Automatic Control of Hydroponic Plant Ph Levels Using Sensor Sku Sen 0161

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ABSTRACT

The hydroponic method of growing has developed rapidly in recent years because it can save agricultural land. Hydroponic planting systems need to pay more attention to the pH content of the water because water is the main factor for the growth of hydroponic plants. So far, hydroponic owners still use manual methods to monitor Ph levels in the water, measuring PH levels using a PH meter and then giving a solution to lower or increase PH levels according to the measurement results. This activity must be done regularly to maintain plant fertility. This research develops a solution in the form of a tool to control the PH level of the water automatically using the SKU SEN 0161 sensor. This sensor works by checking the PH level of the water. If the PH level of the water is too low (acidic), then the alkaline solution pump will turn on to increase the PH level of the water. If the PH level of the water is too high, then the acid solution pump will turn on to lower the PH level of the water. To get good measurement results, a PH sensor calibration process is carried out using a linear regression method by comparing the voltage data from the sensor with the water PH data measured using a PH Meter. From the results of testing the accuracy of the water PH sensor, it has good accuracy with an average error of 0.51%.

Keywords: Hydroponics, PH Sensor, Arduino

INTRODUCTION

Lately, the increase in the world's population has been very rapid, resulting in reduced land available for agriculture used as a shelter. In the long term, the narrowing of agricultural land will impact the scarcity of food sources and damage the ecosystem. Apart from being a food source, the main function of a plant is to produce O2 (Oxygen) which is needed by every living thing to breathe and absorb CO2 (Carbon Dioxide) which can harm living things (Denanta et al., 2020).

Therefore, the role of plants is very important for the survival of organisms, not only as a food source but also as an oxygen producer and carbon dioxide absorber. The agricultural sector needs to use existing technologies for development and innovation (Sufaidah & Asyari, 2021). Francis Bacon wrote the beginning of plant cultivation using water in his book Sylva sylvarum. The book was published in 1627, a year after his death. Plant cultivation techniques using water became popular after that (Alviani, 2015).

Hydroponics or hydroponics comes from Latin (Greek), namely hydro, which means water and phonos, which means work (Hardiyanto & Airlangga, 2021). So hydroponics is meant as working water. Hydroponics is an agricultural activity that uses water as a medium to replace the soil (Sujono & Herlambang, 2021). So, hydroponics can be interpreted as a work or management of water for plant growth without using soil media as a growing medium and taking the required mineral nutrients from a nutrient solution dissolved in water (Istiqomah, 2007). The hydroponic method is planting without using soil media but using nutrient solutions as a food source for plants and substrates as a supporting medium or plant support. In the hydroponic method, the regulation of nutrients and the level of acidity (pH) will

be easier to do than with soil media. Plants grown using the hydroponic method will more easily absorb nutrients than plants grown with soil media. Plants no longer need to enlarge and extend roots to absorb nutrients (Setiawan, 2017).

Wherever a plant or vegetable grows, it will develop well if supplied with sufficient nutrients (nutrients). In this context, soil supports plants and water as a source of plant nutrients, and then these nutrients will be absorbed by plants. This thinking finally gave birth to the technique of planting with a hydroponic system, where the priority is the fulfilment of nutrients in plants.

One aspect, especially in planting a hydroponic system, is the quality of the pH of the water in plants. pH is the degree of acidity used to measure the level of acidity or alkalinity of a solution. The letter "H" in the abbreviation of pH is defined as the collogarithm of the dissolved hydrogen ion (H+) activity. On the other hand, the letter "p" is not known exactly what it means. What is the pH of a Hydroponic Nutrient Solution? The pH of a hydroponic nutrient solution is the degree of acidity or alkalinity that a hydroponic nutrient solution has. The average plant requires a nutrient solution with a neutral pH, a pH scale in the range of 6.0 to 6.5. If the pH scale of a nutrient solution is below or above this number, certainly, the plant cannot grow and produce. Only a few types of plants can grow well at pH below 6.0 (acidic) and pH above 7.0 (alkaline) (Azzamy, 2016).

Hydroponic plants have a growth rate and survival, influenced by six important factors, including temperature and water pH. In general, the ideal pH for hydroponic plants is between 6.0 - 7.0. Plant roots can properly absorb the nutrients and food needed (Megawati et al., 2020).

The degree of pH affects the development and survival of hydroponic plants or vegetables. A hydroponic nutrient solution that is neutral allows plants to develop properly and survive for an optimal period. The hydroponic nutrient solution has a pH of 6.0 (acidic) and above 7.0 (alkaline)—this research to identify the pH content of plants using a pH meter sensor and a pH sensor. And will be managed by Arduino, which to send to 12x2 LED display.

METHOD

In this study, the authors use research methods or research. This research took place at the University of KH. Abd Wahab Hasbullah, which is on Jl. Garuda No.9, Tambakberas, Tambakrejo, Kec/Kab. Jombang. The tools used in this research are pH meter, pH sensor, Arduino and others. The materials used in this research are acid liquid. Alkaline liquid and clear water, and others.

The research method that I will use is the Waterfall method. This method was first introduced by Winston Royce around 1970. This method consists of 5 stages: the literature study analysis stage, the design/design stage, the hardware assembly stage, the coding stage, and the testing stage. These stages are carried out from the top stage sequentially to the final stage. Below is the following picture:
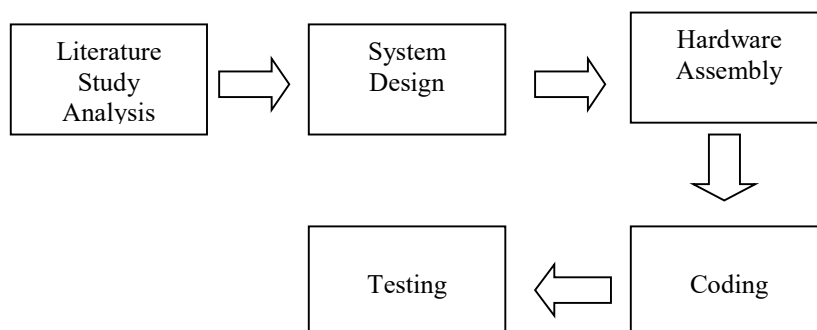

Figure 1. Stages of the waterfall method

From the picture above, it can be described as follows:
- System Analysis Stage

  This stage aims to analyze the needs of a system to be worked on; information and insights can be obtained from interviews, surveys, literature studies, observations, and discussions.

- Stage Design/system design

  The system design designed in this study aims to clearly describe the development of data structures, software architecture, interface design to the design of internal and external functions of each procedural algorithm.

- Block Diagram Design

  The researchers made a prototype of equipment that can act as a pH controller of the water used as a plant medium. The water's pH-regulating liquid (alkaline and acidic) will be pumped into the hydroponic plant water reservoir. The state of the water in the reservoir will control its pH state. The main component of this equipment is the Arduino Uno material which will receive input from the SKU SEN 0161 pH sensor. After that, it will open the pH liquid faucet based on the input value from the pH sensor.

  System design consists of hardware and software design. The equipment used is Arduino Uno as a microcontroller, pH sensor SKU SEN 0161, and a water quality detector in hydroponics. The brain is the Arduino Uno. The pH sensor SKU SEN 0161 is an input in which the pH sensor sends information to the Arduino Uno microcontroller to be managed and processed. And the information is to be forwarded into the output that Arduino has processed. The output in this research is a water pump. In this research, two water pumps are used for alkaline solutions and acid solutions. The water pump will work for the pH sensor where the system turns on the pump from the existing alkaline or acid liquid. The water pump will work according to the commands sent by the Arduino. Arduino's information from the SKU SEN 0161 pH sensor will be forwarded to the 16x2 LED screen.

- Flowchart of pH Monitoring System

  The software design in this research is explained in the flow chart of the water pH monitoring system as a systematic and tool design. The photo below explains the process of monitoring the pH of the water
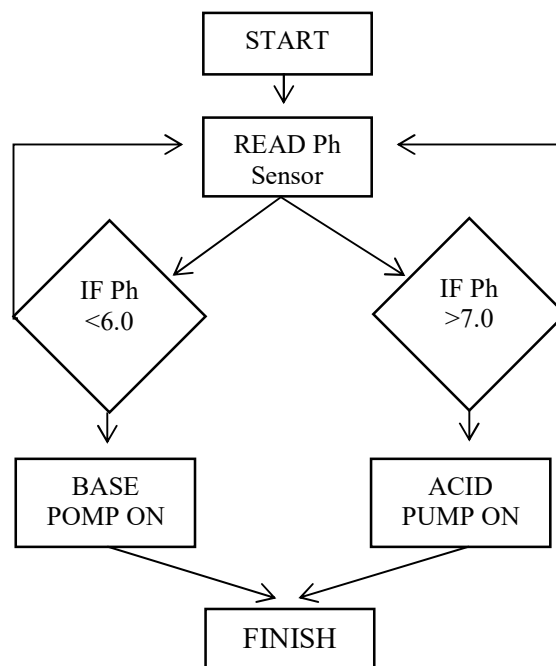

Figure 2. Flowchart of plant pH control system automatically

The initial process is to activate all devices and start reading the pH sensor value. If it has been read, the sensor knows the pH value and will repeat if it is not found. Next, the system shows the pH value on the 16x2 LED display. The pH sensor will detect values in 3 groups, namely, if the pH value is <6.0, then the base pump is turned on, if the pH is >7.0, then the acid pump is turned on, and if the pH value is between 6.1 - 7.1 then the acid pump and the base pump will be turned off. The grouped values will automatically move the servo according to the command.

- Hardware Assembly Stage

At this stage, the Arduino UNO R3 is assembled with several sensors and other electronic components.

- Coding stage

The Arduino coding system uses the Arduino IDE application with the C++ programming language.

RESULTS AND DISCUSSION
Results

The pH sensor measurement results begin with a calibration process using simple linear regression consisting of a variable (X), namely the voltage or analogue value of the pH sensor and a variable (Y), the pH value obtained from the pH meter.

Table 1 Sample data for linear regression calculation

X	Y	XY	X²
283	2.4	679.2	80089
384	7	2688	147456
487	12	5844	237169
1154	**21.4**	**9211.2**	**464714**

Here are the results of calculations with simple linear regression.
Y = a + bX
Where :
Y = pH value on pH meter
X = voltage value on the pH sensor
a = Constant.
b = Regression coefficient (slope);
The mathematical formula is as follows:

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum y)^2} = \frac{3 \cdot 9211.2 - 1154 \cdot 21.4}{3 \cdot 1154^2 - (21.4)^2} = \frac{2938}{62426} = 0.047063723$$

$$a = \bar{Y} - b\bar{X} = \frac{\sum Y}{n} - b\frac{\sum X}{n}$$

$$a = \frac{21.4}{3} - 0.047063723 \frac{1154}{3} = -10.97051229$$

From the results above, the following equation is obtained:
Y = a + bX
  = -10.97051229 + 0.047063723X

The equation from the linear regression is then used as a guide for measuring the pH value, which is entered in the Arduino script. The results of measuring the PH content of hydroponic plant water carried out ten times under various conditions of PH content in the water can be seen in the table below.

Table 2 PH Sensor and PH Meter Test Results

Sample	pH		Error	%Error
	pH Sensor	pH Meter		
1	2,35	2,40	0,05	2,08
2	2,63	2,60	-0,03	-1,15
3	2,91	2,90	-0,01	-0,34
4	5,6	5,60	0,00	0
5	6,35	6,40	0.05	0,78
6	6,73	6,80	0,07	1,02
7	7,1	7,10	0,00	0
8	7,71	7,80	0,09	1,15
9	11,76	11,80	0,04	0.33
10	11,95	12,10	0,15	1,23

The table above is the result of experiments carried out ten times in several pH conditions in water, and then the comparison results are linked not too far with an average error of 0.51%.

Table 3 below proves the results of testing the status of the acid pump and base pump, which were tested ten times with low to high pH levels.

Table 3 Pump Status Test Results

No	PH	Status Pompa Basa	Status Pompa Asam
1	2,35	On	Off
2	2,63	On	Off
3	2,91	On	Off
4	5,6	On	Off
5	6,35	Off	Off
6	6,73	Off	Off
7	7,1	Off	On
8	7,71	Off	On
9	11,76	Off	On
10	11,95	Off	On

The pump in this study has been programmed automatically, where the acid pump will turn on when the water pH is below 6.0, and the alkaline pump is off. The Base Pump will turn on when the water pH is above 7.0, and the acid pump is off. When the pH of the flowing water is 6.0 – 7.0, the acid pump and the base pump will both turn-off.

Discussion

To complete this research, there are several stages that we do:

- Design stage

The design of this system is to simplify and assist the process of assembling and manufacturing the necessary tools. The design of the tool in this study can be seen in the image below

Figure 3. Flow of automatic plant PH monitoring system

Arduino will manage the data generated by the pH sensor, and the results will be executed by an alkaline liquid pump or an acid liquid pump. When the pH meter detects water pH levels below 6.0, the alkaline liquid pump will turn on until the pH levels in the water return to normal. When the pH level of the water is above 6.0, the acid pump will turn on until the pH level in the water returns to normal.

- Implementation stage

The following is a picture of the assembly of tools that we have previously designed. The container for nutrient water uses a 1.5L jerry can, the pump and water flow sensor are placed on top of the jerry can with wood as a support for the water flow sensor

Figure 4. Tool assembly results

- Coding stage

Coding is used to give commands to the tool to run according to the command; the code can be seen in the following picture.

Figure 5. Arduino source code

CONCLUSION

Based on the design and testing results in this research, information was obtained from testing the pH sensor with three conditions, namely acidic water, acidic water, and medium water. In the experiment 10 times, the error rate in this test was 0.51%. It can be seen from the error percentage showing a very small number. And concluded that the pH sensor could be accurate for measuring the pH content of water. Furthermore, testing the pH monitoring on the software is said to be good because 99% accuracy is obtained, which indicates that the test is working properly. From the results obtained, the tool runs well and as desired.

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