Journal of Experimental and Applied Physics
Journal Homepage: jeap.ppj.unp.ac.id
Vol. 2, No. 1, March 2024.
ISSN (Print): 2988-0378 ISSN (Online): 2987-9256

Hydroponic Plant Nutrition Measurement System Using Display Smartphone Internet Based Of Things

Dwina Melisa[1], Asrizal[1*], Yulkifli[1], Hufri[1], Harman Amir[1]

[1] *Department of Physics, Universitas Negeri Padang, Padang 25131, Indonesia*

Article History
Received : January, 25th 2024
Revised : February, 28th 2024
Accepted : March, 31st 2024
Published : March, 31st 2024

DOI:
https://doi.org/10.24036/jeap.v2i1.38

Corresponding Author
*Author Name: Asrizal
Email: *asrizal@fmipa.unp.ac.id*

Abstract: Hydroponics is an alternative for people who want to garden, but don't have enough space to grow crops. The most important issue that must be considered in cultivation is the provision of sufficient nutrients for plants. Lack of nutritional value results in less maximum yields. Nutritional measurements can be carried out without having to go to the cultivation site. The purpose of this study was to determine the performance specifications of the nutrient measurement system components for hydroponic plants. Determine the precision and accuracy of the nutrient measurement system on the results of limited-scale tests and field-scale test results. This type of research is engineering research. The data analysis technique used is descriptive data analysis and error analysis. From the data analysis it can be stated that three research results are first, the specification of system components includes sensor performance, ESP8266, LCD, Blynk. Second, the precision of the average nutrition on a limited scale is 99.97% and the average accuracy is 99.14%. Third, precision of nutrition on a field scale is 99.47% and the average accuracy is 99.14%. Field-scale test results were carried out for 3 days to obtain varied data. For cultivators of hydroponic plants it is useful for measuring nutritional value so they no longer make measurements manually.

Keywords: Internet Of Things, Hydroponic Plants, Nutrition Measurement, Smartphone Display.

1. Introduction

Indonesia is an agricultural country because most of the population earns a living in the agricultural sector. Physics is a scientific subject that emphasizes logic and is related to phenomena occurring in nature. Natural phenomena related to the field of physics in everyday activities can be explained using experimental methods. Indonesia is an agricultural country because most of the population earns a living in the agricultural sector. With a population that continues to increase, it

How to cite:
D. Melisa, Asrizal, Yulkifli, Hufri, and H. Amir, 2024, Hydroponic Plant Nutrition Measurement System Using Display Smartphone Internet Based Of Things, *Journal of Experimental and Applied Physics,* Vol.1, No.1, page 17-34.

is necessary to have a planting medium that can replace and minimize the use of soil as a planting medium. One of the cultivation of plants without soil media is hydroponics. Hydroponics is a method of cultivating plants that utilizes water without using soil by emphasizing the nutritional needs of plants [1]. Hydroponics is a cultivation system that is widely used by people, the hydroponic system has developed. Both the development in terms of methods and materials used. The basic principle of hydroponic plant cultivation is one of the efforts to engineer nature and regulate ideal environmental conditions for plant development and growth so that plant dependence on nature can be controlled [2]. One of the most important in the hydroponic process is the provision of regular nutrition. Providing adequate nutrition for plants is an important part that must be considered in hydroponic cultivation. The nutrient solution or formula is the basis for cultivation without soil, which is a complete set of nutrients for the needs of plants that are mixed in sufficient concentrations [3]. Hydroponic plants need adequate nutrition to grow properly. Good nutrition only has good quality if it has levels that are suitable for plants. Nutritional needs are the most influential thing in hydroponic cultivation on plant growth. Fertilizer is given in the form of a solution containing macro and micro elements in it. The nutrient solution is very influential for hydroponic plants because it is used as a supply of both macro and micro nutrients to support optimum plant growth, namely AB Mix solution. There are hydroponic nutrients or AB Mix in solid form (powder) and some in liquid form in bottles. Basically, nutrients in liquid form come from powders that have been dissolved, so buyers don't have to bother making AB Mix solutions, because this solution consists of nutrients A and nutrients B which are packed separately [4].

The addition of nutrients for nutrients in NFT hydroponics is usually done manually and checks are erratic. The value of Electrical Conductivity (EC) which is a unit of measurement contained in water will be measured using an EC sensor. The system will set the opening time of the Selenoid Valve which flows nutrients in the form of AB Mix or water to the reservoir in NFT hydroponics using the PID method [5]. In the implementation of hydroponics, of course, can not be separated from the nutrients used. The potential problems that often occur regarding the cultivation of hydroponic plants are the amount of water used that is not appropriate and nutrients that have variable values [6]. Monitoring of nutrients, temperature and water level in hydroponic farming can be seen on a website-based interface. The process of sending data from hardware to software so that it can be displayed on the website interface is carried out by NodeMCU [7]. NodeMcu is a microcontroller board that is equipped with wifi features and open source firmware. NodeMcu has several advantages including being open source, easy to program, affordable price and can support many sensors [8]. Microcontrollers have several advantages, namely the ability to create mathematical and logic functions, store and run a program. The microcontroller program can make decisions based on the desired situation [9]. The main problem faced by many in agriculture is the lack of technological mechanisms in agricultural activities. One solution is using a smartphone that can be taken anywhere and does not need to be connected to the telephone network using a cable. This application is a place for creativity to create graphical interfaces for projects that will be implemented only with the drag and drop widget method. The platform used is blynk, this application can control anything remotely, anywhere and at any time. Blynk is a platform for Mobile OS applications (iOS and Android) which aims to control Arduino, Raspberry Pi, ESP8266, WEMOS D1, and similar modules via the internet. Blynk can display data in graphical form on mobile-based applications [10]. With smart farming, you can reduce manual work and automate agricultural activities. Smart farming is an agricultural system that is supported by current technology to support maximum crop yields, this system aims to regulate and predict crop yields and the problems faced by farmers [11]. Hydroponics is one of the future agricultural systems because it can be done in various places such as in villages, cities, open fields or above apartments. The hydroponic plant cultivation system is the cultivation of plants without using soil as a plant medium with the addition of nutrients for growth [12]. The intelligent farming system that has been developed uses IoT sensor devices to turn off and turn on the sprinkler, measure nutrient levels, moisture and soil nutrients, monitor water conditions and measure crop volume when harvesting. IoT is an internet network that provides, processes and transfers digital information obtained from sensor equipment such as radio frequency identification (RFID), infrared sensors, GPS, scanners and smart meters [13]. Smart farming focuses on getting data and monitoring the environment on farms [14]. The measurement system is an activity to obtain quantitative data information. The results of obtaining quantitative data information, both data expressed in the form of numbers and descriptions, are very useful in making decisions, therefore the quality of information must be accurate. The sensor is used to measure a solid contained in water in millimeter units. The TDS sensor is a tool for measuring how much solid is dissolved in a solution. So it is very important in the measurement of hydroponic plant nutrition. Measurement of the TDS of nutrient solutions can be used as a reference to determine the addition of nutrients needed so that the concentration is in optimal conditions. The TDS sensor is used to determine the amount of dissolved solids in a solution. This sensor has two iron rods or probes that are aligned parallel. The distance between the two is about 1 cm with the iron length being 5.5 cm [15]. The design of a hydroponic plant nutrient measurement system aims to allow plants to grow well. Provision of nutrients for each plant according to what the plant needs. Hydroponic farmers don't have to take measurements on hydroponic plants every day. By paying attention to the timing of the nutrients to be added to the plants, it will maximize yields. Hydroponic farmers must check the PPM value of the solution on hydroponic plants every day using an EC meter. This is inefficient because hydroponic farmers are not always close to hydroponic land. The importance of the Internet of Things for hydroponic plants is so that hydroponic farmers can always monitor the nutrient levels needed by plants without having to go to the hydroponic plant location. In this research we will use lettuce plants, good nutrition for lettuce plants is 560-840 ppm. The nutritional value is below 560 to 840 ppm so farmers must add AB Mix nutrient solution so that the nutrient water is within normal limits. Optimal plant development requires proper regulation of nutrients and measurement of nutrients [16].

In field conditions, hydroponic farmers measure nutrients using an EC meter every day. Measurement of hydroponic plant nutrition is still done manually so it is not effective in making measurements. This is inefficient because not every time the hydroponic farmers are close to the hydroponic land. The solution to this problem is to design a hydroponic plant nutrient measurement system based on the Internet of Things. The importance of the Internet of Things in hydroponic plants so that hydroponic farmers can always monitor the levels of nutrients needed by plants without having to go to the hydroponic plants. researchers are interested in creating a "Hydroponic Plant Nutrition Measurement System with Internet Of Things-Based Smartphone Display".

2. Materials and Method

This research belongs to engineering. The research procedures carried out in this study consisted of ideas and clarity of tasks, conceptual design, geometric and functional arrangements, detailed designs, making prototypes/models, and testing.

A conceptual design will be prepared when the idea for the research has been discovered. Conceptual design is the stage of realizing an idea before forming a part of the research that will be created. The form of system design that will be created in this research is a system for measuring nutrients in hydroponic plants with a smartphone display based on the internet of things. The tool that has been made will be compared with a standard tool, namely the EC meter, with measurement results using the system. The tool that has been made will be compared with a standard tool, namely the TDS EC meter, with measurement results using the system. This tool can be used to measure the number of dissolved particles in drinking water and also used to measure the sensitivity of hydroponic nutrient solutions or in other words the concentration of nutrient solutions. The geometric and functional arrangement, at this stage all components are designed and arranged geometrically based on their function. The design form of the geometric arrangement can be seen in Figure 1.

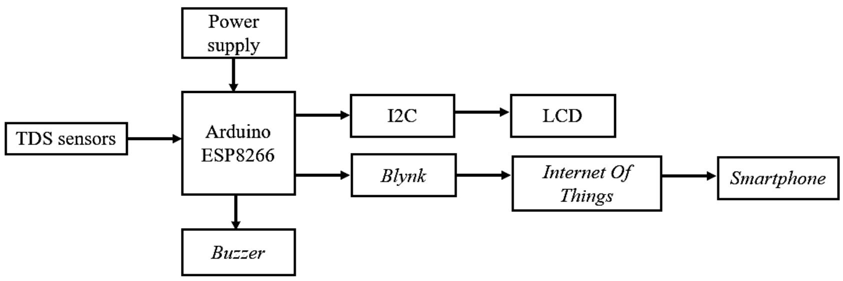

Figure 1. Block Diagram of the Nutrition Measurement System Structure

Based on Figure 1, it can be explained that a power supply is needed to activate the system circuit. Programming is carried out using the Arduino programming language. The TDS sensor is used to measure nutrition and the data is sent to the ESP8266, if the nutritional value read is below 560 ppm then the ESP8266 activates the buzzer, the data is displayed on the smartphone via the Blynk application using the WiFi network and displayed on the LCD. Fourth, the detailed design of the nutrition measurement system consists of hardware design and software design. The hardware design describes the physical part of the nutrition measurement system. While software design is related to measurement systems as instructions for hardware in completing work. The software design of the nutrition measurement system can be seen in Figure 2.

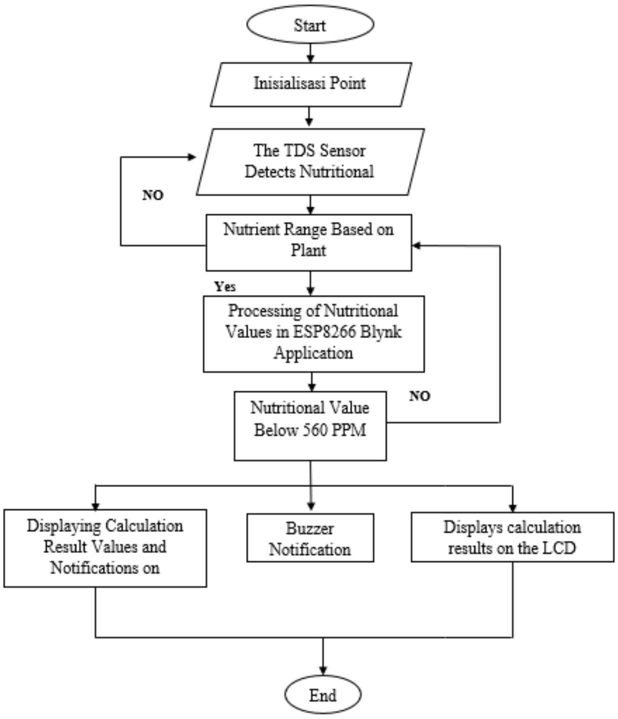

Figure 2. Flowchart of the Nutrition Measurement System

The flowchart in Figure 2 explains the nutrition program and measurements. The required nutritional value is entered, then the sensor will measure the nutritional value of the solution that is in the nutrient tank. In the measurement process there is a determined value and the TDS sensor will read the nutritional value, if the nutritional value read by the sensor is below 560 ppm then the ESP8266 will activate the buzzer, so the buzzer will sound as a sign that additional nutrition must be added, and vice versa if the nutritional value is above 560 ppm then the buzzer will stop sounding. Then the ESP8266 will give a signal to the smartphone to provide a notification that the nutritional value is below the specified value so additional nutrition must be added. To make it easier not to open the application on your smartphone every time. The nutritional value will be displayed on the LCD and will also be displayed on the smartphone. The nutritional value depends on the plant's needs. The hardware design in this study is divided into two, namely the limited-scale test design and the field-scale test design. The laboratory scale test design can be seen in Figure 3.

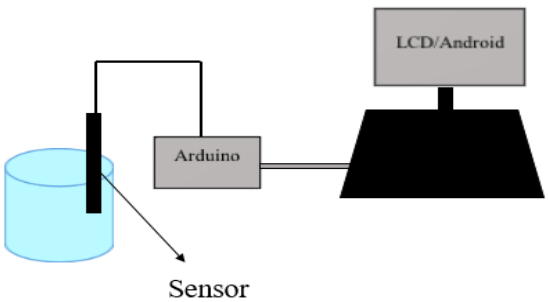

Figure 3. Limited Scale Test Design

Based on Figure 3 is a limited scale test design consisting of sensors connected to Arduino. Arduino connects to an LCD or Android and uses the Arduino programming language. The sensor is dipped into a tube containing the solution that will measure the nutrients. The nutritional value will be displayed on the Smartphone serial or LCD. If the nutritional value is below 560 ppm then the buzzer will sound, and conversely if the nutritional value is above 560 ppm then the buzzer will stop sounding. The field-scale test design is an illustration of the measurement of nutrient solutions applied to hydroponic plants. The design of a field-scale test for measuring nutrient solutions can be seen in Figure 4.

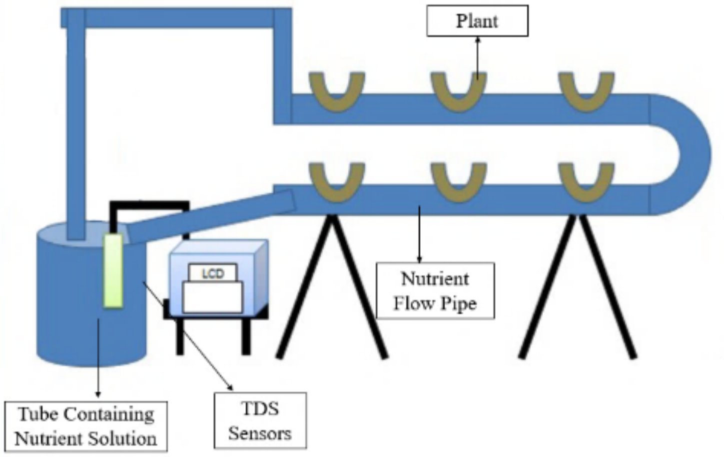

Figure 4. Field Scale Test Design

Based on Figure 4 it can be stated the form of product design for the field scale. The sensor is inserted into the nutrient container to measure the nutritional value. Measurement of nutrients in hydroponic plants consists of a power supply, a TDS sensor, a box containing a circuit, as well as an LCD, Android. The pipe from the nutrient solution tube will drain the solution into the hydroponic plants and the solution will flow back into the nutrient tube. Software is closely related to hardware performance. This software serves to provide instructions and run the measurement system. The nutrient measurement system for hydroponic plants will be made according to the design plan that has been described. The finished system will be tested for tools. If testing has been carried out on the tool, it can carry out experiments in this study.

The fifth is making a prototype/model, namely the stage of unifying all the components that make up the system. The manufacture of this nutrition measurement system is made with acrylic material that has been designed and cut according to predetermined sizes. The sixth is testing, at this stage all components have formed a complete experimental tool, tests are carried out such as accuracy, thoroughness, accuracy and error of the hydroponic plant nutrient measurement system tool with a smartphone-based display. This research uses data collection techniques through measurements of the physical quantities contained in the system. Measurement techniques carried out include two ways, namely directly and indirectly. Direct measurements are measurements that do not depend on other quantities. Indirect measurement is the measurement of a number whose value is influenced by other quantities and the value is not directly obtained. The data obtained directly are time, nutritional value, output voltage. Meanwhile, data from indirect research is the accuracy and accuracy of the sensors as well as the measurements obtained.

Data analysis techniques are carried out to get conclusions. Data analysis techniques from this study consisted of descriptive analysis techniques and error analysis. Descriptive analysis is a statistical analysis that provides a general description of the characteristics of each research variable consisting of means, pareto charts and tables. While the error analysis consists of the percentage of errors, precision and accuracy. After the measurement and calculation data are obtained, the data analysis technique is carried out graphically and statistically, graphics are useful for providing visual results in describing the relationship between the two variables obtained from measurements and calculations. The data plot aims to determine the relationship between the variables measured. This is done by plotting the data at XY coordinates using the Microsoft Excel program. The general technique used to plot data on an XY graph is the independent variable on the X axis and the dependent variable on the Y axis. Data analysis is carried out to draw conclusions.

3. Results and Discussion

Farming with a hydroponic system requires nutrients as a food source for plants. The hydroponic system is the cultivation of plants by placing plant roots in a shallow layer of water that circulates and contains nutrients according to the needs of the plants. Caring for hydroponic plants must be done properly and correctly in order to get healthy crops and grow well. Always check the condition of the water in the holding tank, check the condition of the nutrient solution, clean the planting media container and nutrient solution, maintain environmental sanitation.

The sensor used in the nutrition measurement system is the TDS sensor. The TDS sensor is used to measure nutrients. The probe from the sensor is inserted into the reservoir containing the nutrient solution to measure the ppm value of the solution. The sensor position can be shown in Figure 5.

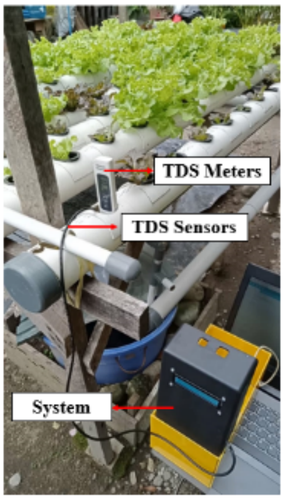

Figure 5. Sensor Position In Plants

Figure 5 is the position of the sensor on a hydroponic plant, the data obtained from the measurement is used to calculate accuracy, precision and accuracy. presentation of data presented in the form of tables and graphs. The performance specifications for the components of the nutrition measurement system include the performance specifications for each component. First, the performance of the TDS meter sensor has the performance of changing the nutritional value in the solution into an electrical signal in the form of analog data. Before the sensor is used for measurement, it is necessary to calibrate it using a standard measuring instrument so that the data can be used. Before the sensor can be used for measurement or measurement, it is necessary to calibrate it using standard measuring instruments so that the data can be used. Calibration is a series of activities to compare or establish a relationship between a measurement system with known values or quantities that have been measured under certain conditions. Relationship between. Calibration data uses the voltage value at the sensor output.

The reading calibration is obtained from the comparison between the sensor voltage and the nutritional value on the TDS&EC Meter. The relationship of these two quantities produces a polynomial graph with a relationship efficiency of 0.9557. The sensor used in the nutrition measurement system is the TDS sensor. This sensor serves to measure the level of nutrient solution. Data from sensor testing results can be seen in Table 1.

Table 1. Data On Sensor Test Results

No	Solution (ml)	EC Meter (ppm)	SPNTH (ppm)	Error Percentage (%)	Precision Percentage (%)
1	1	422	410	2.84	97.16
2	2	548	538	1.82	98.17
3	3	628	634	0.95	99.05
4	4	718	713	0.69	99.31
5	5	792	787	0.63	99.37
Average				1.39	99.61

Based on Table 1 it can be explained the comparison of standard tool measurements with TDS sensors. The ppm value was measured with each addition of 1 mL of AB Mix solution mixed with water. The precision of the test results ranges from 97.16% to 99.37% with an average of 99.61%. the percentage of errors ranged from 2.84% to 0.63% with an average of 1.39%. The output voltage from the TDS sensor is 3.3 Volts to 5.5 Volts. The value of the output voltage on the TDS sensor from 0 to 2.3 Volts. The sensor probe must be immersed in a nutrient solution in order to take a measurement. The output signal from the sensor is in the form of a voltage and the sensor is connected to the NodeMcu so that the voltage from the sensor can also appear on the serial monitor.

The two performances of ESP8266, namely ESP8266 functions as a data processor, ESP8266 is a microcontroller that is commonly used for the benefit of the Internet of Things because its facilities are equipped with wifi to connect to the internet. The ESP8266 microcontroller is used as the main controller of the circuit as the main controller of the electronic circuits used. ESP8266 has input as input and output as output that can control electronic components and equipment. The ESP8266 module series is used to send sensor data to Blynk online. Designing ESP8266 WiFi module programming as sending sensor data to the Blynk server. The performance of the LCD, namely the LCD (Liquid Crystal Display) is used to display the results of the TDS sensor data. From the LCD shows the display results in accordance with the program that has been made. Placement of characters is in accordance with the desired. The LCD is used to display the results of the tool data that has been run.

Monitoring TDS in real time on the LCD monitor. First the TDS sensor is inserted into the nutrient water, after that the results from the sensor will be sent to the microcontroller which will be processed to determine the level of accuracy of the nutrient content for hydroponic plants and these results will be displayed on the LCD to find out the nutrient levels in the plants. LCD test results data can be seen in Figure 6.

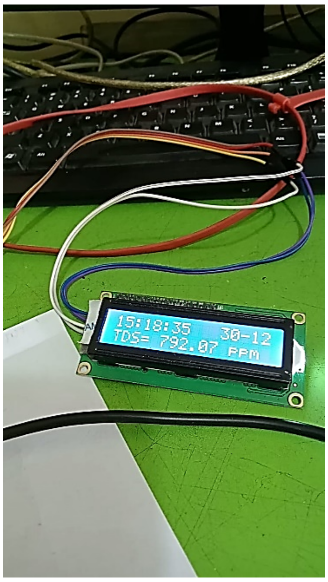

Figure 6. LCD Test Result Data

Based on Figure 6 it can be seen that the measured data can be read on the LCD. On the LCD you can read the results of nutrition measurements in units of ppm, the time and date of measurement. Data that has experienced a measurable increase.Data display on the LCD is displayed in realtime. The four performances of Blynk are the blynk application used to support the Internet of Things project. This server service has a mobile user environment for both Android and iOS. Blynk supports a variety of hardware that can be used for internet of things projects. The Blynk application has three main components, namely Applications, Servers, and Libraries. Tests on the software are carried out to determine the connectivity of the circuit with the Blynk application and also smartphones. From the results of testing Wifi connectivity works based on distance. The results of testing the Blynk application can be seen in Figure 7.

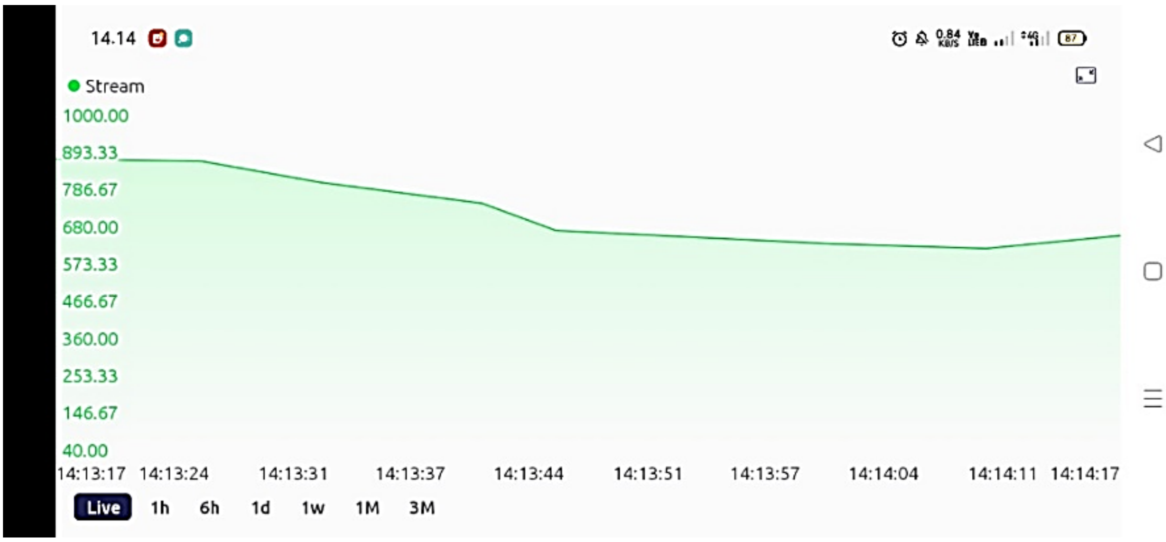

Figure 7. The Results of the Blynk Application Test

Based on Figure 7 it can be explained that the data on the results of measuring nutrients in hydroponic plants can be read through the Blynk application in graphical form. After the results will be issued using the Output pin obtained on the ESP8266 in the form of a display and a WiFi signal on the smartphone. In the test results, it was stated that Blynk could work according to the instructions in blynk. To make it easier to understand the shape of the nutrient measurement system for hydroponic plants, it can be seen in Figure 8.

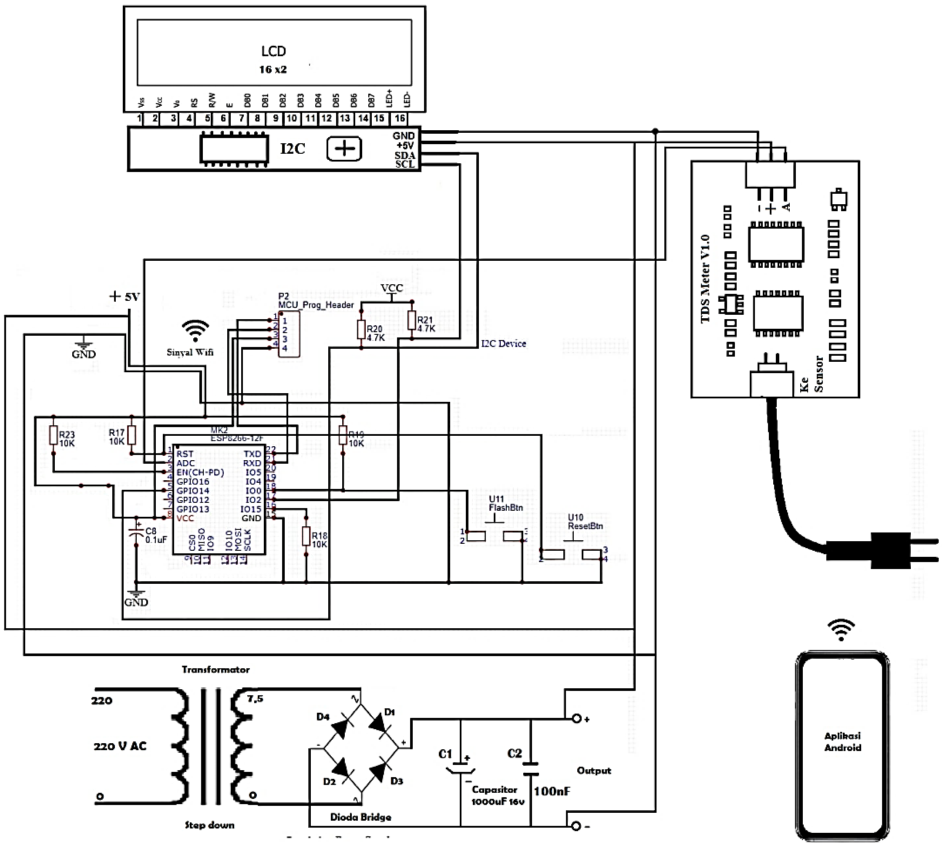

Figure 8. Series of Nutrition Measurement Systems

Based on Figure 8, it can be explained that the ESP8266 functions as a data processor, where the ESP8266 receives input from the TDS meter sensor and then calculations are carried out by the system using programming techniques which will later be calibrated according to measurement standards by comparing using standard measuring instruments. Once the results are obtained, they will be output using the Output pin on the ESP8266 in the form of a display using the LCD and WiFi signal on the smartphone. If the nutritional value is below what has been set, the ESP8266 will activate the buzzer as an alarm that additional nutrients must be added.

The next component is the TDS EC meter sensor which has the performance of converting the nutritional value in the solution into electrical signals in the form of analog data. This TDS sensor has a very important role in the tool because it can determine the values of the solution which is changed to another form which can be accessed by the ESP8266. The LCD functions as a display that can display values that are useful for collecting data and displaying the results of data processing from the ESP8266.

The power supply plays an important role as a power provider to activate the entire circuit in the device, without a power supply the device cannot work. Smartphones are useful for displaying the results obtained from the WiFi signal issued by the ESP8266, smartphones are very useful for users who display the results of existing data on plant conditions or changes in nutrient solutions. After successfully designing a hydroponic plant nutrition measurement system, the next step is to carry out a calibration test process and sensor characteristics on the samples that have been prepared. The next component is the buzzer, the buzzer requires an electrical voltage input which is then converted into sound vibrations or sound waves which have a frequency ranging between 1-5 KHz, the buzzer works on DC voltage. The buzzer application is usually used as a system indicator that states certain conditions. The buzzer is usually used as an indicator that the process has been completed or an error has occurred with a tool. Buzzer test results can be seen in Figure 9.

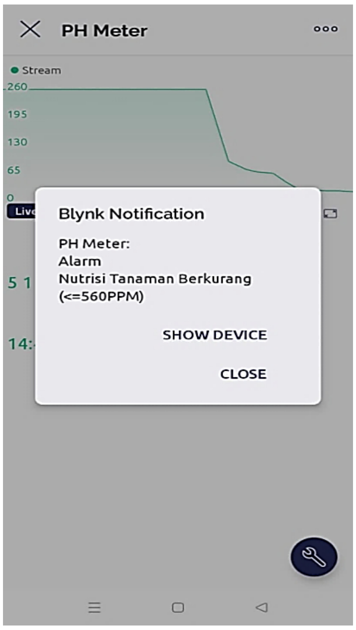

Figure 9. Blynk Application Testing Results

Based on Figure 9, it can be explained that the buzzer is used as an indicator alarm, where if the nutrients in the reservoir are less than 560 ppm, the buzzer will sound, and conversely, if the nutritional value is above 560 ppm, the buzzer will stop sounding. The circuit box is useful as a place to store the electronic circuits of the nutrition measurement system. The part of the frame box consists of the front, back and sides. The overall design of the tool can be shown in Figure 10.

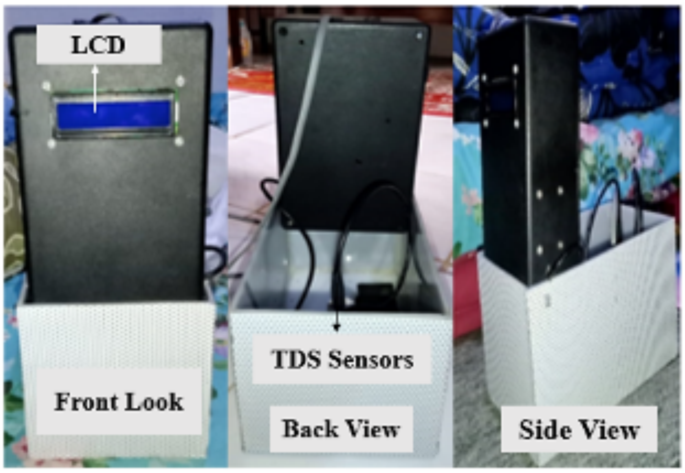

Figure 10. Overall Design of Hydronic Plant Nutrient Measurement System

Figure 10 is the result of the overall design, the circuit box used in this nutrition measurement system is black with a size of 14.5 cm x 9.5 cm x 5 cm. On the front of the circuit box there is an LCD. On the side of the circuit box there are several cables including sensor cables and power supply cables. Part of the contents of the circuit box can be shown in Figure 11.

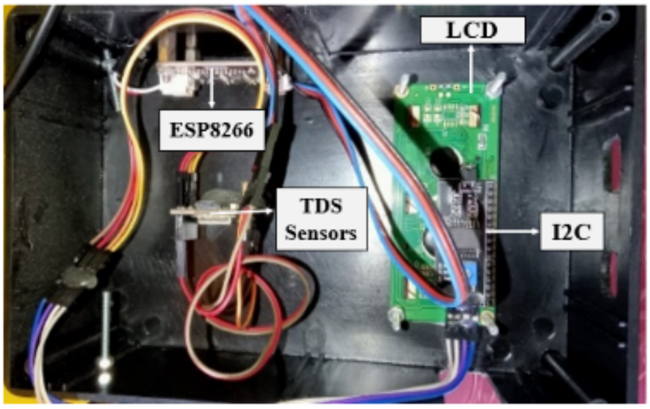

Figure 11 Contents of the Circuit Box

In Figure 11 it can be explained that the contents of the circuit box contain a Mcu Node, connecting cable, LCD. The source of the Mcu uses a 5 Volt power supply. NodeMcu is a microcontroller that can send data to Blynk via wifi. From NodeMcu it will be programmed on Arduino and data can be displayed on the serial monitor and Blynk. The circuit box used in this nutrition measurement system is black with a size of 14.5 cm x 9.5 cm x 5 cm.

Accuracy and precision nutrition measurement system on the results of limited scale tests. The nutrition measurement system on the results of this laboratory scale test was carried out in several experiments, namely the precision and accuracy of the measurement system. The results of the measurement of nutritional value were compared with a standard measurement tool. Measurements were carried out without plants for 4 days, during which the nutrient solutions used were 600 ppm, 1000 ppm, 1100 ppm and 1200 ppm. The precision of measurement is determined by comparing the measurement data on the sensor with the result data on a standard measuring instrument. Based on the calculation results can be determined the percentage of accuracy. Data from the comparison of the TDS sensor with standard measuring instruments can be seen in Table 2.

Table 2. TDS Sensor Comparison Results Data With Standard Measuring Instruments

Orde	EC Meter (ppm)	SPNTH (ppm)	Precision Percentage(%)
1	600	598	99.67
2	1000	995	99.5
3	1100	1095	99.54
4	1200	1190	99.16
	Average		99.47

In Table 2 a comparison of standard measuring instruments and sensors can be explained. The precision of the measurement results ranges from 99.5% to 99.67% with an average value of 99.47%. Accuracy can be determined from the similarity of measurement results based on repeated measurements of 10 times. Based on the results of repeated measurements, the percentage of accuracy is obtained. Accuracy data from the nutrition measurement system can be seen in Table 3.

Table 3. Accuracy Data From Nutritional Measurement Systems

Orde	Nutrition After Measurement (ppm)	% Accuracy
1	602	98.35
2	599	98.85
3	597	99.18
4	595	99.51
5	593	99.85
6	591	99.81
7	589	99.48
8	587	99.14
9	585	98.80
10	583	98.46
Average	592.1	99.14

In Table 3 it can be explained that the accuracy values range from 602 ppm to 583 ppm. Measurement of nutritional value was carried out 10 repetitions. The results of nutritional measurements can be seen with accuracy ranging from 98.35% to 98.46% with an average accuracy of 99.14%.

Precision and accuracy of the nutrition measurement system on field-scale test results. The nutrition measurement system on the results of field-scale tests with plants carried out for 3 consecutive days obtained various data results. Field-scale testing using lettuce plants with a nutritional value of 650-840 ppm. On the first day of field testing, the sensor was placed in a nutrient container where the water continued to flow into the hydroponic pipe. The plants used were lettuce with a nutritional value range of 560-840 ppm. The measured nutritional value is around 849 ppm to 750 ppm. Nutrition data can be seen in Blynk with a graphical display. Data on Blynk can be seen in Figure 12.

Figure 12. PPM Data For the First Day Test

Based on Figure 12 the measured ppm values are in the range of expected values. The nutritional value on the first day varies from 850 ppm to 750 ppm. On the first day of field testing, the measured nutritional value decreased. The nutritional values measured on the first day of field testing were within the specified range of nutritional values. The method of testing the nutrition measurement system on the second day was also the same as the first day. The TDS sensor is placed in the solution container. Data on the nutritional value of Blynk can be seen in Figure 13.

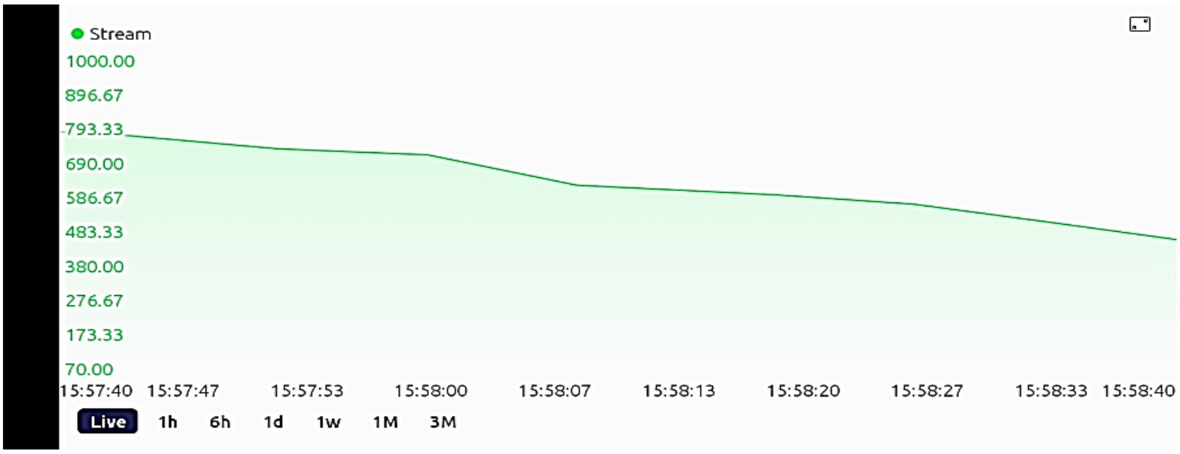

Figure 13. PPM Data For Second Day Testing

Based on Figure 13 the measured ppm values are in the range of expected values. The nutritional value on the first day varies from 735 ppm to 578 ppm. On the second day of field testing the measured nutritional value decreased. The measured nutritional values on the second day of field testing were within the specified range of nutritional values. On the third day of testing there was the addition of a nutrient solution, because on the third day the nutrients in the plants were not as expected. Data on the nutritional value of Blynk can be seen in Figure 14.

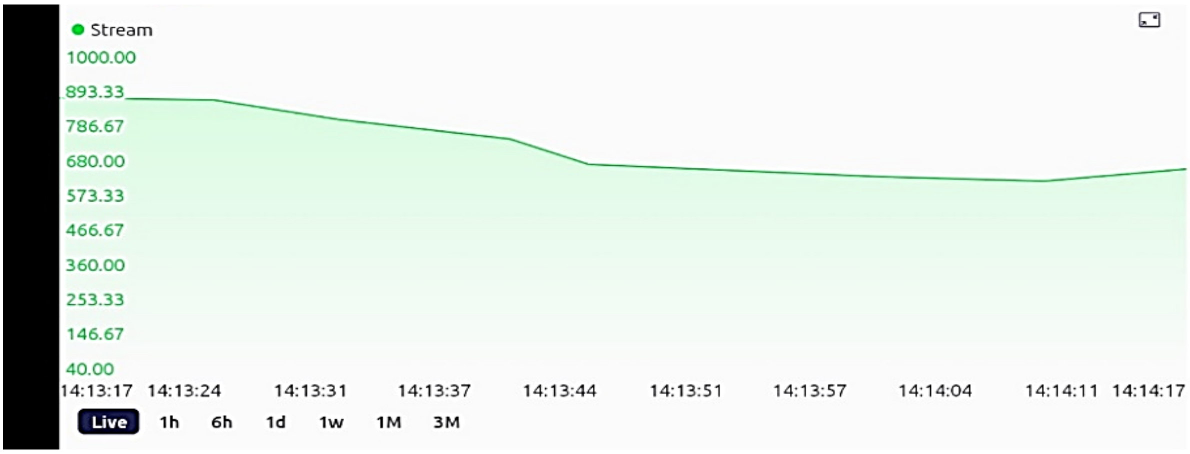

Figure 14. PPM Data On the Third Day Of Testing

Based on Figure 14 the measured ppm value is within the expected value range. The nutritional value on the first day varies from 735 ppm to 578 ppm. The nutritional value measured on the third day of field testing was within the specified nutritional value range. Based on the analysis that has been carried out, it can provide research results that are in accordance with the research objectives. The research results obtained are the performance specifications of the components of the hydroponic plant nutrient measurement system, the accuracy and accuracy of the nutrient measurement system on a limited test scale, and test results on a field scale. Activities before conducting research start from preparing the tools to testing the tools.

The first result of the research achieved was the component performance specifications of the nutrition measurement system including the performance of each part of the measurement system. The components contained in this measurement system are power supply, LCD, TDS, ESP8266, Blynk, Buzzer. The sensor used is a TDS sensor with an output signal in the form of voltage. This sensor has two parallel iron rods and is used by dipping the probe or electrode from the sensor into the solution. The TDS sensor is a sensor used for measurements, the measured values will be accessed by the ESP8266. The ESP8266 receives input from the TDS sensor and is then calculated by the system using a programming language which will previously be calibrated by comparing with standard tools. After the results are obtained, they will be output using PinOutput on the ESP8266 in the form of a display using the LCD and the blynk application on the smartphone.

The output voltage measurement is not only measured on the sensor, but also the voltage on the Mcu and Blynk nodes. The voltage on the NodeMcu is displayed on the Arduino serial monitor and on Blynk it is displayed in graphical form. The effect of the results of measuring the output voltage at these three points and the measured nutritional values on the TDS&EC Meter will be plotted to form a graph which will produce an equation. The graph plot obtained can be concluded that the output voltage is directly proportional to the nutritional value. The greater the amount of dissolved solids, the greater the output voltage of the sensor. This is because the large number of ions in solution is directly proportional to the value of the amount of solute. The more ions in the solution, the greater the potential difference that can be generated, which indicates the greater the amount of dissolved solids.

The next experiment is the precision and accuracy of the nutritional value measurement system on the results of a limited scale test. The results of measuring the nutritional value were compared with a standard measuring instrument, namely the TDS&EC Meter and the results were close. The precision value is obtained from a comparison of the measurement results from the sensor with a standard measuring instrument. Accuracy is obtained from repeated measurements. Measurement of the nutritional value of hydroponic plants was carried out 10 repetitions. The accuracy (precision) of a measuring instrument is determined by means of calibration under certain operating conditions and can be expressed in the form of a percentage or at a specific measurement point. A good measuring instrument has an accuracy close to 1 or 100.

The next experiment is the precision and accuracy of the nutritional value measurement system on the field scale test results. Field scale test results were carried out for 3 consecutive days. Testing on a field scale starts from 07:00 to 18:00. Field-scale tests were carried out on lettuce plants that had a nutritional value range of 560 ppm to 840 ppm. In field testing for 3 days various data were obtained. On the first day of field testing the measured nutritional values were within the expected range so no addition of AB Mix solution was needed. On the second day of field testing it was also the same as the first day, namely the measured nutritional values were in the expected range so there was no need to add AB Mix solution. On the third day of testing the nutritional value was below the expected range so that AB Mix solution was added.

Based on research, it can be compared that this tool can be used to measure hydroponic plant nutrient solutions, the measurement results can be seen via smartphone and LCD. Farmers do not need to check nutrition manually every day. This tool is equipped with a buzzer as an alarm if plant nutrients decrease, a notification will be sent to the smartphone.

4. Conclusion

Based on the results of testing and data analysis and discussion of the nutrient measurement system for hydroponic plants, several conclusions can be formulated. Results of performance specifications for hydroponic plant nutrition measurement system components consisting of performance specifications for TDS, ESP8266, LCD, Blynk and Buzzer sensors. Second, the accuracy and accuracy of the nutritional measurement system on limited scale test results. The results of nutritional value measurements are compared with standard measuring instruments. Measurements were carried out without plants for 4 days, during which the nutrient solutions used were 600 ppm, 1000 ppm, 1100 ppm and 1200 ppm. The accuracy of the measurement is determined by comparing the measurement data on the sensor with the result data on a standard measuring instrument. The accuracy value of the measurement results ranges from 99.5% to 99.67% with an average value of 99.47%. Accuracy can be determined from the similarity of measurement data based on repeated measurements 10 times. accuracy values range from 602 ppm to 583 ppm. Nutritional value measurements were carried out 10 times. Data from nutritional measurements can be seen with accuracy ranging from 98.35% to 98.46% with an average accuracy of 99.14%. Third, 3. The accuracy and accuracy obtained from the nutrition measurement system are 99.47% and 99.14%. Accuracy and precision of the nutrient measurement system in field scale test results. The results of field scale tests were carried out for 3 consecutive days and obtained different values. On the first and second days the measured nutritional values were within the expected range. On the third day of testing, the nutritional value decreased, so the ESP8266 activated the buzzer as a notification that the nutrient solution had to be added. Accuracy on the first day was 99.00%, on the second day it was 99.04% and on the third day it was 99.14%.

Acknowledgments

Thanks to Deny hydroponics for providing a place for research and allowing me to use plants as research objects.

References

[1] R. Yudha Koswara and N. Kadarisman, "Otomatisasi Pengendalian Cara Pengairan dan Pemberian Nutrisi pada Sistem Tanam Hidroponik untuk Tanaman Selada (Lactuca sativa L.)," *Journal Fisika*, 2016.

[2] N. Sharma, S. Acharya, K. Kumar, N. Singh, and O. P. Chaurasia, "Hydroponics As An Advanced Technique for Vegetable Production: An Overview," *J Soil Water Conserv*, vol. 17, no. 4, p. 364, 2018, doi: 10.5958/2455-7145.2018.00056.5.

[3] E. Tando, B. Pengkajian, T. Pertanian, and S. Tenggara, "Review : Pemanfaatan Teknologi Greenhouse dan Hidroponik Sebagai Solusi Menghadapi Perubahan Iklim dalam Budidaya Tanaman Hortikultura," 2019.

[4] M. F. Rustan, M. Fuad Mansyur, and M. A. Akbar, "Smart Hydroponic Monitoring Based on the Internet of Things," *JCIS (Journal of Computer and Information System)*, vol. 4, no. 2, pp. 51–61, 2021, doi: 10.22146/jcis.xxxx.

[5] M. Ikhlas[1] and S. M. T. [2] Sony, "Design of Controlling Nutrients in Hydroponics Nft (Nutrient Film Technique) Using Pid Method Design of Controlling Nutrients In Hydroponics (Nutrient Film Technique) Using PiD," *e-Proceeding of Engineering*, vol. 5, no. 1, pp. 79–85, 2018.

[6] D. Ambarwati and Z. Abidin, "Rancang Bangun Alat Pemberian Nutrisi Otomatis pada Tanaman Hidroponik," *Jurnal Teknologi dan Sistem Informasi (JTSI)*, vol. 2, no. 1, p. 29, 2021, [Online]. Available: http://jim.teknokrat.ac.id/index.php/JTSI

[7] E. Yudaningtyas, *Belajar Sistem Kontrol: Soal dan Pembahasan*. Malang: UB Press, 2017.

[8] L. S. Ode Hasnuddin Sagala and M. Sainal Abidin, "Internet of Things For Early Detection of Lanslides," in *Seminar Nasional Risey Kuantitatif Terapan*, 2017, pp. 113–115. [Online]. Available: http://thinger.io.

[9] J. Lovine, *Pic Microcontroller Project Book*. USA: MC Graw Hill Book Company, 5555555555852000.

[10] N. A. Noor, K. Naim, Sofyan, and Asriyadi, "Implementasi Webserver Thingspeak pada Alat Ukur Parameter Portable Solar Panel," in *Prosiding Seminar Hasil Penelitian (SNP2M)*, Telekomunisasi…, 2018, pp. 121–128.

[11] T. Hidayat, "Internet of Things Smart Agriculture on ZigBee: A Systematic Review," *Jurnal Telekomunikasi dan Komputer*, vol. 8, no. 1, p. 75, Dec. 2017, doi: 10.22441/incomtech.v8i1.2146.

[12] S. A. Pohan and O. Oktoyournal, "Pengaruh Konsentrasi Nutrisi A-B Mix Terhadap Pertumbuhan Caisim Secara Hidroponik (Drip system)," *LUMBUNG*, vol. 18, no. 1, pp.

20–32, Jan. 2019, doi: 10.32530/lumbung.v18i1.179.

[13] J. A. Momoh, "Smart Grid Design for Efficient and Flexible Power Networks Operation and Control," in *IEEE/PES Power Systems Conference and Exposition*, IEEE, 2009, pp. 1–8.

[14] M. Ryu, J. Yun, T. Miao, I. Y. Ahn, S. C. Choi, and J. Kim, "Design and implementation of a connected farm for smart farming system," in *2015 IEEE SENSORS - Proceedings*, Institute of Electrical and Electronics Engineers Inc., Dec. 2015. doi: 10.1109/ICSENS.2015.7370624.

[15] Weli Erlina and Asrizal, "Pengembangan Sistem Pengontrolan Konduktivitas Listrik Larutan Berbasis *Internet Of Things* Untuk Tanaman Hidroponik," *Pillar of Physics,* Vol. 13, Universitas Negeri Padang, 2020.

[16] D. R. Wati and W. Sholihah, "Pengontrol pH dan Nutrisi Tanaman Selada pada Hidroponik Sistem NFT Berbasis Arduino," *Jurnal Multinetics*, vol. 7, no. 1, pp. 12–21, 2021.