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# DESIGN OF AUTOMATIC WATERING SYSTEM FOR JASMINE FLOWER ORNAMENTAL PLANTS USING IOT-BASED MICROCONTROLLER

**Hartesa Osi[1], Ali Nurdin[2], Suroso[3]**
[1,2,3] Program Studi Teknik Telekomunikasi, Politeknik Negeri Sriwijaya
Email: hartesa0901@gmail.com[1], aalinurdin67@gmail.com[2], suroso@polsri.ac.id[3]

Corresponding Author: aalinurdin67@gmail.com

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**Abstract**

The rapid development of information technology has provided convenience in various aspects of human life, including in the fields of agriculture and ornamental plant care. One of the technologies that is currently developing is the Internet of Things (IoT), which allows the integration of physical devices with internet networks to automate and monitor in real time. This study aims to design and build an automatic watering system for jasmine ornamental plants based on a microcontroller using the Arduino IoT Cloud platform. This system is designed to help homeowners care for ornamental plants more efficiently, especially in terms of watering which has so far been done manually. With the help of soil moisture and temperature sensors, this system can monitor the environmental conditions of plants and water them automatically as needed. Through the Arduino IoT Cloud application that can be accessed via smartphone, users can also monitor and control the system remotely. It is hoped that this system can overcome the limitations in manual plant care, as well as increase the effectiveness and efficiency in maintaining the health of jasmine ornamental plants.

Keywords: ***Internet of Things, Arduino IoT Cloud, automatic watering, jasmine flowers, soil moisture sensor, microcontroller.***

## INTRODUCTION

The development of technology in today's era is very rapid and very fast. In the development of technology in this era of globalization, it is very helpful and provides many benefits in the sustainability of supporting human life. [1] The convenience offered by each technology product seems to have confirmed the expression of the world in the palm of your hand. Armed with a smartphone the size of a hand, there is a lot of information that can be owned. This can only be followed by its development using information literacy mastery that supports information literacy technology. The advancement of information technology has been widely applied in government institutions or private companies and institutions, one of which is utilizing the Internet of Things (IoT).

With the rapid development of technology, IoT has also begun to develop and can be used to help various human activities and tasks at home, office, road, school and others. IoT is not limited to the industrial context, but can also be used for daily needs, such as home voice control, doorbells, smart lights, room pollution monitors, and so on [2], One of the applications of technological developments and the Internet of Things is in the Arduino IoT application.

Arduino IoT Cloud as one of the applications for controlling IoT devices, claims to be able to cover some of the shortcomings of other applications. Arduino IoT is a cloud-based application and encryption tool. As a real-time IoT device control application, Arduino IoT Cloud provides easy access for users because it is available on both mobile and desktop platforms. On the mobile platform, Arduino IoT can be used on the iPhone, Android, and Windows Phone platforms, while on the desktop platform Arduino IoT does not provide a native application, but users can still access IoT device control via the Arduino IoT Web Dashboard using a browser on the Windows, Linux, and Mac OS platforms. For example, there is automation of watering jasmine ornamental plants based on the Internet of Things (IoT).

Watering is one of the important factors in the growth of jasmine ornamental plants. The success that occurs in the growth system will be achieved if the watering time and soil moisture are regulated in jasmine ornamental plants. Water in the soil always carries nutrients in its solution to replace water lost due to evaporation that occurs

in the soil and transpiration from plants. This automatic watering system uses a soil moisture sensor and a temperature sensor to detect dry soil conditions, as well as an ultrasonic sensor to measure the water level in the watering tank. Thus, this system can ensure timely and efficient watering, optimizing the growing conditions of ornamental plants [5]. One of the factors in the growth and development of plants is the watering process. Watering can maintain and care for plants so that they grow well. The need for sufficient water is very important for plants. So it is necessary to monitor the watering process to ensure that watering runs optimally. There are several things that must be considered in monitoring plant watering, including soil moisture and air temperature.

Plants are one of the living things that need water for their development. Fertile soil is one of the requirements for plants to grow well. The level of fertility can be influenced by the intensity of the water it contains. For that, the temperature and humidity of the soil need to be maintained. Each plant has a different temperature and humidity,

Based on current research, there are still many people who water ornamental plants manually, one of which is in my own place. Watering ornamental plants in polybags or in the yard is still done manually or using human power such as watering using buckets and watering cans. With the development of the times, technology is getting more sophisticated, there are many ways that can be done to water ornamental jasmine plants, one of which is to use a Smartphone connected to the internet, of course the Smartphone has an application installedArduino IoT Cloudwhich is used to monitor the condition of ornamental plants.

## LITERATURE REVIEW

### Jasmine Flower Ornamental Plants

Jasmine ornamental plants are a type of plant that is cultivated for the beauty of its flowers, both in terms of color, shape, and aroma, and are usually used to beautify the environment such as gardens, yards, or rooms. One example of a popular ornamental flower plant is jasmine, which is known for its fragrant aroma and graceful appearance.

Jasmine flowers should be watered every day because water is essential to support their life processes, such as photosynthesis, nutrient absorption, and maintaining soil moisture so that roots can grow well. Regular watering helps jasmine flowers stay fresh, not wilt, and are able to produce fragrant and beautiful flowers consistently. Without sufficient watering, jasmine flowers can become stressed, wilt, and are at risk of dying from lack of water.

To facilitate maintenance, an automatic watering system was built which can be used so that plants receive water regularly and efficiently without relying on manual watering. With automatic watering, soil moisture can be maintained consistently, water is not wasted, and jasmine flowers continue to grow healthily even though the owner is busy or often travels.

Jasmine flowers are also a commodity with high economic value, their use is not only as ornamental potted and garden plants, but also as tea fragrances, raw materials for the perfume industry, cosmetics, traditional medicine, grave flowers, room decorations, wedding decorations, and accessories in traditional ceremonies.[3]

**Jasmine Flower Picture [3]**

### Internet of Things (IoT) in Automatic Watering Systems

Internet of Things (IoT) is a concept where devices for watering plants are automatically controlled and monitored using sensors and internet connectivity. These systems typically consist of soil moisture, temperature, and weather sensors that collect data in real-time, then send it to a cloud platform or microcontroller (such as Arduino or Raspberry Pi) for analysis.

Based on the data collected, the system can activate or deactivate the water pump or irrigation valve according to the needs of the plants. Some IoT systems can also be integrated with smartphone applications or web-based dashboards, allowing users to monitor and control watering remotely. Automatic watering is a modern watering technique without using human objects as the main role.[4]

**NodeMCU**

NodeMCUis an ESP8266-based microcontroller equipped with Wi-Fi connectivity, which is often used in various Internet of Things (IoT) applications. In the automatic watering system for plants, NodeMCU plays a very important role in connecting hardware such as soil moisture sensors, water pumps, and controller applications on the IoT platform to automate watering.

***Figure 2 MCU Node***

**DHT22 Temperature and Air Sensor**

The temperature and humidity sensor used in this jasmine flower research is the DH122 sensor which has three terminals, namely GND, VCC, and Vout. The GND and VCC terminals are connected to a voltage divider circuit with a 7805 regulator IC, while the Vout terminal which is a data terminal is connected to the Al input pin on the Arduino Uno Board[6]. so that the IoT-based microcontroller can determine the time and watering needs precisely based on the environmental conditions around the plant.

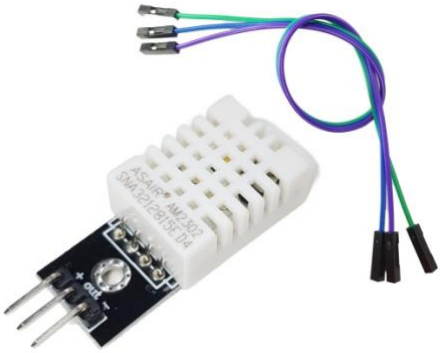

***Figure 3 DHT22 Sensor[6]***

The DHT 22 sensor operates in a temperature range between 40 °C and 80 °C, has an accuracy of + 0.5 °C and humidity between 0-100%.**[6]**

**Soil Moisture Sensor**

The function of Soil Moisture is tomeasuring the moisture and water content of the planting substrate is called a soil moisture sensor. In general, these sensors operate by providing power to both plates. Electrons leave the two plates when they come into contact with a conductive material. The potential difference is the result of current flowing from the anode to the cathode. The presence or absence of water in the plant substrate is determined by this flow of electrons. An Arduino microcontroller is needed to translate analog data from the soil moisture sensor into digital data.

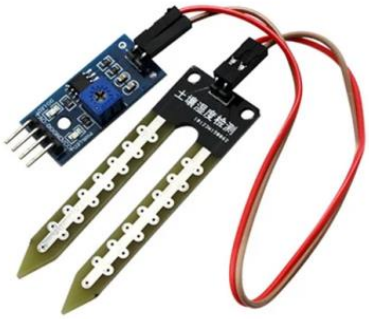

***Figure 4 Soil Moisture Sensor***

**Module Relay**

A relay is a mechanical switch that can be operated electrically or magnetically. A relay switch will move from off to on in response to electromagnetic energy. Basically, a relay consists of two main components: an electromagnetic generating system (iron core inductor) and a mechanical switch. The switch lever or relay contactor is pulled by an electric voltage applied to the magnetic generating inductor. In principle, a relay is a switch lever with a wire wound on a nearby iron rod (solenoid). When the solenoid is supplied with electric current, the lever will be attracted due to the magnetic force that occurs in the solenoid so that the switch contacts will close. When the current is stopped, the magnetic force will disappear, the lever returns to its original position and the switch contacts open again. [7] Relays are usually used to drive large currents / voltages (for example, 4 A / AC 220 V electrical equipment) using small currents / voltages (for example 0.1 A / 12 Volt DC) [8]


***Figure 5 Relay***

**Alarm Buzzer**

Alarm Buzzeris an electronic device that produces sound (buzzer) to provide a warning signal or notification to the user. This buzzer is often used in various applications to indicate a certain condition that requires attention, such as system failure, time limit reached, or status that needs attention.

*Figure 6 Alarm Buzzer*

**Indicator Lights**

Indicator Lightsis a device used to provide a visual sign of the status or condition of a system or device. Usually the indicator light is an LED (Light Emitting Diode) that can light up in a certain color, such as green, red, or yellow, to indicate a certain condition that is happening on a device or system.

**Water pump**

A pump is a tool used to move a fluid from one place to another by increasing the pressure of the fluid, the increase in fluid pressure is used to overcome flow obstacles, these flow obstacles can be in the form of pressure differences, height differences or frictional resistance. In principle, the pump changes the mechanical impeller into a fluid flow impeller, the impeller received by the fluid will be used to increase the pressure and overcome the resistance in the channel through which it passes [7].

One type of fluid equipment used to move fluids from one location to another is a pump. Pumps do this by converting fluid pressure and kinetic energy from the mechanical energy of the shaft, which drives the pump impeller.

*Figure 7 Water Pump*

**Jumper Cable**

Jumpersis a small cable or connector used to connect two pins or points on an electronic circuit or circuit board, such as a breadboard or printed circuit board (PCB). Jumpers are commonly used to temporarily organize or connect circuits, allowing for the organization of signal or power paths in electronic projects.

*Figure 8 Jumper Cable*

**Arduino UNO**

Arduino was invented by Massimo Banzi and David Cuartielles with the initial goal of helping students create low-cost design and interaction devices, arduino comes from Italian which means brave friend. The first launch for the Arduino Uno R3 type was the Arduino Uno R3 type which was released in 2011. R3 itself means the third revision of this type which will be used to create the automatic door project.[9]

Arduino Uno is a type of board containing a microcontroller that is the size of a credit card and is equipped with a number of pins that are used to communicate with other equipment. Arduino is a versatile microcontroller that can be programmed[7] Arduino is usuallyequipped with 14 digital input/output pins that allow users to connect various electronic components such as LEDs, sensors, and motors. Arduino UNO also has 6 analog input pins that are used to read analog signals from sensors. This board is programmed using Arduino IDE with C/C++ programming language, which makes it easy to understand, especially for beginners. Arduino UNO can be powered using a USB cable or external power source, and is often used in projects such as automation systems, robotics, and IoT-based applications.

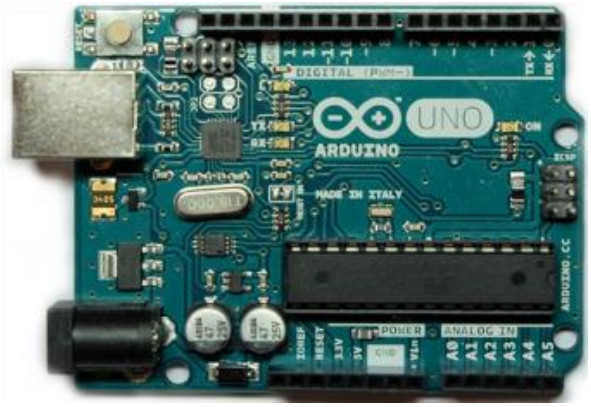


***Figure 9 Arduino UNO***

**Arduino IoT Cloud**

Arduino IoT Cloud is an IoT platform that allows users to control and monitor microcontroller-based devices such as Arduino, ESP8266, ESP32, and Raspberry Pi through mobile or web applications. With Arduino IoT Cloud, users can easily create user interfaces without having to write applications from scratch, making it easier to develop IoT projects. This platform provides various widgets, such as buttons, graphs, and sliders, which allow users to control devices in real-time and access sensor data quickly. In addition, Arduino IoT Cloud also supports cloud-based automation, making it suitable for various purposes, from DIY projects, IoT prototypes, to implementation in smart homes and environmental monitoring.

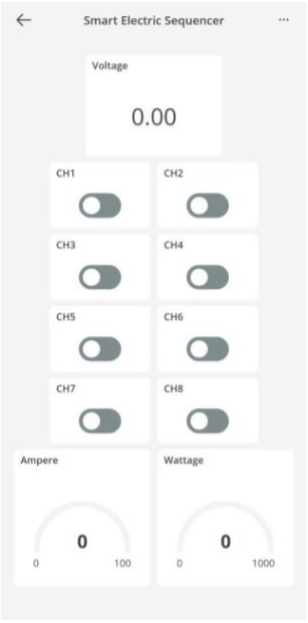


***Figure 10 View***Arduino IoT Cloud

**RTC**

A Real-Time Clock (RTC) is an electronic component that functions to maintain and regulate time accurately, even when the main device is turned off or loses power. can receive and store real-time data in the form of time descriptions such as day, date, month and year.[10] RTCs are usually equipped with a backup power source such as a small battery or supercapacitor, so that they can continue to operate without depending on the main power. This component is widely used in various devices, such as computers, microcontrollers, embedded systems, and other electronic equipment, including digital clocks and cameras. In computer systems, the RTC ensures that the time and date are stored correctly even when the device is turned off. Some popular RTC chips, such as the DS3231 and DS1307, are often used in Arduino and other microcontroller-based projects because of their ability to maintain time with high precision.


***Figure 11 RTC***

**LCD**

LCD (Liquid Crystal Display) is one type of display media that is already commonly known in the community. LCD already uses liquid crystals or liquid crystals so that it can produce an image that looks good. Display technology that uses liquid crystals is one of the liquid crystal displays that has been widely used in various industrial products[7]. The main advantage of LCD is lower power consumption compared to other screen technologies such as CRT (Cathode Ray Tube), as well as its ability to produce sharp and clear images with a thinner and lighter screen size.

## METHOD

### Research methods

The research method used in the design of the automatic watering system for jasmine ornamental plants uses the Threshold method. This system is designed to monitor soil moisture in jasmine ornamental plants and carry out automatic watering based on a predetermined humidity threshold (threshold method).

### Research Framework

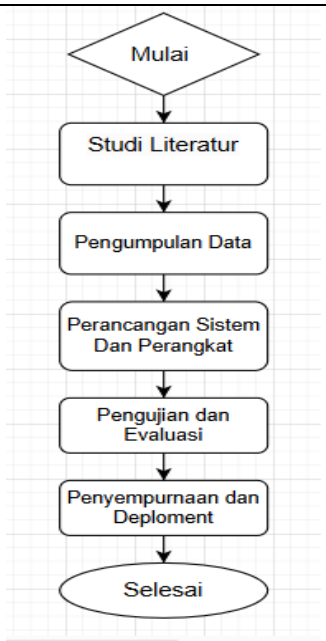


***Figure 12 Research Framework***

This research begins with problem identification and formulation of objectives, namely to design and build an automatic watering system for ornamental plants based on the Internet of Things (IoT). Furthermore, a literature study was conducted to collect and understand various relevant scientific references, such as journals, articles, and other library sources that discuss IoT technology, microcontrollers (Arduino and NodeMCU), and soil moisture and air temperature sensors. After that, the data collection process was carried out through field observations to determine the actual conditions of manual watering and user needs for an automatic system. The data obtained also includes the technical specifications of the hardware and software to be used. The next stage is the design of the system and circuit, which includes the creation of block diagrams, flowcharts, and electrical circuit schematics. At this stage, the soil moisture threshold is also determined as the main parameter of the automatic watering system. After the design is complete, the device is implemented and integrated with the Arduino IoT Cloud platform. All components such as NodeMCU, Arduino Uno, DHT11 sensor, soil moisture sensor, relay, water pump, indicator lights, and buzzer are installed and configured to function according to plan. The system is then connected to the Arduino IoT Cloud to support remote monitoring and control via mobile devices.

After the system is installed, testing and evaluation are carried out to assess the system's performance in various environmental conditions, especially against soil moisture fluctuations. Evaluation is carried out to measure the accuracy of sensor readings, watering accuracy, and system response through cloud-based applications. If deficiencies are found, improvements and refinements are made to the system until the system can function optimally. The final stage of this research process is deployment, namely the application of the system at a predetermined location (house yard), and the preparation of a final report containing the entire process and results of the research. Conclusions are drawn up based on the effectiveness and reliability of the automatic watering system that has been successfully implemented.

**Block Diagram**

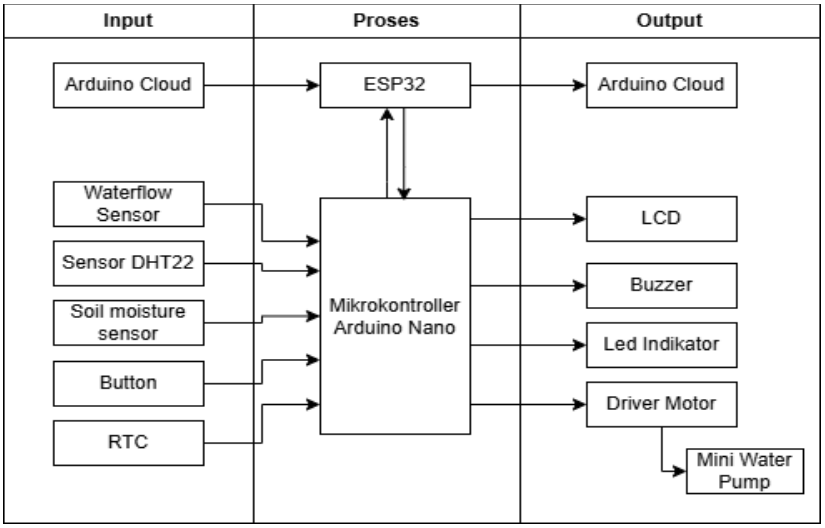


***Figure 13 Block Diagram***

There are several sensors used in making this tool, starting from Input, Process, and Output sensors. On the input sensor there is a Waterflow sensor that functions to calculate the amount of water released or used by this automatic watering system, then there is a DHT22 sensor that is used to take temperature and humidity data around the Jasmine plant, then there is a soil moisture sensor that functions to take soil moisture data on this Jasmine plant, then there is an RTC sensor on this automatic watering device, the RTC used is the DS3231 series which functions to run the watering process automatically on a schedule that has been set from the Arduino IoT Cloud to the RTC sensor, then finally there is an input button that functions to manually water if needed.

Next is the process, which is where this process is carried out on the Arduino Nano microcontroller as the brain or main system on this tool. Then there is ESP32 which functions to send and retrieve data from the Arduino IoT cloud for processing the work of the automatic watering system on this Jasmine plant. Finally there is the output, the output here is the expected result after processing the input sensor processed by the Arduino nano. For the output here using several components. Among them are, the 16x2 I2C LCD is useful for displaying status data or statistical data regarding soil moisture and some other information, then there is a buzzer that functions to provide a signal to the owner if the soil moisture has decreased or reaches the lower threshold of the humidity value that has been set, then there is an LED indicator that functions to provide status in the form of a light on this automatic sprinkler system, and finally there is a motor driver that functions to regulate the on-off of the water pump which is useful for flowing water to this Jasmine plant.

**Flow chart**

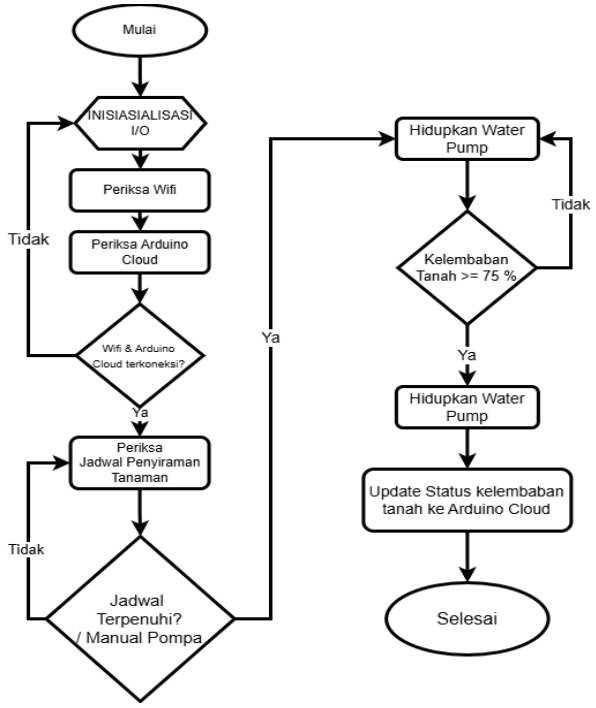


***Figure 15 Flowchart***

In the flowchart diagram above, the workflow of this automatic watering system has been explained, the first thing that is run by the program when the new system is turned on is I/O Initialization which is useful for checking the Input and Output sensors whether they have been properly connected or not, then checking the wifi signal whether the system is in the wifi range that has been set to connect and at the same time checking the Arduino IoT Cloud whether it is connected or not, if the connection to wifi and Arduino IoT Cloud has not been fulfilled, the system will restart itself until the wifi and Arduino IoT cloud are fulfilled or connected properly, If it is connected, the next process is to check the RTC sensor whether it is time to water or not or the input button is pressed to water manually, if the schedule is fulfilled, the system will send a command to the Motor Driver to turn on the water pump to water up to a humidity level >= 75%. If the soil moisture has not been fulfilled, the system will water continuously until the soil moisture value is fulfilled. And finally the system will send a signal to the Arduino IoT Cloud to update the soil moisture status of the Jasmine flower plant.

**Electrical Circuits**

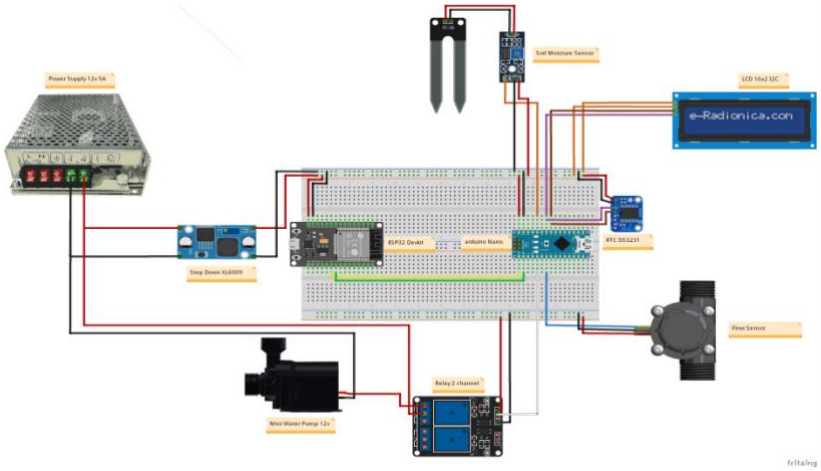


***Figure 16 Electrical Circuits***

In the schematic above, the wiring system that will be applied to the automatic watering device for this Jasmine flower has been seen, starting from the 12v 5A power supply then reduced to a voltage of 5v 3A to supply the esp32, Arduino nano, and the sensors used. The sensors are connected via analog or digital pins, then data from

the sensor is sent to the esp32 via the RX TX pin to perform serial communication which is useful for updating the moisture value of the Jasmine flower soil to the Arduino IoT Cloud in real time.

## RESULTS AND DISCUSSION

### Discussion

The discussion focuses on testing the previously designed system. This test has several stages or functions that will be tested and to see whether the system performance is in accordance with what was previously designed. In the tool there are several components that are interconnected with each other which are controlled by 1 microcontroller, namely ESP32 DevkitC V4, then there is also a DC Motor Pump to pump or channel water from the water reservoir to the jasmine plant automatically, then to find out the amount of water usage there is a waterflow sensor which functions to find out the amount of water discharge that has been flowed to the jasmine plant so that the jasmine plant will not lack water which causes the plant to die or dry out.

To find out the level of dryness or humidity in the soil, this tool has been embedded with a humidity sensor or moisture sensor which functions to calculate or find out how moist the soil is in the jasmine plant by calculating the level of electron flow in the soil when it comes into contact with the sensor. To find out the temperature and humidity levels around the plant, there is also a DHT22 sensor with a high level of reading accuracy so that to keep the plant fresh if the temperature is too hot and the soil becomes dry, water will automatically flow to the plant. Then to find out all the information that has been collected or obtained by the existing sensors, the function of the 16x2 I2C LCD component here works which will display the level of soil moisture, the temperature level around the plant and the level of water usage, and also to find out more complete information, all the information that has been obtained by the sensor will be sent via the cloud to the Arduino Cloud's IOT Remote application.

Here there are 2 conditions that will trigger the pump to turn on, namely "Moist Soil", and "Dry Soil". In moist soil conditions the system will change to standby mode and will continue to monitor the temperature and humidity levels of the soil. If the Dry Soil condition occurs, the microcontroller will send a signal to the L298N motor driver to turn on the DC pump motor and flow water to the plants and soil until the moist soil limit is reached. The application also has a slider widget that can set the desired soil moisture level and a scheduler widget that can set the schedule in real time and flexibly. The results of the design and manufacture of the Automatic Jasmine Plant Watering System based on Microcontrollers and IoT can be seen in Figures 16 and 17.

**Figure 16 Exterior View**

**Figure 17 Inside View**

**Sensor Sensitivity Testing**

**Soil Moisture sensor sensitivity testing**

In table 1, the sensitivity test of the soil moisture sensor is carried out by dipping the sensor into water and seeing what value is produced or read by the soil moisture sensor to be used as a reference for the highest value when the soil conditions are moist.

Table 1 Soil Moisture Sensor Test Results

| Testing To - | Soil sensor condition | The value generated by the sensor | Sensor Response Time | Test Description |
|---|---|---|---|---|
| 1 | Dry | 4096 | 1000 ms | Sensor reading is good |
| 2 | Dipped in water up to 25% | 1796 | 1000 ms | Sensor reading is good |
| 3 | Dipped in water up to 50% | 1560 | 1000 ms | Sensor reading is good |
| 4 | Dipped in water up to 100% | 165 | 1000 ms | Sensor reading is good |

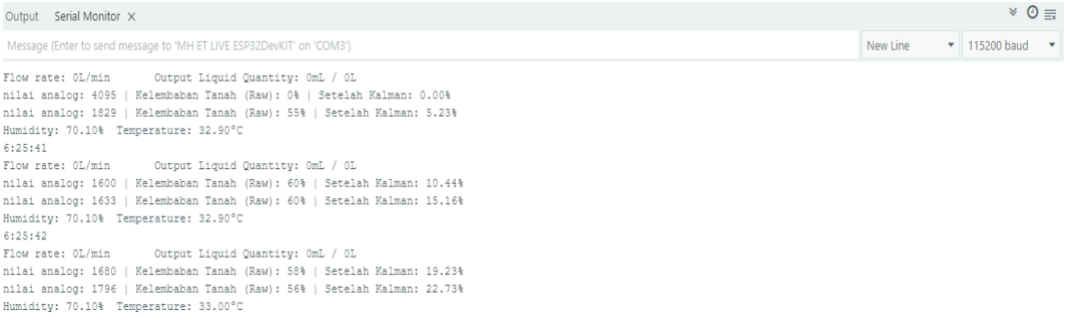


**Figure 18 Output results of Soil Moisture Sensor values on the Serial Monitor**

**DHT22 sensor sensitivity testing**

In table 2, the DHT22 sensor sensitivity test is carried out by running the program that has been uploaded into the .microcontroller and reading the temperature value produced by the sensor on the Serial Monitor or LCD.

Table 2 DHT22 Sensor Sensitivity Test Results

| Testing To - | Temperature Value around the test area | The temperature value produced by the sensor | Sensor Response Time | Testing Accuracy |
|---|---|---|---|---|
| 1 | 32.9 oC | 32.80 oC | 500 ms | 90% |
| 2 | 32.7 oC | 32.70 oC | 500 ms | 100% |
| 3 | 32.9 oC | 32.90 oC | 500 ms | 100% |
| 4 | 32.9 oC | 32.80 oC | 500 ms | 90% |

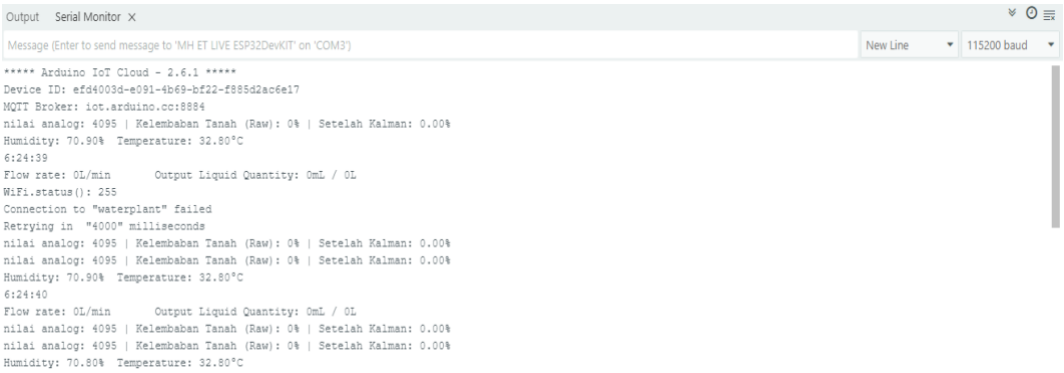


**Figure 19 DHT22 Sensor Output Value Results**

## Arduino Application Tester

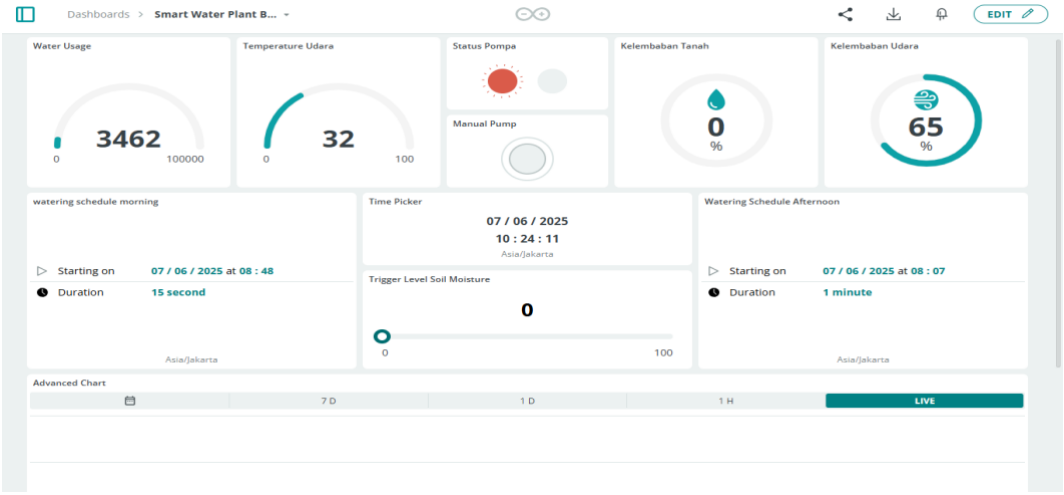


Figure 20 Arduino Cloud Website Dashboard View

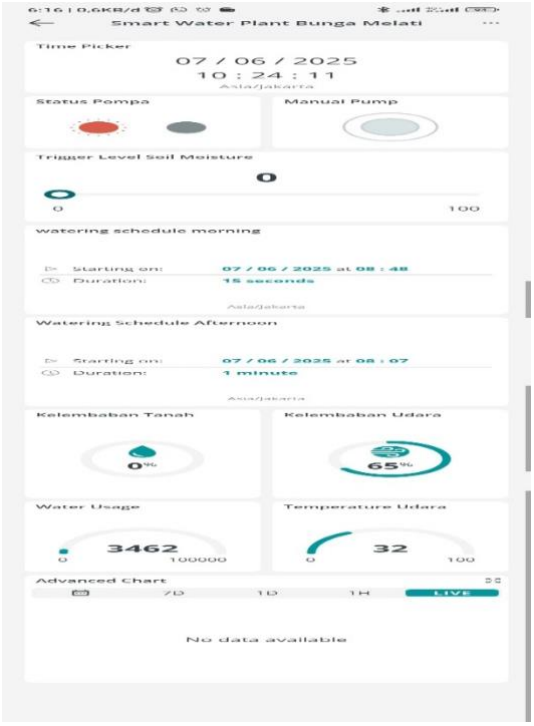


Figure 21 Arduino IoT Remote application dashboard view

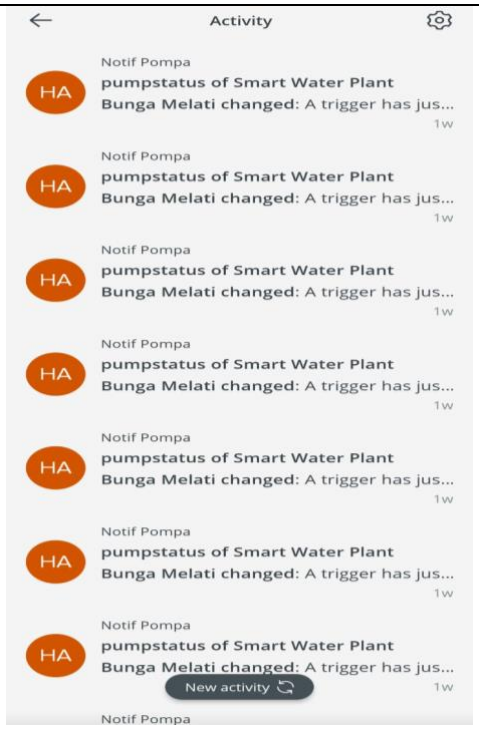


Figure 22 Notification sent by Arduino Cloud

**Tool Performance Testing**

At the performance testing stage of this tool, there are several test scenarios that will be tested and see or conclude the level of success that will be obtained in the automatic plant watering system for jasmine ornamental plants using this Microcontroller and IoT.

Table 3 Table of Tool Performance Test Results

| No | Test Scenario | Expected results | Test Results |
|---|---|---|---|
| 1 | When the Land is Dry | The system automatically waters plants until the soil moisture level is reached. | Succeed |
| 2 | When the Soil is Damp | The system will not water and monitor the Soil moisture readings and area temperature. | Succeed |
| 3 | The Manual button on the tool is pressed | Manual plant watering system for 3 seconds | Succeed |
| 4 | Manual buttons on IoT Remote app | The system will water the plants manually for 3 seconds. | Succeed |
| 5 | Morning watering schedule settings take place on the IoT Remote application. | The system will water the plants automatically according to the schedule and hours set in the IoT Remote application. | Succeed |
| 6 | Afternoon watering schedule settings take place on the IoT Remote application | The system will water the plants automatically according to the schedule and hours set in the IoT Remote application. | Succeed |

After conducting the testing phase on the tool, it can be concluded that the tool is functioning and working according to the design that has been done, with different test scenarios. In Table 4.1 is the data from the soil moisture sensor test results will be the reference value for the level of humidity and dryness of the soil and at the same time calibrate the soil moisture sensor so that there is no error or wrong reading in the system function test. In

Table 4.2 is the data from the DHT22 sensor test results to test the level of accuracy and function of the DHT22 sensor itself.

## CONCLUSION AND SUGGESTIONS

### Conclusion

The results of the testing and discussion carried out by the author at the sensor and system testing stage can be concluded that:

1. The accuracy level of the DHT22 sensor reading obtained a fairly high and good accuracy value.
2. The soil moisture sensor reading value was successfully tested and the resulting value was stable.
3. The system successfully executes commands from or to the Arduino IoT Cloud wirelessly.

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