENGENDALI SUHU RUANGAN SERVER MENGGUNAKAN SENSOR LM35 DENGAN INFORMASI SMS BERBASIS ATMEGA16,” *AKRAB JUARA*, vol. 4, no. 3, pp. 50–65, Aug. 2019.

[2] R. Tahara Shita and L. Li Hin, “SISTEM MONITORING DAN CONTROLLING SUHU DENGAN MIKROCONTROLLER BERBASIS PC DAN SMS PADA DATA CENTER PT. MNC MEDIA,” *Jurnal TELEMATIKA MKOM*, vol. 9, no. 2, pp. 72–78, Jul. 2017.

[3] S. Bahri and Suhardiyanto, “SISTEM KEAMANAN RUANG SERVER MENGGUNAKAN TEKNOLOGI RFID DAN PASSWORD,” *Jurnal Elektum*, vol. 15, no. 1, pp. 11–18, 2018.

[4] S. Suherman, I. Andriyanto, and)Saleh Dwiyatno, “RANCANG BANGUN ALAT UKUR TEMPERATUR SUHU PERANGKAT SERVER MENGGUNAKAN SENSOR LM35 BEBASIS SMS GATEWAY,” *PROSISKO*, vol. 2, no. 1, pp. 42–63, 2015.

[5] M. Ridwan, D. Djamaludin, and M. Roqib, “Prototype Monitoring Temperature and Humidity Sensor Room Server-Based Internet of Things (IOT),” 2020. doi: 10.4108/eai.23-11-2019.2301576.

[6] R. R. Abdullah and A. Wibowo, “Monitoring Suhu Ruangan Server Dengan Fuzzy Logic Metode Sugeno,” *Swabumi*, vol. I, no. 1, 2014.

[7] M. F. Awaj, A. F. Rochim, and E. D. Widianto, “Sistem Pengukur Suhu dan Kelembaban Ruang Server,” *Jurnal Teknologi dan Sistem Komputer*, vol. 2, no. 1, 2014, doi: 10.14710/jtsiskom.2.1.2014.40-47.

[8] N. F. Khobariah, P. D. S. Hermawan, and S. K. Rini, “SISTEM MONITORING SUHU DAN KELEMBAPAN RUANG SERVER BERBASIS WEMOS D1,” *JIPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika)*, vol. 7, no. 1, pp. 32–42, Mar. 2022.

[9] M. Supriyanto and F. A. Nugroho, “PERANCANGAN SISTEM PENDETEKSI ASAP DAN MONITORING KELEMBABAN SUHU PADA RUANG SERVER BERBASIS INTERNET OF THINGS MENGGUNAKAN METODE FUZZY LOGIC STUDI KASUS : RUANG SERVER YBY.NET,” *INFORMATIKA*, vol. 3, no. 1, pp. 105–142, Jul. 2022.

[10] Telecommunications Industry Assosiation, “Telecommunications Pathways and Spaces,” 2012. [Online]. Available: http://www.tiaonline.org/standards/catalog/

[11] G. T. Hadi and J. Jn, “RANCANG BANGUN PROTOTIPE MONITORING SUHU RUANG SERVER MENGGUNAKAN SISTEM ARDUINO UNO ATMEGA328 DENGAN SENSOR LM35 PADA PT. X DI BATAM,” *Jurnal JURTIE*, vol. 2, no. 2, pp. 17–24, 2020, [Online]. Available: https://jurnal.ugp.ac.id/index.php/jurtie

[12] F. H. Purwanto, E. Utami, and E. Pramono, “Implementation and Optimization of Server Room Temperature and Humidity Control System using Fuzzy Logic Based on Microcontroller,” in *Journal of Physics: Conference Series*, 2018. doi: 10.1088/1742-6596/1140/1/012050.

[13] W. Wardani, S. Hadi, and J. Budiarto, “Rancang Bangun Sistem Monitoring Suhu dan Kelembaban Udara Pada Ruang Server Berbasis Wireless Sensor Network,” *JURNAL TEKNOLOGI TERPADU*, vol. 9, no. 2, pp. 115–125, 2021.

[14] ASHRAE, “Data Center Power Equipment Thermal Guidelines and Best Practices,” *Standard*, 2016.

[15] D. Ramdan, H. A. Hendrawan, and R. Ritzkal, “SMART ROOM RUANG SERVER,” in *Seminar Nasional Teknologi Informasi Universitas Ibn Khaldun Bogor 2018*, Bogor: Universitas Ibnu Khaldun, 2018, pp. 167–176.

[16] H. Nainggolan and M. Yusfi, “RANCANG BANGUN SISTEM KENDALI TEMPERATUR DAN KELEMBABAN RELATIF PADA RUANGAN DENGAN MENGGUNAKAN MOTOR DC BERBASIS MIKROKONTROLER ATMEGA8535,” *Jurnal Fisika Unand*, vol. 2, no. 3, 2013.

[17] M. A. Agustyan and A. R. Pratama, “MONITORING SUHU DAN KELEMBABAN PADA RUANG SERVER BERBASIS ARDUINO DENGAN NOTIFIKASI EMAIL,” *Scientific Student Journal for Information, Technology and Science*, vol. II, no. 1, Aug. 2021.

[18] D. Fatra and A. Syazili, “SISTEM MONITORING SUHU JARAK JAUH PADA RUANG SERVER BERBASIS INTERNET OF THINGS,” *Bina Darma Conference on Computer Science*, 2021.

[19] R. A. Perdana, “Sistem Pemantauan Suhu Ruang Berbasis Nodemcu Dan Website Dirumah Tangga,” in *Seminar Nasional Teknologi Informasi dan Komunikasi-2022*, MADIUN: PROGRAM STUDI TEKNIK INFORMATIKA – UNIVERSITAS PGRI MADIUN, 2022, pp. 606–616.

[20] F. Y. Q. Ontowirjo, V. C. Poekoel, P. D. K. Manembu, and R. F. Robot, “Implementasi Internet of Things Pada Sistem Monitoring Suhu dan Kelembaban Pada Ruangan Pengering Berbasis Web,” *Jurnal Teknik Elektro dan Komputer*, vol. 7, no. 3, pp. 331–338, 2018, [Online]. Available: www.cec-unsrat.com.

[21] R. Rahim *et al.*, “Humidity and temperature prototype for education with internet of things,” *International Journal of Pure and Applied Mathematics*, vol. 119, no. 16 Special Issue B, 2018.

[22] M. Alvan Prastoyo Utomo, A. Aziz, Winarno, and B. Harjito, "Server Room Temperature & Humidity Monitoring Based on Internet of Thing (IoT)," in *Journal of Physics: Conference Series*, 2019. doi: 10.1088/1742-6596/1306/1/012030.

[23] A. P. Kemala, M. E. Syahputra, H. Lucky, and S. Achmad, "Pengembangan Smart Air Condition Control Menggunakan Platform Blynk Berbasis Mikrokontroler ESP8266 dan Sensor DHT11," *Engineering, MAthematics and Computer Science (EMACS) Journal*, vol. 4, no. 1, pp. 19–23, Feb. 2022, doi: 10.21512/emacsjournal.v4i1.8072.

[24] F. Susanto, M. N. Rifai, and A. Fanisa, "INTERNET OF THINGS PADA SISTEM KEAMANAN RUANGAN, STUDI KASUS RUANG SERVER PERGURUAN TINGGI RAHARJA," *Seminar Nasional Teknologi Informasi dan Multimedia*, Aug. 2017.

[25] S. Noertjahjono and F. Y. Limpraptono, "Monitoring Sistem Udara Ruang Server dengan Multi Sensor Berbasis Web," in *Seminar Nasional Inovasi dan Aplikasi Teknologi di Industri 2019*, Feb. 2019, pp. 79–84.

[26] M. A. Rizkiawan, H. Ramza, and E. S. Alim, "SISTEM INFORMASI PENCATATAN ASET DAN PEMINJAMAN BARANG MENGGUNAKAN METODE PENGEMBANGAN AGILE PADA BPTI UHAMKA," *Journal of Scientech Research and Development*, vol. 5, no. 2, 2023, [Online]. Available: https://idm.or.id/JSCR/in

[27] I. Hermala, A. Ismail, N. Hendrasto, H. Harisuddin, and S. Daulay, "Sistem Pintar IoT Berbasis Arduino dan Android untuk Pengontrolan Kondisi pH dan TDS pada Pengairan Hidroponik," *JRST (Jurnal Riset Sains dan Teknologi)*, vol. 6, no. 1, 2022, doi: 10.30595/jrst.v6i1.12387.

[28] F. Ifacturrohman and I. Sucahyo, "Rancangan Alat Monitor Volume Air Dalam Tangki Berbasis IoT dan Smarphone," *Inovasi Fisika Indonesia*, vol. 9, no. 2, 2020, doi: 10.26740/ifi.v9n2.p56-63.

[29] B. Artono and R. G. Putra, "Penerapan Internet Of Things (IoT) Untuk Kontrol Lampu Menggunakan Arduino Berbasis Web," *Jurnal Teknologi Informasi dan Terapan*, vol. 5, no. 1, 2019, doi: 10.25047/jtit.v5i1.73.

[30] A. Fitriansyah and M. R. Suryanto, "Teknologi Kontrol Lampu dan Kunci Rumah Berbasis IoT," *Jurnal Teknologi Informatika dan Komputer*, vol. 7, no. 1, 2021, doi: 10.37012/jtik.v7i1.505.

[31] N. L. Kakihary, "Pieces Framework for Analysis of User Saticfaction Internet of Things-Based Devices," *Journal of Information Systems and Informatics*, vol. 3, no. 2, pp. 243–252, 2021, [Online]. Available: http://journal-isi.org/index.php/isi

[32] D. T. Rezalti and Ag. E. Susetyo, "Kadar Suhu Dan Kelembaban Di Ruang Produksi Wedang Uwuh Universitas Sarjanawiyata Tamansiswa," *IEJST (Industrial Engineering Journal of The University of Sarjanawiyata Tamansiswa)*, vol. 4, no. 2, 2020.

[33] Sufian and D. Setiyadi, "Sistem Keamanan Pada Ruangan Server Menggunakan Teknologi Berbasis Internet of Things dan Aplikasi Blynk," *INFORMATICS FOR EDUCATORS AND PROFESSIONALS*, vol. 5, no. 2, pp. 186–195, 2021.

[34] P. Narkhede, B. Kiratkar, and B. Suryawanshi, "Physical Conditions Monitoring in Server Rooms Internet of Things," *International Journal of Electrical and Electronics Research*, vol. 3, no. 4, pp. 237–239, Dec. 2015, [Online]. Available: www.researchpublish.com

[35] P. Serikul, N. Nakpong, and N. Nakjuatong, "Smart Farm Monitoring via the Blynk IoT Platform : Case Study: Humidity Monitoring and Data Recording," in *International Conference on ICT and Knowledge Engineering*, 2019. doi: 10.1109/ICTKE.2018.8612441.

[36] R. K. Kodali and K. S. Mahesh, "Low cost ambient monitoring using ESP8266," in *Proceedings of the 2016 2nd International Conference on Contemporary Computing and Informatics, IC3I 2016*, 2016. doi: 10.1109/IC3I.2016.7918788.

[37] G. Hergika, Siswanto, and S. S, "PERANCANGAN INTERNET OF THINGS (IOT) SEBAGAI KONTROL INFRASTUKTUR DAN PERALATAN TOLL PADA PT. ASTRA INFRATOLL ROAD," *PROSISKO: Jurnal Pengembangan Riset dan Observasi Sistem Komputer*, vol. 8, no. 2, 2021, doi: 10.30656/prosisko.v8i2.3862.

[38] Y. S. Parihar, "Internet of Things and Nodemcu," *Journal of emerging technologies and innovative research*, vol. 6, no. 6, 2019.

[39] R. A. Rahman, U. R. Hashim, and S. Ahmad, "IoT based temperature and humidity monitoring framework," *Bulletin of Electrical Engineering and Informatics*, vol. 9, no. 1, 2020, doi: 10.11591/eei.v9i1.1557.

[40] L. Barik, "IoT based temperature and humidity controlling using Arduino and Raspberry Pi," *International Journal of Advanced Computer Science and Applications*, vol. 10, no. 9, 2019, doi: 10.14569/ijacsa.2019.0100966.

[41] P. Prasetyawan, S. Samsugi, and R. Prabowo, "Internet of Thing Menggunakan Firebase dan Nodemcu untuk Helm Pintar," *Jurnal ELTIKOM*, vol. 5, no. 1, 2021, doi: 10.31961/eltikom.v5i1.239.

[42] T. Susilawati and I. Awaludin, "Eksplorasi Sensor , Gps , dan Moda Komunikasi Nirkabel Internet Of Things," *Ikra-Ith Informatika*, vol. 3, no. 2, 2019.

[43] H. Beze, "Rancang Bangun Tanggap Darurat Bencana Berbasis Sistem Informasi Geografis (SIG)," *Buletin Loupe*, vol. 16, no. 02, 2020, doi: 10.51967/buletinloupe.v16i02.243.

[44] L. Siregar, "Review Pengujian Keamanan Perangkat Lunak dalam Software Development Life Cycle (SDLC)," *Journal of Applied Sciences, Electrical Engineering and Computer Technology*, vol. 1, no. 3, 2020, doi: 10.30871/aseect.v1i3.2380.

[45] R. Aditya, V. H. Pranatawijaya, and P. B. A. A. Putra, "Rancang Bangun Aplikasi Monitoring Kegiatan Menggunakan Metode Prototype," *Journal of Information Technology and Computer Science*, vol. 1, no. 1, 2021.

[46] D. Adit Dwi Prasetyo, subandi Subandi, D. Kusumaningsih, and purwanto Purwanto, “Implementasi Sistem Monitoring Multi Sensor pada Ruang Server Berbasis Iot Menggunakan Wemos D1 R2,” *JURNAL INFORMATIK*, vol. 19, no. 1, Apr. 2023.

BIBLIOGRAPHY OF AUTHORS

M. AsepRizkiawan, The author received a Bachelor of Engineering degree in Electrical Engineering at the Muhammadiyah Prof. Dr. HAMKA University Jakarta, currently the author is continuing his Master of Engineering studies in electronics and control at the National Institute of Science and Technology Jakarta. The author is interested in research with the scope of electronics, Internet of Things, Control Systems and others.

Ir. Harry Ramza, M.T., Ph.D. MIPM., The author is a Head of Electrical Engineering Department at University of Muhammadiyah Prof. DR. HAMKA, Doctor (PhD) in Electrical Engineering, Department of Electrical Engineering, Electronics and Technology Systems, Faculty of Engineering and Natural Development., Universitas Kebangsaan Malaysia, Selangor Darul Ehsan (UKM). The author received his Bachelor of Engineering degree in Telecommunication Engineering at the Indonesian Institute of Technology and Master of Engineering (M. Eng) at the Department of Optoelectrotechnics and Laser Applications, Faculty of Engineering, University of Indonesia.

Dr._Ing Agus Sofwan, M.Eng.Sc. An Electrical Engineer, Doctor and Master in Electrical Engineering (Germany) with specialization in Power Electrical and Control Design Engineering. Excellent, senior Lecturer and Leader in Electrical Engineering Master Department of National Institute of Science and technology Jakarta. Scientific researcher and with several successful research projects and national and international scientific papers. Reviewer and Pro-motor of the electrical and automatic articles, thesis and Expert Electrical Engineering Consultants (Aut.HAEI). The main Subject in this Semester: Protection System, Model and Simulation, Automation and Electrical Design Engineering and Professional Ethic.