IoT-Based Automatic Plant Watering System with the Blynk Application

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Abstract: Agriculture is one of the main products in Indonesia. Based on this issue, the process of automatic monitoring and watering can utilize automatic microcontrollers. Therefore, a monitoring system for watering plant seeds by monitoring the condition of flowing water can be implemented. In addition to monitoring the watering conditions, it is essential to monitor soil moisture. This monitoring is necessary to trigger the right time for the watering process so that it can run automatically. The test results indicate that the IoT-based greenhouse system successfully controls the temperature and humidity of plants effectively. With a temperature condition above 34°C, the pump is on, and below 34°C, the pump is off. For humidity below 50%, the pump is on, and above 50%, the pump is off, monitored using Android through the Internet of Things (IoT) technology with the Blynk framework. After testing this tool, the room temperature or ambient temperature is also considered. With this system, it is expected to improve the efficiency of plant production and environmental control, thus enhancing the quality of plant growth.

1 INTRODUCTION

Agriculture is one of the primary products in Indonesia. Therefore, Indonesia is recognized as an agrarian country, a nation that possesses agricultural commodities.

In addition to the water flow process, another issue concerns the determination of an appropriate watering schedule for plants. The timing of irrigation is influenced by several factors, including soil humidity, air humidity, light intensity, and air temperature in a specific area. In the research location, the control of air temperature and humidity already employs automation and control systems. However, determining soil humidity still relies on an observation system, resulting in a watering process based solely on a fixed schedule, typically in the morning and evening, rather than being responsive to actual soil moisture levels. This practice renders seedlings highly sensitive to soil moisture content (Putri et al., 2019).

To address this issue, an automated monitoring and watering process can be implemented using automatic microcontrollers. Therefore, a system for monitoring seedling irrigation, which monitors the flow of water, can be established. Additionally, monitoring soil humidity is crucial. This monitoring is necessary to trigger the precise timing of the watering process, enabling it to be carried out automatically. The conditions within the greenhouse will be monitored using Android devices through IoT technology with the Blynk framework (Tullah et al., 2019).

2 LITERATUR REVIEW

In the first research conducted by Astriana Rahma Putri, Suroso, and Nasron is about the "Design of an Automatic Plant Watering Device in an IoT-Based Miniature Greenhouse." The authors utilized Arduino Uno, ESP8266 Module, DHT11, Moisture Sensor, Water Pump, Relay, and a Web Server for monitoring purposes. This research serves as an initial phase before conducting testing to ensure that the device aligns with the expected outcomes. The design of the automatic plant watering device in the IoT-based miniature greenhouse aims to simplify the task of farmers in managing the irrigation system for greenhouse plants (Putri et al., 2019).

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In the second research conducted by Zaini Nadizf, Ucuk Darrusalam, and Agus Iskandar. The study is about the "Design and Construction of an Automatic Watering System for Ornamental Plants Based on the ESP8266 Microcontroller." In this research, the authors used ESP8266, RTC DS3231, Moisture Sensor, and a Servo Motor. Based on the testing of the automatic watering system for ornamental plants, it can be concluded that this system can facilitate users in watering their ornamental plants according to a schedule that can be customized by the user. This customization involves setting the watering time and humidity level suitable for the respective ornamental plants (Nadizf et al., 2021).

In the third research conducted by Daffa Eka Nadindra and Joko Christian Chandra. The study is about the "IoT-Based Automatic Plant Watering System Using Arduino with Telegram Control." The authors utilized Arduino UNO, ESP8266 Module, DHT11, Soil Moisture Sensor, Water Pump, LCD 16x2, Relay, and Telegram for monitoring. Based on the design, implementation, and testing, it can be concluded that this system can serve as a solution to help automate plant watering based on sensor data and, if necessary, water the plants based on commands sent via the Telegram application (Nadindra & Chandra, 2022).

1) ESP8266

ESP8266 is a Wi-Fi module used as an extension for microcontrollers like Arduino to enable direct connection to Wi-Fi networks and establish connections. This module requires a voltage of approximately 3.3V and has three Wi-Fi modes: Station Mode, Access Point Mode, and Both Mode. The module is also equipped with a processor, memory, and GPIO pins, and the number of available pins depends on the type of ESP8266 used. Therefore, this module can function independently without requiring an additional microcontroller because it already has components equivalent to a microcontroller (Widiyaman, 2023).

Figure 1: Module NodeMCU ESP8266.

2) Soil Moisture Sensor

The Soil Moisture sensor is used to measure soil volumetric water content or moisture loss due to evaporation and plant uptake. For the survival of a plant, water is the most crucial factor. This soil moisture sensor determines the amount of water required for plant irrigation (Kodali & Sahu, 2016).

Figure 2: Soil Moisture sensor.

3) DHT 11 Sensor

This module features a humidity and temperature complex with a calibrated digital signal output means DHT11 sensor module is a combined module for sensing humidity and temperature which gives a calibrated digital output signal. DHT11 gives us very precise value of humidity and temperature and ensures high reliability and long-term stability. This sensor has a resistive type humidity measurement component and NTC type temperature measurement component with an 8-bit microcontroller inbuilt which has a fast response and cost effective and available in 4-pin single row package (Srivastava et al., 2020)

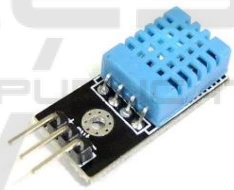


Figure 3: DHT 11 Sensor.

4) Relay Module

A relay module is one of the devices that operates based on electromagnetic principles to actuate a contactor, moving it from an ON to OFF position, or vice versa, by utilizing electrical energy. The closing and opening of this contactor occur due to the magnetic induction effect generated by the electric induction coil (Widyanto & Erlansyah, 2014).

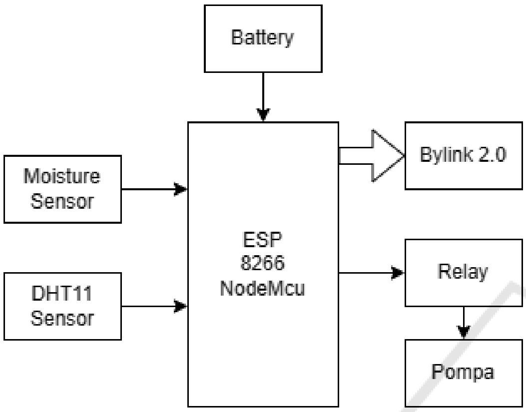
Figure 4: Relay module.

3 METHODS

This research was conducted at several locations, including the electrical laboratory of University 17 August 1945 Jakarta.

3.1 System Block Diagram Design Tool

The following describes the hardware block diagram planning in this study:



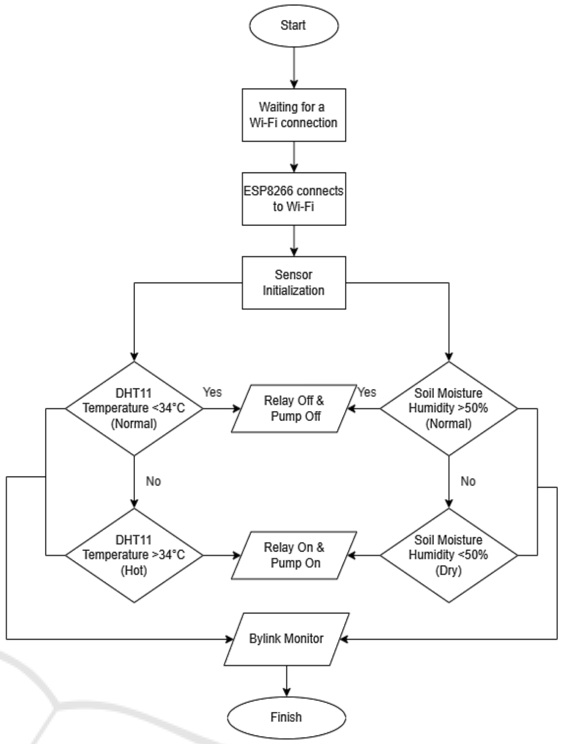
The research design consists of several components divided into three parts: input, process, and output. In the input section, there are power supplies, soil moisture sensors, and DHT11 sensors. The process is carried out by the NodeMcu Esp8266 microcontroller. The outputs include a relay to activate the pump, and the final output is the monitoring system provided by the Bylink 2.0 application.

3.2 The Workflow of the Device

The flowchart outlining the functionality of this research tool is designed to offer a comprehensive visualization of its operational procedure, ensuring clarity, and understanding for the readers. The flowchart illustrating the research tool's workflow is available for viewing and explanation in the accompanying image.

When the ESP8266 is activated or turned ON, it will wait to connect to a Wi-Fi network or a mobile hotspot. Once it is connected to the Wi-Fi network, the Soil Moisture sensor and DHT22 sensor will start working and detect the plant conditions.

The Soil Moisture sensor will detect the soil humidity conditions. When the condition is >50%, the pump will be turned off; conversely, when the soil moisture is detected as <50%, pump will be turned on.



The DHT22 sensor will detect room temperature and room humidity conditions. When the temperature is <34°C, the pump will be turned off. Conversely, when the temperature is detected as >34°C, pump will be turned on.

3.3 Circuit Diagram

Here is the circuit diagram for this research.

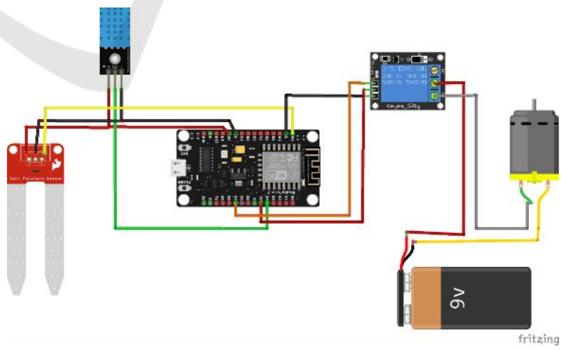


Figure 5: Circuit Diagram.

Above is the circuit diagram of this project, which consists of several components, particularly the ESP8266 module, DHT11 sensor soil moisture sensor, 5V relay, and a DC 5V pump.

3.4 Formula for Converting ADC Reading

In the soil moisture sensor, the output values for soil moisture are in the form of analog numbers ranging from 282 to 618. These values do not directly indicate the percentage of soil moisture. Therefore, the following formula is used:

$$\text{Percent} = \frac{(ADC\_Value - ADC\_Min)}{(ADC\_Max - ADC\_Min)} \times 100 \qquad (1)$$

Explanation of the Formula:

1) Percent:
represents the percentage value of soil moisture.
2) ADC_Value:
indicates the recorded ADC value derived from the soil moisture sensor.
3) ADC_Min:
corresponds to the ADC value when the soil is extremely dry or at its minimum moisture level.
4) ADC_Max:
corresponds to the ADC value when the soil is highly saturated or at its maximum moisture level.

By utilizing the formula provided, the ADC value obtained from the soil moisture sensor can be transformed into a soil moisture percentage, facilitating comprehension and analysis.

4 RESULTS AND DISCUSSION

4.1 Device Model

Here is the prototype device design in this research.

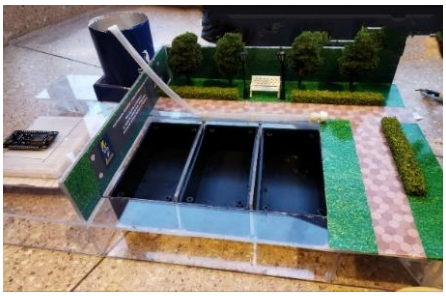


Figure 6: Design Prototype

Above is the design prototype image of a garden that has been created and equipped with an automatic plant watering system. In the prototype, there are three black boxes, each of which will be filled with soil/plant fertilizer under three conditions: dry soil, moist soil, and wet soil.

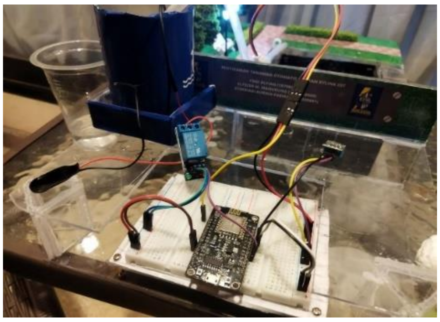


Figure 7: The device circuit.

The image above is a view of the designed and assembled device

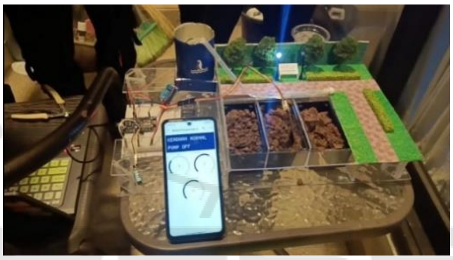


Figure 8: The overall view of the device prototype.

The picture above shows the testing process of the device, where the prototype has been provided with soil/fertilizer under three soil conditions: dry soil, moist soil, and wet soil.

4.2 Sensor Testing Results Data

4.2.1 Soil Moisture Sensor

Here are the results of the soil moisture sensor testing.

Table 1: The table of soil moisture sensor testing results.

Soil Moisture Sensor	Description
530 (31%)	Dry Condition: Pump ON
432 (62%)	Normal Condition: Pump Off
368 (82%)	Wet Condition: Pump Off

In Table 1, data was collected under three soil conditions: dry, normal, and wet. The table displays the readings of the soil moisture sensor, and these values have been converted using Formula 3.1.

4.2.2 DHT 11 Sensor

Here are the results of the DHT11 sensor testing.

Table 2: The table of DHT11 sensor testing results.

DHT 11 Sensor	Description
> 34°C	High Temperature (Pump On)
< 34°C	Normal Temperature (Pump Off)

In Table 2, two temperature conditions are observed. If the temperature is above 34°C, the pump will turn on, and if it's below 34°C, the pump will turn off.

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

After testing the 'IoT-Based Automatic Plant Watering System with Bylink,' several conclusions can be drawn:

1) The system alleviates the workload of humans in terms of plant watering and adapts the watering process according to soil conditions, ensuring that plants receive water as needed.
2) Room temperature or ambient temperature also affects plant conditions. In this case, with the DHT11 sensor, plants receive the required temperature.

5.2 Recommendation

As for recommendations for this project, it is suggested that the device be further developed to include alerts or notifications regarding soil and temperature conditions, without the need to open the Bylink application first.

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