Research Article

Internet-based Design of Hydroponic Plants Monitoring and Automation Control Systems

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Abstract: Melons are one of the fruit types widely favored in the market due to their high content of vitamins, minerals, and water. Melon plants are challenging to cultivate when environmental conditions such as soil and air do not align with their characteristics. One way to address this is through hydroponic cultivation, which reduces the interaction of melon fruits with the air and environment. However, this method has a drawback in that the nutrient solution and water circulation of the plants must be continuously monitored. Therefore, a system is needed to automatically monitor and control the conditions of hydroponic plant growth with the assistance of IoT technology. This research proposes the Design and Implementation of a Monitoring and Automation System for Hydroponic Plant Control Based on the Internet of Things. The hydroponic system, specially designed for melon plants, is equipped with various sensors that can monitor soil nutrients in real time through mobile devices. Based on the test results, the TDS sensor yielded a result of 1313 PPM, the pH Water sensor showed 50.1, and the system also measured air temperature and humidity using DHT22, with air temperature at 29.5°C and humidity at 71.2%.

Keywords: Hydroponics; TDS Sensor; pH Sensor; Internet of Things; automatically monitor

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1. Introduction

Indonesia is a truly fertile country in the plantation sector one of the sectors that has received attention from the government, a lot of research related to agriculture and plantations is carried out, with the help of technology in agriculture in the hope of getting satisfactory yields and high quantities. But in big cities in Indonesia generally, a lot of land used for agriculture has been reduced, Hydroponics is the answer to deal with the problem of reduced land for farming, because this method can be used in unused or empty places or locations in the countryside or city.

Hydroponics is a method of growing plants without using soil but plants grown using water that contains a mixture of nutrients. Hydroponic plants do not require large land so narrow yards can be utilized. Planting hydroponically will also produce relatively faster harvests and high-quality crop production (Setiawan et al., 2020). There are several ways to grow plants using hydroponic techniques, one of which is the Flow system. According to researchers, the flow system is an easy technique to make because this technique only uses water, pipes, plant nutrients, and water jackfruit as planting media. Several aspects must be considered in its maintenance, one of which is the regular watering of plants so that plants can grow well (Prayitno et al., 2017).

Hydroponics is one alternative to growing fruit in densely populated areas that generally lack land for agriculture and can be done on land with low fertility. In addition, it does not require large land, the advantage of hydroponic cultivation is planting by utilizing water without using soil by emphasizing the fulfillment of nutritional needs for plants. This is because the water used in the cultivation of hydroponic method plants will continue to be circulated.

Technological innovation in agriculture that is growing rapidly provides benefits in the need for monitoring and control of melon fruit plants. Internet of Things-based research has been conducted on melon plants, such as automatic watering systems and monitoring soil moisture and greenhouse temperature to take over the role of humans in watering melon fruit plants (Rahmat Saputra, 2021).

The previous study, namely research on the Control and Monitoring System of Soil Conditions and Water Levels in Web-Based Melon Plants Using a Wireless Sensor Network (WSN) conducted (Masyudi, 2020), is a tool application used to automate plant watering and irrigation disposal. The tool is designed using a Wireless Sensor Network (WSN) and soil moisture sensor as a determinant of when watering is done, an ultrasonic sensor as a determinant of when irrigation is open/closed, and a water pump for watering plants. The tool is designed to make it easier for people who farm in terms of watering and discharging irrigation water, while the results of this study can determine soil moisture using a soil moisture sensor, to regulate the soil moisture level, the selenoid valve will irrigate the land automatically if the soil moisture is below the specified limit and will stop irrigating the land if the soil moisture is following the provisions.

Based on the description above, researchers design and develop a system that can monitor and automate the control of hydroponic plant growing conditions automatically with the help of IoT technology. This system will be equipped with various sensors such as temperature, humidity, pH, and nutrient levels sensors that can monitor plant growing environmental conditions in real-time. In addition, this system will also be equipped with a control automation feature that can regulate plant growing environmental conditions automatically with the title "Internet-Based Design Of Hydroponic Plants Monitoring And Automation Control Systems".

2. Literature Study

2.1 Monitoring System

A monitoring system is a system used to monitor and supervise various activities, conditions, or parameters in an environment or system. The main purpose of the monitoring system is to detect changes or problems that occur in real-time so that corrective action can be taken as quickly as possible to prevent or reduce negative impacts (Ahmadi, 2018).

2.2 Hydroponic

Hydroponics is a method of growing crops without using soil media, but by using nutritious mineral solutions or other materials that contain nutrients such as coconut husk, mineral fiber, sand, broken bricks, sawdust, and others as a substitute for soil media (Izzuddin, 2016). Hydroponic melon cultivation with a drip irrigation system has advantages in efficient water use and plant maintenance. This study aims to find out the best media for melon cultivation techniques (Cucumis melo L.) (Nora et al., 2020).

The KBBI dictionary explains that hydroponic melon gardening is a planting technique that does not use soil media, and the process is carried out in a glass room using a water medium containing nutrients (KBBI 2016). If we observe growing melons hydroponically is much better than planting melons in polybags or pots. First The treatment process and growing media used are much safer and sterile from fungal pests and bacteria. The second planting process does not require weeding. In addition to these two things, we can consume the fruit produced and the plants can also be used as ornamental plants.

Melon fruit (Cucumis melo L.) is annuals that grow vines, soft-stemmed, from each base of the petiole on the main stem to grow lateral shoots. Through these lateral shoots grow female flowers (prospective fruits) which can usually produce one to two prospective fruits (Mardiyanti 2018).

Growing hydroponic melons is very suitable for urban people. The difficulty of obtaining soil media in urban areas, as well as very limited land conditions, are also choices in utilizing yards with hydroponic melon cultivation. Besides being used for consumption, the fruit also functions as an ornamental plant. The difficulty of obtaining soil media in urban areas, as well as very limited land conditions, are also reasons to utilize yards with hydroponic melon cultivation. Then the nutritional parameters in hydroponics are the process of analyzing the composition and content of nutrients in the nutrient solution used in the hydroponic system. There is a table of nutritional parameters in Table 1.

Table 1. Nutritional Parameters

No	Parameter	Measurement Method	Optimal range	Measurement Results
1	TDS Nutrition	TDS Meter	1000-1500	1400
2	Excess Nutrients	Monitoring	1800-2500	1900
3	Nutritional deficiencies	Monitoring	600-800	700

Table 1. is a nutritional parameter table where nutritional parameters have parameter table where parameters are used, namely nutrient TDS and a TDS meter measurement method that has an optimal range of 1000-1500 and produces measurements of 1400, then excess nutrients have a measurement method in monitoring and have a range of 1800-2500 then produce 1900, nutritional deficiencies where nutritional deficiencies have a measurement method in monitoring and a range of 600-800 later made 700.

2.3 Internet Of Things (IoT)

The Internet of Things (IoT) is an area of knowledge that enables systems to integrate with sensors, software, and technologies that interconnect and share data over networks. If used correctly, the application of IoT in everyday life will provide many benefits and services to users, which is an important element of IoT technology (Oracle, 2022).

3. Method

Research methods The type of research used by research and development (R & D) is a type of research by designing a new product or developing an existing product. Then according to Nusa Putra (2015), Research and Development (R & D) is a research method deliberately, systematically, to find, improve, design, produce, and test the effectiveness of products, models, and methods or strategies or ways that are superior, new, effective, efficient, productive, and meaningful. Research on the Design and Build of Internet of Things-Based Hydroponic Plant Control Monitoring and Automation System in the Department of Informatics and Computer Engineering, Faculty of Engineering, Makassar State University was carried out in the JTIK lab.

The prototype and application site are designed to control plant conditions using NodeMCU as a control center by sensors. This technology has a simple design and is used to test the performance of the prototype made. The sensors used include humidity sensors, temperature sensors (DHT22), and several other sensors or parameters that are used as complements. NodeMCU ESP32 is used as a microcontroller equipped with a built-in wifi module.

3.1 Overall System Schematic

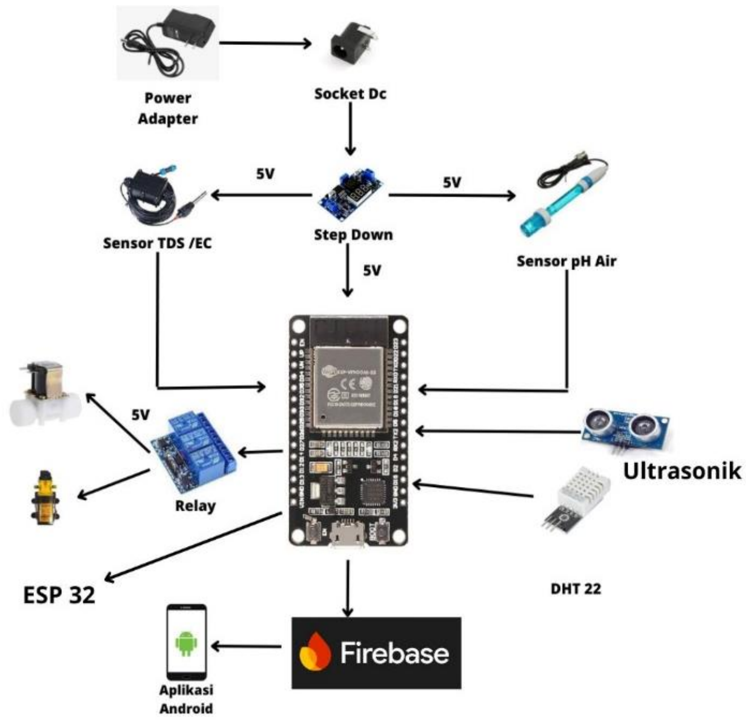


Figure 1. Prototype Schematic

Figure 1 shows an illustration of a hydroponic system that applies Internet of Things (IoT) technology by utilizing sensors, computing devices, and Internet networks to monitor and control plant environmental conditions in a hydroponic system. This IoT-based hydroponic system focuses on creating tools or systems that can make it easier for farmers to monitor water pH, temperature, humidity, and automatic settings of hydroponic plants continuously (real-time). The utilization of ultrasonic sensors in this system is to assist the process of filling water storage containers automatically when the amount of water in the tank decreases. After that, the ultrasonic sensor will send the water level data to the NodeMCU as a data processing device.

Air temperature and humidity sensors are used to monitor the temperature and humidity of the air around hydroponic plants and pH sensors measure nutrients in hydroponic plants. The water pump control device is used to control the watering of hydroponic plants. This device will receive signals from ultrasonic sensors and air humidity and temperature sensors to determine the watering time automatically. NodeMCU is used to receive data from sensors and send commands to the water pump control device. The monitoring system website is used to monitor the condition of hydroponic plants to monitor the condition of hydroponic plants. The designed website will receive data from NodeMCU devices and display information on filling water containers via ultrasonic and air humidity and temperature and pH sensors to display hydroponic plant nutrients on mobile phones and laptops.

3.2 System architecture

The system architecture that you want to implement on the prototype is in a design or size along with the information used is addressed to the image as follows:

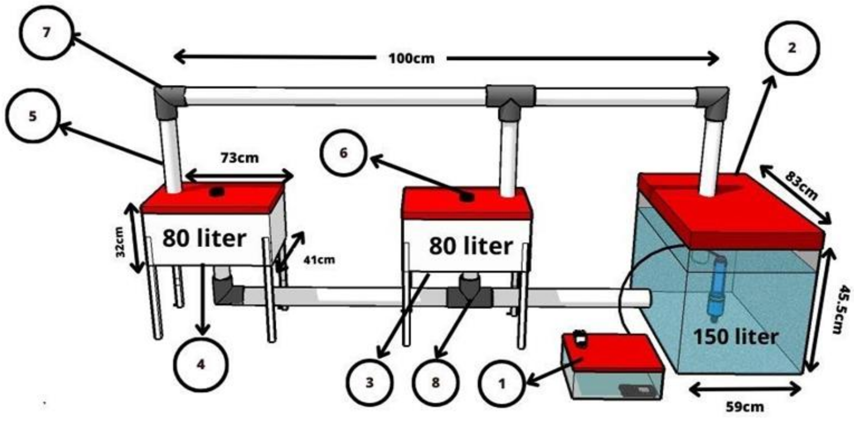


Figure 2. System architecture

The system architecture in Figure 2 is explained in detail at the following points:

1. Box Controller
   A Box Controller is a hardware device used to control and manage devices. The Box Controller serves as the brain or control center of the system that consists of components.
2. Nutrient Container
   A nutrient container is a container used in a hydroponic system to store nutrient solutions needed by plants. In hydroponic cultivation, plants grow in a nutrient solution consisting of a mixture of water and nutrients that are essential for plant growth and development.
3. Plant Box 1 and 2
   A hydroponic plant box is a special container or container used to grow melon plants using the hydroponic method. In hydroponic cultivation, melon plants grow in a nutrient solution that is circulated through the roots of the plant, without using soil as a growing medium.
4. Pipe1/2
   A 1/2 pipe is used as part of an irrigation system to drain the nutrient solution to the plants. The pipe acts as the main channel or branch of the irrigation system that connects the nutrient container with the plant parts that need water and nutrients.
5. Net Pot Place Hole
   A hole where a net pot is a hole made or provided in a hydroponic system to place a net pot or filter pot. A net pot is a special pot that has filter walls or small holes around it, allowing plant roots to grow through those holes and absorb water and nutrients.
6. L Pipe Connection
   L pipe joints are used to change the flow direction of pipes by 90 degrees. The L pipe joint has the shape of a right angle, with the two incoming and outgoing ends parallel to each other, forming sharp corners.
7. T Pipe Connection
   The T pipe connection is used to divide the pipe flow into two branches at an angle of 90 degrees. The T pipe joint has a shape similar to the letter "T", with one end in and two ends out forming sharp corners.

3.3 System architecture

A system flowchart is a graphical representation of a workflow or process in a computer system or application. It is used to model the steps, tasks, decisions, data flows, and interactions that occur in the system. The flowchart used in this study is as follows in Figure 3.

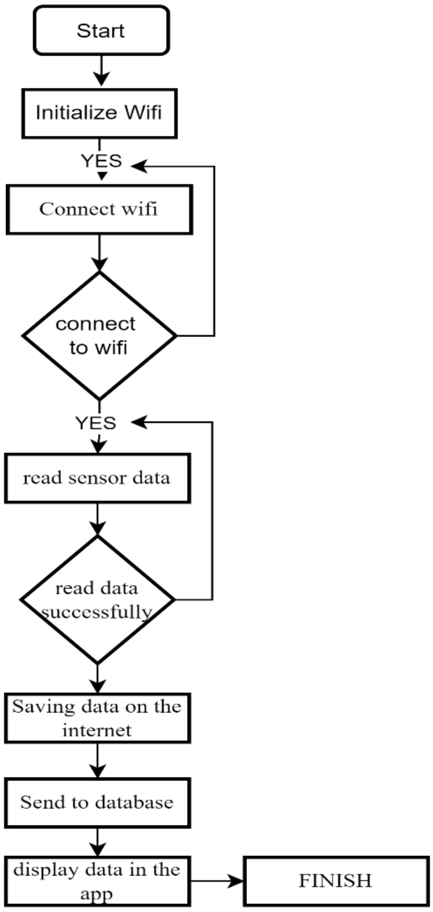


Figure 3. Flowchart Monitoring System

In Figure 3 of the Flowchart, the process of collecting and managing sensor data using Node MCU begins with the initialization of the Wi-Fi module, which involves initial setup and connection to the Wi-Fi network by using information such as SSID and password. If the connection is successful, the system proceeds by reading data from the sensors connected to the device. This sensor data is then stored online, either in the form of cloud storage or web services. After that, the stored sensor data is sent to the database for further management. If the data submission is successful, the next process is to display the data on the web, perhaps in the form of graphs or reports that can be accessed through a web browser. Once all steps are complete, the process is considered complete and the system is ready to begin the next monitoring cycle. After all, steps are completed and the sensor data is successfully displayed on the web, the system will update the information continuously by reading the new sensor data and sending it to the database for further processing. This process allows continuous, real-time monitoring of the conditions or parameters observed by the sensor. With this monitoring system, users can access information quickly and easily through the web interface, making it possible to identify patterns, trends, or significant changes in the collected sensor data. In addition, the data that has been stored can also be used for further analysis, prediction, or decision-making supported by data. Thus, this monitoring system provides benefits in monitoring and managing various types of environments or systems efficiently and effectively.

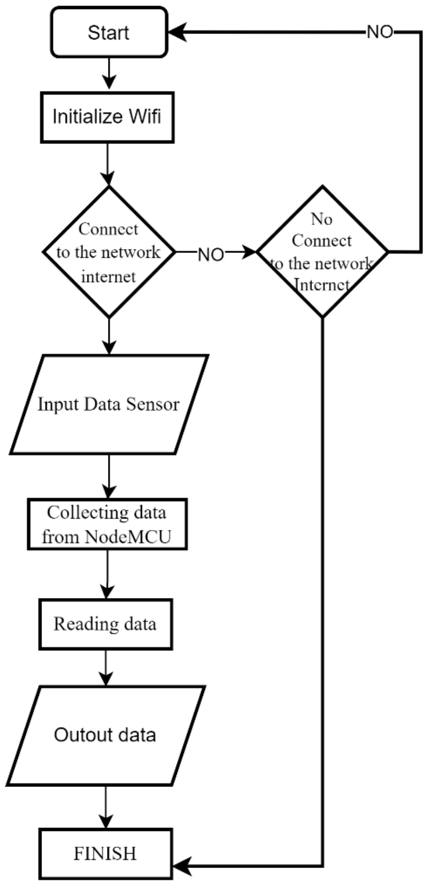


Figure 4. Flowchart working principle of the system

In Figure 4 Flowchart The monitoring process using Node MCU starts with the initialization of the Wi-Fi module to enable and configure the Wi-Fi connection on the device. After that, Node MCU connects to the Internet network using an initialized Wi-Fi connection. If it is not connected, the system will attempt to reconnect to the internet. Next, the Node MCU receives input data from connected sensors, such as temperature, humidity, or air pressure. The data obtained from such sensors is collected by Node MCU. Then, the process of reading data is carried out to process the information that has been collected. After the data is read, Node MCU will display or send the data to the desired destination. This can be in the form of displaying data on an LCD screen, sending data via a communication protocol such as MQTT, or sending data to a server or database. Once the entire process is complete, the system has completed the monitoring cycle and is ready to start the next one.

After the data is successfully processed and sent to the desired destination, Node MCU will continue the process by completing the monitoring cycle. This process includes the completion of the last tasks that need to be done before the system enters the resting stage or waits for the next monitoring. While this can vary depending on specific needs and configurations, this last stage usually includes validation of data that has been sent to ensure its integrity. In addition, Node MCU can also perform additional actions such as clearing buffers or resetting system conditions to be ready to start the next monitoring cycle. After all tasks are completed, the monitoring system in Node MCU is considered complete and ready to start the next monitoring cycle according to a set schedule or pre-set conditions. Thus, the Node MCU monitoring cycle provides continuous and reliable monitoring of the environment or system being monitored and ensures the resulting data can be used effectively for decision-making and further analysis.

4. Result and Discussion

In this section, the results of this research are described in the form of designing a hydroponic plant control monitoring and automation system based on the Internet of Things. The system is created using Javascript programming language, using Android studio software. In this study, there are three results obtained based on several stages, namely hardware, application, functionality, and system function.

4.1 Hardware

Hardware in hydroponic cultivation is a set of physical components used to support plant growth without using soil. This includes various tools and infrastructure that help control environmental conditions and deliver the nutrients needed by plants appropriately. Here are some of the main hardware components in hydroponics:

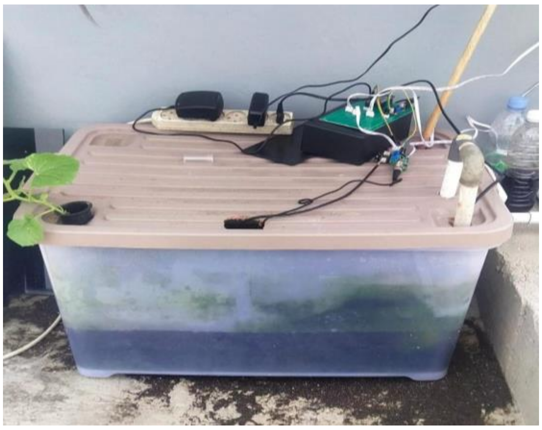


Figure 5. Tool and Device Installation

In Figure 5 the installation process of hydroponic plant tools and devices The first step is the selection of a qualified site, ensuring sufficient sun exposure and ease of access for maintenance. Next, nutrient tanks are installed to provide the plants with a suitable nutrient solution. The irrigation system is organized by installing pipes or water hoses to evenly distribute the nutrient solution to the plant containers. A water pump is installed to ensure a continuous flow of nutrient solution. A pH meter is installed in the nutrient tank to monitor and regulate the nutrient balance.

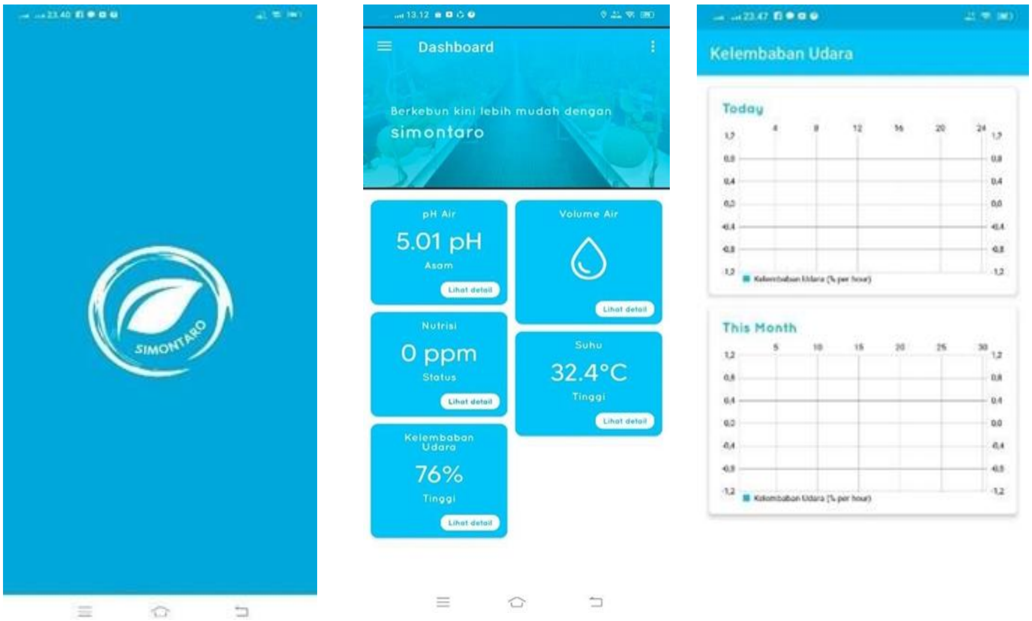
(a) (b)

Figure 5. (a and b) Tool and Device Installation

In Figure 5.a 5-day melon plant on hydroponic plants this process ensures that the plant has reached the appropriate stage of development, which usually occurs after the seedling phase in which the root system has developed properly. Next, it is necessary to pay attention to the quality of the water used to make the nutrient solution. Water should be clean and free from contaminants that can damage plants.
In Figure 5. b a 27-day plant hydroponic system plant will begin to absorb nutrients provided through the nutrient solution. It is important to monitor the plant's response to a given AB mix, including growth and overall plant health. During this period, attention should be paid to changes in leaf color, root growth, and fruit or flower development. In addition, it is also important to continuously monitor the pH and nutrient concentration in the AB mix solution, as well as make adjustments as needed to ensure plants receive optimal nutrition. During this phase, regular monitoring of plant conditions and the hydroponic environment needs to be done to prevent problems that may arise and ensure healthy and productive plant growth.

4.2 Application

The application in this study is used to monitor the conditions of the plant growing environment such as humidity, temperature, nutrients, and pH of nutrient solutions. Here is the result of a capture of the application layer that has been built using Android Studio used in this study.



(a) (b) (c)

Figure 6. (a, b, and c) App-specific views

Figure 6. a is a splash display or opening page that is only seen temporarily when going to the login menu when you are not logged in and if you are logged in, then enter the application dashboard. Moreover, Figure 6. b is the result of integration between the prototype design of a hydroponic plant monitoring system with a real-time database. Delivery is done in real-time every time there is a change in data using the orderByKey method, to sort data by key (ID). Using this method, the app gets the latest data based on the continuously updated ID. Then perform a get data function from the real-time database to an application that has been designed to monitor sensor parameters and displays on the application interface. In Figure 6.c The display of diagrams in applications refers to the way data or information represented in the form of diagrams or graphs is displayed to the user on the screen of an Android device. The diagram view is an important part of the application's user interface and serves to visualize data in a way that is easy for users to understand.

4.3 Sensor Functionality Testing

Sensor functionality testing is the process of validating and verifying the performance of a sensor to ensure that it can provide accurate measurements or detection. The test results of all sensors are in Table 2.

Table 2. All-sensor testing

Test Grains	Function	Information
ESP 32	As a prototype control center and also as a program repository	Works Well
pH Sensor	Measuring pH values in hydroponic plants	Works Well
DHT 22 Sensor	Measuring air temperature and humidity values	Works Well
TDS Sensor	Measuring nutrient value in hydroponic plants	Works Well
Ultrasonic Sensor	Measuring water levels in nutrient reservoirs	Works Well

Based on the results of the test summary conducted in Table 2, the overall designed system prototype has run well. ESP32 can read sensor data and store it in the firebase real-time database and the pH sensor can measure pH value in hydroponic plants the DHT22 sensor can measure air temperature and Air Humidity and the TDS sensor can measure nutrients in nutrient tanks and hydroponic plant containers then the ultrasonic sensor can measure water level level.

A. Microcontroller port testing

Testing on port esp 32 as a microcontroller is intended to check whether the data entered (input) and output (output) can run according to the description made on the system. In testing, the Arduino IDE program was used to find out the analog input from the sensor that entered the microcontroller port and the data input sent to the Android-based application ran properly.

B. pH sensor testing

pH sensor that serves to measure acidity levels in hydroponic plants. The results of pH sensor performance testing are based on the values obtained in the test in Figure 7. Figure 7 is a graph of the results of testing a water pH sensor, the overall average value in testing a water pH sensor has an average value of 5.01+5.01+5.01+5.01+5.01+5.01+5.01+5.01+ 5.01=50.1 then divided by the number of readings pH value =50.1/10= 5.01, the average pH value of water obtained.

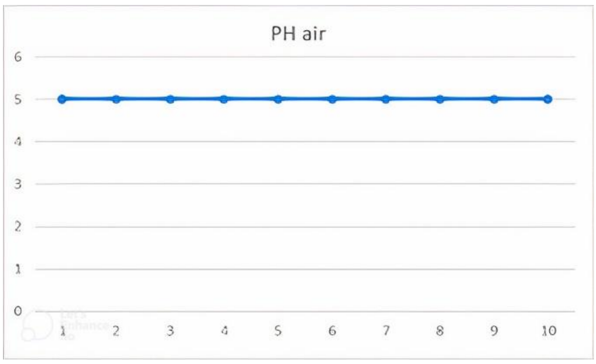


Figure 7. Water Sensor pH Graph

C. DHT22 sensor testing

DHT22 sensor testing measures air temperature and humidity in hydroponic plants. The results of the DHT22 sensor performance test are based on the values obtained in the test in graphic Figure 8.

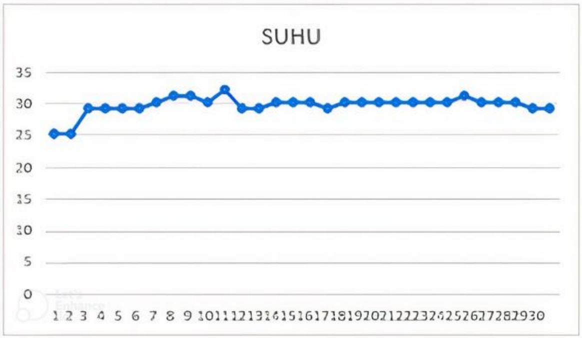


Figure 8. DHT22 Temperature sensor graph

Figure 8 shows a graph of the temperature on the DHT22 sensor scanner. If the overall average value in the dht22 sensor test there is an average value from the temperature test of 29.5 °C using the formula for the sum of temperature values 25 + 25 + 29 + 29 + 30 + 31 + 31 + 30 +32+ 29 + 30 + 30 + 30 + 30 +30 + 30 + 30 + 30 + 29 + 29 = 886 then divided by the number of readings T=886/30 = 29.5 °C the average temperature obtained.

Figure 9. Air Humidity Sensor Graph

Figure 9 is a graphic display of air humidity on the dht22 sensor value pembacan in the air humidity test there is an average value of 73+73+75+72+75+73+69+70+73+65 +72+72+74+70+71+65+67+70+70+71+72+74+73+72+72+72+70+69+70+72=2.136 then divided by the number of readings H=2.136/30 = 71.2% of the average air humidity value obtained.

D. TDS sensor testing

TDS (Total Dissolved Solids) sensor testing is a process to check the performance and accuracy of TDS sensors, TDS sensors are used to measure nutrient levels. There are TDS sensor test results in Figure 10.

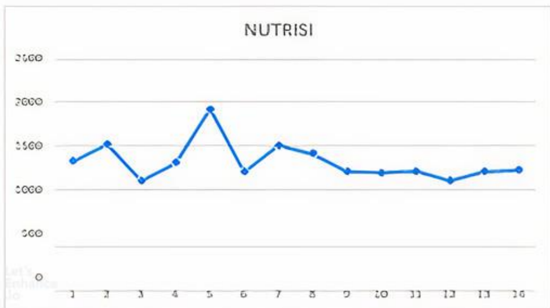


Figure 10. TDS Graph

In Figure 10, it can be noted that the test results obtained in the test fall into the normal and high categories where normal values range from 1000 to 1500 and high 1800 to 2500 in melon hydroponic plants and the average value produced is 1320 + 1516 + 1100 + 1300 + 1920 + 1200 + 1502 + 1402 + 1202 + 1192 + 1211 + 1100 + 1203 + 1220 = 18388 PPM then divided by the number of readings TDS=18388/14 = 1313 PPM the average TDS meter value is obtained.

4.4 System Functions

At this stage, it is done to ensure that the system meets the prototype requirements that have been determined previously and can operate following the desired objectives. The following are the test results of the Internet of Things (IoT) based hydroponic plant monitoring and control automation system design.

4.4.1 Nutrient Water Distribution Testing

Irrigation testing is a process to ensure that the provider of water and nutrients to plants in a hydroponic system is optimal and following plant needs The Nutrient Water Distribution table is in Table 3.

Table 3. Nutrient Water Distribution Tester

No	Test Parameters	Test Methods	Test Results	Information
1	Water flow	Pay attention to the water flow in the installation	Good	Paying attention to the flow of water in the stables runs smoothly without any obstacles.
2	pH Water	Using a pH Sensor	Good	The test results of the water pH sensor run smoothly because it provides a good sensor value.
3	Temperature and humidity	Using DHT 22	Good	Produce good air temperature and humidity values

Table 3 is the result of irrigation testing where irrigation testing has parameters for testing water flow in irrigation and produces good because there are no obstacles to the flow of water entering the hydroponic plant random then the pH of the water is good because the sensor test results run well to measure the acidity value in the nutrient tank and produce good sensor values and air temperature and humidity produces good testing because it has produced sensor values on air temperature and air humidity in the air around hydroponic plants.

4.5 Discussion

The design of the Internet of Things (IoT) based hydroponic plant control monitoring and automation system produced a system prototype by combining two sciences, namely Arduino and Android Studio. This research aims to help hydroponic farmers monitor nutrient levels in hydroponic plants based on the Internet of Things and produce sensor data on system prototypes. The prototype of the Internet of Things (IoT) based hydroponic plant monitoring system in this study is a system designed to monitor nutrients, humidity, temperature, pH, and water level in hydroponic plants. This prototype is equipped with an ESP32 microcontroller that connects the DHT22 sensor to collect air temperature and air humidity data, ultrasonic sensors function to measure water levels in plant containers and nutrient containers, Water pH sensors that function to collect acidity data in nutrient tanks, TDS sensors function to measure nutrient levels in nut containers (water reservoirs). The data collected by these sensors is sent to the Firebase real-time database as a server.

Making hydroponic plant monitoring applications based on the Internet of Things using Android Studio with Java programming language. As for the data storage (database) application uses Firebase as a system database that holds the value of DHT22 sensors, TDS sensors, ultrasonic sensors, water pH sensors, and integration between the application and the design of the tool (hardware) made. Features on the application interface (interface) There are hour units that show real-time time sourced from the firebase real-time database, real-time monitoring is done with the get data function connected to the application to display DHT22 sensor data, TDS sensors, ultrasonic sensors, and water pH sensors to the application interface. Another additional feature is a real-time graphical display that allows users to see sensor history that updates automatically as new data becomes available.

The results of system prototype testing are carried out in stages starting with fungality testing and then prototype testing, implementing the Internet of Things system, and implementing a monitoring system, until the prototype is ready for testing according to hydroponic plant conditions. The results of functionality testing show that ESP32 as a microcontroller can run well by reading and saving sensor data to the Firebase real-time database. TDS (Total Dissolved Solids) sensor in this study can detect nutrient levels containing nutrients and plant containers in hydroponic plants and produce a value of 18388 and an average value of 1313 PPM which is obtained, the pH sensor of water in this study can read the acidity level in the nutrient tank and can produce a value of 50.1 and an average of 5.01 the results of the value obtained do not change because the sensor value in calibration is initially still mined then recalibrated its value changed the result plus then the resulting value was 50.1 and the value did not change every one hour, the DHT22 sensor in this study was able to read the air temperature around the prototype and produced a value of 886 and produced an average value of 29.5 ° C while the air humidity produced 2.136 and produced an average of 71.2% obtained then ultrasonic sensors were used to measure water level in nutrient containers and hydroponic plant containers.

The results of the Prototype test show several stages of testing, the first is nutritional testing where this nutrient testing uses a TDS meter and has a range of 1000 to 1500 and produces a value of 1400 then there is an excess of nutrients in the TDS meter test ranging from 1800-2500 and produces a value of 1900 excess nutrients and finally the lack of nutrients has a range of 600 to 800 and produces 700 nutritional deficiencies, the second irrigation testing where irrigation testing has test parameters where the first test parameter is the flow of water flowing in irrigation then entering the plant container has good test results because there is no obstacle when the water channel enters the nutrient container then the second test is water pH where the pH of this water functions in irrigation testing to measure acidity in the nutrient tank produces well even though the pH sensor value does not change, The third test of air temperature and humidity works in the irrigation system because it measures the air temperature in the channels and hydroponic jacks used and produces good air humidity, the third test in prototype testing is drainage testing where drainage testing records the date and time and has observations whether there are obstacles when there are conservations it is noted that there are obstacles when there are no feeding barriers in the writing there are no obstacles then there are actions in Where this action when there is an obstacle on the drainage of feeding is done action when there is no do not perform the action.

5. Conclusions

Based on the results of the research that has been done, it can be concluded that [1] The results of the design of a hydroponic plant control monitoring and automation system based on the Internet of Things produce a system that can be monitored remotely and the parameters used will provide input to ESP 32 and will provide output according to sensor needs. [2] Based on the results of monitoring in hydroponic agriculture prove that monitoring and controlling critical environmental variables such as pH sensors have an average yield of 5.01, temperature sensors have an average yield of 29.5 ° C, air humidity has an average yield of 71.2% and nutrient levels have an average yield of 20188 PPM. [3] The results of the design of a hydroponic plant control monitoring and automation system based on the Internet of Things produce a system that can be monitored remotely and the parameters used will provide input to ESP 32 and will provide output according to sensor needs. [4] Based on the results of monitoring in hydroponic agriculture prove that monitoring and controlling critical environmental variables such as pH sensors have an average yield of 5.01, temperature sensors have an average yield of 29.5 ° C, air humidity has an average yield of 71.2% and nutrient levels have an average yield of 20188 PPM.

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