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Internet of Things Based Computer Laboratory Room Temperature and Humidity Quality Monitoring (Case Study at Institut Teknologi Bisnis AAS Indonesia)

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Abstract— *Computer laboratories are important facilities in educational institutions, especially to support technology-based academic activities. However, laboratory environmental management often faces challenges in maintaining ideal temperature and humidity stability, which can affect hardware performance and life. This study aims to design and implement a temperature and humidity quality monitoring system for a computer laboratory room based on the Internet of Things (IoT) at the AAS Indonesia Business Technology Institute. The developed system utilizes temperature and humidity sensors integrated with an IoT platform for real-time data collection, processing, and presentation. Environmental data is monitored through a cloud-based application, which is equipped with automatic notifications if abnormal conditions occur, such as high temperatures or humidity outside the ideal limits. System testing shows that this technology is able to provide accurate and continuous monitoring, and helps make faster decisions in managing the laboratory environment. The results of the study show that the application of an IoT system in monitoring temperature and humidity improves the efficiency of laboratory management while supporting the principle of energy efficiency. This system also provides easy access to data remotely, thereby minimizing the risk of device damage. With effective implementation, this study not only provides a practical solution for laboratory facility management but also makes a significant contribution to driving digital transformation in the education sector.*

Keywords*: Internet of Things (IoT), temperature, humidity, computer laboratory, real-time monitoring*

I. INTRODUCTION

A computer laboratory (LabKom) is one of the facilities that must be available in educational institutions, especially in supporting technology-based teaching and learning processes. [1]. In a computer laboratory, electronic devices such as computers, servers, and network devices are used intensively, environmental conditions in the laboratory greatly affect the performance and lifespan of the devices, so good management is needed so that the equipment in the laboratory can operate optimally. [2]. The two main parameters that affect the environmental conditions are temperature and humidity. The temperature in the laboratory must be maintained at the temperature and humidity. If the temperature is too high or the humidity is not controlled, it can cause damage to the hardware, reduce efficiency, and increase the risk of operational disruptions. Therefore, monitoring environmental conditions in the computer laboratory is an urgent need to ensure that electronic devices can function optimally. [3],[4].

Institut Teknologi Bisnis (ITB) AAS Indonesia, as one of the educational institutions based on technology. ITB AAS also has an Informatics study program that has a high intensity in the use of computer laboratories. The computer laboratory is used for various academic activities such as practicums, research, and technology development and is used for non-academic student activities such as supporting student SMEs in the field of informatics. However, monitoring the quality of temperature and humidity in this laboratory is still done manually, namely by estimating temperature and humidity. This approach is not only less efficient but also unable to provide real-time and continuous data. As a result, the potential for damage to devices due to non-ideal environmental conditions is difficult to identify early on. So a real-time and continuously recorded monitoring system is needed to help maintain room comfort and ensure that the devices in the computer laboratory at ITB AAS are well maintained.

Internet of Things (IoT) technology is a concept for utilizing the internet in real time and continuously using sensors and smartphones for monitoring. [5],[6]. The concept of IoT is machine-to-machine communication, where a device has the ability to transfer data in real time over a network without requiring human-to-human interaction. IoT offers an efficient and innovative solution for automatic, real-time, and integrated monitoring of environmental conditions. With IoT, sensor devices can

be used to continuously measure temperature and humidity parameters, the data of which can be accessed through cloud-based applications.[7]. This system allows users to monitor and control laboratory conditions remotely, provide notifications if abnormal conditions occur, and help make faster and more accurate decisions. The implementation of IoT technology also supports the application of energy efficiency principles, because cooling or humidity control devices can be activated only when needed based on measured environmental data.[8].

This study aims to design and implement a monitoring system for the quality of temperature and humidity of a computer laboratory room based on IoT at the AAS Indonesia Business Technology Institute. This study uses ESP32 and DHT sensors as temperature and humidity detection. This system can also be monitored in real time, the monitoring design is made with the blynk IoT application and monitoring is carried out using a smartphone[9],[10]. This study is expected to provide practical and effective solutions in maintaining ideal laboratory environmental conditions, as well as being a model for other institutions facing similar challenges. In addition, this study also contributes to the development of IoT technology in the context of education, especially to support the efficiency of laboratory facility management.

With an IoT-based monitoring system, laboratory managers can utilize the data generated for further analysis, such as developing predictive algorithms to detect potential problems before they occur. This research is also relevant in supporting digital transformation efforts in the education sector, where the use of modern technology is expected to improve the quality of services and operations. Through this case study, it is hoped that a system can be created that is not only technically beneficial, but also able to provide a positive impact on the sustainability of facility management in educational institutions.

II. BASIC THEORY AND METHOD

ESP32

The ESP32 microcontroller is an integrated SoC (System on Chip) microcontroller equipped with WiFi 802.11 b/g/n, Bluetooth version 4.2, and various peripherals. The ESP32 is a fairly complete chip, with a processor, storage, and access to GPIO (General Purpose Input Output). The ESP32 can be used as a replacement circuit on Arduino, the ESP32 has the ability to support direct WI-FI connections [11].

The ESP32 microcontroller functions as the control center for all components. ESP32 functions as the control or processing part and the measurement results are received and processed by ESP32. After the data is processed, ESP 32 sends the data and displays the data on the IoT-based monitoring application [12]. The physical image of the ESP32 can be seen in figure 1.

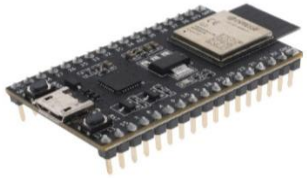

Figure 1. ESP32 Board

DHT11

This module includes a temperature and humidity sensor with a digital output signal that is aligned, meaning the DHT11 sensor module is a combined temperature and humidity sensor module that provides a dedicated digital output signal. DHT11 provides us with accurate temperature and humidity measurements and ensures high quality and long-term durability. This sensor has a resistive type humidity sensing segment and an NTC type temperature sensing segment with an 8-bit microcontroller. attached, which has a fast and practical response, and can be accessed in a 4-bar line assembly. The DHT11 module handles the following communications, for example, single-wire communication. This module sends information in the form of a series of heartbeats at certain time intervals. Before sending information to the Arduino, several input commands are required with periodic delays. Furthermore, the total duration of this procedure is about 4 ms. The single-wire sequential interface allows for fast and simple frame connections. Its small size, low power consumption, and signal transmission up to 20 meters make it the best choice for a variety of applications, including the most mentioned ones[13].

Figure 2. DHT11 Sensor

Arduino IDE

The Arduino IDE (Integrated Development Environment) is a free, open-source platform that simplifies programming and uploading code to Arduino boards and compatible microcontrollers. Designed with beginners and hobbyists in mind, the Arduino IDE features a straightforward interface where users can write, edit, and debug code in a language based on C/C++. It includes a library of pre-written functions, examples, and tools, allowing users to quickly implement tasks like reading sensors, controlling

motors, and establishing communication protocols. The IDE supports a wide range of boards, from classic Arduinos like the Uno and Mega to advanced microcontrollers like the ESP32. With its built-in compiler, serial monitor, and one-click upload functionality, the Arduino IDE makes prototyping and experimenting with electronics projects accessible to users of all skill levels[14].

Blynk.Cloud

Blynk.Cloud is an advanced platform designed for building and managing Internet of Things (IoT) solutions. It serves as the backbone for connecting your hardware devices to the cloud and provides a user-friendly interface for monitoring, controlling, and automating. Blynk connects to Arduino via token and configures Wi-Fi to communicate. Blynk communicates with ESP32 or Arduino via source code written using Arduino IDE. When it first appeared, Blynk came with an application called Blynk Legacy. Then, in May 2021, the developer officially announced that the application was no longer under development. Instead, the application developer launched Blynk 2. 0 or Blynk IoT. The Blynk application allows developers to create Projects interact with various input-output components that support sending and receiving data, as well as presenting data based on selected components. Data presentation can be in the form of graphs or visual images. Blynk is a cloud-based support service that is responsible for managing communication between smartphone applications and hardware environments.

Method

The research stages in this study can be seen in figure 3.

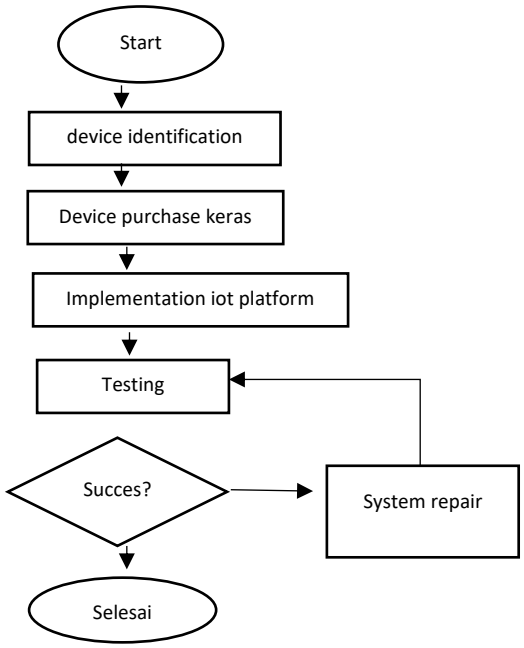

Figure 3. Research Framework

1. Literatur Review
   At this stage, a literature study was conducted related to IoT, computer laboratory management, temperature and temperature sensors. This stage aims to gain a deep understanding of IoT technology, temperature and temperature sensors. The results of this stage are used as the basis for designing a temperature and humidity monitoring system in the computer laboratory of the AAS Indonesia Business Technology Institute.

2. System Design
   The next stage is to design hardware and software for the temperature and humidity monitoring system in the ITB AAS Indonesia computer laboratory room. Some of the device requirements for this system are:
   a. Temperature and humidity sensors using dht sensors
   b. Temperature sensors to monitor the condition of the toilet room, whether it is stuffy or not.
   c. Designing a sensor integration scheme with Arduino Uno
   d. Determining the data communication method, namely by using a Wi-Fi network

3. Technology Design
   Technology design is the process of designing, developing, and implementing innovative technology solutions to meet specific needs. The following is the initial design of the technology design planned in this study.
   a. Main componennt
      sensors to monitor the temperature and humidity of the laboratory space are The sensor used is the DHT11 sensor which can monitor the condition and humidity of the computer laboratory room.
   b. Architecture layer
      The architecture in this study consists of :
      - Sensor Layer Sensors are placed in strategic locations in the computer laboratory room to obtain real-time data on room temperature and humidity.
      - Communication Layer This study uses wifi technology as communication between sensors and smartphones.
      - Application Layer To be able to monitor in real time, the IoT platform used is Arduino cloud. This IoT platform helps build objects that can be connected in real time, using smartphone devices.

      An initial overview of the technology design can be seen in Figure 4.

Figure 4. Technology Desain

4. Hardware development
   At this stage, the development of the IoT device is carried out by combining the ESP32 board with a sensor device as input. At this stage, it is ensured that the sensor works properly.
5. Monitoring temperature and humadity implementation
   At this stage, a temperature and humidity monitoring application was developed in the Labkom room at ITB AAS Indonesia by developing software that can collect, process, and send sensor data to a real-time monitoring platform. At this stage, code is also written to read data from sensors and send it via a network to a server or cloud.
6. Simulation
   At this stage, it is simulated by placing the IoT device that has been designed at a potential point in the ITB AAS Indonesia computer lab room. At this stage, the room conditions are simulated at different times, namely when the computer lab room is empty and all computers are turned off, when the computer lab is used for practicums and during the holiday break where the room is not operated for more than 24 hours.
7. Testing
   At this stage, testing is carried out on the work of the sensor and the data of temperature and humidity recorded at the specified times. In addition, at this stage, testing the accuracy of the sensor's work is also carried out by measuring the room temperature conditions by comparing it with the existing room temperature meter.

III. DISCUSION

Development of temperature and humidity monitoring IoT applications. In the development of this IoT application, there are 3 stages, namely the development of temperature and humidity monitoring hardware, configuration of the IoT platform with Blynk Cloud and testing the use of the IoT application.

a. Hardware develompment
   The hardware developed in this study integrates sensors, ESP32 microcontrollers, Wi-Fi modules, and sensors as the main components. The system is designed to detect indicators of temperature and humidity changes in the computer laboratory room at ITB AAS. The sensor used is a DHT sensor connected to an ESP32 microcontroller. ESP32 is a microcontroller with Wi-Fi and Bluetooth modules. The study used a DHT 11 sensor type that functions to detect temperature and humidity conditions. The program was created using the Arduino IDE, by adding the blynk cloud library, DHT11 and Wi-Fi module.

The first step in hardware preparation is the preparation of the device and installation of the ESP32 device with the DHT11 sensor, in this study the ESP32 board was used which was already connected to the DHT11 sensor. after the sensor installation is successful, the next step is to set the device to work with commands on the Arduino IDE. to see the hardware design see figures 4 and 5

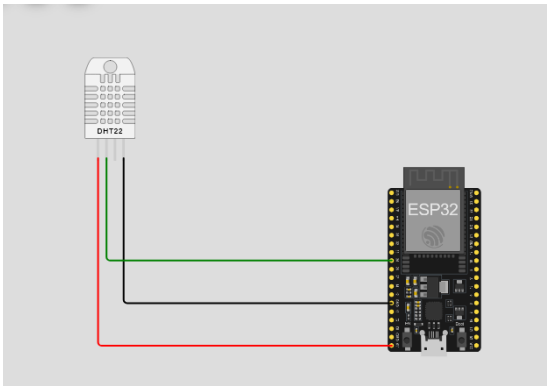

Figure 5. ESP32 circuit and DHT sensor

Figure 6. Iot application circuit for monitoring Temperature and humidity

This hardware series is designed to ensure that the temperature and humidity monitoring process runs automatically, accurately, and in real time. With the integration of IoT technology through ESP32, this system is able to provide convenience for users in managing laboratory room conditions effectively, preventing potential damage to devices due to unstable temperature or humidity, and providing a more energy-efficient and efficient solution compared to conventional monitoring methods.

b. Konfigurasi platform IoT dengan blynk Cloud

Blynk.Cloud is a cloud-based platform that allows users to manage and monitor IoT devices in real-time. The temperature and humidity monitoring application in the computer laboratory at ITB AAS was built using the Blynk cloud platform. The way Blynk.cloud works in this study is to monitor and control ESP32-based hardware. Data from the sensor is sent to the Blynk server via the Wi-Fi protocol so that users can access data through the Blynk application installed on their smartphones.

The results of the study show that Blynk.Cloud is able to provide stable performance for real-time data delivery. With low latency below 500 ms, this platform can be relied on for applications that require fast response, such as security monitoring systems or smart home device control. In this study, blynk.cloud displays a dashboard that displays temperature and humidity information. The dashboard on blynk.cloud can be seen in Figure 7.

Figure 7. View on Blink.cloud

The display above shows that the computer laboratory room temperature is 30 degrees and the humidity is 75 percent. The temperature was taken during lectures and as many as 22 computers were on.

c. System Testing

System testing was conducted after all components were applied in the computer laboratory room, the testing was conducted for 4 days. This testing aims to compare the temperature and humidity of the laboratory room when used and all computers are on and when the computer room is empty with all computers off. The test results obtained data conclusions from several data at different times. The test results can be seen in table 1.

Table 1. Temperature and humidity sensor test in the ITB AAS Indonesia lab room

Date	Time	Room conditions	Temperature	Humidity
10-12-2024	07.00 WIB	the computers all died	22	50%
10-12-2024	09.00 WIB	the computer is all on	25	45%
10-12-2024	13.00 WIB	the computer is all on	28	58%
10-12-2024	21.00 WIB	the computers all died	22	40%
12–12-2024	06.00 WIB	the computer is all on	24	60%
12-12-2024	10.00 WIB	the computer is all on	26	54%
12-12-2024	14.00 WIB	the computer is all on	28	58%
12-11-2024	21.00 WIB	the computers all died	23	52%
13–11-2024	07.00 WIB	the computers all died	22	50%
13-11-2024	12.30 WIB	the computer is all on	25	48%
13-11-2024	17.00 WIB	the computer is all on	28	54%
13-11-2024	21.00 WIB	the computers all died	22	48%
13–11-2024	07.00 WIB	the computers all died	31	45%

Tabel 2. Continued Temperature and humidity sensor test in the ITB AAS Indonesia lab room

Date	Time	Room conditions	Temperature	Humidity
13-11-2024	12.30 WIB	the computer is all on	26	42%
13-11-2024	17.00 WIB	the computer is all on	25	43%
13-11-2024	21.00 WIB	the computers all died	30	38%
16-11-2024	07.00	the computers all died	27	65%

From the test results conducted for 1 week, it was concluded that the laboratory conditions would experience a significant increase in temperature when the computer was used for practicum and all computers were on. While the increase in humidity was found during the day on Sundays, where the room was not used for more than 24 hours. These conditions must be a concern for laboratory managers to create better circulation so that the temperature and humidity are maintained properly, so that computer devices can also maintain their performance and prevent premature damage.

IV. CONCLUSIONS

The research entitled "Monitoring the Quality of Temperature and Humidity of Computer Laboratory Space Based on Internet of Things (Case Study at AAS Indonesia Business Technology Institute)" successfully

designed and implemented an IoT-based monitoring system that can monitor temperature and humidity parameters in real-time. Based on the research results, the following conclusions can be drawn:

1. The designed system is able to detect and send temperature and humidity data from the computer laboratory room to the Blynk.Cloud platform in real-time. The data is visualized via a web and smartphone dashboard, so users can easily monitor the condition of the laboratory room anytime and anywhere.
2. The temperature and humidity sensor using the DHT11 sensor used in this study showed accurate and stable performance during testing. The data generated is in accordance with manual measurements using a calibration tool.
3. This IoT-based monitoring system provides an efficient and cost-effective solution compared to manual monitoring methods. With the notification feature, users can immediately find out if the temperature or humidity is outside the safe limit, so that preventive measures can be taken to prevent damage to laboratory equipment.
4. The laboratory temperature increases when the room is used for practical work and all computers are on. While humidity will increase when the room is not used for more than 24 hours.

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