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IMPLEMENTATION OF DHT11 SENSOR AND YL-69 SENSOR IN AUTOMATIC PLANT WATERING SYSTEM BASED ON INTERNET OF THINGS (IOT) USING BLYNK

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Abstract

Naturally, plants need water and nutrients that are essential for their growth and development. Therefore, watering the plant must be done regularly every day to keep the plant healthy. If watering is not done in accordance with the required time, the plant will have difficulties in the process of photosynthesis and food production, which can be fatal, including the death of the plant or disruption of its growth process. Many people have difficulty watering plants at the right time due to busyness or ignorance. To solve this problem, an automatic watering system is needed that can be set according to the schedule and allows remote control using a microcontroller. In this study, several components were used, such as the RTC DS3231 to access the time accurately, the YL-69 sensor to detect soil moisture so that if the soil is already moist enough the system will not water. DHT11 to measure the temperature and humidity of the surrounding air, if the soil condition is dry but the temperature is too hot, watering will not be carried out because it can damage the plant. Relays are used to control water pumps. All of these components are integrated in an ESP32 NodeMCU. The system will run water pumps every 8:00 a.m. and 4:00 p.m. every day. The test results concluded that the system can work well where this system has the ability to increase efficiency and productivity in the process of watering plants.

Keywords: *RTC DS3231, ESP32, DHT11, YL-69 Sensor*

INTRODUCTION

Indonesia is known as an agricultural country that is highly dependent on the agricultural sector, both as a source of livelihood for the community and as a pillar of development. This sector plays a crucial role in the Indonesian economy, where quality agricultural products can drive economic growth and provide benefits to the wider community (Wahjudi & Nugroho, 2023). To achieve optimal agricultural results, there are several important factors that must be considered, such as nutrition, lighting, temperature, and soil moisture (Raihan & Firmawati, 2022). Soil functions as the main medium for plants, where plants get nutrients, water, and other nutrients. It is important to pay attention to soil moisture in order to achieve good quality and quantity of results. Soil that is too wet can inhibit the absorption of nutrients by plants, while soil that is too dry can result in a lack of water and minerals needed for optimal growth (Anjellita Sundari Sumarsono, Novriyenni Novriyenni, & Milli Alfhi Syari, 2024).

In the rainy season, plants generally do not require additional watering because they already get enough water from the rain (Elfira, Lubis, & Wibowo, 2021; RAHMAH, 2023; Ruth Chyntia Rouli Marpaung, Adi Sastra P Tarigan, & Zuraidah Tharo, 2023; Sirait & Wibowo, 2021). However, during the dry season, watering must be done regularly based on soil moisture conditions. To overcome the challenges that arise during the dry season and ensure good plant growth, it is necessary to regulate watering with the right intensity. It is important to ensure adequate water supply, because lack of water can result in plant death. To control soil moisture as needed, a daily scheduled watering system is implemented using the RTC DS3231, which functions to set the watering time (Erbyansyah Fauzan Muhamad, 2023; Putra, Hamdani, Aryza, & Manik, 2020; Wibowo & Lubis, n.d.). This setting is assisted by a relay to command the pump to release water. The DHT11 sensor is used as a measure of ambient temperature and humidity. The YL-69 sensor is also used to monitor soil moisture. This sensor is equipped with a potentiometer that allows adjustment of the sensitivity of the digital reading (Cahyatama, Sulistio, & Al Azhar, 2024). If the soil is detected as moist, the relay will automatically cut off the current to the pump so that watering is not carried out. The water pump functions to water plants automatically, which is controlled by the ESP-32 microcontroller as the control center in the prototype of the automatic plant watering system to be developed (Fahrezi, Rusman, Yuwono, Satriyo, & Saufa, 2024).

In the research entitled "Design and Build a Cost-Effective Automatic Plant Watering System Based on the Internet of Things". What Zeluyvenca Avista and the team did. This tool utilizes the NodeMCU ESP8266 as the main microcontroller. Based on the analysis that has been carried out, it can be concluded that this plant watering monitoring system allows users to monitor the watering process remotely without the need to go directly to the location wirelessly on the mobile application. This automatic plant watering tool uses a soil moisture sensor and a DHT11 sensor which is used as a humidity and environmental temperature sensor.

Based on a review of previous research, the author plans to utilize several components of the study to be applied in this study. The research to be carried out is the Implementation of DHT11 Sensor and YL-69 Sensor in an Internet of Things (IoT)-Based Automatic Watering System Using Blynk. This tool is expected to make it easier for users to develop more modern and sustainable agricultural technology, make it easier in the farming process and provide solutions for farmers to increase their crop yields.

METHODS

Design Making Tools and Materials

Each tool has a specific function, namely: solder is used to connect component legs, electric drill is used to make holes in PCB and project box, analog multimeter is used to regulate voltage or check for short circuits, scissors are used to cut jumper cables, cutting pliers are used to cut harder cables, and laptop is used as a device to compile prototype programs in this study (ULFA, 2021).

Hardware Design

In hardware design, the design of each part of the circuit will be discussed.

Overall Series

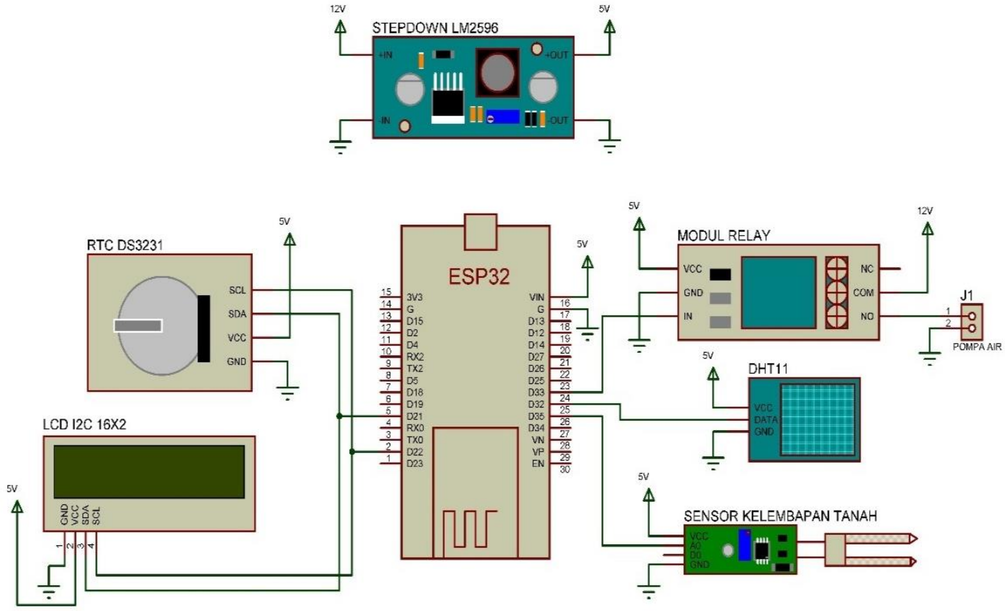

Figure 1. Overall circuit

The overall scheme of the plant watering system is shown in Figure 3.8. When activated, the NodeMCU ESP32 will start running the program by reading input from the YL-69 sensor. This sensor functions through analog input and will output a LOW value if the soil moisture exceeds the threshold, indicating that the soil is dry (Mulyadi, 2023). The collected data will be processed and displayed on the LCD screen. The NodeMCU ESP32 will also send the information to the relay to turn on the water pump and water it. When the sensor detects sufficient soil moisture, the output from the sensor will change to HIGH, meaning that the soil is wet. However, if the DHT11 sensor detects a temperature >= 34°C, watering will not be carried out even though the soil is dry. Furthermore, the data will be sent to the Blynk application to display information regarding data requests and settings. To send data via the internet, the NodeMCU ESP32 must be connected to a hotspot using a wifi connection. The data received by the hotspot is then forwarded to the Blynk application (Firdaus et al., 2022).

In addition, the NodeMCU ESP32 will also read the time information stored on the RTC (Real Time Clock). The time set on the RTC will be read by the NodeMCU ESP32, which then turns on the pump according to the programmed watering schedule. The data will be displayed on the LCD and the monitoring results can be seen directly on the Blynk application.

Software Design

In the software design, the programming used in ESP 32 and the design of the flowchart will be discussed.

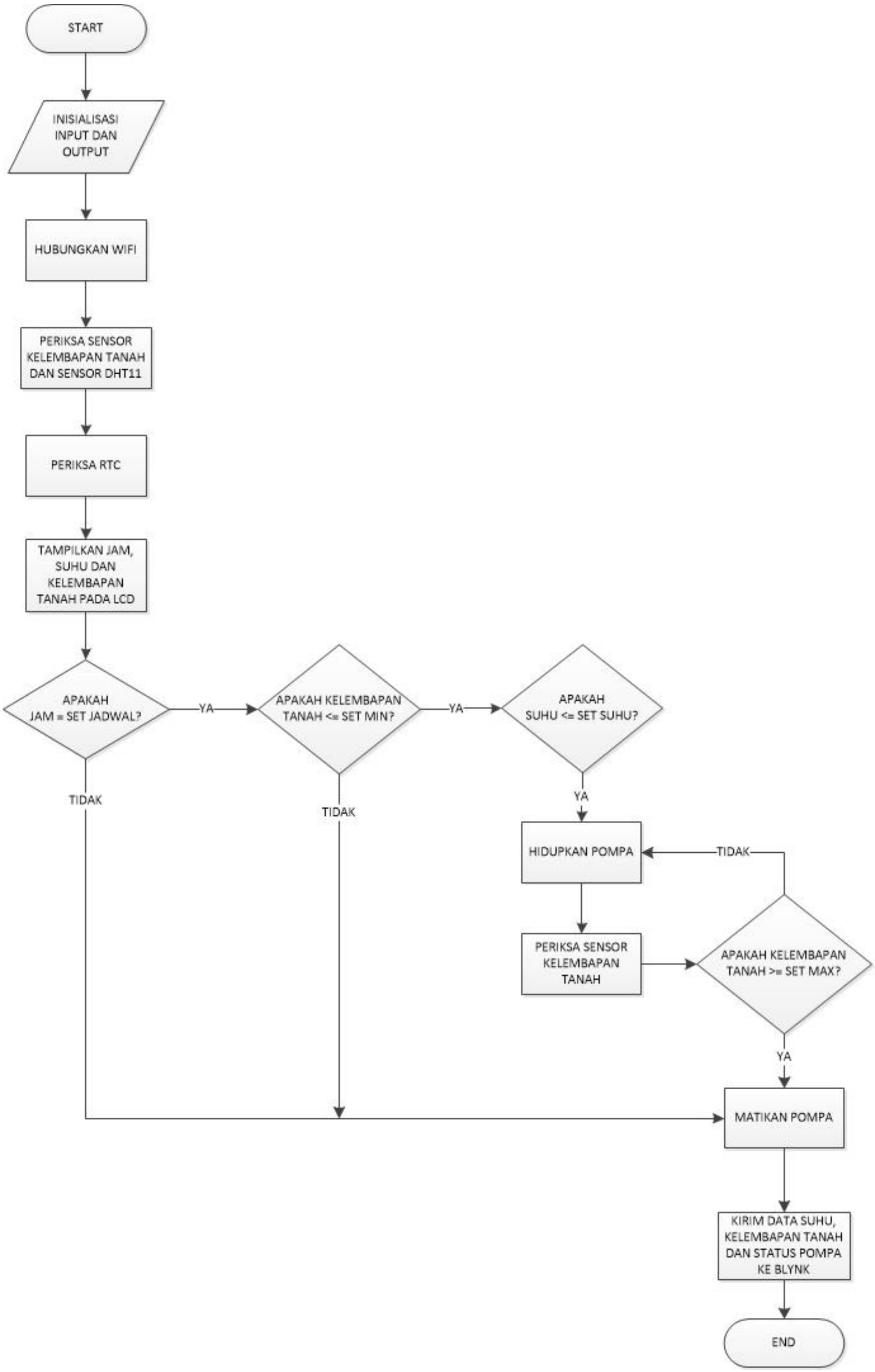

Figure 2. System Flowchart

1. When "START" it indicates that the appliance has switched on.
2. Initialization is the process of recognizing the inputs and outputs used in these tools. The ESP32 NodeMCU functions as a microcontroller. The inputs used include the

DS3231 RTC, YL-69 Sensor, and DHT11 Sensor, while the outputs include a 16x2 I2C LCD, relay, and water pump. Wi-Fi and Blynk work as both inputs and outputs.
3. Next, the device is connected to Wi-Fi, and checks are carried out on the soil moisture sensor, air temperature, and the DS3231 RTC.
4. The display on the LCD will show information about the clock, air temperature, and soil moisture.
5. After that, the system checks whether the schedule listed is in accordance with what has been determined, as well as ensuring that the humidity and temperature sensor values have reached the minimum limit for watering.
6. If all is right, the ESP32 NodeMCU will send voltage to the relay, which will activate the water pump. Then, the system checks whether the soil moisture has reached the maximum limit for watering cessation. If it has been reached, the pump will shut off. If the soil moisture has not reached the desired value, the pump will continue to function until it reaches the maximum limit. Next, data regarding temperature, soil moisture, and pump status will be sent to the Blynk application.
7. Finish.

Method of collecting data

In this study, the data collection methods used are designing, testing and observing the tool. The methods used to obtain data include:

1. Library Study (Literature) , Studying books, articles and other references related to automatic plant watering tools based on the Internet of Things (IoT).
2. Consultation , Conducting consultations with the supervising lecturer regarding problems related to tool design and final project reports.
3. Scheduling , Creating a schedule for implementing research activities so that work can run smoothly (Avista, Kurniawan, Fadly, Witanto, & Ajitomo, 2024).
4. Collecting Materials , Selecting the required components and devices based on the theory and references of the tool.
5. Design, Designing an automatic plant watering tool using a timer with a DHT11 sensor and a YL-69 sensor based on the Internet of Things (IoT).
6. Making , Making an automatic plant watering tool using a timer with a DHT11 sensor and a YL-69 sensor based on the Internet Of Things (IoT).
7. Testing , Conducting testing on automatic plant watering tools using a timer with a DHT11 sensor and a YL-69 sensor based on the Internet of Things (IoT).
8. Data Analysis , Collecting and processing data, then analyzing the data based on the results of the tests that have been carried out.
9. Conclusion , Preparation of Final Report

Design Testing Methods / Tools

1. YL-69 Sensor Testing

Moisture sensor testing is done to determine the accuracy of the soil moisture sensor reading. Basically, the YL-69 sensor (soil moisture) works to detect soil moisture. When the sensor detects soil moisture in a dry state, the water pump will turn on and when the sensor detects soil in a moist or wet state, the water pump will turn off. Thus, to test the soil moisture sensor is to measure the sensor output logic by providing water input (Muttaqi, Nurchim, & Ningsih, 2024).

2. DHT11 Sensor Testing

This sensor test is done to determine the accuracy of the temperature sensor reading. Basically, the DHT11 sensor works to detect temperature where if the temperature is >= 34° then the pump will not turn on even though the soil moisture is dry. Thus, to test the temperature sensor is to measure the sensor output logic by providing hot or cold temperatures (Tarigan, Bukit, & Yilu, 2023).

3. RTC (Real Time Clock) Testing

RTC testing with relay is done to determine the accuracy of the time reading from the RTC which is then processed by the NodeMCU ESP32 to be forwarded to the relay. This test is done by connecting the RTC with the NodeMCU ESP32 as a microcontroller which is also connected to the relay.

4. Testing the 16 x 2 I2C LCD

LCD testing is used to determine whether the LCD can display the required information accurately. This LCD testing uses a program specifically created to display a message on the LCD by the microcontroller (Khairunisa, 2022).

5. Method of Processing / Analysis of Testing Results

The working principle of this tool is when the RTC DS3231 is in accordance with the scheduling that has been done to carry out automatic watering, the YL-69 sensor will detect soil moisture in plants and the DHT11 sensor also detects air temperature. Then the sensor will send a message to the ESP32 whether the soil is wet or not, the LCD will display a message from the sensor and blynk. If the soil is wet, the scheduled watering will be delayed, and if the soil is dry, watering will be carried out. However, if the soil is dry and the air temperature exceeds the set temperature, watering will also be delayed (Suwandhi & Hendra, 2020).
When the RTC DS3231 is in accordance with the schedule for automatic watering, the YL-69 sensor sends a message to the ESP32, then the ESP32 gives a logic "0" to the relay, then the relay is "ON" and vice versa if the ESP32 gives a logic "1" to the relay, then the relay is "OFF". When the ESP32 gives a logic "0" to the relay, the relay will be "ON" and the pump "ON" until the soil moisture has reached the maximum limit for watering (Arief, Zarory, Jufrizel, & Mursyitah, 2024). The LCD display will show the percentage of soil moisture, and will display the pump status whether the pump is "ON" or the pump is "OFF". Blynk will display the pump status "ON" which indicates that watering has started, after the soil is wet enough, the pump status will change to "OFF" which indicates that watering has been completed (Anasurya & Srikanth, 2022).

RESULTS AND DISCUSSION

A series of automatic plant watering system tools using DHT11 Sensor and YL-69 Sensor based on *IoT* . After designing and making the tool, the next step is testing and analyzing data from the tool that has been made. The following is the implementation of the tool on plants in the Rindam I/BB garden (Priya & Balambica, 2023).

Figure 3. Implementation of Automatic Plant Watering on plants in the Rindam I/BB garden

YL-69 Sensor Testing

Moisture sensor testing is done to determine the accuracy of the soil moisture sensor reading. Basically, the YL-69 sensor works to detect soil moisture. When the soil detects dry soil, the water pump will turn on and when the sensor detects moist or wet soil, the water pump will turn off (Fitra & Sunardi, 2023). Thus, to test the soil moisture sensor is to set the sensor output logic by providing water input between the sensors. This testing process is done by placing the red (positive) multimeter *probe* with the YL-69 sensor pin while the black (negative) multimeter *probe is on the GND on the YL-69 sensor* .

Figure 4. YL-69 Sensor Testing

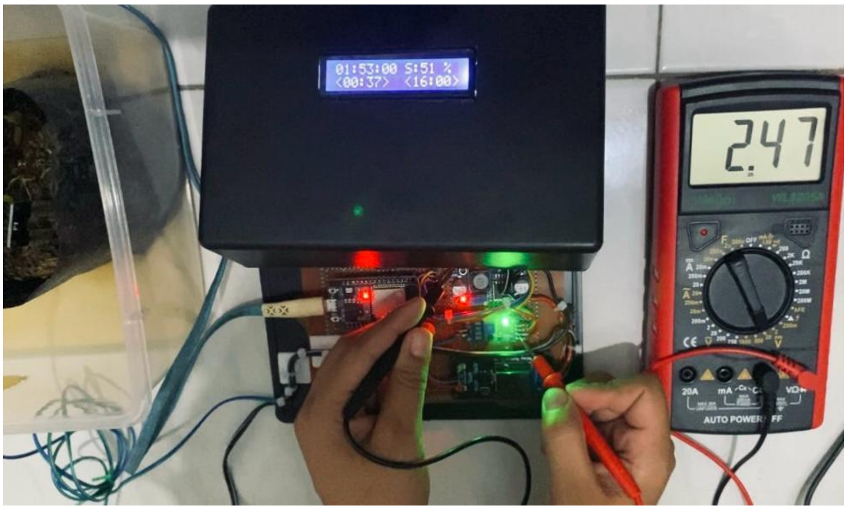

Figure 5. YL-69 Sensor Voltage Measurement

I2C 16 x 2 LCD Testing

LCD testing is used to determine whether the LCD can display the required information correctly. This LCD testing uses a program specifically created to display a message on the LCD by a microcontroller. The program is created in C language, and is run by the controller with the condition of being connected between the controller and the LCD (Muthmainnah et al., 2024).
Here is a picture of the LCD test:

Figure 6. I2C LCD testing

After being uploaded to the microcontroller and activated, the display will display a message on the LCD. With such a display, this test is declared successful and works well so that it can be applied to the system (Faruque, Sharif, Tamim, Ishan, & Kabir, 2023).

***Real Time Clock)* Testing**

RTC testing with relay is done to determine the accuracy of the time reading from the RTC which is then processed by the NodeMCU ESP 32 to be forwarded to the relay. This testing is done by connecting the RTC with the NodeMCU ESP 32 as a microcontroller and also connected to the relay (Tumpa, Fahim, Rahman, & Newaz, 2023).

By conducting the test, it can be concluded that the relay has a very good response seen from the testing of different set times and the relay successfully reads all times with conditions according to the settings. Thus, it can be concluded that the RTC test with the relay was successful.

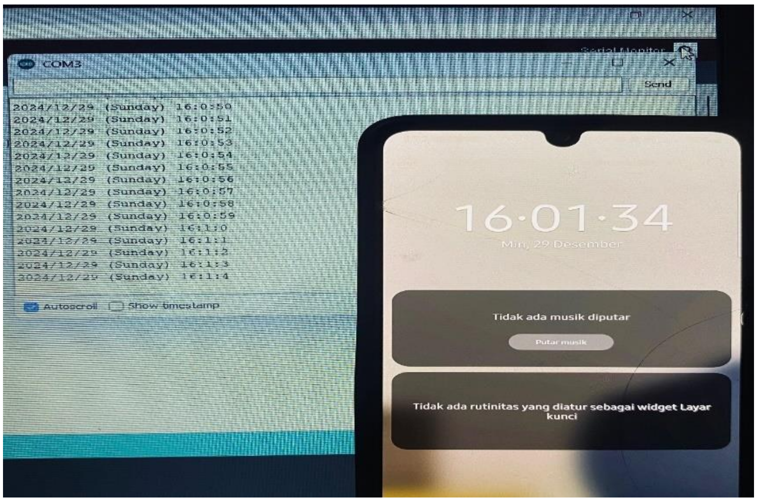

Figure 7. RTC testing

DHT11 Sensor Testing

DHT11 sensor testing is done to determine the accuracy of the sensor readings to air temperature. When the sensor detects hot air temperature (>=34°), the water pump will not turn on at the specified time even though the soil is dry. Thus, to test the DHT11 sensor is to set the sensor output logic by providing heat input near the sensor (Gunawan, Kamarudin, Kartiwi, & Effendi, 2022).

Figure 8. DHT11 Sensor Testing

NodeMCU ESP 32 *WiFi* Connectivity Testing with *Hospot*

NodeMCU ESP 32 connectivity testing is done by running the program that has been uploaded to this module and seeing the module's connectivity with existing *wifi* or *hotspots* . *The* testing process is to activate the hotspot according to the name that already exists in the program (Ojo et al., 2024). In this case, the name of *the hotspot* created in the plant watering tool program is *moonimoon* with *the password moonimoon2.* After *the hotspot* is activated, wait a few moments later, if the connectivity is successful, then on *the smartphone* used as *a hotspot* , 1 device will appear connected to *the hotspot* . If this connectivity is successful, the NodeMCU ESP32 has worked well and can be continued with further testing (SINGH, 2022).

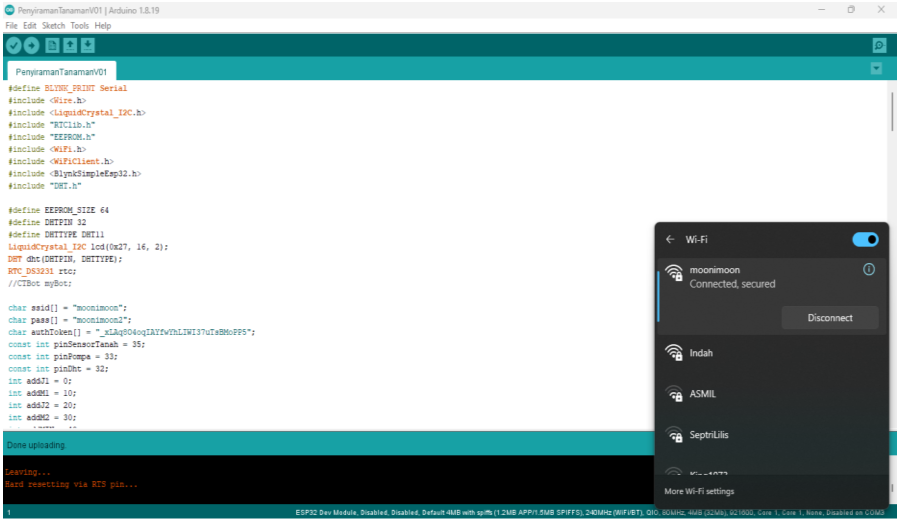

Figure 9. NodeMCU ESP 32 *WiFi* Connectivity Testing with *Hospot*

Overall Tool Testing

After the component testing is successful and working, the next stage is to test the system as a whole. Prepare the system by providing all the needs, for example, plants, YL-69 sensors and so on. Run the system by connecting the power supply to the terminal. Activate the hostpot and observe the system work from start to finish (Arta, Arifin, & Yudantoko, 2020).

The test results are when the system is activated the module will be connected to the hotspot that has been provided. Then the LCD display displays the schedule and soil moisture. The next stage is to test the system connectivity with the blynk application. If it has been connected, the DHT11 sensor data display and the YL-69 sensor, schedule settings, temperature and humidity settings, and pump status will appear. The following is a picture of the overall test.

Figure 10. Overall Testing

Discussion

YL-69 Sensor

The following is some information obtained during the trial of the automatic plant watering device using the DHT11 sensor and the YL-69 sensor, with the NodeMCU ESP32 as a microcontroller. This test was carried out in two conditions, namely:

Table 1. Soil Moisture Testing

No.	Soil Moisture (%)	Soil Condition (Dry/Wet)
1	<= 30 – 70	Dry
2	71 – 100	Wet

Information :

In the Blynk application, we can set the soil moisture level by entering the values in the "set humidity min" and "set humidity max" columns as desired. The specified soil moisture setting is a minimum of <=30%, and a maximum of >=70%.
If the soil moisture reaches 30% or less, watering will be carried out until the soil moisture reaches 70%. After the soil moisture reaches 71%, the pump will automatically turn off (OFF) because it is considered that the soil is wet enough. If before watering the soil moisture has reached 71%, the pump will not be activated. The following is a table of the YL-69 sensor test results:

Table 2. YL-69 Sensor Test Results

No.	Soil Moisture (%)	Pump Status (ON/OFF)	Soil Condition (Wet/Dry)	Voltage (Volt)
1	0	ON	Dry	3.78
2	51	ON	Dry	2.47
3	80	OFF	Wet	1.88
4	92	OFF	Wet	1.64
5	100	OFF	Wet	1.43

DHT11 Sensor

The following is some information obtained during the DHT11 sensor trial on an automatic plant watering tool with NodeMCU ESP32 as a microcontroller.
This test is carried out under two conditions, namely:

Table 3. Temperature Sensor Testing

No.	Air Temperature (^{o})	Pump Status (ON/OFF)
1	<= 33	ON
2	>= 34	OFF

Information :

In the Blynk application, we can set the air temperature level by entering a value in the "set temperature" column as desired. If the air temperature reaches 33^o or less, then watering will be carried out. However, if the air temperature reaches 34^o or more, the pump will not be activated. The following is a table of DHT11 sensor test results:

Table 4. DHT11 Sensor Test Results

No.	Air Temperature (^{o})	Pump Status (ON/OFF)
1	26	ON
2	28	ON

3	33	ON
4	34	OFF
5	35	OFF

RTC DS3231

After conducting a trial of the RTC DS3231 on the automatic plant watering system, the results showed that the system was functioning properly. The RTC DS3231 worked properly, was able to read the time in real time, and provided the appropriate signal (Aziz, Asgarnezhad, & Mahmood, 2021). The time setting was done in 10 minute intervals to observe changes in the RTC (real time clock). The testing process was carried out by uploading the program, and if there were no error messages or errors, it indicated that the process was running smoothly. After testing, the resulting time slowed down and there was a difference (Ruzek, Ville, Velex, Boni, & Marchesse, 2019). Measurements on the cellphone clock were about 30 seconds faster than the RTC, as seen in table.

Table 5. DS3231 RTC Test Results

No.	Day and date	RTC DS3231	Clock (HP)
1	December 29, 2024	16:01:04	16:01:34
2	December 29, 2024	16:11:05	16:11:34
3	December 29, 2024	16:21:04	16:21:34
4	December 29, 2024	16:31:04	16:31:34

CONCLUSION

From the results of the Implementation of DHT11 Sensor and YL-69 Sensor in an Internet of Things (IoT)-Based Automatic Watering System Using Blynk, it can be concluded that the application of IoT in automatic plant watering systems has been successfully implemented in the field. The design and construction of an automatic watering system for water use efficiency by considering the needs of plants both from soil moisture and temperature has been implemented. The wireless monitoring and control system carried out through the Blynk application on mobile devices to manage the watering process remotely has been realized appropriately. Watering that is carried out according to the schedule of time, soil conditions and air temperature that has been determined goes well. This system has the ability to increase efficiency and productivity in the process of watering plants.

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