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Ornamental Plant Watering System based on NodeMCU ESP8266 Microcontroller

Aodah Diamah, Muhammad Yusro, Aditya Putra Kurniawan
Electronics Engineering Education, Universitas Negeri Jakarta, Jakarta, Indonesia
adityapk48@gmail.com

***Abstract* — This study integrates the NodeMCU ESP8266, soil moisture sensor, water flow sensor, ultrasonic sensor LCD, and relay as a link between the pump and the microcontroller so that the pump can be controlled with a microcontroller. This study shows that the system can water ornamental plants automatically using a pump with a voltage of 12.02 VDC when the sensor detects dry soil conditions (<50%) and reads the water that comes out with the largest difference of 0.02 liters from the measurement results. In addition, plant conditions can be displayed on the user's Android and the system can also be controlled using Android.**

***Key words*: ESP8288, Ornamental plants, soil moisture sensor**

I. Introduction

Caring for plants is one of the hobbies of the Indonesian people. Ornamental plants are often found in the yard starting from the type, shape, color, and size. Ornamental plants can be used as decorations indoors or outdoors.

One of the ornamental plants that is often found is Aglaonema. This plant is included in the type of leaf ornamental plant group because it has a beautiful location on the leaves which have many color variants. This plant is very suitable to be placed on the terrace of the house. This plant lives in fairly moist soil conditions so that the watering process needs to be done correctly so that this plant can grow properly.

To get the growth and quality of beautiful and healthy ornamental plants is influenced by the levels of nutrients in the planting medium. In addition to nutrition, routine maintenance is also needed, in this case, the provision of water which functions to maintain the humidity level of the planting medium. Plants need enough water to grow properly. As explained in Waworundeng et al's research, it is explained that watering plants is a job that needs to be done by farmers and lovers of ornamental plants. It is important to irrigate with the appropriate volume of water as it will have a direct impact on the plant. [1]

With the development of current technology, the maintenance of ornamental plants can be made easier, especially in terms of keeping the planting media moist. To make it easier for humans to water ornamental plants, we can implement an automatic system that is able to control the activities of giving water to the planting media in a timely manner. So that humans can save time and effort because the provision of water is done automatically, which was previously done manually.

NodeMCU ESP8266 is one of the microcontrollers that can be used to make it easier for humans to care for ornamental plants besides using Arduino Uno, Atmega etc. The use of the NodeMCU ESP8266 was chosen in this study because it has a fairly small shape and a low price when compared to other microcontrollers such as Arduino. NodeMCU ESP8266 can also be used for IoT (Internet of Things) without the addition of other modules. The working principle of watering the plants will work automatically when the sensor detects the moisture of the planting media in dry soil, and the watering process will stop automatically when the soil planting media has reached the required humidity level.

II. Literature Review

[1] Watering System

The system can also be interpreted as a unit consisting of several sub-systems that are regularly arranged, interact with each other, and cannot be separated to achieve goals. [2]

Watering is the process of giving water when it is lacking, and throwing it away when it is excess. The amount of water given to plants depends on the types and elements of plants, tigers and soil conditions, soil processing, and climatic conditions. [3]

So from the understanding of the system that has been described, it can be concluded that the plant watering system is a system device consisting of several components put together into a unit that aims to treat or maintain plants so that they grow healthy and well, one of which is by regulating the process of providing water according to the needs on plants.

[2] Decorative plants

Ornamental plants are plants whose main function is to decorate. The decorative function is meant to give beauty and be attractive or can be enjoyed visually, both planted in the yard and in the room [3].

[3] Aglaonema

Aglaonema or more commonly known as Sri Fortune is one of the ornamental leaf plants. Its beautiful leaves have many color variants, causing this plant to get the title of the queen of ornamental plants. Algaonema can grow well in protected conditions with light intensity of 35-40% sunlight with humidity around 50% which is the ideal temperature mix is 25 °C during the day and 16-26 °C at night. [4]

This plant can grow well with an ideal soil moisture level in the range of 50-75%. [5]

[4] Soil Moisture Sensor

Soil moisture sensor is a humidity sensor that can detect the level of moisture in the soil. This sensor consists of two probes to pass current through the ground, and to read the humidity level can be done by reading the resistance. More water makes it easier for the soil to conduct electricity (small resistance value), while dry soil is very difficult to conduct electricity (high resistance value). [6]

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Fig. 1. Aglaonema

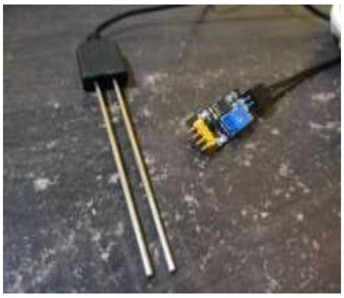

Fig. 2. Sensor Moisture Sensor

[5] Sensor Water Flow YF-S201

Water Flow Sensor is a sensor that has a function as a volume meter of flowing water in which the movement of the motor occurs which is converted into a liter unit value. This sensor consists of several parts, namely a plastic valve, a water rotor, and a hall effect sensor. When water flows through the rotor, the rotor rotates and the speed of the rotor corresponds to the flow of water entering through the rotor. The pulse signal from the rotor is received by the hall effect sensor for further processing on the microcontroller. The number of pulses generated per second is the frequency of the pulse signal. The pulse signal frequency can be found by the following formula:

Information: $f = 7 \times Q$
Q = water discharge (liters/minute)

Water discharge is the volume of water that flows every minute. The overall water discharge is the number of pulses generated multiplied by the volume of water flowing every minute for a pulse. [7]

Fig. 3. YF-S201 Water Flow Sensor

[6] Sensor Ultrasonik HC-SR04

Ultrasonic sensors are sensors that work using the principle of reflected ultrasonic sound waves which have frequencies above 20 Khz so that humans cannot hear them and are usually used to detect the distance of objects in front of them. Ultrasonic waves can propagate in solids, liquids and gases. This sensor consists of a series of ultrasonic transmitters called transmitters and ultrasonic receivers called receivers.

In this test the ultrasonic sensor is used to find the water level in the bucket which will later be used in the formula for the volume of the tube with the formula

$$V = \pi \, x \, r^2 \, x \, t$$

V = Volumes
π = 22/7 or 3.14
r = 15.25 cm (diameter of the bucket)
t = ultrasonic sensor reading

Fig. 4. Ultrasonic Sensor HC-SR04

[7] NodeMCU ESP8266

NodeMCU is an open source IoT platform. It consists of hardware in the form of the ESP8266 System On Chip from ESP8266 made by Espressif System, as well as the firmware used, which uses the Lua scripting programming language. However, NodeMCU has packaged the ESP8266 into a compact board with various features such as a microcontroller + Wi-Fi access capability as well as a USB to serial communication chip. So to program it only requires a USB type B data cable extension.[8]

Fig. 5. NodeMCU ESP8266

[8] LCD (Liquid Crystal Display)

LCD (Liquid Crystal Display) is a type of display media that uses a crystal as the main viewer. LCD consists of layers of

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liquid crystal layers between two glass pallets. Transparent film that can conduct electricity or backplan, placed on the back sheet of glass. The transparent portion of the electrically conductive film on the outside of the desired character is superimposed on the palette front. When there is a voltage between the segment and the back plan, this current-carrying portion changes the transmission of light through the area under the film segment. [9]

Fig. 6. LCD 2x16

[9] DC pump

The pump is a tool that is used to drain water in a certain discharge by sucking water and then the water is released in a different channel on the pump. The pump operates on the principle of creating a pressure difference between the suction and compression sections. The difference in pressure results from a mechanism such as the rotation of the impeller wheel which makes the suction contents almost vacuum. The difference in scientific pressure sucks liquid so that it can move from one reservoir to another. [10]

Fig. 7. 12 VDC Pump

[10] APP Inventor

App Inventor is an open-source web-based system that was originally provided by Google, and is now managed by the Massachusetts Institute of Technology (MIT) and is used to create an application program on Android. App Inventor is very easy to use because in the process of making simple applications it can be done without having to learn or use too many and difficult programming languages.

Fig. 8. App Inventors

[11] Google Firebase

Firebase Realtime Database is a feature that provides a NoSQL database that can be accessed in real time by application users. Firebase Realtime Database is a cloud database where data is stored in JSON format and synchronized in real time to every connected user. a firebase database can be created by importing a JSON file into the Firebase console, or it can also be created directly through the Realtime Database console page manually. [11]

Fig. 9. Firebase

[12] Blok Diagram

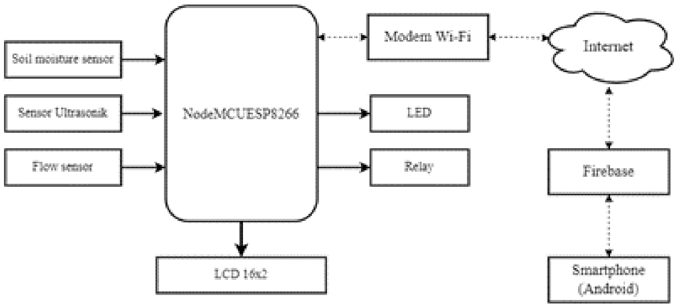

Fig. 10. System Block Diagram

III. Research Method

The method used in this research is research and development (Research and Development) by Borg & Gall. The Borg & Gall research and development method consists of 10 stages. The method used in this study only carried out 4 stages, namely the data collection stage, the design stage, the development stage, and the testing stage.

IV. Result and Discussion

A Tool View

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Fig. 11. Front View of the Tool

B Android View

Fig. 12. Display Android

C Reseacrh Data Analysis

1. Soil Moisture Sensor Testing

Data obtained from the results of testing the soil moisture sensor used in this study can be seen in TABLE I

TABLE I. SOIL MOISTURE SENSOR TESTING

No	Soil Condition	Criteria	Sensor Readings	Pump Condition
1.	Dry	<50%	40%	On
2.	Moist	50-75%	61%	Off
3.	Wet	>75%	78%	Off

As shown in TABLE I, when the sensor reading is 40%, it is included in the dry soil criteria with a criterion value of <50% and the pump condition is on. When the sensor reads a value of 60%, it is included in the criteria for moist soil where the value is 50-75% and the pump is off. When the sensor reads the soil moisture value at a value of 78%, it is included in the criteria for wet soil where the value is > 75% and the pump is off.

2. *YF-S201 Water Flow Sensor Testing*

The following data obtained from the results of testing the water flow sensor obtained by researchers can be seen in TABLE II

TABLE II. WATER FLOW SENSOR TESTING TABLE

Condition	Test	Sensor Readout (Liters)	Measurement Result (Liters)	Difference (Liters)
	1	0.48	0.48	0.00
	2	0.48	0.49	0.01
Pump On	3	0.49	0.50	0.01
	4	0.49	0.47	0.02
	5	0.48	0.48	0.00

In TABLE II it can be seen that the water flow sensor test has been carried out 5 times and the biggest difference from the sensor reading results with measurements is 0.02 Liter.

3. *HC-SR04 Ultrasonic Sensor Testing*

The following table shows data from the results of ultrasonic sensor testing used in research on automatic ornamental plant watering systems based on the NodeMCU ESP8266 microcontroller

TABLE III. TESTING OF THE HC-SR04 ULTRASONIC SENSOR

No	Water Height (cm)	Measurement (cm)	Sensor reading (cm)	Calculation result (Liters)	Result of reading (Liters)	Difference
1.	< 8	7,3	7	5,3	4	0,7
2.	8 – 20	13,5	13	9,8	9	0,8
3.	> 20	26	19,7	19,7	18	1,7

In TABLE III it can be seen that the sensor can read the height of the water which will later be used to find the volume of water in the bucket using the cylinder volume formula.

4. *Water Pump Testing*

Data obtained from the results of testing the water pump used in this study can be seen in TABLE IV

TABLE IV. WATER PUMP TESTTING

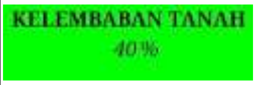
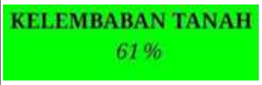
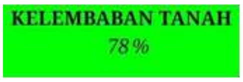
No	Condition		Results	Pump Vout (VDC)	Vout NodeMCU (VDC)
1	Order Via App	ON button pressed	Pump On	11.85	3.12
		OFF button pressed	Pump Off	0.37	0.06
2.	Soil Condition	Dry	Pump On	12.02	2.96
		Moist	Pump Off	0.34	0.01
		Wet	Pump Off	0.29	0.04

In TABLE VI it can be seen that when the pump is active when the ON button is released the voltage is 11.85 VDC and when the pump is activated automatically with a voltage of 12.02 VDC.

5. *Soil Moisture Display Test*

The following data obtained from the results of testing the display of soil moisture obtained by researchers can be seen in TABLE V.

TABLE V. SOIL MOISTURE DISPLAY

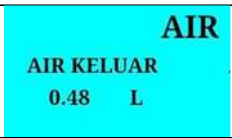
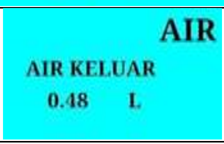
No	Soil Moisture Reading Value Criteria	Sensor reading results	Appearance
1.	Read dry land (<50%)	40%	
2.	Read moist soil (50 – 75%)	61%	
3.	Wet soil reading (>75%)	78%	

In TABLE V testing the soil moisture display, it can be seen that the value displayed on the display on Android is the same as the result of the soil moisture sensor reading.

6. *Testing the Display of the Amount of Water Out*

TABLE VI is the data obtained from the results of testing the appearance of water coming out on Android used in an automatic ornamental plant watering system based on the NodeMCU ESP8266 microcontroller

TABLE VI. EXIT WATER DISPLAY TESTING

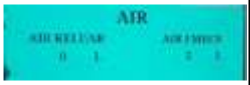
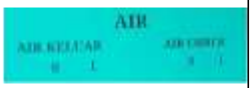
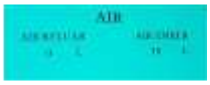
No	Test	Results Display Water Out	Display Results on Android
1.	First	0,48 L	
2.	Second	0,48 L	
3.	Third	0,49 L	
4.	Fourth	0,49 L	
5.	Fifth	0,48 L	

In TABLE VI it can be seen that the display of the amount of water that comes out on Android is the same as the amount of water that comes out that is read by the water flow sensor when the system works to water the plants.

7. *Remaining Water Volume Display Test*

TABLE VII is the data obtained from the results of testing the remaining water volume display on the android used in the automatic ornamental plant watering system based on the NodeMCU ESP8266 microcontroller.

TABLE VII. REMAINING WATER VOLUME DISPLAY

No	Test	Remaining Water	Display On Android
1.	First	5 L	
2.	Second	9 L	
3.	Third	18 L	

As seen in TABLE VII, the display test has been carried out, where the result is that the amount of water remaining in the bucket can be displayed properly on the Android user.

8. *System Control Button Testing*

TABLE VIII is the data obtained from the results of testing the control button on Android used in an automatic ornamental plant watering system based on the NodeMCU ESP8266 microcontroller

TABLE VIII. SYSTEM CONTROL BUTTON TESTING SYSTEM CONTROL BUTTON TESTING

No	Application Display State	Pump Condition	Display On Android
1.	ON button pressed	On	
2.	OFF button pressed	Off	

In TABLE VIII it can be seen that when the ON button on the application is pressed, the appearance on Android also changes and the pump condition will turn on, and so also when the OFF button on the application is pressed, the display will also change and the pump condition will turn off.

V. CONCLUSION

The automatic ornamental plant watering system based on the NodeMCU ESP8266 microcontroller has been successfully

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carried out through the designed, built, and tested stages. From several stages in this study it can be concluded that:

1. The design of an ornamental plant watering system based on the NodeMCU ESP8266 microcontroller can be realized.
2. The system can display the results of sensor readings used in real time.
3. The system can be controlled using an application on an Android user connected to the internet network.
   The system can perform the watering process automatically or manually by using a button on the Android application.

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