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Soil Moisture Monitoring System and Soil PH on IoT-based Aglaonema Crop

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Abstract

Aglaonema is an ornamental plant with soft, watery (herbaceous) stems that dislikes too moist media and needs precise irrigation. Using Internet of Things (IoT) technology, which integrates soil moisture sensors YL-69 Soil moisture sensor, soil pH sensors, and NodeMCU ESP8266 as a microcontroller with the Thingspeak IoT Platform and the Blynk Application via Android, it is possible to monitor soil moisture and pH, which is a determining factor in the planting media for ornamental plant cultivation. Additionally, it may enable remote control operation of a watering system for ornamental plants that holds soil moisture when it exceeds a predetermined threshold. The design of an IoT (Internet of Things)-based soil moisture and pH monitoring system has successfully been applied to the cultivation of ornamental plants. This is expected to help owners of cosmetic plant businesses make decisions based on online information about soil moisture and pH values.

Keywords: *Aglaonema, NodeMCU ESP8266, YL-69 sensor, soil pH sensor*

Abstrak

Aglaonema, tanaman hias yang berbatang basah (herbaceous) yang lunak dan berair, tidak menyukai media yang terlalu basah sehingga memerlukan ketelitian dalam proses penyiraman. Sulitnya melakukan monitoring kelembaban dan pH tanah yang menjadi faktor penentu pada media tanam pada budidaya tanaman hias tersebut, dapat diatasi dengan penggunaan teknologi *Internet of Things* (IoT) yang mengintegrasikan antara sensor kelembaban tanah *Soil moisture* sensor YL-69, sensor pH tanah dan NodeMCU ESP8266 sebagai mikrokontroler dengan *Platform IoT Thingspeak* dan Aplikasi Blynk melalui Android. Hal ini juga dapat memungkinkan pengguna untuk melakukan pengontrolan jarak jauh terhadap alat penyiraman tanaman hias yang akan mengontrol secara online kelembaban tanah apabila melewati ambang batas. Hasil rancangan sistem monitoring kelembaban dan pH tanah berbasis IoT *(Internet of Things*) ini berhasil diterapkan pada budidaya tanaman hias yang diharapkan dapat membantu pemilik usaha tanaman hias dalam pengambilan keputusan berdasarkan informasi nilai kelembaban tanah dan pH tanah yang telah diperoleh secara online.

Kata kunci: *Aglaonema, NodeMCU ESP8266, YL-69 sensor, sensor PH Tanah*

Introduction

Aglaonema comes from the Greek meaning bright or shiny or known as "sri rejeki" is an ornamental plant included in the valas-talasan plant or Aracaeae [1]. This plant has an attractive appeal and even gives a relaxing effect to its fans because its leaves are round-shaped longitudinally with varying leaf colors, green-white, red-green, even light-red [2], with a typical pattern or pattern, with vegetative reproduction, either through the separation of offspring, the method of occulation, or by the isolation of plant tissue. [3]. Aglaonema is a moist herbaceous ornamental soft plant because it can produce a lot of bacteria that cause rot in the roots of plants [4].

A good growing medium must meet some conditions of both physical, chemical, and biological factors, such as porosity, water and air capacity, pH, EC and others [5]. PH affects the ability of plants to absorb the nutrients available in the soil. Generally, the acidity of the soil is on a scale of 4 to 10 [6]. In addition to sunlight, soil moisture or the amount of water stored between the pores of the soil plays an important role in plant growth [7]. Aglaonema needs a shaded place to grow and thrive with a lighting limit of 10 – 30% with the humidity level of the aglaonema plant that is not too high and not too low, this is to maintain the health of the Aglonema root [8]. The acidity level that the aglonema plant needs is about 6 or 7 (neutral) [9].

The availability of water in the planting medium is a very important thing to deliver the element of harassment and care for Barangayema [10], because irregular and excessive watering will make the growth of Barangayema less maximum, the resulting leaf color does not look beautiful, fuzzy and dead [11]. Generally, aglonema irrigation is done manually, because these plants have a sensitivity in water absorption, which, when a lack of water will result in death for the plant [12], and excess water will cause degradation of the plant roots) [13]. For that, the application of IoT technology is a suitable solution, in addition to controlling the availability of water on plants, it can also efficiently save aglonema farmers' time in monitoring plants [14].

The Internet of Things (IoT) is an electronic device that is used every day and connected to a computer network [2] and [15]. According to analysis by the McKinsey Global Institute, IoT is a technology that connects machines, equipment, other physical objects with sensors and network aquaters to obtain data and manage its own performance [16]. This technology allows all devices connected to the Internet to be controlled and monitored using Android anywhere and anytime [10]. To support the monitoring process, a NodeMCU ESP8266 microcontroller is required, which is an electronic board based on the ESP 8266 chip with the ability to perform microcontrollers (monitoring and controlling) and also internet connections (WiFi), soil moisture sensors, and soil pH sensors [17]. The Monitoring soil moisture and soil acidity levels on plants in real time, carried out through Thingspeak IoT Platform and controlling automatic irrigation using the Blynk App installed on Android farmers.

Methodology

The NodeMCU ESP8266 microcontroller, YL-69 soil moisture sensor, Arduino-compatible soil pH sensor, PCB (Printed Circuit Board), mini pump, breadboard, relay with two channels, timber, solder, 5V adapter, LCD with 16x2 I2C, USB cable, Android, PC, or laptop are the materials used to make this tool. The hardware design and software design phases are separated in the design and production of the soil moisture monitoring system and soil pH. (software).

a. Hardware design (Hardware)

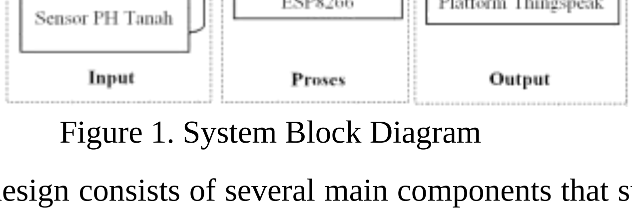

Figure 1. System Block Diagram

The hardware design consists of several main components that support the work of this monitoring system, i.e. soil moisture monitoring and soil pH monitoring systems.

The soil humidity monitoring network consists from NodeMCU ESP8266 and the soil Moisture sensor as shown in Figure 2 below.

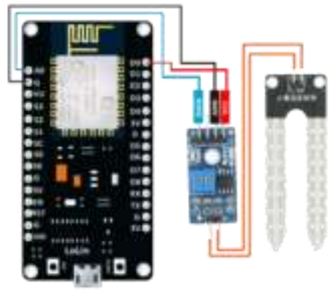

Figure 2. Soil Moisture Monitoring Network

The soil pH monitoring set was designed by connecting the NodeMCU ESP8266 to the soil PH sensor shown in Figure 3. The ground pH sensor used is an arduino soil support pH sensor that has two cables namely black cable as the output and white cable is GND (Ground). The output of this sensor is an ADC analogue.

Figure 3. Soil PH Monitoring Network

The overall schematics of the electronic components will be arranged as shown in Figure 4 below.

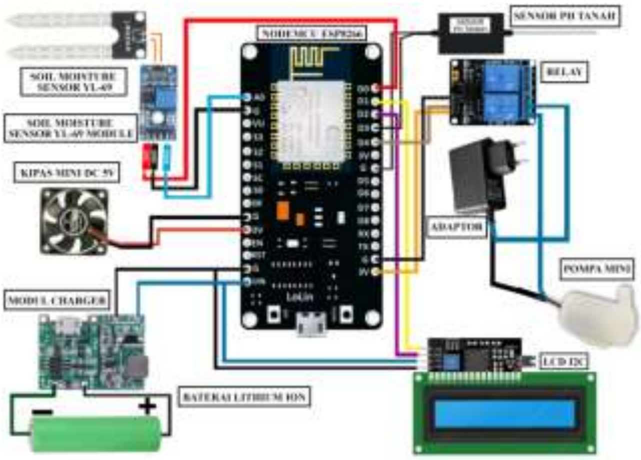

Figure 4. System-Wide Schematic Network

b. Software Planning (Software)

Linearly, this monitoring system is described through the following flowchart. Flowcharts are defined as steps to solve problems written in certain symbols [18]. The sequence on the flowchart is described logically to make it easy to understand. In addition, the flowchart can also represent the flow in the program logically.

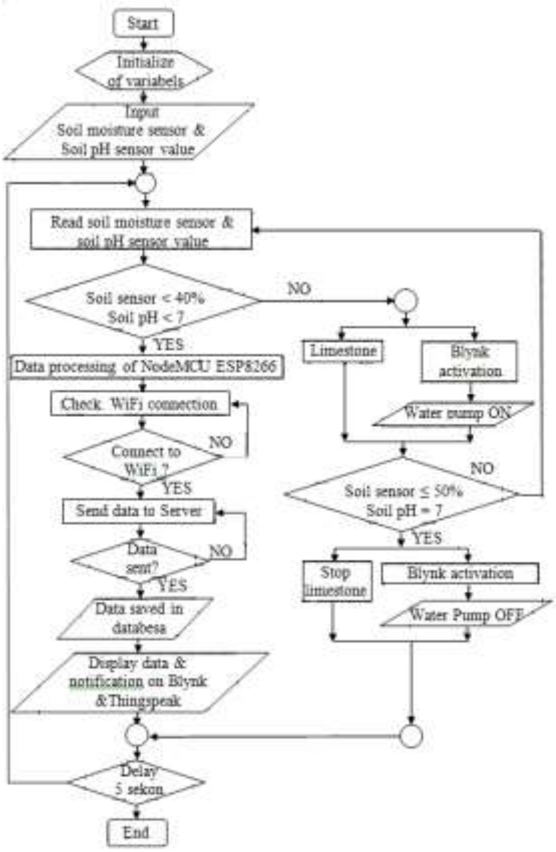

Figure 5. System Flow Diagram

Software design consists of several stages namely system design on thingspeak platform, system planning on blynk applications, program testing and system automatic irrigation planning. Planning the monitoring system on the thingspeak platform is by accessing the Thingspeak account at the link <https://thingspeak.com/>, then creating an account and filling in the form provided. Fields are based on two types of sensors that are used: field 1 for monitoring soil humidity and field 2 to monitor soil pH. A view of the monitoring made through the Thingspeak platform can be seen in Figure 6 below.

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Figure 6. View Channel Stats

The design of the monitoring system on the blynk application is made by installing the blynnk application via Android. To obtain a blynk token it is important to create a monitoring template on the Blynk Web Dashboard using a Laptop. Then fill in the data that matches the monitoring system. Notification settings for soil moisture monitoring, which means when soil humidity is <40%, an Android notification will appear for irrigation.

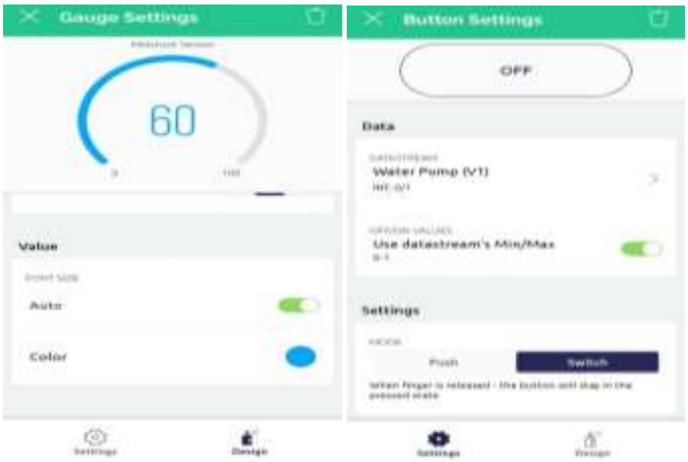

Figure 7. Blynk Settings View

System program testing is done by connecting NodeMCU ESP8266 to a laptop using a USB cable. Arduino IDE software is useful for creating, storing, calling microcontroller program files (also called ‘sketch’ with the extension ‘ino’) and uploading sketch files to the microcontrollers. The system program view can be seen in Figure 8 below.

Figure 8. System Program View

Pengkalibrasian sensor kelembaban tanah dan pH tanah perlu dilakukan agar mendapatkan nilai Calibration of soil moisture sensors and soil pH must be performed to obtain accurate values. The calibration of the soil moisture sensor is shown on the following equation 1.

$$\text{Moisture} = ((100 - ((\text{value}/1023.00) * 100)) + 0.1 \quad \ldots\ldots\ldots\ldots\ldots 1)$$

Then, for calibration of the soil pH sensor is shown on the following 2 equation.PH

$$\text{Soil} = ((-0.0139 \times \text{Voltage}) + 7.7851) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2)$$

where, the pH voltage value of the soil is obtained based on the following 3 equation.

$$\text{Voltage} = ((3.3/4096.0) \times \text{sensor value})) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3)$$

Testing Blynk as an automatic irrigation control by looking at how the automatic Irrigation works when soil humidity is <40%, then the system will send a notification via the Blynks application to perform the irrigations automatically through the blynks. This automatic is controlled by clicking ON and OFF on the Blynnks Automatic Irigation Device.

Figure 9. Automatic Irrigation Testing

Result and Discussion

The soil moisture and pH monitoring system is designed with the NodeMCU ESP8266 microcontroller to read analog data from the sensor which is then converted into digital data form. For measurement of soil humidity and pH use soil Moisture sensor YL-69 and soil pH sensor support arduino. This monitoring system uses the Thingspeak Platform and the Blynk Application as a medium to receive and read the monitoring results of the system.

The soil humidity sensor type YL-69 and the soil pH sensor, which can detect soil ph levels, were employed in this investigation as the soil moisture sensors. The percentage of the sensor's readings will rise if the probe's water content is high enough. Similar to this, if the water content around the probe is sufficiently low, the sensor will read a lower result for soil moisture. The soil pH sensor's next operating principle is to measure the acidity and level of the soil. The calibration of this tool has been completed by the device's creators. This sensor contains a single probe and outputs digital data from the sensor readings. Data collection of research results of soil moisture monitoring system and soil pH on IoT (Internet of Things) based ornamental crops cultivation was carried out in order to know the performance of each system of the entire tool chain. The data obtained is expected to be valid, so that the tool can work effectively according to its function and purpose.

Aglaonema plants were used in the research's soil testing to acquire the findings. The purpose of testing this system is to see how well it measures soil moisture and soil pH on soil aglaonema plants. The care required for an aglaonema plant is complex; for example, the soil moisture level must be between 50% and 70% and the pH level must be neutral. In order to assist users in monitoring soil humidity and plant soil pH, this monitoring system was created. The readings of both sensors can be viewed through the Thingspeak Web Dashboard, which can be monitored via a laptop. Thingsview is an application that displays data that corresponds to the data sent on Thingsspeak. Generally speaking, here's a picture of the whole set of system components.

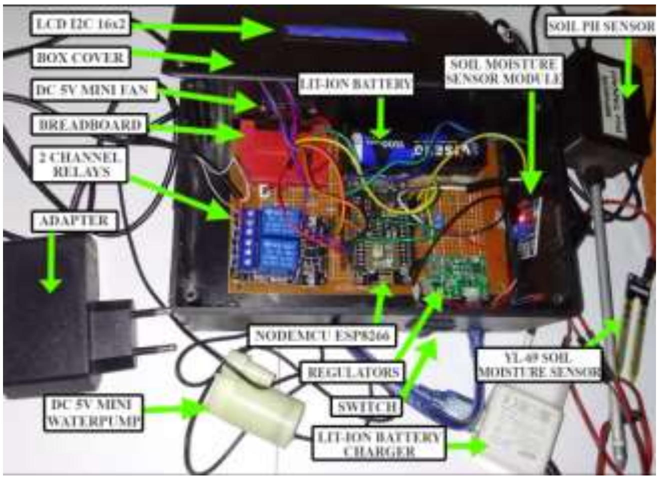

Figure 10. Monitoring System Network

The whole testing procedure of the system's hardware and software can be used to determine the effectiveness and implementation of the soil moisture monitoring system and soil pH. (software). By placing a two-sensor probe on the soil of the plant housed in the pot, this test utilizes the Aglaonema plant. Figure 11 below shows the outcomes of the soil moisture monitoring test.

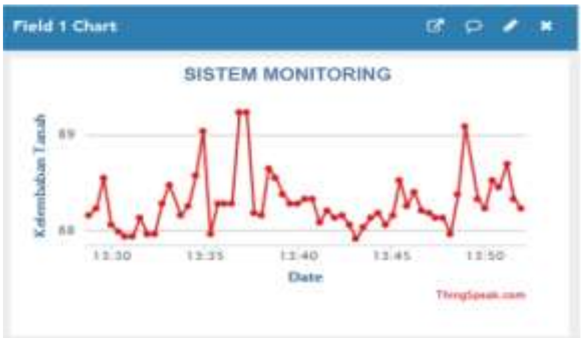

Figure 11. Graphic Results of Soil Moisture Monitoring

The Figure 11 demonstrates how the rate of soil moisture monitoring changes over time, albeit only slightly. This is due to the fact that indoor plants are not exposed to direct sunshine, which causes the soil to hold onto water longer. The data from the Thingspeak platform's web server used to monitor ground moisture is shown below.

Table 1. Data of Test Results of Soil Moisture Sensors

Time	Soil humidity (%)	Category
2022-12-18T04:15:58+00:00	100	Very Wet
2022-12-18T04:14:40+00:00	99.60899	Very Wet
2022-12-20T12:50:40+00:00	90.60059	Very Wet
2022-12-20T13:18:50+00:00	89.08691	Wet
2022-12-21T02:25:15+00:00	87.89063	Wet
2022-12-20T13:37:26+00:00	76.66016	Wet
2022-12-21T14:57:03+00:00	75.04883	Wet

2022-12-21T15:21:46+00:00	59.53079	Normal
2022-12-21T15:23:22+00:00	51.6129	Normal
2022-12-21T15:21:46+00:00	49.07136	Dry

Based on Table 1, it is obtained that the monitoring results of soil moisture sensors are divided into 5 categories namely; very dry, dry, normal, wet, and very wet.

Figure 12 Graph of The Results of The Ph Of The Soil Monitoring

Figure 12 is a field 2 graph that shows the results of monitoring the unchanged soil pH condition. This is because the plant has sufficient nutrient content to maintain the soil pH conditions of the plant. So the graphic rate is straight graphic which means the rate of the pH value of the ground is constant. Here's the ground pH monitoring data obtained through the Thingspeak platform's web server.

Table 2. Soil PH Sensor Test Result Data

Time	Soil PH	Category
2022-12-21T14:06:58+00:00	7.7851	Neutral
2022-12-21T14:08:23+00:00	7.7851	Neutral
2022-12-21T14:09:26+00:00	7.7851	Neutral
2022-12-21T15:01:09+00:00	7.7851	Neutral
2022-12-21T15:08:31+00:00	7.7851	Neutral

According to Table 2, the values obtained through monitoring of soil pH sensors are divided into three categories: Acid, Neutral and Base. It is known that the system monitoring soil moisture and soil pH is operating effectively based on the system's test findings. It can be observed that both sensors are capable of keeping an eye on the pH and humidity of the soil. As a result, it enables users to monitor simply through Android and can conserve user energy by avoiding constant direct plant monitoring. According to Table 1, sensor kelembaban tanah monitoring data was divided into five categories: very dry, dry, normal, wet, and very wet.

Conclusion

The Thigspeak Platform was utilized in the creation of the soil moisture and pH monitoring tool as an application of the IoT system. The gadget for measuring soil pH and humidity performs effectively. The system's readings of the soil's moisture content and pH for ornamental plants serve as evidence of this. Therefore, it can be inferred from such use that the instrument has performed as intended.

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