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Smart Farming on IoT-Based Aeroponik Systems

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Abstract: Today, urban agriculture, or "urban farming," is one of the things that is much talked about. Urban agriculture is the process of production, processing, distribution, and sale of agricultural products in urban areas. The advancement of agricultural technology is very beneficial for areas with limited land, resulting in innovations to use modern tools. Aeroponics is a method of farming that uses air as a growing medium and can be used for urban farming. The use of less water when compared to conventional or hydroponic farming is one of the advantages of aeroponic farming. In the digitalization era, it is necessary to look to technology as a solution to address these issues. This research combines hydroponic plants with the help of Internet of Things (IoT) technology using aeroponic planting techniques. The design of IoT devices uses a microcontroller that is integrated with the Arduino Mega as a center for running supporting sensors such as water level, ultrasonic, ph, tds, and dht22 sensors. The Android mobile application is used as an interface for controlling and monitoring the device by the user. From the design and a series of trials on the system, it is concluded that the design of an IoT-based aeroponic hydroponic plant system is capable of monitoring and controlling plants, as well as automating the mixing of nutrients according to plant needs.

Keywords: Aeroponics, IoT, Arduino, Smart, Vegetables.

INTRODUCTION

Aeroponics is a way of growing vegetables in the air without using soil, nutrients are sprayed on plant roots, water containing nutrient or nutrient solutions is sprayed in the form of mist to hit plant roots. Hanging plant roots will absorb the nutrient solution. Water and nutrients are sprayed using sprinkler irrigation (Endra et al., 2020)The main point of aeroponic application in the field is the pressure generated by the pump height and suitability of the installation design. High pressure in the line hose will produce granules misty water. During the journey from the sprinkler hole to the roots, the grains will add oxygen. Aeroponics is a good method because it produces liquid droplets fine droplets (droplets) in the form of mist (Siregar & Rivai, 2019). Specially formulated nutrients from soluble mineral salts in water, contains important nutrient elements needed by plants to grow and develop. The speed of nutrient delivery by the aeroponic method is up to 135% faster than other hydroponics and vegetable cultivation that is done normally grown using soil planting media (Widodo & Subandi, 2016)

Agriculture is one of the businesses for the community that is growing in line with the increasing demand for community needs. One of the offers for the development of agricultural systems is the ease of cropping patterns, namely without soil media. One of the cultivation patterns without soil media is the Aeroponic system. Aeroponics is a cultivation method by empowering air to increase the productivity of agricultural land. One of the key advantages of aeroponics is the oxygenation of each fine mist of nutrient solution so that root respiration is smooth and produces a lot of energy (Sariayu, 2017).

Several studies have examined farming using Internet of Things technology in the agricultural sector to address agricultural land problems using hydroponic and aeroponic planting techniques combined with IoT (Internet of Things) devices, including the application of a hydroponic system made using a raspberry pi microcontroller and a wifi microcontroller. esp8266 to connect to the internet network which allows users to manage and monitor plants through a web-based application (Crisnapati, 2017). Other research examines the system design made using a microcontroller as a work regulator of an aeroponic planting system which provides nutrients in the form of mist directly to the roots so that plants can more easily absorb nutrients (Widodo, 2016). while other research is in the form of developing an automation system for mixing nutrients using tds and ph sensors in reading nutrient solutions that will be given to plants so that nutrition can be carried out optimally

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according to plant needs which can be arranged through an Android-based mobile application (Jayawiguna, 2018). In the research that has been done before, it still has some weaknesses, such as there are no indicators in reading the conditions on the device, instructions for providing nutrition, not using fans as an alternative if the temperature is too hot on the plants, and several other weaknesses.

Other research examines the system design that is made using a microcontroller as a regulator of the work of aeroponic planting systems that provide nutrients in the form of the mist goes directly to the roots so that plants can more easily absorb nutrients(Widodo & Subandi, 2016).

In this study using Arduino UNO R3 which functions as a controller, receiver and sender of sensor output data. The use of the DHT11 sensor functions as a temperature and humidity detector around the plant(Sariayu et al., 2017).

This research was attempted to provide alternative solutions in aeroponic plant cultivation using IoT-based technology that can help in controlling and monitoring plants automatically so that they can help the wider community in cultivating hydroponic plants. The system created integrates IoT features with an Android smartphone that plays a controlling and monitoring role in plants.

LITERATURE REVIEW

ARDUINO

Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as pluse width modulation (PWM) outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and reset button.It contains everything needed to support the microcontroller simply connect it to the computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

Fig. 1 Arduino Mega 2560

TEMPERATURE AND HUMIDITY CONTROL

The DHT 11 sensor is one of the sensors that we can use to get temperature data as well as humidity data, the DHT 11 sensor is also easy to communicate with various types of controllers that are popular today such as Arduino and Microcontrollers with the serial communication method (single wire bi-directional) (Hartono & Widjaja, 2022). By only having 1 data pin, the DHT 11 sensor can communicate with the controller, either a microcontroller or an Arduino using the serial communication method (single wire bi-directional). The data sent by the DHT 11 sensor to the controller is 40 data bits, the first 16 data bits are humidity binary data, the next 16 bits are temperature binary data, and the last 8 data bits are the sum of the temperature and humidity values. With the method of sending data serially as much as 40 bits consisting of temperature and humidity data, this DHT 11 sensor does not require calibration anymore. The temperature and humidity data can be read by translating the 40 bit binary data sent by the DHT 11 sensor into decimal data. The image of the DHT 11 sensor can be seen in the image below.

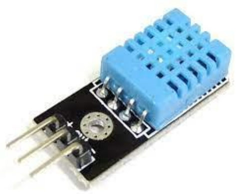

Fig. 2 DHT sensor 11

LIGHT DEPENDENT RESISTORS(LDR)

LDR sensor or light sensor is a tool used in the field electronics that function to convert the amount of light into electrical quantities. LDR light sensor (Light Dependent Resistor) is a type of resistor that is sensitive to light. The LDR resistance value will vary according to the received light intensity. If the LDR is not exposed

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to light then the resistance value will be large (about 10 MO) and if exposed to light the resistance value will be be small (about 1kO). (Novianty, Lubis, & Tony, 2012: 1).

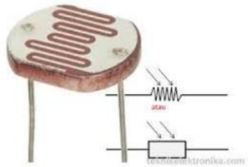

Fig. 3 LDR sensors

NUTRITION CONTROL

TDS (Total Dissolved Solid) sensor is a sensor that works by detecting the conductivity of a solution, the more conductive a solution is, the value will change, so if the liquid contains a lot of minerals, the conductivity will be higher and the output will be bigger, and vice versa if the liquid contains a little minerals, the smaller the output. The sensor is connected to the ADC pin on Arduino to read voltage changes. In hydroponics, this sensor is used to measure the concentration of hydroponic solutions or nutrient concentrations. In hydroponics, the measurement of hydroponic nutrients is absolutely necessary because if the nutrient solution is not measured, the plants may lack nutrients or excess nutrients which will result in being toxic to the plants themselves. The unit used for this TDS sensor is PPM (Part Per Million) which is a unit for measuring the amount of dissolved particles. In hydroponics and aeroponics it is important to measure nutrients because these measurements are useful for knowing exactly how much a plant needs for nutrients. Each type of plant requires a different concentration of nutrients, for example, leafy vegetables require a nutrient solution concentration of between 900 – 1200 PPM. The image of the TDS sensor can be seen in the image below.

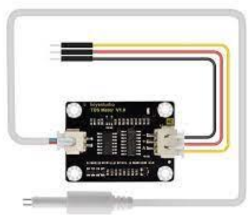

Fig.4 TDS Sensors

METHOD

RESEARCH MODEL

This study refers to the prototype model of the Pressman Hospital, 2015 with stages as shown in Figure 5. below.

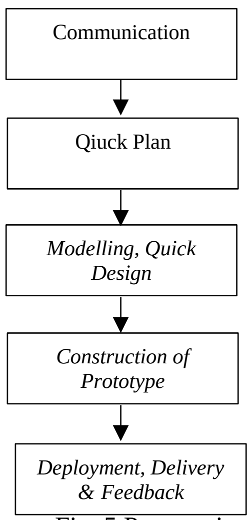

Fig. 5 Prototyping

The stages of the Prototyping model are:

1. *Communication*

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At this stage, the problem analysis is carried out by conducting interviews. Then after that do an analysis to identify all the needs and specifications of the requirements that will be made.

2. *Quick Plan*

At this stage, a prototype design is carried out quickly by making a temporary design based on the analysis of the problems obtained after conducting interviews with resource persons and needs.

3. *Modeling, Quick Design*

At this stage, prototype modeling is carried out. The process of creating a model design to assist in the creation of the system.

4. *Construction of Prototype*

At this stage the prototyping model is evaluated according to user needs based on the previously modeled design.

5. *Deployment, Delivery & Feedback*

At this stage, prototype. Responses from users are used to improve the system according to user needs. Development is carried out so that the prototype can be improved to satisfy the needs of the user. If the user is satisfied with the prototype to be developed, the system is developed based on the final prototype.

BLOCK DIAGRAM

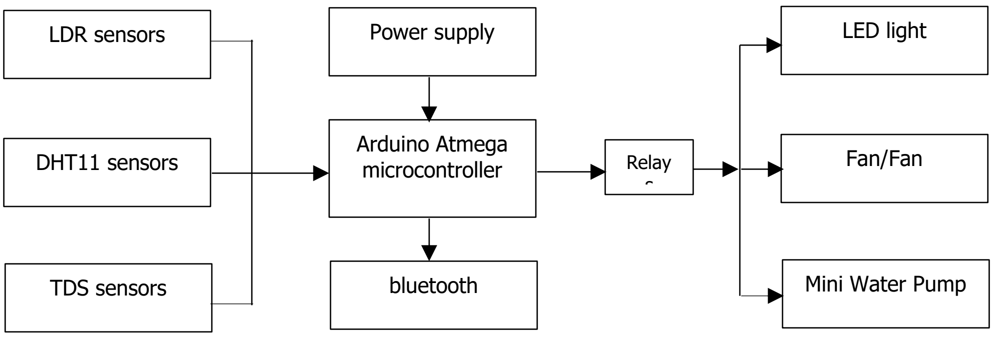

Fig.6 Smart Farming Block Diagram

Information:
From the block diagram design in Figure 6 it can be seen the circuit aeroponic plant monitoring system has several blocks that have function as follows:

1. The Light dependent Resistor (LDR) sensor functions as a trigger for LED lights based on their resistance value based on light reception.
2. The DHT11 sensor functions as a temperature and humidity sensor which will trigger the fan.
3. The Total Disolved Solid (TDS) sensor functions to determine plant nutrient levels in water.
4. The Arduino Mega microcontroller acts as a system work controller that processes the input, then gives commands to the output.
5. The power supply functions as an intake of electric current or voltage
6. *Relays*used to connect the flow and drive the water pump and fan.
7. *bluetooth*works wirelessly to send data to an android smartphone.
8. The fan functions to regulate air circulation if the temperature is too hot.
9. Led lights function as a substitute for sunlight during the day.
10. *Miniwater*The pump functions to move water into the aeroponic plant pipes

RESULT

After carrying out the analysis and design carried out in the previous chapter, the designSmart Farming on IoT-Based Aeroponic Systems has been made, so to find out how the Arduino device works, it is necessary to test how the device works, as well as the function of the device for aeroponic plants, so that the weaknesses and limitations of the functions of the system that have been made can be identified. This test aims to find out how this tool can later be used optimally. Testing will be carried out in several stages on the application system and the following tools:

DHT11 SENSOR TESTING

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The first test was carried out on the DHT11 sensor, when the system is turned on the DHT11 sensor is active and reads the normal room temperature of 32°C, humidity of 66%, in this condition it does not trigger the fan to activate because the temperature and humidity conditions are still normal. The test step is to increase the temperature and humidity at a certain point using a match so that the temperature increases to a point that can trigger a fan. After the temperature increases to 36 °C it will trigger an active fan and slowly the air in the room will change and lower the temperature in the room slowly to the normal point of 32 °C which will triggers the fan to turn off again. From the tests carried out it can be concluded that the system can work properly and in accordance with the wishes.

Table 1. DHT11 Sensor Test Results

Components Tested	Test Scenario	Expected results	Results
DHT11 sensors	At <35ºC Temperature	Fan does not start at <35	As planned
	At temperatures > 35 ºC	The fan does not turn on >35	As planned

In table 1 it can be seen that the DHT11 sensor test runs according to what the author wants at <35 °C the fan does not turn on at normal room temperature and if the temperature increases at >35 °C the fan will turn on and slowly change the air circulation in the room, so that room temperature back to normal and not too hot.

TDS SENSOR TESTING

In the previous TDS meter test, the authors had previously tested the size of concentrated A and concentrated B nutrients which would be mixed into concentrated AB Mix nutrients into 1 liter of water which would later be needed to get the parts per million (PPM) according to what the plants needed. This is done using 2 different TDS meters.

Table 2. TDS Sensor Testing

Components Tested	Water type	Lots of water	Package A	Package B	Total AB Mx	PPM Nutrition
TDS Meters (Manufacturer)	Mineral water	1 Liter	-	-	-	105
			1 ml	1 ml	2 ml	491
			2 ml	2 ml	4 ml	790
TDS Meter Arduino V 1.0	Mineral water	1 Liter	-	-	-	81
			1 ml	1 ml	2 ml	425
			2 ml	2 ml	4 ml	801

After testing the TDS Meter sensor, the results obtained from the test are as shown in table 2 which will then be adjusted to the nutritional needs of plants, the following is table 2 of plant nutritional needs.

TESTING LDR SENSORS

Tests carried out on the light dependent resistor (LDR) sensor when conditions are bright, the LDR sensor will cut off the electric current so that the LED light will turn off. Subsequent tests if the environmental conditions are dark then the sensor will activate and trigger an electric current and cause the LED light to turn on, the test the author does by covering the surface of the sensor with a finger which aims to darken the surface of the sensor and then the LED light light up.

Table 3. LDR Sensor Testing

Components Tested	Test Scenario	Expected results	Results
Light Sensors dependent resistors (LDR)	Condition Bright environment	The LED does not light up.	According to which expected
	Dark environmental conditions or the sensor surface is closed using a finger.	The LED light is on.	According to which expected

Tests carried out on light dependent resistor (LDR) sensors running well and as expected in environmental conditions when the light is bright the LED light will automatically turn off and if the environment is dark then the LED light will automatically turn on.
From the test results it can be concluded that the system has been able to run very well starting from controlling nutritional needs, lighting, humidity and room temperature, so that the needs by plants can be met and plants can grow quickly and optimally. In addition, users are able to monitor plants to check every condition that exists on

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the device. Success in planting this plant is due to the fact that the system has been tested beforehand starting from the beginning to the end.

DISCUSSIONS

To determine the success of the system that has been designed, the results obtained are in accordance with those hypothesized at the beginning of the research, so that this system can find out how this system works to monitor and control plants, as well as automation in mixing nutrients. Many research results have been carried out, this can provide a variety of good perceptions and new, fresh idea in terms of system creation and allow for better updates and developments in the future

CONCLUSION

From the design and trial results, it can be concluded that an IoT-based aeroponic hydroponic plant control and monitoring system has been designed. This has been proven by a series of trials, such as sensor calibration, testing of features, and Android applications. This study found that in trials, the system was capable of monitoring and controlling plants, as well as automating the mixing of nutrients based on plant needs. Users can control all the conditions needed by plants, such as the amount of watering, temperature, lighting, limit value of TDS, and pH, and users can carry out direct monitoring by checking the conditions contained in the features and also the amount of nutrients given to plants each watering. The results obtained in testing hydroponic plants are that plants can develop well with the IoT features that are made available.

REFERENCES

Assa et al, Internet of Things-Based Hydroponic System Monitoring Design, vol. 17 no. 1, 2022

Ciptadi et al, Penerapan Teknologi IoT pada Tanaman Hidroponik menggunakan Arduino dan Blynk Android, Dinamika Informatika Volume 7, No 2, 2018

Crisnapati N, Wardana K, Aryanto A, Hermawan A, Hydroponic management and monitoring system for an IOT based NFT farm using web technology. ResearcGate. 2017:1-6

Dimas, "Cara Menanam Kangkung Paling Mudah," 2020. [Online]. Available: https://kutanam.com/cara-menanam-kangkung/.

Endra, R. Y., Cucus, A., & Wulandana S, M. A. (2020). Perancangan Aplikasi Berbasis Web Pada System Aeroponik untuk Monitoring Nutrisi Menggunakan Framework CodeIgniter. *Explore: Jurnal Sistem Informasi Dan Telematika*, *11*(1), 10. https://doi.org/10.36448/jsit.v11i1.1453

F. Rahman, I. J. Ritun, M. R. Ahmed Biplob, N. Farhin, and J. Uddin, "Automated aeroponics system for indoor farming using arduino," *2018 Jt. 7th Int. Conf. Informatics,Electron. Vis. 2nd Int. Conf. Imaging, Vis. Pattern Recognition, ICIEV-IVPR 2018*, pp. 137–141, 2019, doi: 10.1109/ICIEV.2018.8641026.

Groover, M. P. (2010). Sheet Metalworking. *Fundamenals of Modern Manufacturing*. https://doi.org/10.1017/CBO9781107415324.004

Hartono, A., & Widjaja, A. (2022). *Prototype Pendeteksi Kebakaran Menggunakan Sensor Flame , Sensor Dht11 Dan Mikrokontroler Nodemcu Esp8266 Berbasis Website Prototype Fire Detector Using Flame Sensor , Dht11 Sensor And Nodemcu Esp8266 Microcontroller Based*. *September*, 734–741.

H. Sugito, "Rancang Bangun Sistem Pengaturan Suhu Ruang Inkubator Bayi Berbasis Microcontroller AT89S51," vol. 12, no. 2, pp. 55–62, 2009.

I. A. Lakhiar, J. Gao, T. N. Syed, F. A. Chandio, and N. A. Buttar, "Modern plant cultivation technologies in agriculture under controlled environment: a review on aeroponics," *J. Plant Interact.*, vol. 13, no. 1, pp. 338–352, 2018

Jayawiguna P. Rancangan Bangun Sistem Tanam Hidroponik NFT (Nutrient Film Technique) Berbasis Teknoilogi Internet of Things. Badung: Universitas Udayana. 2018.

M. . Palada, L. C. Chang, and M. Hidayat, "Budidaya Dan Produksi Benih Kangkung." [Online]. Available: http://hortikultura.litbang.pertanian.go.id/teknologidetail-35.html#:~:text=Kangkung Dapat memberikan hasil yang,oC tanaman akan rusak.&text=Bila sudah berdaun dua%2C kurangi,berjarak tanaman 10-15 cm.

P. Tani, "Perbedaan Sayur Hidroponik VS Organik," 2018. [Online]. Available: https://paktanidigital.com/artikel/perbedaan-sayur-hidroponik-denganorganik/#.X0DSRsgzaUk.

Prasetyo, Agung. Perancangan Sistem Monitoring Pada Hidroponik Selada (Lactuca Sativa L.) Dengan Metode NFT Berbasis Internet of Things (IoT), Jember, 2021

Putu et al, Sistem Kontrol dan Monitoring Tanaman Hidroponik Aeroponik Berbasis Internet of Things, Jurnal Ilmiah Merpati Vol. 8, No. 3, 2020

Santoso, A. B., Martinus, & Sugyanto. (2013). Pembuatan Otomasi Pengaturan Kereta Api , Pengereman , Dan Palang Pintu Pada Rel Kereta Api Mainan Berbasis Mikrokontroler. *Jurnal FEMA*, *1*(Januari 2013), 16–

*name of corresponding author

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DOI : https://doi.org/10.33395/sinkron.v8i1.11988
e-ISSN : 2541-2019
p-ISSN : 2541-044X

23.

Sariayu, M. V., Priyatman, H., & Sanjaya, B. W. (2017). Dengan Sistem Aeroponik Berbasis Arduino Uno R3. *Jurnal Teknik Elektro Universitas Tanjungpura*, *2*(1).

Siregar, S. L. H., & Rivai, M. (2019). Monitoring dan Kontrol Sistem Penyemprotan Air Untuk Budidaya Aeroponik Menggunakan NodeMCU ESP8266. *Jurnal Teknik ITS*, *7*(2). https://doi.org/10.12962/j23373539.v7i2.31181

Subandi A, Widodo M. Rancang Bangun Sistem Aeroponik Secara Otomatis Berbasis Mikrokontroler. Jurnal Seminar Nasional Inovasi Dan Aplikasi Teknologi di Industri. 2016

T. Priyowidodo, “Budidaya kangkung darat organik,” 2013. [Online]. Available: https://alamtani.com/budidaya-kangkung-darat-organik/.

Widodo, M., & Subandi, A. (2016). Rancang Bangun Sistem Aeroponik Secara Otomatis Untuk Budidaya Beberapa Sayuran. *Jurnal Teknik Elektro*, *3*(1), 1–13.

Yuliana, Esti. (2011). Microcontroller http://teknikinformatikaesti.blogspot.com/2011/03/pengertianmikrokontroler.html diakses tanggal 20 November 2014.

*name of corresponding author