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Temperature, Humidity, And Voltage Monitoring System Based On Arduino Uno

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ABSTRACT

This research discusses the development and implementation of a temperature, humidity, and voltage monitoring system using Arduino Uno. This device is designed to accurately measure and record environmental parameters. By using Arduino Uno as the core of the system, the gathered data can be processed efficiently. This research employs the Research and Development methodology. The device design incorporates Arduino Uno, DHT11 temperature sensor, ZMPT101B voltage sensor, and Arduino IDE for software development. Experimental results demonstrate that the system functions effectively and provides the required information with a high level of accuracy. This monitoring system holds significant potential for various applications, particularly in environmental monitoring and security supervision.

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1. INTRODUCTION

The temperature and humidity conditions in a room have a significant impact on the room's safety[1]. Therefore, it is crucial to monitor and maintain room temperature effectively[2]. This is done to prevent potential damage to devices in the room and to ensure flight safety[3]. Moreover, high temperatures can also cause electronic devices to have unstable performance and shorten their lifespan. Temperature is a measure of the average kinetic energy of particles in a gas. Temperature determination is carried out using a device called a thermometer[4]. Temperature is the level of warmth or coolness measured on a specific scale, and the instrument used to measure it is called a thermometer[5]. The common unit for temperature is degrees Celsius (°C) [6][7]. Temperature generally refers to the warmth or coolness level of an object or a system. Objects with high warmth have high temperatures, while those with low warmth have low temperatures. Essentially, temperature is an indicator of the average kinetic energy possessed by the molecules in an object[8].

Humidity is the condition of moisture content in the air, resulting from the evaporation of water[9], [10]. The level of humidity is closely related to temperature. When the partial pressure of water vapor equals the saturated vapor pressure, a saturated condition occurs. Mathematically, relative humidity (RH) is expressed as a percentage of the ratio between the partial pressure of water vapor and the maximum vapor pressure[11], [12].

There are The Arduino Uno-based temperature, humidity, and voltage monitoring system is an innovative solution that leverages microcontroller technology to monitor and control the physical environment[13]. Using the reliable and programmable Arduino Uno platform, this system enables users to monitor critical parameters such as temperature, humidity, and electrical voltage in real-time.

As a result, the system not only provides accurate and timely information but also offers the capability to take corrective actions when needed. In this document, we will provide a detailed explanation of the components, how the system works, and the benefits of this monitoring system.

2. RESEARCH METHOD

The research and design of this tool use "research and development" as the research method. The Research and Development method is a research method that generates innovation, whether it involves creating new products or improving existing ones to make them more engaging and aligned with the learning objectives of a specific topic [14], [15].

2.1 Equipment Design

Before the equipment design is carried out, it's essential to establish a concept for the monitoring tool that will be created

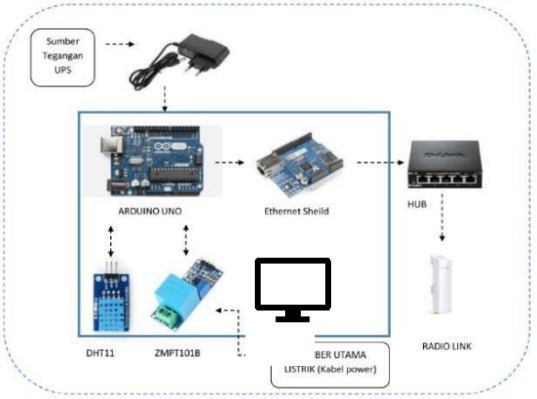

Figure 1. Equipment Design

In the above image, it represents the workflow of the equipment. The system begins with voltage sensors, humidity sensors, and temperature sensors reading the room temperature and the main electrical source. After that, the results are processed by Arduino Uno as the controller. Arduino processes the voltage, temperature, and humidity sensor data and then forwards it to an Ethernet shield for connecting to a LAN cable. It is then connected to a hub in the standby room's PC to obtain equipment information.

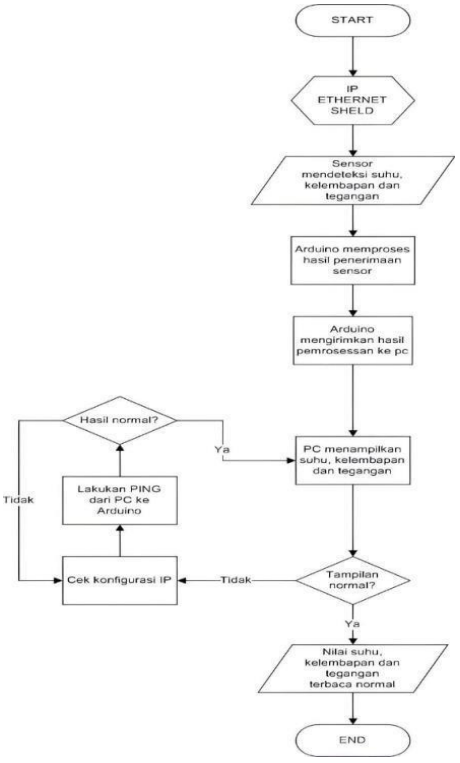

Figure 2. Equipment Flowchart

Based on the flowchart that has been prepared, this step is the initial step in the operation of this device. The Ethernet Shield's IP module is responsible for connecting the internet network to Arduino Uno, and then it passes information to the sensors to detect temperature, humidity, and voltage. Data is then forwarded to Arduino for processing. After that, Arduino sends the processing results to the PC, which then displays the detected data for temperature, humidity, and voltage. If the display does not appear normal, a configuration and network check is performed between the PC and Arduino to ensure whether the results are normal or not. If everything is running normally, the PC will display the temperature, humidity, and voltage detection data correctly.

2.2 Hardware and Software components

a. Arduino Uno is one form of a microcontroller that falls under the category of physical computing systems. Physical computing systems create or build physical devices or systems by utilizing a combination of interactive software and hardware. These systems are capable of receiving signals or inputs from their surroundings and providing responses or feedback. The natural concept of physical computing bridges the gap between the analog and digital worlds. Arduino Uno features 14 digital input/output pins (often written as I/O, with 6 of them usable as PWM outputs), 6 analog input pins, a 16 MHz crystal, USB connectivity, a power jack, ICSP header, and a reset button. These components provide everything needed to support a microcontroller circuit.

b. The Ethernet shield is an add-on that extends the capabilities of an Arduino board to connect to a computer network. Built using the Wiznet W5100 Ethernet chip, this shield enables the Arduino board to be networked. In programming, the Ethernet library is used to connect the Arduino to the network through the Arduino Ethernet shield. The Ethernet shield includes a micro-SD card slot, which is used to store files that can be accessed over the network. The micro-SD card reader inside it can be accessed using the SD library.

c. The DHT11 sensor is a sensor module designed to read temperature and humidity values, providing analog voltage output that can be further processed using a microcontroller-equipped device with digital signal calibration to provide information about air temperature and humidity. This component is known for its excellent stability and highly accurate calibration features. The calibration coefficient is stored in the one-time-programmable (OTP) program memory, so when the internal sensor detects something, the module incorporates this coefficient into its calculations and can transmit signals up to a distance of 20 meters.

d. The ZMPT101B voltage sensor is a sensor applied for various functions, one of which is monitoring the voltage value of an alternating current (AC) power source present at two points in a circuit. The ZMPT101B sensor can measure electrical voltage ranging from 110-250V AC.

e. The Arduino IDE (Integrated Development Environment) application is used to create, open, and edit programs that will be uploaded to an Arduino board. The Arduino IDE is designed to make it easy for users to develop various applications. It features a simple programming language structure and comprehensive functions, making it easy for beginners to learn.

2.3 Equipment Testing Techniques

1. Testing the Office PC Network to Arduino via Ethernet Shield
2. Hardware Testing
   a. Performing measurements on a 5VDC adapter.
   b. Performing AC power cable measurements.
   c. Displaying data read by Arduino sensors on a PC

3. RESULT AND DISCUSSION

In the design of this device, several essential components are used, including the Arduino Uno, Ethernet Shield, DHT11, and ZMPT101B

3.1 Device Design

The Arduino Uno serves as the data processing unit, while the Ethernet Shield functions as the intermediary device connecting the Arduino Uno to the internet. The DHT11 sensor is used to monitor temperature and humidity, whereas the ZMPT101B serves as a sensor for measuring electrical voltage. In the initial step, the author establishes a connection between the Arduino Uno and Ethernet Shield by linking each pin on the Ethernet Shield to the corresponding pinouts on the Arduino Uno. The purpose of this step is to enable the Arduino to connect to the internet through the Ethernet Shield. In the subsequent phase, the author connects the ZMPT101B sensor to the Ethernet Shield by linking specific pins

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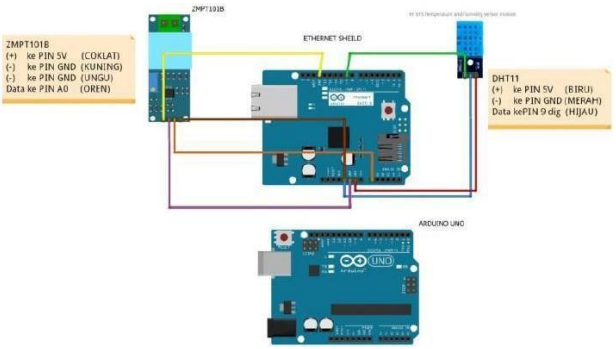

Figure 3. Device Design

3.1 Testing and Analysis

Testing the Network Connection from the Office PC to the Arduino via Ethernet Shield To check the network connection between the office PC and the Arduino through the Ethernet Shield, whether the network is connected or not, it is necessary to perform a ping test or check via the Command Prompt (CMD).

A. First Stage, we configure a Class A IP because the monitoring device uses Class A. To do this, select the "properties" option in the Ethernet status, as shown in the image below.

Figure 4. Ethernet Display

B. After clicking on "properties," select "Internet Protocol Version 4 (TCP/IPv4)" to set the IP to be used. The next step is to set the IP to Class A because the monitoring device uses Class A. Next, open the Command Prompt (CMD) to check the network connection by verifying if the IP set for monitoring the DVOR shelter, which is 13.22.18.131, receives a continuous response, indicating a successful network connection. as shown in the figure 5 and 6.

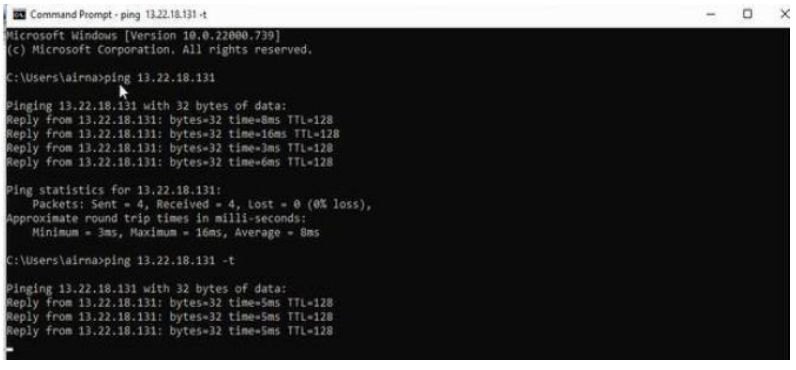

Figure 5. CMD Display When Checking IP

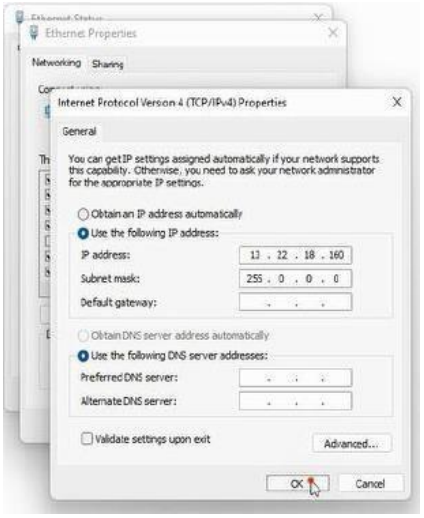

Figure 6. Class A IP Setting Display

C. Test Result Data

Table 1. Network Testing Results from Office PC to Arduino via Ethernet Shield

Testing	Test Results	Description
Setting Class A IP	The PC is connected to a Class A IP network	Normal
Checking the network from the office PC to the Arduino via Ethernet Shield using CMD	Continuous replies indicate that the network is connected".	Normal

D. Hardware Testing

1. Testing Input and Output Voltage on the Power Supply
   As an input, the Arduino requires power between 5 to 12 Volts DC to operate its programs. The 5 Volt DC power supply is obtained from an external adapter. The supply voltage is converted from 220VAC to an output of 5VDC. Below are the results of the adapter voltage testing.

Table 2. Results of the Power Supply Voltage Testing

Power Supply Adapter Input	Power Supply Adapter Output Voltage
220 VAC	5VDC

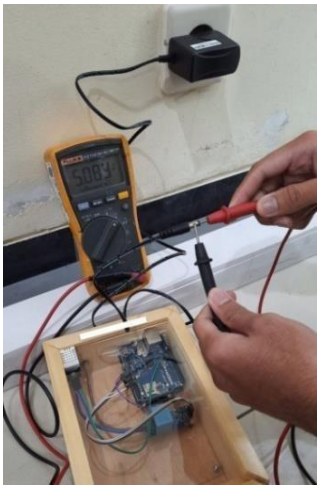

Figure 7. Checking the adapter cable

In this testing step, it can be observed that voltage measurement is carried out using the VCC power supply pin and a black probe connected to the ground. If the measurement results fall within the range of 5 to 12 Volts, the device is considered to be in a normal state. If the device's design can operate according to its program, then the supplied voltage will meet the device's requirements. Further information can be found in the experiment documented in table 2.

2. Testing Voltage at the Voltage Sensor Input
   This test is conducted to identify the main power source. Input from the AC electrical cable is required, which will assist the voltage sensor in detecting voltage values by drawing from the main power source and transmitting 220VAC. The test results are as follows :

Table 3. Results of the Power Supply Voltage Testing

AC power cable input	Output voltage of the power cable
220 VAC	

3. Testing Arduino sensor device on a PC
   After connecting the monitoring device to a PC/laptop using an Ethernet cable, the next step is to open the control panel on the laptop to check if the LAN cable is connected to the laptop. Then, configure the pre-defined IP address to establish a connection with the monitoring device, allowing temperature, humidity, and voltage monitoring to appear, as shown in the image below.

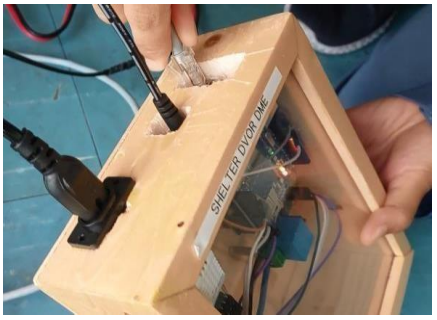

Figure 8. Testing of the Arduino sensor equipment

After several steps and stages of testing, the following results were obtained:

Table 3. Results of the Power Supply Voltage Testing

NO	Display Testing	Test results		
		Temperature (°C)	Humidity (%)	Voltage (V)
1.	On-site Testing	21.50 ^{0}C	50.50%	220V

The test results indicate that the equipment is operating properly and can receive data without the need for a radio link connection, allowing the data to be read on the laptop. Therefore, it can be concluded that the monitoring device is functioning normally.

4. CONCLUSION

In the testing, this system has operated normally and can provide accurate information about temperature, humidity, and voltage conditions. In the temperature, humidity, and voltage monitoring system based on Arduino Uno, this device can accurately monitor these parameters. By using Arduino Uno, the data can be collected and processed effectively.

In the future, it is hoped that this web server system can be fu To monitor the data generated the application through the monitoring application on the PC located the local IP address 13.22.18.131 is used. In the future, it is hoped that this web server system can be further developed to become more complex, allowing it to display alarms in case of room errors. It is also expected that this web server can be developed to be accessible on mobile devices. This way, the system can be relied upon as a monitoring tool for various purposes, including in environments that require accurate and reliable temperature, humidity, and voltage control.

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