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Hydroponic Nutrient Film Technique (NFT) System Based on Automation in Ciparay Village

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ABSTRACT

Hydroponics is a farming technique that brings about various advantages. There are many types of hydroponics, for example the Nutrient Film Technique (NFT). In this activity, an NFT hydroponic system based on automation was created for parameter settings that affected plant growth. Several parameters were controlled, such as pH and TDS on plant nutrition, as well as humidity and air temperature in the environment. This system was placed in Ciparay village to help the community learn hydroponic farming. As a result of this activity, the entire system could work well, but there werr still some leaks. After this system working, socialization activities were carried out to the Ciparay community to explain how to use the system for hydroponic cultivation.

Keywords: *hidroponik, NFT, sistem otomasi, Desa Ciparay*

1. INTRODUCTION

Hydroponics is a farming technique without using soil as a growing medium, but replacing it with water that contains nutrients **(Helmy, Marsha Gresia Mahaidayu, Arif Nursyahid, Thomas Agung Setyawan, & Abu Hasan, 2017)**.

This technique is suitable for use in cities with high populations, resulting in reduced agricultural land (Desta Yolanda, Hilwadi Hindersah, Febrian Hadiatna, & Muhammad Agus Triawan, 2016). Besides land limitations, another reason this technique is good to use is to reduce the occurrence of crop failures, due to weather conditions. With this technique, all parameters that affect plant growth are controlled continuously. For example, in agriculture in the tropics, several parameters that need to be controlled include air humidity, air temperature, water level, pH, and EC **(Jirabhorn Chaiwongsai, 2019)**.

In this research, a prototype of a hydroponic system with the Nutrient Film Technique (NFT) type was made. NFT is a hydroponic method that provides nutrients shallowly, therefore the plant roots can get water, nutrients, and oxygen properly**. (Iswanto, Prisma Megantoro, & Alfian Ma'arif, 2020)**. This prototype is used for the people of Ciparay Village. The location of this village is shown in Figure 1.

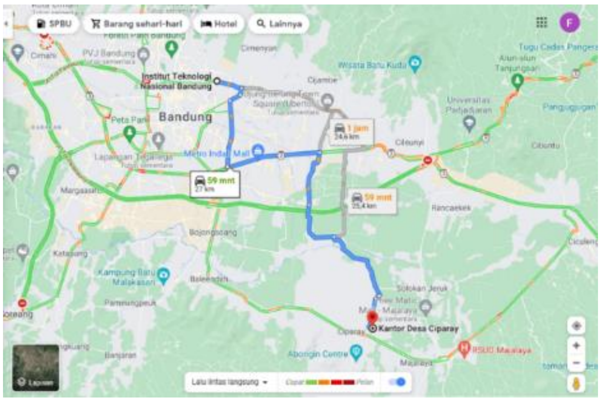

Figure 1. Ciparay Village Location Map

Ciparay Village is one of the villages located in Kabupaten Bandung. Most of the people there work as factory workers, traders, and farmers. Since 2020, the economic sector in the village has declined due to the COVID-19 pandemic. Many people lost their jobs, especially those working in factories. They turned to the agricultural sector. Ciparay is a rice-producing area. According to the Governor of West Java, Ridwan Kamil, he explained that the agricultural sector is one of the formidable fields in dealing with the Covid-19 pandemic **(Kompas.com, 2021).**

2. METHOD

The realization of this activity was carried out at the Ciparay village office from September to December. The process flow of the activities carried out from this activity can be seen in Figure 2.

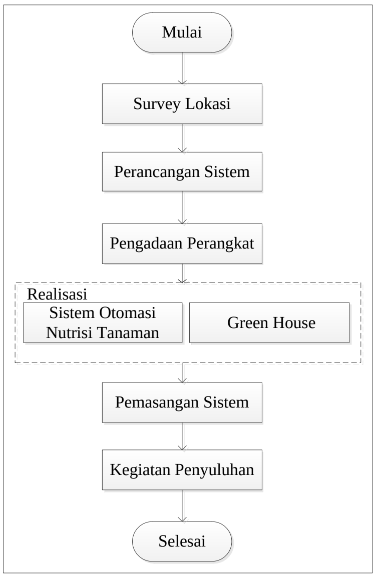

Figure 2. Flowchart for the implementation of activities

The design of this system consists of the greenhouse section and the control system section. The design made in the greenhouse is shown in Figure 3.

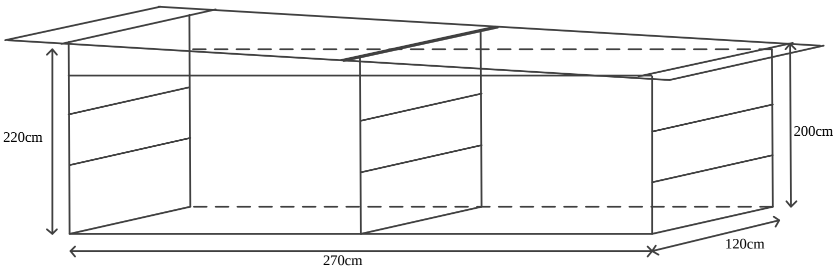

Figure 3. Greenhouse design

The dimensions of this greenhouse with LxWxH are 270cmx120cmx200cm. This greenhouse consists of two shelves to place pipes used as hydroponic plant stands. Each rack can accommodate as many as 12 pipes with a size of 2". The designed NFT system has a slope angle of ±5º on each pipe. The greenhouse is placed in an area condition as shown in Figure 4.

Figure 4. (a) Ciparay village office (b) vacant land on the 2nd floor of the office

In the control system section, this system is designed with a block diagram as shown in Figure 5.

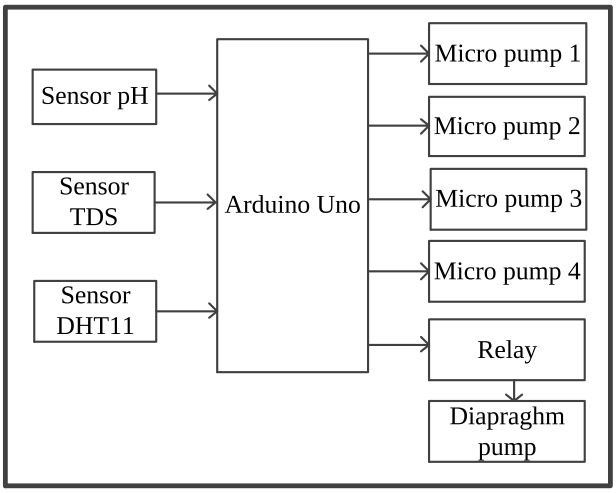

Figure 5. Block diagram system

The control system created for this hydroponic system is to control the nutritional conditions of plants and their environment. In-plant nutrition, the control carried out is on the pH and TDS parameters of the nutrients. In the environment, the parameters of humidity and air temperature are set. Some of the components used in this system, include the following:

a. Arduino Uno

Arduino Uno is an open source Atmega328 based microcontroller board. This device works on a voltage of 5V and the clock frequency used is 16MHz. The number of digital I/O ports this device has is 14 pins, and the analog input is 6 pins. The following Figure 6 shows the Arduino Uno device used in this activity.

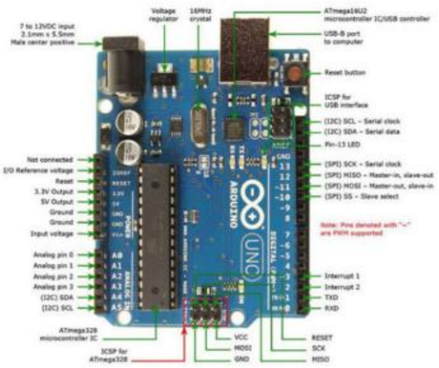

Figure 6. Arduino Uno

b. Potential of Hydrogen (pH) Sensor

The degree of acidity or pH is a very small hydrogen ion concentration, as the base-10 logarithm of the hydrogen ion concentration **(M.A.I. Shahrulakram, 2016)**. The content of pH, required by plants in a certain value to obtain optimal growth. If the pH is too high or too low, it will inhibit plant growth. Figure 7. shows the pH sensor used in this system.

Figure 7. pH SEN0161 Module sensor

c. Analog Total Dissolved Solids (TDS) Sensor

TDS (Total Dissolved Solids) is a quantity used to indicate how many milligrams of dissolved solids dissolved in one liter of water. In general, the higher the TDS value, the more dissolved solids dissolved in the water, and the less clean the water is. Therefore, the TDS sensor is used to measure plant nutrient levels in this system. Figure 8. shows the TDS sensor used in this system.

Figure 8. TDS Module Sensor

d. DHT11 Sensor

The DHT11 sensor is a sensor that is used to measure the humidity and temperature conditions of the air. This sensor requires a power supply of between 3volt to 5volt, with a maximum current consumption of 2.5mA. The humidity that can be measured using this sensor is 20-80% with an accuracy of 5%, and the temperature that can be measured is 0-50°C with an accuracy of ±2°C. The DHT 11 sensor is used in this system to monitor the humidity and temperature conditions of the environment around the hydroponic system. Figure 9. shows the DHT11 sensor used.

Figure 9. DHT11 Sensor

e. Micro Pump DC
Micro Pumps are small pumps that are usually used to control and manipulate small volumes of liquids. This device is commonly used in household electronic equipment, such as dispensers, juicers, coffee machines, etc. In the nutrition automation system, a micro pump device is used to control the pH up, pH down and ABmix nutrient solutions. The following is Figure 10. showing the micro pump used with the required power supply specifications of 12 volts.

Figure 10. Micro pump actuator

f. Submersible Pump
A submersible pump is used in the system to distribute plant nutrients to each hydroponic plant placed on a PVC pipe. This pump is used continuously for 24 hours. The specifications of this device are 45Watt, 2500 Liter/Hour, and the output water level is up to 2.5 meters. Figure 11 shows the submersible pump used.

Gambar 11. Submersible pump Kiyosaki PSP2300

g. Diapraghm Pump
This device is used to regulate the humidity of the air around the system, by being connected to a number of sprinklers. The pump specifications used are 12volt DC voltage, with a maximum power of 60-65Watt. The amount of pressure generated by this pump is

0.5 MPa and the water suction capability is 4L/minute. Figure 12. shows the diaphragm pump used.

Figure 12. Diapraghm pump

Based on Figure 5, the controller on this system uses Arduino Uno. The controller device receives data from the DHT11 sensor, pH sensor, and TDS sensor. The DHT11 sensor transmits information about the temperature and humidity conditions around the greenhouse. When humidity conditions are low, Arduino activates a relay that functions as a switch on the diaphragm pump to work to spray water around the greenhouse. The pH and TDS sensors have a function in controlling plant nutrients. To stabilize the pH of the nutrient solution, Arduino will control two micro pumps that can pump pH up and pH down solutions. Meanwhile, to stabilize the TDS condition of the nutrient solution, Arduino will control another micro pump that can pump solution A and solution B, which functions as a plant nutrient solution.

3. RESULTS AND DISCUSSION

The realization of this system is the production of a prototype of an NFT-based hydroponic system that uses an automation system to measure all parameters that affect plant growth. With this system, it can help the Ciparay village community in learning hydroponic cultivation. The following Figure 13 shows the realization of the system.

Figure 13. Realization of automation-based hydroponic NFT system

Fiberglass is used on the roof so that sunlight can enter the plants. Fiberglass material has a drawback, which is easily damaged due to excessive heat, so paranet is used to reduce the amount of light intensity that reaches the fiberglass. In addition, light intensity that is too large can affect plant growth.

In some parts of the water installation channel that has been made there are still leaks, but the water circulation has worked well. At the input of the nutrition channel in each pipe, blockages still occur frequently, so it is necessary to check regularly.

All sensors and actuators used are working properly, but regular monitoring is required. The monitoring function carried out is to ensure that all sensor devices used are working properly. This is due to environmental factors that can affect the performance of the sensors used. Figure 14, shows the measurement results of the pH sensor as one of the sensors used in this system.

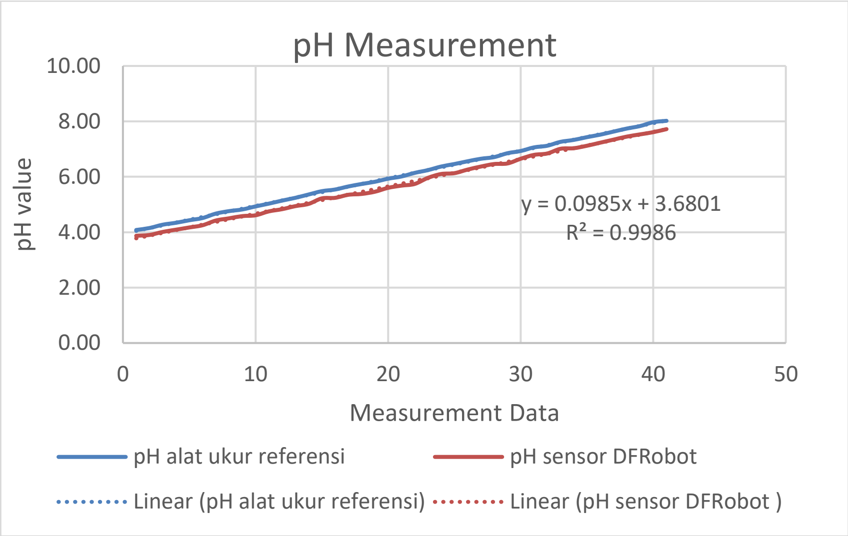

Figure 14. Analog pH Sensor Measurement Chart with Reference Meter

Figure 14 shows the linearity between the calibrated pH sensor and the pH meter, with a value of R2 = 0.9986. The average error value of this pH sensor is 5%. In addition to the pH sensor, the average error value generated on other sensors also has a small value, which is less than 10%.

4. CONCLUSIONS

Based on the system prototype that has been realized, all components used have worked according to the given settings. All of the sensor devices used have worked, but they need to be a monitoring process that is carried out regularly. These activities are necessary, to ensure that environmental factors do not affect the performance of all sensors. The actuator devices used, namely submersible pumps and Diapraghm pumps produce output with less than maximum water pressure for the greenhouse used.

Furthermore, villagers need to learn how to use this system. These activities are needed to teach about hydroponic cultivation. In addition, these activities are needed to teach how to use this system. the process of equipment maintenance and socialization regarding handling when damage occurs to the tool needs to be informed as well.

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