Monitoring pH in Hydroponics Using the Blynk Application

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ABSTRACT

Indonesia is an agrarian country, with a 40% level of livelihood of the population being farmers. However, the widespread conversion of agricultural land functions into settlements and industry in Indonesia is an additional problem in the agricultural sector. This is the basis for new innovations in agriculture, namely hydroponics. In its use, hydroponics is able to minimize land use but requires a long time to monitor its growth. This study uses a pH sensor to read acidity data in hydroponics with the wick system method which works using a wick as an intermediary to absorb nutrient solutions from the reservoir to the plant roots. In this study using the experimental method with data collection every 30 minutes for 12 hours. The pH sensor generates a voltage value which will be converted to a pH value. The value will be sent to the Blynk application in real-time. The results obtained in this study were that the celery plant had an accuracy value of 98.33% and the tomato plant had an accuracy value of 98.68% while the pakcoi plant had an accuracy value of 98.45%. This research can be said to be successful, this is indicated by the high accuracy value of celery and pakcoi plants and the appearance of data on the Blynk application.

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1. INTRODUCTION

As the era develops, technology advances so quickly and it is evident that there are many new technologies. One of them is in the field of agriculture, namely hydroponics. Hydroponic cultivation is very beneficial for urban communities because it only requires a small amount of land [1]. This method is very easy because in the process of planting it only uses water [2]. So hydroponics can be called agricultural activities that are carried out without using soil but still use water as a substitute medium [3][4]. This cultivation is an alternative choice for people who want to grow various plants that can be consumed for daily life [5].

Hydroponics is a solution to farming or gardening without having to utilize a large area of land, so this method is good for use in urban areas [6]. However, this method has a drawback, namely, it requires a monitored environment, one of which is the level of acidity of the plant. And monitored to avoid a decrease in plant quality until the plant withers or dies. Some ways can be done by using the manual method which will actually be a waste of time if the hydroponic system is on a large scale or the owner does not have time for it due to his busy work schedule [7]. Then there must be a solution to monitor the state of the plant so that it matches the expected conditions. Internet of things (IoT) is a technology that supports communication from device to device using the internet as a connector [8]. IoT can provide remote data through a computer that has been connected to the internet by translating the programming language that has been entered on the microcontroller. The microcontroller that has been connected to the internet will be connected to the hydroponic reading results will be sent to the bynk application via android in real time [9].

The wick system is a very easy method of hydroponic cultivation. This hydroponic method works like an oil stove through a wick. The wick hydroponic system uses water-absorbent media such as flannel fabric [10].

This method is a hydroponic method that uses the principle of capillarity in water. The nutrient solution flows into the growing medium through the wick as an intermediary medium. This system is very simple and very suitable for those who want to start growing with the hydroponic method [11].

Pakcoi (*brassica rapa var. chinensis*) is a vegetable that comes from China [12]. In Indonesia, it is often called spoon mustard because it resembles a spoon, this plant grows slightly upright with a height of approximately 15 to 30 cm. This vegetable has many health benefits, including for the eyes, because pakcoi contains vitamin A. In addition, pakcoi also has vitamin E which is beneficial for skin health. This vegetable can be cultivated anywhere either lowland or usually pakcoi can be harvested at the age of 30-35 days after the seeds are sown [13]. The optimal pH of pakcoi is 7.0.

Celery (*Apium graveolens L.*) is a plant that has many benefits, especially as a vegetable and medicine. It is usually used as a vegetable, leaves, petioles, and bulbs for soup mixes. Leaves are also eaten as a salad, or used as a complement to food by sprinkling it on top. Celery is said to have anti-hypertensive properties. Other properties are as a diuretic, anti-rheumatic and appetite generator (*carminativa*) [14]. This plant can be cultivated in the lowlands and highlands, especially in mountainous areas the ideal planting time for this plant is at the beginning of the rainy season or the end of the rainy season. The optimal pH of celery is 6.5 [15].

Tomato or (*Lycopersicon esculentum mill*) is a fruit vegetable that is classified as a shrub-shaped annual plant and belongs to the solanaceae family [16]. The fruit is a source of vitamins and minerals. The use is getting bigger because in addition to being consumed tomatoes are also for seasoning and can also be processed as raw materials for the food industry such as juice and tomato sauce. Tomato plants are one of the agricultural commodities that are much needed by the community. Most farmers plant tomatoes in a conventional way in fields, fields or gardens without any control and measurement, relying only on experience and habit factors, so that the pH needs of tomato plants cannot be given according to their needs, while the pH needs of tomato plants are 6.5 [17].

Therefore, pH monitoring is needed in hydropinic plants so that the pH conditions in these plants are in optimal pH conditions. This monitoring is done through a smartphone with the Blynk application that supports IoT features. Using a microcontroller device equipped with wifi such as a programmed NodeMCU ESP8266, then for the sensor used pH sensor.

2. METHODS

Before designing the pH monitoring system in hydroponics using the Blynk application, a literature study was carried out first. collecting papers, deepening topics, and all references related to the internet of things and Blynk that can support the design of this research. using experimental methods as a method of data collection. Using McuESP8266 Node and Blynk to see the reading result.

3. RESULTS AND DISCUSSION

3.1. Testing the pH Sensor

This pH sensor test aims to see the accuracy of the pH sensor used as a sensor that will be used to measure the pH of hydroponics. How to obtain a pH value with a range of 0-14 needs to be calibrated first by comparing the voltage with a buffer solution with levels of 4.01 as an acidic solution and 6.86 as a neutral solution. In this process using the equation (1).

$$pH\ Voltage = Analog\ \times \left(\frac{5.0}{1024}\right) \tag{1}$$

where,
Analog is the number read by the pH sensor, 5.0 is the maximum voltage number used on Arduino, 1024 is the maximum analog number read by the sensor.

To obtain the analog conversion value read to the voltage value, with the distance of the analog value produced by the pH sensor of 0-1024 and the distance of the voltage value sought from 0-5 volts. From the test results obtained a voltage value of 2.4 volts at pH 4.01 buffer solution and 2.11 volts at pH 6.86 buffer solution. Calibration value obtained by calculation in equation (2).

$$y = ((x\_A - x\_B))/((B - A)) \tag{2}$$

with,
y is the alibration number, x_A is the voltage test result of sample A, x_B is the voltage test result of sample B, A is sample A, and B is sample B.

A pH sensor calibration value of 0.119 was obtained below.
Calibration = (2.45-2.11) / (6.86-4.01)
= 0.34 / 2.85
= 0.119

The sensor calibration value will be used to determine the pH value contained in the solution in the calculation of the equation (3).

$$P\_O = 6.86 + (((x_B - \text{VoltagepH}))/y) \quad (3)$$

with,
P_O is pH unit value, x_B is voltage test result of sample B, y is calibration value , VoltagepH is the rated voltage.

The next test, namely the results of the pH sensor output value from microkontroller will be assessed for the accuracy of measuring the acquisition of the value with the acquisition of the value from a standard tool as a comparison, namely the pH meter. Table 1 and Fig. 1 are a comparison of pH measurements of Standard Tools and Design Tools.

Table 1. Comparison of pH Measurement of Standard Tool and Design Tool

Sample (Ph)	Standard Tools	Design Tools	Voltage	Difference	Error (%)
4.01	4.00	3.98	2.54	0.02	0.5
6.86	6.90	6.84	2.18	0.06	0.87
9.18	9.20	9.16	1.89	0.04	0.43
Total				**0.12**	**1.8**
Average				**0.04**	**0.6**

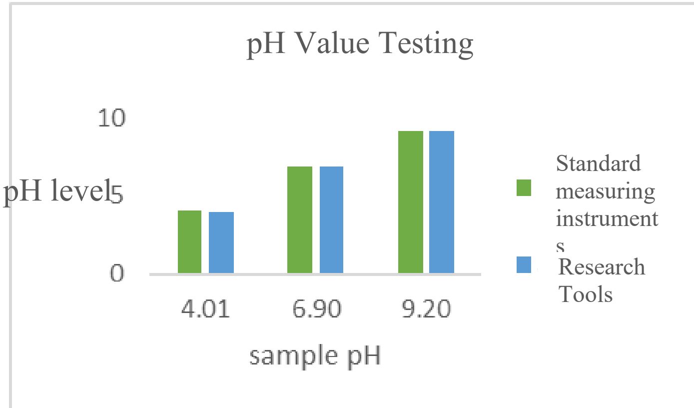

Fig. 1. Comparison of pH Measurement of Standard Tool and Design Tool

From the measurement results of 3 samples whose pH values are known using standard tools and research, in Fig. 1 it can be seen that the increase in pH values using research results and standard tools both show linear changes and can be seen in the data in Table 1 It was analyzed that the accuracy of the pH sensor as a pH measurement tool was 99.65%. This result is obtained from mathematical calculations on the equation
Accuracy = 100% $-(Total\ Error\ (\%))/(Jumlah\ Data\ (n)))$
Accuracy = 100% - ((1,8 (%))/3)
= 100% - 0.6%
= 99.4%

Then the correlation between the pH output value and voltage is tested. The test results are shown in Fig. 2. Based on the test results, it shows that the pH output value is inversely proportional to the voltage value, where the higher the measured pH value, the lower the output voltage value, so it can be concluded that the sensor can work well to detect an increase in pH.

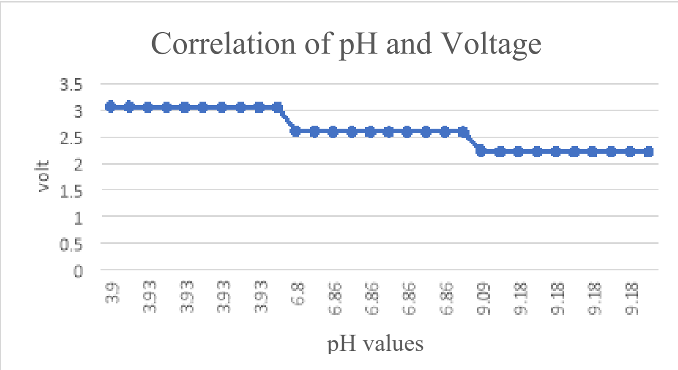

Fig. 2. Correlation between pH and Voltage Output Values

3.2. Testing on NodeMCU

NodeMCU is an IoT platform that is opensource. The software used for programming on the NodeMCU ESP8266 is the Arduino IDE. Arduino IDE which is specially made to design a program and run the system, to create a program many things must be learned such as the functions available and what libraries are in accordance with the hardware we want to use so that it must be careful in the design process. When the coding process is complete then the compile becomes successful the following Arduino IDE display after successfully compiling is shown in Fig. 3.

```
void setup()
{
  Serial.begin(9600);

  delay(2000);

  pinMode(ph_Pin, INPUT);
  Serial.begin(9600);
}
void loop()
{
  int nilai_analog_PH = analogRead(ph_Pin);
  TeganganPh = 5 / 1024.0 * nilai_analog_PH;

  PH_step = (PH4 - PH7) / 2.85;
  Po = 6.86 + ((PH7 - TeganganPh) / PH_step);

  Serial.print("Nilai PH Hidroponik: ");
  Serial.println(Po); //nilai pembacaan ph meter
  Serial.print("Nilai tegangan: ");
  Serial.println(TeganganPh, 2);
  delay(2000);
}
```

Fig. 3. Arduino IDE display

3.3. Blynk Testing

Blynk is software used to create IoT-based projects with the help of wifi, ESP8266 modules and the internet, the software and hardware in the project will be connected to each other. Here's how to use and create an account on Blynk and test the software. First install the Blynk application on the Play store, after installed. Open the application, then we will be displayed the Log in and Creat new account menu if you have not registered then it is better to register first on the Creat new account menu. After successfully entering the application then select a new project then fill in the fields according to the project we are doing. Then select Creat and the Blynk application will send an Auth Token code to the email used when we registered. Then select the widget according to the needs we want. Then set the address according to the pin configured with the Arduino IDE. Then set the wifi settings and auth token on the Arduino IDE, now the Blynk application is ready to run. After doing these steps, the Blynk application is ready to be used to test the following test results of the Blynk application in this study can be seen in Fig. 4.

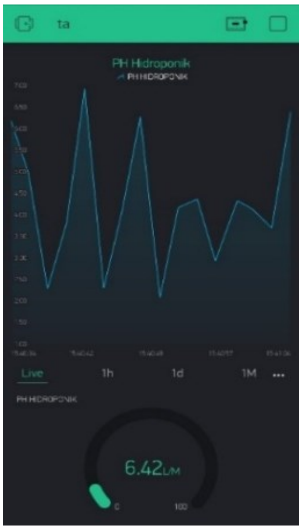

Fig. 4. View on Blynk

3.4. System Testing

In this research, testing was carried out on hydroponic plants in a tub filled with 6-7 liters of water. In this test, data is collected every 30 minutes and 48 samples are obtained (24 pH samples on celery 24 pH on pakcoi).

3.4.1. Testing on Celery

In this test, data collection is carried out every 30 minutes and compared with standard measuring instruments. In pakcoi plants the optimal ph in these plants is 6.5 to 7. The results of this test show the pH value of the pH range of 6.30 to 6.68 which is shown in Table 2.

Table 2. Testing on Celery

Celery pH			
Research Tools	**Standard Measuring Instruments**	**Difference**	**Eror(%)**
6.47	6.5	0.03	0.46
6.63	6.5	0.13	2
6.63	6.5	0.13	2
6.42	6.5	0.08	1.23
6.34	6.5	0.16	2.46
6.51	6.5	0.01	0.15
6.63	6.5	0.13	2
6.42	6.5	0.08	1.23
6.30	6.5	0.20	3.07
6.55	6.5	0.05	0.76
6.59	6.5	0.09	1.38
6.42	6.5	0.08	1.23
6.51	6.5	0.01	0.15
6.42	6.5	0.08	1.23
6.38	6.5	0.12	1.8
6.63	6.5	0.13	2
6.38	6.5	0.12	1.84
6.47	6.5	0.03	0.46
6.59	6.5	0.09	1.38
6.34	6.5	0.16	2.46
6.68	6.5	0.18	2.77
6.68	6.5	0.18	2.77
6.68	6.5	0.18	2.77
6.34	6.5	0.16	2.46
Total		2.61	40.1
Average		0.10	1.67

In Table 2 is a comparison of measurements with standard measuring instruments and research tools 24 times with time every 30 minutes and obtained an analysis that the accuracy of pH measurement is 98.33%.

$$\text{Accuracy} = \frac{1{,}67\ (\%)}{24}$$
$$= 100\% - 1.67\%$$
$$= 98.33\%$$

3.4.2. Testing on Pakcoi

In this test, the same as the test on pakcoi plants, data collection is carried out every 30 minutes on hydroponic plants in a tub filled with 6 to 7 liters of water and compared with standard measuring instruments. In celery plants the optimal pH in these plants is pH 7. The results in this test show a pH value of pH range of 6.80 to 7.18 which is shown in Table 3.

Table 3. Testing on Pakcoi

Pakcoi pH			
Research Tools	**Standard Measuring Instruments**	**Difference**	**Eror(%)**
7.14	7.0	0.14	2
7.06	7.0	0.06	0.86
7.10	7.0	0.10	1.43
7.10	7.0	0.10	1.43
7.06	7.0	0.06	0.86
7.14	7.0	0.14	2
7.18	7.0	0.18	2.57
6.89	7.0	0.11	1.57
7.14	7.0	0.14	2
6.97	7.0	0.03	0.42
7.10	7.0	0.10	1.43
6.80	7.0	0.20	2.85
6.93	7.0	0.07	1
7.01	7.0	0.01	0.43
6.80	7.0	0.20	2.86
7.10	7.0	0.10	1.43
6.97	7.0	0.03	0.42
6.80	7.0	0.20	2.86
7.14	7.0	0.14	2
7.06	7.0	0.06	0.86
7.06	7.0	0.06	0.86
6.80	7.0	0.20	2.86
7.08	7.0	0.08	1.14
7.08	7.0	0.08	1.14
Total		2.59	37.28
Average		0.11	1.55

Table 3 is a comparison of measurements with standard measuring instruments and research tools 24 times with a time every 30 minutes on hydroponic plants in a tub filled with 6 to 7 liters of water and obtained an analysis that the accuracy of pH measurement is 98.45%.

$$\text{Accuracy} = 100\% - \frac{1.55(\%)}{24}$$
$$= 100\% - 1.55\%$$
$$= 98.45\%$$

3.4.3. Testing on Tomatoes

In this test, data collection is carried out by taking 30 minutes once for 12 hours in a tub filled with 6 to 7 liters of water that has been mixed with ab mix liquid and compared with standard measuring instruments. In pakcoi plants the optimal pH in these plants is 6.5. The results of this test show a pH value in the range of pH 6.30 to 6.59 which is shown in Table 4.

Table 4. Testing on Tomatoes

Tomatoes pH			
Research Tools	**Standard Measuring Instruments**	**Difference**	**Eror(%)**
6.46	6.5	0.04	0.61
6.42	6.5	0.08	1.23
6.52	6.5	0.02	0.30
6.30	6.5	0.20	3.07
6.48	6.5	0.02	0.30
6.32	6.5	0.18	2.76
6.54	6.5	0.04	0.61
6.34	6.5	0.16	2.46
6.32	6.5	0.18	2.76
6.52	6.5	0.02	0.30
6.38	6.5	0.12	1.84
6.46	6.5	0.04	0.61
6.40	6.5	0.10	1.53
6.34	6.5	0.16	2.46
6.46	6.5	0.04	0.61
6.42	6.5	0.08	1.23
6.52	6.5	0.02	0.30
6.32	6.5	0.18	2.76
6.46	6.5	0.04	0.61
6.38	6.5	0.12	1.84
6.52	6.5	0.02	0.30
6.48	6.5	0.02	0.30
6.59	6.5	0.09	1.38
6.40	6.5	0.10	1.53
Total		2.07	31.88
Average		0.08	1.32

Table 4 is a comparison of measurements with standard measuring instruments and research tools 24 times with a time of 30 minutes once measured for 12 hours in a tub filled with 6 to 7 liters of water that has been mixed with ab mix liquid and obtained an analysis that the accuracy of pH measurement is 98.33%.

Accuracy $= 100\% - \frac{1.32\ (\%)}{24}$

$= 100\% - 1.32\%$

$= 98.68\%$

4. CONCLUSION

After designing, and testing the research entitled "Monitoring pH in Hydroponics Using the Blynk Application" it can be concluded that the pH Monitoring System in hydroponics using NodeMCU ESP8266 and pH sensor produces a voltage value that will be converted to a pH value. The value will be sent to the Blynk application in real-time. The monitoring application that uses Blynk software successfully displays the data as read by the system so that it makes it easier to monitor the situation on hydroponic plants, On tomato plants measurements are taken every 30 minutes for 12 hours in a tub filled with 6 to 7 liters of water that has been mixed with ab mix liquid with an accuracy value of 98.68%. Celery plants are measured every 30 minutes for 12 hours in a tub filled with 6 to 7 liters of water that has been mixed with ab mix liquid with an accuracy value of 98.33%. In pakcoi plants, measurements are taken every 30 minutes for 12 hours in a tub filled with 6 to 7 liters of water that has been mixed with ab mix liquid with an accuracy value of 98.45%.

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