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Prototype of Automatic Plant Watering Control Based on Internet of Things Using Blynk App

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ABSTRACT

Ornamental plants can grow both indoors and outdoors and can also be used for room decoration. Problems arise when plants don't get the water they need, resulting in insufficient or excessive watering, which can lead to poor growth. Therefore, the purpose of this research is to create a prototype automatic plant watering system to meet plant water needs. An automatic plant watering control system uses an on-off solenoid valve. This automatic plant watering system utilizes a monitoring method that can be remotely monitored using the Blynk IoT (Internet of Things) application in real time to determine soil moisture levels and indicators.Test results showed an average error value for ultrasonic sensor measurements of 0.65%. In soil moisture testing, the soil was dry at less than 38% humidity, damp at 38%-65% humidity, and wet at more than 65% humidity. The test results showed that the DC motor pump output will operate to flow water to the water storage tank if the ultrasonic sensor in the water tank measures the water level below the set point of 10 cm. The solenoid valve will be activated to flow water for the plant watering process if the soil moisture sensor detects a soil moisture value of less than 38%, then the solenoid will be activated until the soil moisture indicator value reaches 65%.

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1. INTRODUCTION

Water is an absolute necessity for human life. Humans use water for various daily activities and needs, including consumption, daily work, and industrial activities [1]. One of the water needs is for watering plants. Watering plants is an important aspect in plant maintenance, because plants need sufficient water for photosynthesis and growth. Watering is one of the factors that influence plant development. An adequate water supply is very important. Failure to do so can have a negative impact on plant development [2]. As technology advances, water used in daily life is usually stored in water tanks or water reservoirs. This is done to anticipate water supply cuts due to power outages or distance from the power source [1].

Watering plants is a routine and conventional process that often causes a number of problems. One of them is inconsistent watering quantity, which can lead to over- or under-watering of plants, which ultimately leads to rot and death[3]. Ornamental plants are plants that are considered beautiful and attractive to many people. Ornamental plants also offer beneficial benefits to humans because of their ability to absorb pollutants, thereby reducing air pollution[4] .Ornamental plants are plants that can live indoors or outdoors and can also be categorized as decorative materials [5]. Generally, people who have a hobby of keeping ornamental plants have an impression of beauty and attraction from various shapes and colors, ranging from flowering plants to plants with unique shapes that are worth collecting [6].

Ornamental plants are also plants in general that have roots, stems, and leaves, where plants really need water which plays an important role in their life cycle [7] . This causes problems when plants do not get the water they need, which causes plants to not get enough water or even too much water so that plants do not grow well [5]. Another problem is when the water level in the water tank is unknown, the tank can overflow or empty due to lack of control over the volume of water in the reservoir. This is especially true for people who forget to turn off the water pump when the reservoir is full. This results in wasted water and electricity, resulting in wasted water [1]. The water tank in the irrigation system is used to store water for the process of watering plants, in the water tank the water level in the tank is regulated so that during the watering process, the water in the tank does not run out of water. Based on the problems of manual plant watering and the lack of previous research that has integrated a plant watering system with the Internet of Things, this study aims to create an innovative prototype entitled "Prototype of an Automatic Plant Watering Control System Based on the Internet of Things Using the Blynk Application."

Technological developments are increasing day by day. Humans are always looking for ways to implement tools or technologies that can assist them in their work, making technology a necessity. The Internet of Things (IoT) is a technology that connects and exchanges data with other devices and systems via the internet. The Internet of Things (IoT) is useful for addressing issues that still rely on conventional systems and transforming them into automated systems [8] . Objects in the Internet of Things are everyday objects whose information is captured through sensors that read environmental conditions in real time and without human intervention [9]. This system uses a soil moisture sensor as an input parameter.

This device is controlled by a small control chip, also called a microcontroller, using the ESP32, which also allows the device to be controlled and monitored remotely using IoT (Internet of Things) technology. IoT (Internet of Things) works by means of communication between devices that are connected automatically without user intervention and at any distance through an internet connection medium between the two interacting devices[10] . The monitoring system is very important for every application. It acts as a data provider, which will then be processed further after the data is sent from the monitoring system [11] . This tool uses a soil moisture sensor to detect the level of moisture in the soil and an ultrasonic sensor to detect the water level [12] . To make it easier for users to read the monitoring output, the Blynk application is used for system monitoring. Blynk is designed for the Internet of Things, allowing users to remotely control hardware and display sensor data [9] . The purpose of this research is to control automatic plant watering using a solenoid valve. With a tool that can work automatically, one no longer needs to worry about the condition of the soil on the plants. This automatic plant watering tool is equipped with a monitoring system so that it can be monitored remotely using IoT (Internet of Things) in real-time to display the value of soil moisture on plants and the water level in the water storage tank.

2. METHOD

The method used in this research is a DC motor control method to flow the filling of the water tank and a DC motor to flow the plant watering process. The electronic system that will be used in the research as in Figure 1, namely there are inputs in the form of ultrasonic sensors, soil moisture sensors, then processed into a process using a microcontroller and output in the form of outputs, namely the DC motor in the tank and solenoid valve. Furthermore, the data results and readings from each input will be processed using the Blynk application as an internet of things.

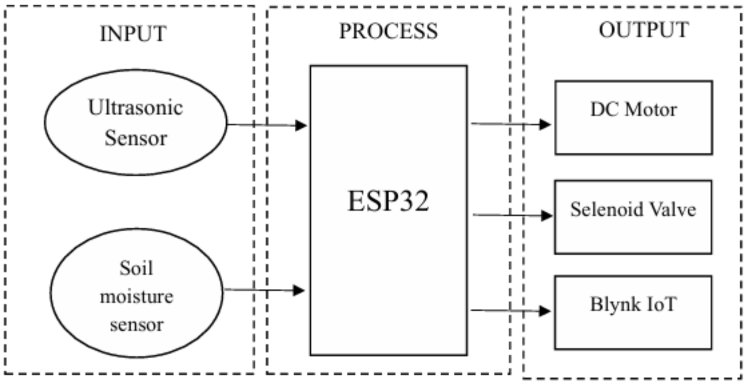

Figure 1. Electronic System Diagram

Figure 1 shows a block diagram of the electronic system for an automatic plant watering device. The block diagram shows three stages: input, process, and output. The initial stage begins with the soil resistance reading taken by the soil moisture sensor and the ultrasonic sensor, which measures the distance of the sound waves reflected by the water. In the next stage, the signals received from the soil moisture sensor and the ultrasonic sensor are received and processed by the ESP32 microcontroller. The reading of humidity values is carried out by a soil moisture sensor using analog method [13]. In the next stage, the analog signal received by the soil moisture sensor is converted into a digital signal by the ADC, which is then forwarded to the ESP32 microcontroller [14]. The ESP32 microcontroller then processes the signal and provides an output signal in the form of an analog reading from the soil moisture sensor, which is then converted to a percentage. If the pin has a voltage of 0V, the relay activates and contacts the solenoid valve, opening it and spraying water. Conversely, if the pin has a voltage of 5V, the relay deactivates and the solenoid valve closes [15] .The ESP32 microcontroller also sends a command signal in the form of an output value to the L298N driver, which controls the DC pump motor, which then rotates and flows water to the water reservoir.

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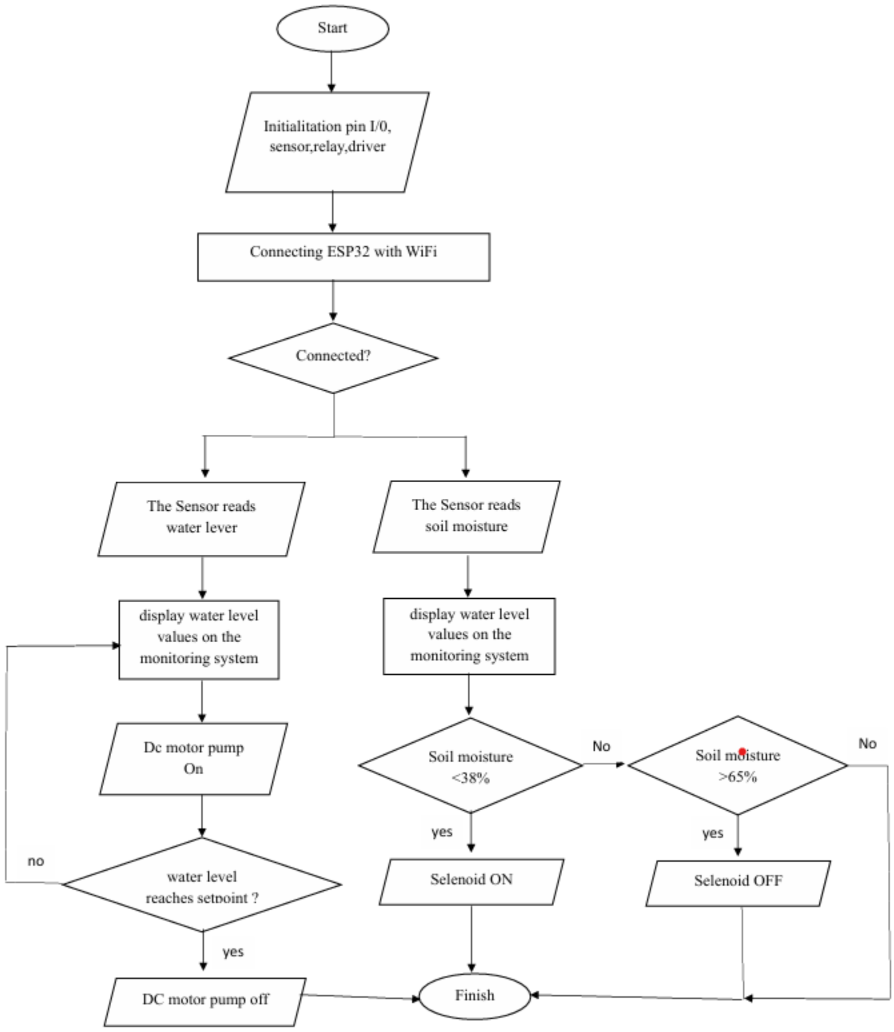

Figure 2. Flowchart System

Figure 2 shows a flowchart of the overall system for a water level control device in a tank for watering plants. The system begins with initializing the I/O pins on the sensor, solenoid, and motor driver. The system is divided into two stages: filling the water tank and watering the plants. The water tank filling stage begins with the sensor reading the water level, which is displayed on the monitoring system. When the water level reaches the set point, the motor driver turns off and stops the DC motor pump. The plant watering stage begins with the sensor reading the soil moisture, which is displayed on the monitoring system. The system is set to a soil moisture value between 38% and 65%. When the soil moisture value is below 38%, the soil is indicated as dry, which turns the relay ON, opening the solenoid valve to water the plants. If the moisture value is above 65%, the soil is indicated as wet, which turns the relay OFF, closing the solenoid valve.

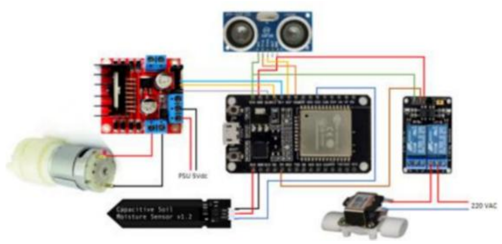

Figure 3. Schematic of an IoT-Based Automatic Plant Watering Monitoring Circuit

The electronic component circuit used to control the water level in the watering tank is connected to each component shown in Figure 3. The working principle when the system is turned on, the ultrasonic sensor detects the water level in the water tank and detects soil moisture, if the water level in the tank is below the setpoint, the water tank will be flowed to fill up to the setpoint. If it is in accordance with the setpoint, if the humidity sensor detects dry soil, the solenoid valve will actively open to flow water to the plants through the hose until the humidity sensor detects wet soil. The device's voltage source is a power supply, which converts AC (alternating current) to DC (direct current) for the automatic watering device [16] . This device is then controlled by an ESP32 microcontroller chip, which has been programmed to give commands to each component. This device has two sensors: a capacitive soil moisture sensor and an ultrasonic sensor that measures the water level. The relay in this circuit functions as an on/off switch, which opens and closes the solenoid valve to water the plants. The motor serves as an output to flow water to the water storage tank.

3. RESULTS AND DISCUSSION

This research test consists of ultrasonic sensor testing, soil moisture sensor testing, solenoid valve testing and testing the entire automatic watering system with the Blynk application..

3.1. Ultrasonic Sensor Testing

The known data generated by the ultrasonic sensor testing can be seen in Table 1, which has been compared with a ruler as measuring instrument. This test was conducted 10 times, each with different heights ranging from 1 to 15 cm. The average error was 0.65%. The results of this sensor testing indicate an error of less than 5%. This means that the error in this sensor measurement is still tolerable compared to actual environmental conditions, making this sensor measurement valid as an example input for the system to be processed.

Table 1. Ultrasonic Sensor Testing

No.	Sensor (cm)	Measuring Instrument (cm)	Error (%)
1.	1.01	1	1
2.	3.22	3.2	0,63
3.	5.15	5,1	0,98
4.	7.05	7	0,71
5.	8.08	8	1
6.	9.05	9	0,55
7.	10.02	10	0,2
8.	11.05	11	0,4
9.	13.10	13	0,7
10.	15.05	15	0,3

3.2. Soil Moisture Sensor Testing

The data generated by the soil moisture sensor testing can be seen in Table 2. Soil moisture conditions are categorized into three categories: dry, moist, and wet. Soil is categorized as "dry" with a moisture content below 40%. Two dry soil samples produced a maximum voltage of 2.05V and an ADC of 2545, resulting in a moisture content of 37%. Furthermore, soil is categorized as "moist" with a moisture content between 38% and 65%. Four moist soil samples produced a maximum voltage of 1.84V and an ADC of 2287, resulting in a moisture content of 45%. Soil is categorized as "wet" with a moisture content above 65%. Four wet soil samples produced a maximum voltage of 1.35V and an ADC of 1392, resulting in a moisture content of 67%. This proves that the soil moisture sensor is still functioning properly, namely it can detect dry, moist, and wet soil conditions based on certain parameter values.

Table 2. Soil Moisture Sensor Testing

No.	Humidity Level Percentage (%)	ADC Value	Soil Condition	Voltage (V)
1.	35	2543	Dry Soil	2.03
2.	37	2545	Dry Soil	2.05
3.	45	2287	Moist Soil	1.84
4.	48	2153	Moist Soil	1.74
5.	52	1969	Moist Soil	1.59
6.	54	1907	Moist Soil	1.54
7.	67	1392	Wet Soil	1.35
8.	70	1100	Wet Soil	0.98

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9.	72	1182	Wet Soil	0.95
10.	75	1100	Wet Soil	0.86

3.3. Selenoid Valve Testing

The data generated by the solenoid is shown in table 3 in three data, each in different soil conditions including dry, damp, and wet. This is intended to test whether the tool that has been made can work as expected by the author. The first data is known to be the condition of the solenoid open with the soil condition indicated dry so that the soil moisture sensor sends a signal in the form of a voltage of 220 V to the solenoid to open and water the plants. The second data is known to be the condition of the soil indicated damp so that the soil moisture sensor sends a signal by not multiplying the voltage so that the voltage is known to be close to zero, namely 0.05V to the solenoid so that it closes again. The last data is known to be the condition of the soil indicated wet so that the soil moisture sensor does not send a signal to the solenoid so that the voltage is known to be close to zero, namely 0.03V and the condition of the solenoid is closed.

Table 3. Selenoid Valve Testing

No.	Selenoid Condition	Soil Condition	Voltage (Volt)
1.	Open	Dry	220
2.	Close	Moist	0.05
3.	Close	Wer	0.03

3.4. Automatic Plant Watering Control Testing

The entire system was tested five times, each time in the morning, afternoon, evening, and night. The first test, conducted in the morning at 8:00 AM, produced a humidity level of 30%, indicating dry soil. At 10:00 AM, the humidity level was 37%, indicating dry soil, causing the solenoid valve to open and water the plants. The third test, conducted in the afternoon at 2:00 PM, produced a humidity level of 53%, indicating moist soil, causing the solenoid valve to close. The test in the afternoon at 5:00 PM produced a humidity level of 70%, indicating wet soil.The test in the evening at 7:00 PM produced a humidity level of 75%, indicating wet soil. This automation allows users to automatically water the plants even when the soil is dry.

Table 4. Automatic Plant Watering Control Testing

No.	Time	Soil Moisture Value (%)	Soil Condition	Water tank Condition	Selenoid Condition	Conditon	Display
1.	08.00 A.M.	30	Dry	According to Setpoint	Open	Plant Watering	

2.	10.00 A.M.	37	Dry	According to Setpoint	Open	Plant Watering	
3.	02.00 P.M.	53	Moist	According to Setpoint	Close	Plant Watering	
4.	05.00 P.M.	70	Wet	According to Setpoint	Close	Not watering	

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5.	07.00 P.M.	75	Wet	According to Setpoint	Close	Not watering	

The Blynk IoT monitoring interface shown in Figure 4 shows one solenoid indicator and two sensor parameters: a soil moisture sensor and an ultrasonic sensor detecting the water level in the reservoir. A red solenoid indicator indicates an open solenoid, and a white indicator indicates a closed solenoid. Below it is a water level indicator, where a value of 100 indicates the reservoir is full of water.

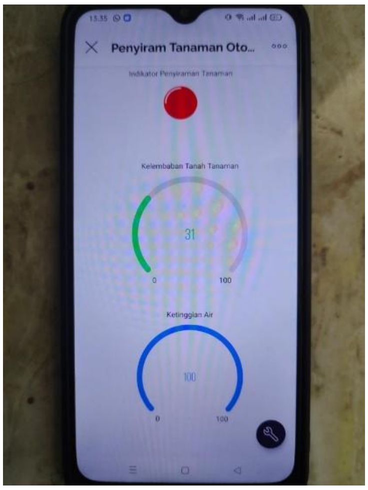

Figure 4. Blynk-Iot Automatic Watering System

Figure 5 shows the Prototype of Automatic Plant Watering Control Based on Internet of Things Using Blynk App .

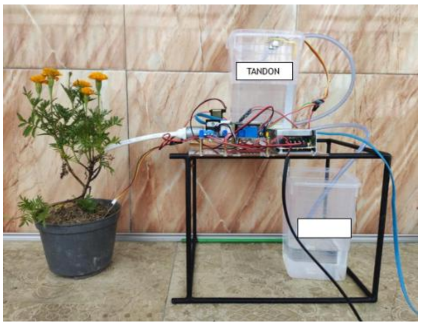

Figure 5. Prototype of Automatic Plant Watering Control

4. CONCLUSION

The overall research on the IoT-based Automatic Plant Watering Control system prototype performed as expected. The soil moisture sensor readings affected the water level in the water tank. If the water level in the tank was below the setpoint (10 cm), the DC motor pump would generate a higher voltage to fill the tank. If the water level in the tank was below the setpoint (10 cm), irrigation would not occur until the water reached 10 cm. The moisture sensor readings control the solenoid valve, which divides the soil moisture indicator into three categories. If the soil is dry (less than 38% of moisture indicator), the solenoid valve opens and waters the plants until the soil is wet (65% of moisture indicator). If the soil is wet (greater than 65% moisture), the solenoid valve closes, stopping watering. If the soil is damp (38%-65%), the solenoid valvo is not open. The soil moisture and watering indicators are displayed in the Blynk app..

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