AUTOMATIC WATERING AND FERTILIZING WITH MICROCONTROL WEMOS D1 R2 BASED ON IoT (Internet of Things).pdf

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AUTOMATIC WATERING AND FERTILIZING WITH MICROCONTROL WEMOS D1 R2 BASED ON IoT (Internet of Things)

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Abstract

Watering and liquid fertilization carried out by plant owners are still manual, where the owner's involvement in these two things requires a long free time until the plants are wet and adequate fertilization is achieved. In other conditions, more attention to the survival and maintenance of plants through watering and fertilization is an absolute necessity so that plants do not wilt easily and eventually die. A solution for watering and fertilizing liquids is automatically offered through the design of watering and fertilizing liquids with a microcontroller as a control center based on Internet of Things communication. The tool is designed to automatically water and fertilize plants and generate a remote monitoring system for soil moisture using the Thinger.Io application. The method used in realizing this design includes several stages, namely system block diagram planning, electrical and mechanical system planning, software design and system testing to prove the tool can work properly according to the initial design. Supporting components for controlling watering and liquid fertilization using Wemos D1 R1, Capacitive soil moisture sensor as a soil moisture sensor, Real-Time Clock (RTC) module as a fertilizer timer. Relay that functions as a switch to turn the pump on and off. The results of the performance of the designed tool can do watering automatically when the soil moisture level is below 20% and will stop when the soil moisture is more than 40%. Meanwhile, liquid fertilization will automatically work according to a predetermined time. The existing monitoring system is accessed using smartphones and computers with the help of the thinger.io application as long as the device is connected to the internet network. Meanwhile, liquid fertilization will automatically work according to a predetermined time. The existing monitoring system is accessed using smartphones and computers with the help of the thinger.io application as long as the device is connected to the internet network. Meanwhile, liquid fertilization will automatically work according to a predetermined time. The existing monitoring system is accessed using smartphones and computers with the help of the thinger.io application as long as the device is connected to the internet network.

Keywords: Ornamental Plants, Automatic Watering and Fertilizing, Monitoring, Internet of Things. Thinger.io

1. INTRODUCTION

Currently, watering and liquid fertilizer application by plant owners are still done manually [1]. The characteristics of watering and semi-manual fertilization based on humidity data can be done with data processing accuracy and scheduled. [2] Manual watering by someone has to hold a hose to water the plants one by one and then have to wait until all the plants are wet, as well as the fertilization method, someone has to bring a container filled with liquid fertilizer and give it one by one to the plants [3]. can be done easily by a plant owner with his spare time. On the other hand, there will be a problem with the wilting and death of the plant due to insufficient care, especially for soil moisture and fertilizer needs. The ideal condition of soil moisture obtained with regular watering is in the range >700 and liquid fertilization is conditioned with a regular schedule. Another consideration of manual watering must pay attention to 2 important things, namely when and how much water and fertilizer plants receive. [4] Automated systems can be used to help do routine work because they can run continuously without knowing the time. This technology can also make it easier for someone to carry out plant care, especially in automatic watering [4][5.] and scheduled liquid fertilization. Automatic watering works based on information about soil moisture obtained from the soil moisture sensor [6] with a set point in the range > 700, and watering will stop when the soil on the plants is wet with a set point humidity value in the range <650 [7]. Meanwhile, scheduled liquid fertilization can be controlled by setting the time according to plant needs. Furthermore, the automated design of a scheduled watering and liquid fertilization becomes an absolute necessity for plant owners by monitoring at any time without taking up their spare time.[8]

Internet of Things is also known by the abbreviation IoT [9],[10]. IoT is a concept that aims to expand the benefits of continuously connected internet connectivity [11]. [12], Having the ability to communicate to transmit data or send data that is designed to work independently without the role of computers and humans [11]. IoT is also used for collecting data from sensors and received by the server for analysis [13]. Until now, the development of IoT can be seen from wireless technology [14], [15], internet, and QR (Quick Responses) Code, [16], even IoT is also used in communication in the form of RFID (Radio Frequency Identification) [17], [18] for many applications. As an example of the use of health IoT, IoT is used to assist in the process of recording heart rate data, measuring body sugar levels, checking body temperature[19], and so on. In the energy field, IoT is used to reduce the problem of energy waste [20.], pollution, and pollution [21] by applying related sensors to provide data and control it. The use of IoT can also be applied in the field of transportation and the environment. In the field of transportation, IoT is used to break down congestion, reduce the risk of accidents and reduce violations by providing accurate information to road users, [22], [23]. Furthermore, in the environmental field, IoT can be used for human activities, pet supervision, plant monitoring, quality processing. water and so on. [24] In general, the benefits of IoT can be seen in several ways, first, facilitating the connectivity process, secondly, achieving efficiency, and thirdly increasing the effectiveness of monitoring activities. [

Thinger.io is a cloud IoT Platform that provides every tool needed to prototype, scale and manage connected products in a very simple way, [25] This research applies automatic control of scheduled liquid watering and fertilization with a wemos D1 R2 microcontroller based on the Internet of Things system which is designed to monitor soil moisture [26] and send message notifications remotely [27]. The humidity value generated by the Soil Moisture Sensor will be sent in the form of percentage value data and will be displayed by the Smartphone using the thinger.io application. Thinger.io will only display the humidity sensor value data in real-time sent by the microcontroller when the system is working (ON). This tool can monitor the value of moisture in the soil anywhere even though it is in a remote state and when the system is connected by the internet network, [28]. The final result of the design is intended to automatically water and fertilize plants and produce a remote monitoring system on soil moisture using the Thinger.Io application.

2. Methodology

Figure 1 is the process flow of the research method to realize the design of the Capacitive Soil Moisture sensor and RTC application for automatic watering and fertilization which includes block diagram design and System Flowcharts, electrical system design, mechanical system design, software design, and system testing.

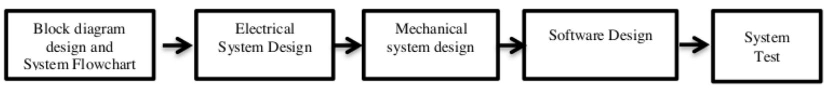


Figure 1. The flow of the research method process

a) Block diagram design and System Flowchart

The design of the block diagram is intended to facilitate the analysis of the component requirements needed in the realization of the intended application design. The designed system block diagram also simplifies the workflow in the form of a flowchart (figure 3) and makes it easier to identify errors when the system is not working.

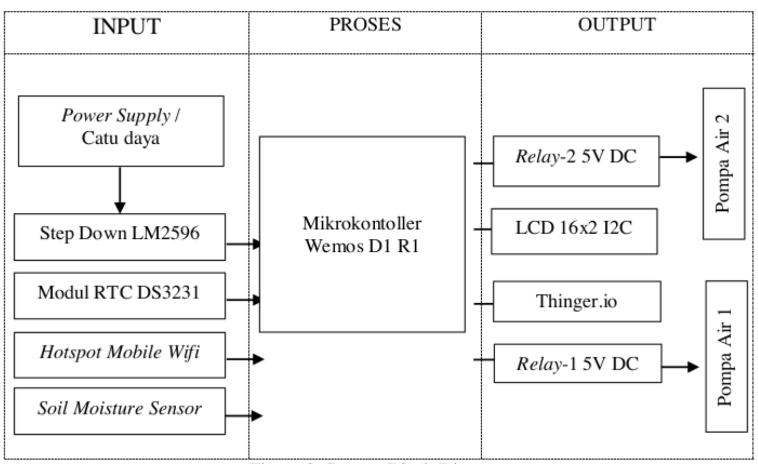
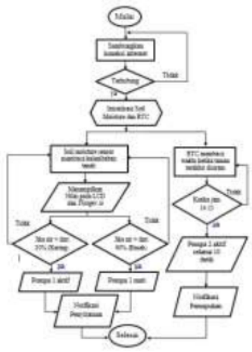


Figure 2. System Block Diagram

Figure 2 is a block diagram as a whole consisting of, first, an input block which has 4 inputs; Hotspot/Wifi as system input serves to divide the wifi network to Wemos D1 R1 so that it can connect to Thinger.Io, Soil moisture sensor to detect soil moisture and RTC (Real Time Clock) system input module as a scheduling function to store time data. Second, the process block, is the Wemos D1 R1 Microcontroller as the controller or the main brain of the electronic circuits used. The input will then be processed by Wemos and will be forwarded to the system output, third; block output, namely 4 outputs in the form of relay 1 will activate and deactivate pump motor 1 for watering, while relay 2 will activate and deactivate pump motor 2 for fertilization,



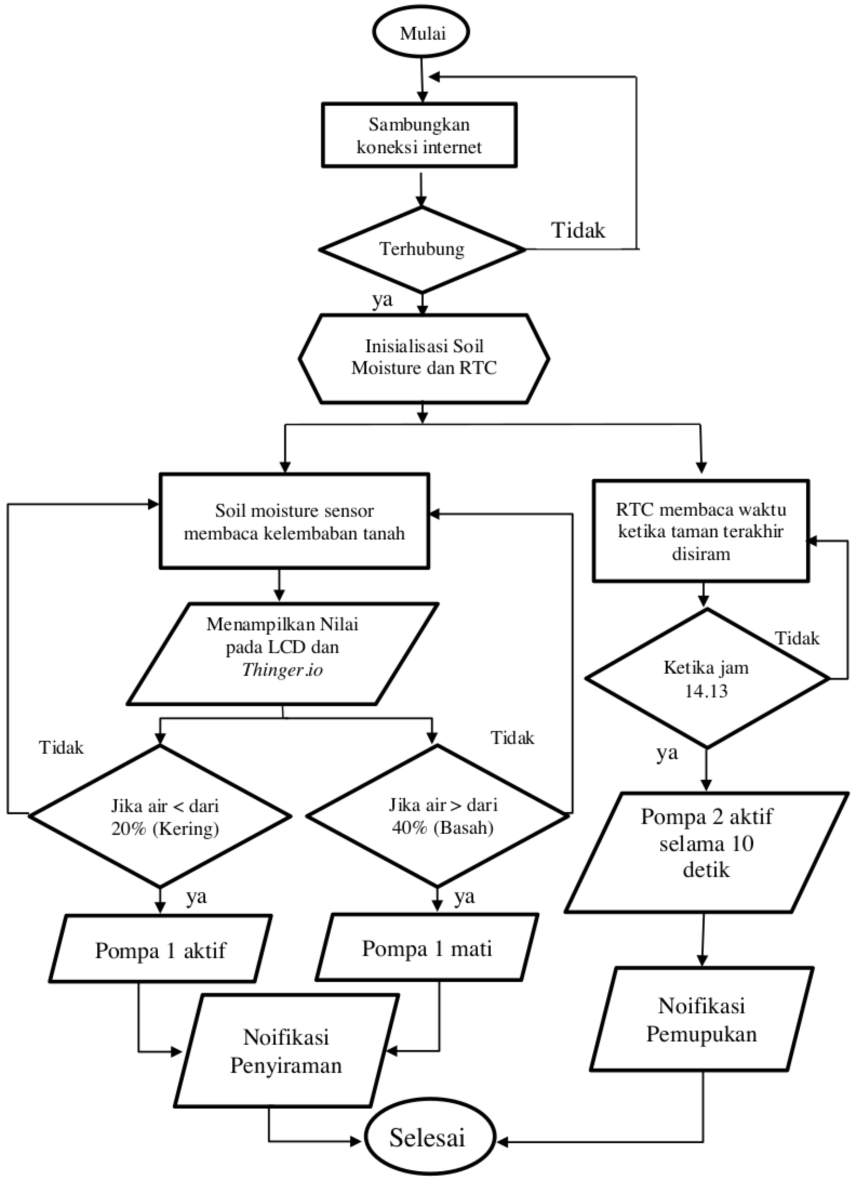


Figure 3. System Flowchart

Figure 3 is a flowchart that explains how the system works as a whole, if the internet is connected to the Wemos D1 R1 microcontroller, simultaneously the Soil Moisture Sensor detects soil moisture, then the results will be displayed on the 16x2 LCD and the Thinger.io application. Then if the soil moisture sensor detects a soil moisture level of less than 20% or in dry conditions, relay 1 will turn on pump 1, until the soil moisture sensor detects a moisture level of more than 40% or in wet soil conditions and if the soil moisture has reached more than 40%, then relay 1 will turn off the pump automatically. As for the fertilization system, the DS3231 RTC (Real Time Clock) module will turn on pump 2 for 10 times via relay 2 based on a predetermined fertilization schedule. Next up is Thingers. io will work if the system is always connected to the internet. Thinger.io will read the value from the sensor in real-time and will display it on the thinger.io dashboard which can be accessed via smartphones and computers.

b) Electrical System Design

There are several stages for making a hardware circuit, namely making a schematic of the circuit using fritzing software, making tool designs, determining the installation layout of each component.

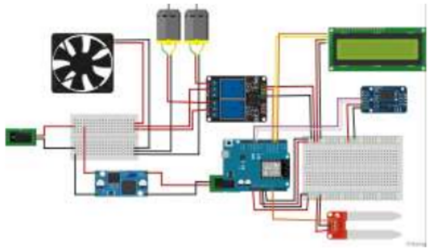
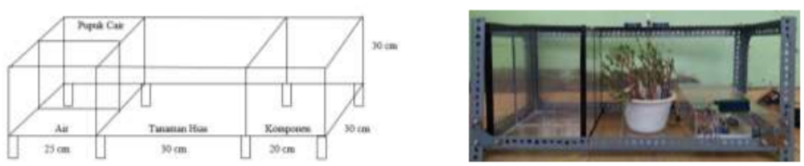


Figure 4 Automatic Watering and Fertilizing Control Circuit

Figure 4 is an automatic watering and fertilization control consisting of wemos D1 which acts as the brain to control the analog input process A0, digital inputs D4, D5, D14 (SDA) and D15 (SCL), soil moisture sensor as a soil moisture sensor serves to detect humidity ground and conditions the relay on pump 1 to Normally Open (NO) or Normally Closed (NC). The DS3231 RTC module will condition the relay on pump 1 to be Normally Open (NO) or Normally Closed (NC) according to the specified schedule. The results of the sensor readings will then be displayed on Thinger.io for remote monitoring and a 16x2 LCD for close-up monitoring.

c) Mechanical system design



(a) (b)

Figure 5. Tool mechanical design and tool realization

Figure 5(a) The framework design measures 75 cm long, 30 cm wide, and 35 cm high. The mechanical design of this tool is done with the original scale of the size of the components needed, to simplify the process of making and assembling the tool as a whole. Figure 5 (b) realization of a mechanical system in the form of a hollow angled iron that is interconnected with one another.

d) Software Design

Is the process of making a software system or programming process using Arduino IDE software and a monitoring system using thinger.io. first, Arduino IDE to write and load programs to the microcontroller, second Thinger. Io to display value data sent by the microcontroller and can be accessed by smartphones or computers.

e) System Test

In testing the application system for watering and fertilization consisting of: testing the power supply, testing the control circuit components determine the voltage at the terminals, testing the function of the Capacitive soil moisture sensor as a soil moisture sensor, and the Real-Time Clock (RTC) module as a fertilization scheduler.

3. Results and Discussion

a) Electrical Circuit Testing

To prove this tool works well according to the plan, then testing is done. The tests carried out were testing the power supply, step down LM2596, Wemos D1 R1, soil moisture sensor, relay, 16x2 LCD, RTC, and monitoring display on the Thinger.io application.

Table 2. Testing of Control Circuit Components

No	Test	Voltage	
		Measurement results	Actual Results
1	Input Power Supply	205V AC	220V AC
2	Power Supply Output	12.06V DC	12V DC
3	Input Step Down LM2596	12.06V DC	12V DC
4	Output Step Down LM2596	9.02V DC	9V DC
5	Wemos D1 R1	8.98V DC	9V DC
6	Capacitive Soil Moisture Sensor	4.95V DC	5V DC
7	Relay (Normally Open)	4.95V DC	5V DC
8	Relay (Normally Close)	4.63V DC	5V DC
9	LCD 16x2 I2C	4.78V DC	5V DC
10	RTC Module	5V DC	5V DC

Table 2 contains the results of voltage measurements on each component. The difference in the measurement results with the actual results for each component is still within tolerance and is still by the datasheet of each component.

b) Automated Watering Test

This test is done by placing the soil moisture sensor in a pot containing ornamental plants. When the soil moisture sensor detects the soil condition is less than 20% or in dry condition, then pump 1 will be active to carry out watering and if the soil condition is more than 40% or in wet condition, the pump will stop watering automatically. This test is carried out to determine whether the watering system can work well or not.

(a) (b)

Figure 7. (a) Automatic Watering On When Soil Humidity is Below 20% (b) LCD Display During Watering

Figure 7 (a) The watering process is active when the soil moisture sensor is active or the soil moisture reading is below 20%, it can be seen in the photo of the watering faucet flowing water from pump 1 which is turned on by relay 1. Figure 7 (b) LCD display when the soil moisture sensor reads the soil moisture value, the soil moisture sensor will always display the moisture value generated by the sensor.

c) Automatic Fertilization Testing

This test is carried out by flowing liquid fertilizer into ornamental plant pots automatically according to the fertilization schedule that has been set on the RTC Module. When the time that has been set on the RTC Module shows the fertilization schedule, then pump 2 will be active for 10 seconds for fertilizing.

d) Monitoring Testing Using the Thinger.io App

This test is carried out to find out whether the monitoring process on the thinger.io application can run well or not. As long as the system is connected to an internet connection, the thinger.io application can remotely monitor the results of the soil moisture sensor values at any time.

Figure 8. Monitoring soil moisture (a) water content value, (b) soil (c) soil condition (d) notification of watering process

Figure 8 (a) shows the results of monitoring soil moisture on the thinger side. io where the value displayed is the reading of the capacitive soil moisture sensor. Figure (b) shows the graph reading of soil moisture in real-time. Figure (c) shows the soil moisture condition with "WET CONDITION" after watering. Figure 8 (d) shows a notification of the watering process with "Watering is being done.

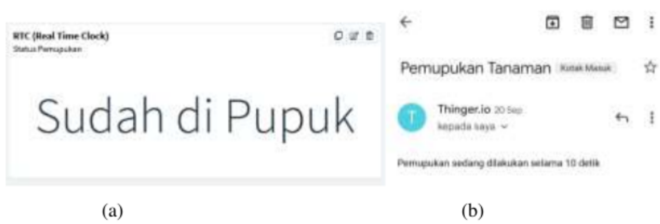


Figure 9. Monitoring of Fertilization (a) Fertilization conditions (b) notification of fertilization results

Figure 9 (a) shows the monitoring of fertilization status with "Already Fertilized" after fertilization has been carried out. Figure 9 (b) monitoring of fertilization with “Fertilization is being carried out for 10 seconds”.

4. Discussion

Controlling this automatic watering and fertilizing tool, using Wemos D1 R1 as the controller or the main brain of the electronic circuits used, this Wemos D1 R1 has Input as input and Output as output that can control electronic components and equipment. As input, a soil moisture sensor is used as a soil moisture sensor, Real-Time Clock (RTC) module is used as a timer. While the output consists of a relay that functions as a switch to disconnect and connect the pump in flowing liquids to plants, a liquid crystal display (LCD) to display the value of the soil moisture sensor, and Thinger.io for monitoring the results of the sensor value reading. remotely using mobile phones and computers.

The work of the watering and fertilizing tool automatically on this ornamental plant, when the system is turned on, the Wemos D1 R1 will connect to the *Wifi/Hotspots,* then *soil moisture sensor* detect the level of moisture content in the soil or read soil moisture. Then the result of reading the sensor value will be displayed by *liquid crystal display* (LCD) in the form of a percentage value of soil moisture. The way the water pump works for watering here is to do watering automatically based on the level of soil moisture, if the soil moisture level is less than 20% or in a dry state, then the water pump 1 will turn on and flow water to the plants and when the soil moisture level reaches 40 % or already in a wet condition, then the water pump 1 will automatically stop.

How it works for automatic fertilization, programming the time for fertilization on Arduino IDE. When the RTC reads at the specified time, pump 2 will automatically start according to the program that has been set for the fertilization time on the Real-Time Clock (RTC) module on the Arduino IDE, then relay 2 will turn on pump 2 for 10 seconds to give liquid fertilizer.

The test results from this monitoring system as long as the tool is always connected to the internet, the thinger.io application can monitor the results of the soil moisture sensor values and fertilization conditions using the thinger.io application at any time and remotely. On the thinger.io dashboard, the author uses a donut chart, a time series chart to display real-time values from the soil moisture sensor, and text/value to display text from soil moisture conditions and fertilization conditions in the form of text that has been fertilized or not. If the watering and fertilization system is running, the next thinger is. For further research, you can add a remote control so you can activate and deactivate the device using the application, as well as add a message notification to provide an indicator as a sign and there is no water and fertilizer in the reservoir.

5. Conclusion

The design of the automatic watering and fertilization device was built using the Wemos D1 R1 microcontroller, with a capacitive soil moisture sensor, the RTC DS 3231 module as input and relay, DC water pump, LCD, and thinger.io as output. The monitoring system for soil moisture values, which is displayed by smartphones through the Thinger.io application in the form of real-time value readings, can work well.

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State a clear claim/topic sentence and stay focused on supporting it.

MEETS EXPECTATIONS	A precise claim/topic sentence based on the historical topic and/or source(s) is present. The response maintains a strong focus on developing the claim/topic sentence, thoroughly addressing the demands of the task.
APPROACHES EXPECTATIONS	A claim/topic sentence based on the historical topic and/or source(s) is present, but it may not completely address the demands of the task, or the response does not maintain focus on developing it.
DOESN'T MEET EXPECTATIONS	The claim/topic sentence is vague, unclear, or missing, and the response does not address the demands of the task.

EVIDENCE

Represent relevant historical information accurately.

MEETS EXPECTATIONS	The most appropriate evidence is presented to support the topic sentence, and all information is historically accurate.
APPROACHES EXPECTATIONS	Appropriate evidence may be presented to support the topic sentence, but it may be inadequate or contain some historical inaccuracies.
DOESN'T MEET EXPECTATIONS	Evidence is general, inappropriate, or inadequate in support of the topic sentence, or is largely inaccurate.

DEVELOPMENT

Explain how evidence supports the topic sentence.

MEETS EXPECTATIONS	The response demonstrates reasoning and understanding of the historical topic and/or source(s), and sufficiently explains the relationship between claims and support.
APPROACHES EXPECTATIONS	Some reasoning and understanding of the historical topic and/or source(s) are demonstrated. The response attempts to explain the relationship between claims and support.
DOESN'T MEET EXPECTATIONS	The response does not demonstrate reasoning and understanding of the historical topic and/or source(s), and explanation of the relationship between claims and support is minimal.

ORGANIZATION

Present ideas in a logical structure that shows the relationships between ideas.

MEETS EXPECTATIONS	An effective organizational structure enhances the reader's understanding of the information. The relationships between ideas are made clear with effective transitional phrases.
APPROACHES EXPECTATIONS	An organizational structure is evident, but may not be fully developed or appropriate. Transitional phrases may be used but the relationships between ideas are somewhat unclear.
DOESN'T MEET EXPECTATIONS	An organizational structure is largely absent and the relationships between ideas are unclear.

LANGUAGE

Communicate ideas clearly using vocabulary specific to the historical topic.

MEETS EXPECTATIONS	Ideas are presented clearly, using vocabulary specific to the historical topic. If errors in conventions are present, they do not interfere with meaning.
APPROACHES EXPECTATIONS	Ideas are mostly clear, using some vocabulary specific to the historical topic. Some errors in conventions are present that may interfere with meaning.
DOESN'T MEET EXPECTATIONS	Ideas are not clear, using little to no vocabulary specific to the historical topic. Several errors in conventions interfere with meaning.