Ph Control System Analysis Hydroponic Plants Smart Vertical In Agriculture

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1. Introduction

1.1Background

Indonesia is a country that most people farming his work as a farmer, but on the other hand that there is land in urban areas is already diminishing because a lot of the construction of buildings, malls, factories and as her even more public demand for vegetables from year to year has increased drastically and the solution to this problem is with a hydroponic system.Hydroponics is growing plants and growing techniques that utilize water instead of soil by emphasizing the need nutrients, temperature and pH for plants. Needs of hydroponic water at less than the plant with soil media, so is suitable for areas that have water supply and limited land. (https://id.wikipedia.org/wiki/Hidroponik) History Hydroponic growth in 1963 was born a term Hydroponics, a term given by someone agronomy from the University of California, United States. beginning of activities to cultivate plants without soil media. Beginning of hydroponics experiment originated from research work in plant physiology laboratory testing using water fished. These systems use a lot of water as a growing medium that many people regard these media as aquaculture (Farming in the water). In the historical record how hydroponics has been around since thousands of years ago, for example, described in Babylon existing hydroponic hanging plants and floating plants in the region of china.In 1980, Indonesia began to develop hydroponics. In Indonesia, the hydroponic system first developed the system of hydroponic substrate, but as the development of a hydroponic system start developing the *Nutrient Film Technique (NFT)* are now widely used in by the people who want to grow crops using hydroponics. *Nutrient Film Technique (NFT)* is one method of cultivation with the roots of plants grown in hydroponic nutrient layer shallow and to circulate so that the plants can get enough water, nutrients and oxygen. Crops grown with polyethylene layer with plant roots submerged in water containing a nutrient solution is circulated continuously with a pump. (http://www.kebunhidro.com).

Development of technology in agriculture must be done with due regard to the agricultural system is used which also includes a wide variety of ways to develop crops other than on technology. The technology today is already highly developed rapidly. for example, today a lot of automation systems are designed to facilitate and ease the work of man in order to work automatically and efficiently and effectively within a short time. One area that is currently using the automation system is in agriculture began because many people who want to develop agriculture but limited problem less land, such as for example agricultural land in urban areas. Hydroponics can be made in large and small, so it allows developed in urban areas who have limited land. The automation system can be applied in various agricultural land with the automatic system made a tool to control some of the activities required by hydroponic crops such as pH sensor, temperature, and nutrition. so will get more effective results and facilitate human work in taking care of the plants. Here are the things the background of scientific writing:

a. Knowing the pH of different plant species
b. Knowing how the hydroponic system
c. Knowing how the pH sensor, temperature, and Nutrition Knowing the volume of the water in hydroponics
d. Knowing how the Arduino, Raspberry and
e. Knowing the light sensor needed in hydroponic

2. Basic Theory

2.1Literature

To support this Scientific Writing use some of the theoretical basis of relevant and related to the subject as follows:

a. According to Ida Syamsu Roidah Research, Faculty of Agriculture that titled *"Land use hydroponic System Using"*the development of technology in agriculture the more years of growing rapidly, so that the public, especially farmers left behind in utilizing technological advances will not get the maximum benefit from doing business activities. One of the technologies is a viable disseminated hydroponics technology, this is due to the increasing scarcity of agricultural land as a result of many industrial and services sectors, so that conventional agricultural activities increasingly uncompetitive because of the high price of land. Agricultural cultivation technology with a hydroponics system is expected to be an alternative for people who have limited space or yard, so it can serve as an adequate source of income. Hydroponics is a method of farming using planting medium other than soil, such as pumice stone, gravel, sand, coconut fiber, wood or foam pieces. This is done because the function of the soil to support plant roots and intermediaries can be replaced with a nutrient solution or increase the flow of nutrients, water and oxygen through the media. ***(Journal****-unita.org/index.php/bonorowo/article/)*

b. Research InSapto Wibowo and Arum Asriyanti S entitled *"Application Hydroponic NFT On Raising Pakcoy"* Hydroponics is one of the future because agriculture system can be operated in a variety of places, both in the village, town, in open fields, or on top of the apartment though. Total land area is narrow, critical soil conditions, pest and disease control, the limited amount of irrigation water, an erratic season, and the quality is not uniform can be overcome with a hydroponic system. Hydroponics can be grown throughout the year regardless of the season. Therefore, the selling price of the harvest are not worried about falling. Maintenance of hydroponic plants even easier because the cultivation is relatively clean, media cropping sterile, the plant is protected from the rain, pests and diseases is relatively small, as well as healthier plants and higher productivity *Nutrient Film Technique (NFT)* is one of the hydroponic system with root plant wearing a thin layer of water that resembles a movie. Circulate water and nutrients needed by plants. nutrient solution circulation movement but because boost pump, is also caused by the slope of the used. Pipes that are too small can cause nutrient flow easily clogged because the flow is too slow. The aim is to determine the effect of the slope of the gutter pipe NFT plants pakcoy results. *(*http://download.portalgaruda.org*)*

c. Research Indra Saputra, Dedi Triyanto and Brotherhood Ruslianto entitled *"Control System Temperature, Humidity and Water Level At Hydroponic Farm Pattern"*. Temperature, humidity and water levels are very influential in the growth and development plant on cropping pattern hydroponic system. This research applies a control system for controlling the temperature, humidity and water level sensor with temperature, humidity and ultrasonic. Controller used is AVR microcontroller Atmega 16. Microcontroller functions to process signals from the sensors enter the temperature, humidity and ultrasonic as feedback components, then produce output directed to the actuator. Microcontroller applied program that serves as initialization and configuration of the hardware as well as read the signal input from the temperature sensor, humidity and ultrasonic then process with given some conditions to produce output. The result of this research is the system can control the temperature, humidity and water levels automatically cropping pattern hydroponic system based on measurements obtained from the sensors - sensors mounted in the model greenhouse. The actuators will be activated if the temperature, humidity and water levels are beyond the prescribed limit and reverse the actuator will shut off automatically if it is located in an ideal condition. Testing of the system to the plant over several days. The result is a plant can grow well, it can be seen from the release segment during the observation of plant leaves. *(*http://download.portalgaruda.org*)*

d. Research In M.Subandi, Nella Purnama Salam, and Budy Frasetya entitled *"The Influence of Different Values EC (Electrical Conductivity) on Growth and Yield of Spinach (Amaranthus SP) In Hydroponics Floating Raft System (floating Hydroponics System) "*.The availability of land is currently the main problems inhibiting agricultural activities, especially for horticultural crops such

as spinach. Spinach is a good source of vitamins and minerals needed by the body. Technically hydroponics system can be used as a way of cultivation with such limitations. Hydroponics with floating raft system is able to provide the nutrients required by plants, because the roots can absorb it and positioning elements expect direct roots submerged nutrient solution. The purpose of this study was to determine the effect of various *EC(Electrical Conductivity)* Mix AB optimal nutrition to the growth of spinach (Amaranthus sp.). This experiment was conducted in the Ciparanje, Jatinangor Sumedang in May-June 2014. This research used non factorial randomized block design, namely the various EC (e1 = 1.5 mS cm-1; e2 = 1.8 mS cm-1 ; e3 = 2.1 mS cm-1; d4 = 2.4 mS cm-1; e5 = 2.7 mS cm-1; and e6 = 3.0 mS cm-1) with four replications. The results showed the level of e6 able to give the best results to the parameters plant height, leaf area index, fresh weight of shoot, and shoot dry weight. While the parameters of root length, harvest index, and the ratio of root dashed did not show significantly different results. This is caused by the pH of the nutrient solution does not fit the needs of spinach plants with hydroponics system. In the hydroponic system nutrient solution pH of 5-6 while the pH of the solution recommended in the nutrition field ranges between 6-10. It is the benchmark for optimal plant growth. *(*http://journal.uinsgd.ac.id*).*

3. Analysis of Results and Discussion

3.1Workflow Hydroponics System

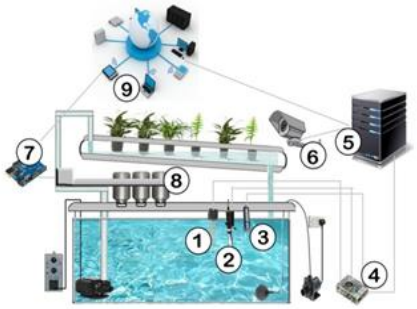

Figure 1. Workflow Hydroponics System

The system works as follows:

a. All results of the data from the sensors is sent to the Arduino
b. Arduino process data and send to raspberry
c. Raspberry receive data from the Arduino
d. Data entered into the Rabbit MQ queue for sorting
e. Once the data is sorted, the data began to enter into the database
f. Database into raspberry
g. And then displayed on the WEB and Mobile

3.2 Testing PH Sensor

Testing PH electrode sensor is done by using several samples of different solutions. Before the measurement of the pH sensor output voltage as a reference for measurement of pH by using a pH meter PH-207. The results of testing the pH electrode sensors are shown in Table 1. This test aims to test the sensors as well as to obtain a solution of acid and alkaline solution to be used.

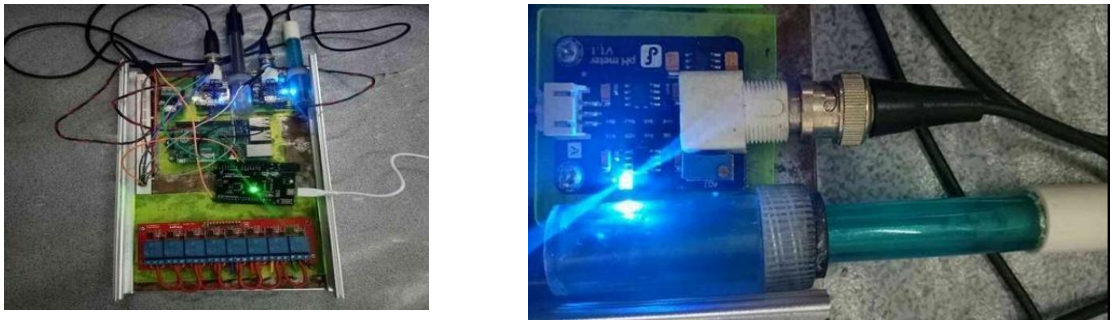

Figure 2. Testing pH sensor

Table 2. Electrode sensor testing pH

Larutan	pH	Vout (mV)
Air+HCl	2.4	120
Air+CH_3OOH	3.81	82
Buffer pH 4	4	75
Air+CH_3OOH	4.60	60
Air+CH_3OOH	5.57	30
Air+CH_3OOH	6.31	6.45
Buffer pH 7	7	-19
Air+ NH_3	7.30	-31
Air+ NH_3H	8.47	-78
Air+NaOH	9.51	-95

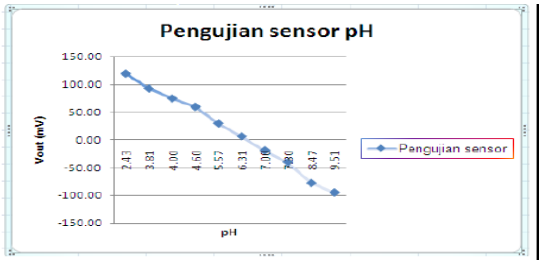

Figure 3. Graph of pH electrode sensor test

From the figure 5.4 shows that the measurement of sensor voltage linear with respect to the levels of pH. Where to pH below 7 has a positive voltage, for pH 7 (neutral) output is close to 0 volts and to a pH greater than 7 has an output voltage that is negative.

3.3 Data Monitoring Crops (Lettuce)

Table 2. Data Monitoring Crops

Date Growing	**Name Plant**	**Ec**	**Temperature**	**pH**
1 February 2017	Lettuce	17.77	26.94	59.92
February 2nd 2017	Lettuce	17.78	25.00	59.99
February 3, 2017	Lettuce	16.88	25.98	59.76
February 4, 2017	Lettuce	17.88	24.34	60.01
February 5, 2017	Lettuce	17.90	25.01	55.00
February 6, 2017	Lettuce	19:03	24.00	59.02
7February 2017	Lettuce	19:05	27.00	56.64
February 8th, 2017	Lettuce	20:09	30.45	57.00
February 9, 2017	Lettuce	21:06	26.90	60.00
February 10th, 2017	Lettuce	22:03	01.27	59.32

3.4 Coding Monitoring and Controller

```
#include <OneWire.h>
defineStartConvert0#
#defineReadTemperature1
// #define SensorPin A2 // pH meter Analog output to Arduino Analog input 0
unsigned long int avgValue; // Store the average value of the sensor feedback
float b;
int buf [10], temp;
char val;
const byte numReadings = 20; // the number of sample times
byte ECsensorPin = A1; // EC Meter analog outputs, analog on pin 1
```

```
byte DS18B20_Pin = 2; // DS18B20 signal, digital on pin 2
bytes in_serial, str;
unsigned int Analog SampleInterval = 25 printInterval = 700, tempSampleInterval = 850;
unsigned int readings [numReadings]; // The readings from the analog inputb
byte index = 0; // the index of the current reading
unsigned long AnalogValueTotal = 0; //the running total
unsigned intAnalogAverage = 0, averageVoltage = 0; // the average
unsigned long AnalogSampleTime, printTime, tempSampleTime;
float temperature, ECcurrent, phVal;
// Temperature chip i / o
OneWire ds (DS18B20_Pin); // digital on pin 2
void setup ()
{//initialize serial communication with computer:
pinMode (3, OUTPUT);
pinMode (4, OUTPUT);
pinMode (5, OUTPUT);
pinMode (6, OUTPUT);
pinMode (7, OUTPUT);
Serial.begin (115200);
// initialize all the readings to 0:
for (byte thisReading = 0; thisReading <numReadings; thisReading ++)
readings [thisReading] = 0;
TempProcess (StartConvert); // let the DS18B20 start the convert
AnalogSampleTime = millis ();
printTime = millis ();
tempSampleTime = millis ();
}
Void loop () {
for (int i = 0; i <10; i ++) // Get 10 sample values from the sensor for smooth the  value
{
buf [i] = analogRead (0);
delay (10);
}
for (int i = 0; i <9; i ++) // sort the analog from small to large
{
for (int j = i + 1; j <10; j ++)
{
 if (buf [i]> buf [j])
{temp
= buf [i];
buf [i] = buf [j];
buf [j] = temp;
}}
// return buf [i];
}
avgValue = 0;
for (int i = 2; i <8; i ++) // take the average value of 6 center sample
        avgValue + = buf [i];
float phValue = avgValue * (float) 5000/1024; // convert the analog into the millivolt
phValue = 3.5 * phValue; // convert the millivolt into pH value
```

```
        in_serial = Serial.read ();
        str = char (in_serial);
        switch (str)
{
        case '1': digitalWrite (3.1); // pump
        break;
        case 'a': digitalWrite (3.0);
        break;
        case '2': digitalWrite (4.1); // ph Valve Bases
        break;
        case 'b': digitalWrite (4,0);
        break;
        case '3': digitalWrite (5.1); // valve ph Acid
        break;
        case 'c': digitalWrite (5,0);
         break;
         case '4': digit7alWrite (6.1); // ec valve A
        break;
         case 'd': digitalWrite (6.0);
        break;
        case '5': digitalWrite (7.1); // ec valve B
        break;
        case 'e': digitalWrite (7.0);
        break;
}
        If (millis () - AnalogSampleTime> = AnalogSampleInterval)
{
        AnalogSampleTime = millis ();
        // subtract the last reading:
        AnalogValueTotal = AnalogValueTotal - readings [index];
        // read from the sensor:
        readings [index] = analogRead (ECsensorPin);
        // add the reading to the total:
        AnalogValueTotal = AnalogValueTotal + readings [index];
        // advance to the next position in the array:
        index = index + 1;
        // if we're at the end of the array ...
        if (index> = numReadings)
// ... wrap around to the beginning:
         index = 0;
         // Calculate the average:
        AnalogAverage = AnalogValueTotal / numReadings;
}
/ *
        Every once in a while, MCU read the temperature from DS18B20 and then let the
DS18B20 start the convert.
        Attention: The interval between start the convert and read the temperature should be
greater than 750 milliseconds, or the temperature is not accurate!
* /
         if (millis () - tempSampleTime> = tempSampleInterval)
```

```
{
        tempSampleTime = millis ();
        temperature = TempProcess (ReadTemperature); // read the current temperature from
DS18B20
        TempProcess (StartConvert); // after the reading, start the convert for next reading
}
/ *
         Every once in a while, print the information on the serial monitor.
* /
        if (millis () - printTime> = printInterval)
{
         printTime = millis ();
         averageVoltage = AnalogAverage * (float) 5000/1024;
        Serial.print (temperature); // current temperature
        delay (5);
         //Serial.print ( "6:00");
        Serial.print ( "");
         Serial.print (phValue, 2);
         delay (5);
         //Serial.print("^C EC: ");
        float TempCoefficient = 1.0 + 0.0185 * (temperature-25.0); // temperature
        compensation formula: fFinalResult (25 ^ C) = fFinalResult (current) / (1.0 + 0.0185 * (FTP-
25.0));
        float CoefficientVolatge = (float) averageVoltage / TempCoefficient;
        if (CoefficientVolatge <10) Serial.println ( "1.7"); // 25 ^ C 1413us / cm <-> about
        216mv if the voltage (compensate) <150, that is <1ms / cm, out of the range
         else if (CoefficientVolatge> 3300) Serial.println ( "Out of range"); //> 20ms / cm, out of
the range
        else
{
         if (CoefficientVolatge <= 448) ECcurrent = 6.84 * CoefficientVolatge-64.32; // 1ms / cm
<EC <= 3ms / cm
        else if (CoefficientVolatge <= 1457) ECcurrent = 6.98 * CoefficientVolatge-127; // 3ms / cm
<EC <= 10ms / cm
         else ECcurrent = 5.3 * CoefficientVolatge + 2278; // 10ms / cm <EC <20ms / cm
        ECcurrent / = 1000; // convert us / cm to ms / cm
        Serial.print ( "");
        Serial.println (ECcurrent); // two decimal
        //Serial.println("ms/cm ");
         delay (500);
}}}
/ *
Ch = 0, let the DS18B20 start the convert; ch = 1, MCU read the current temperature from DS18B20.
* /
Float TempProcess (bool ch)
{//
        returns the temperature from one DS18B20 in DEG Celsius
        static byte of data [12];
        static byte addr [8];
        static float TemperatureSum;
        if (ch) {
```

```
                    if (! ds.search (addr)) {
                    Serial.println ( "no more sensors on chain, reset the search!");
                    ds.reset_search ();
                    return 0;
                    }
                    if (OneWire :: crc8 (addr, 7)! = addr [7]) {
                    Serial.println ( "CRC is not valid!");
                    return 0;
                    }
                    if (addr [0]! = 0x10 && addr [0]! = 0x28) {
                    Serial.print ( "Device is Not Recognized!");
                    return 0;
                    }
                    ds.reset ();
                    ds.select (addr);
                    ds.write (0x44,1); // start conversion, with parasite power on at the
end}
else {
                    byte present = ds.reset ();
                    ds.select (addr);
                    ds.write (0xBE); // Read Scratchpad
                    for (int i = 0; i <9; i ++) {// we need 9 bytes
                    Data [i] = ds.read ();
                    }
                    ds.reset_search ();
                    MSB = byte of data [1];
                    LSB = byte of data [0];
                    float tempRead = ((MSB << 8) | LSB); // using two's compliment
                    TemperatureSum = tempRead / 16;
          }
                    TemperatureSum return;
}
Float ph ()
          {for(int i = 0; i <10; i ++) // Get 10 sample values from the sensor for smooth the value
          {
          buf [i] = analogRead (0);
          delay (10);
          }
          For (int i = 0; i <9; i ++) // sort the analog from small to large
          {
                    for (int j = i + 1; j <10; j ++)
          {
                    if (buf [i]> buf [j])
                    {
                              temp = buf [i];
                              buf [i] = buf [j];
                              buf [j] = temp;
                               }
          }
Return buf [i];
}
```

```
AvgValue = 0;
for (int i = 2; i <8; i ++) // take the average value of 6 center sample
        avgValue + = buf [i];
float phValue = avgValue * (float) 5000/1024; // convert the analog into the millivolt
phValue = 3.5 * phValue; // convert the millivolt intopH value
Serial.print( "pH");
Serial.print (phValue, 2); Serial.println ( ""); }
```

3.5 Results of Testing Temperature Sensors, pH and EC

From the test results the sensor temperature, pH and EC, it can be concluded that a system in which the output of all the conditions of work in accordance with the actual conditions of obtaining results acidic pH with an average pH of 6.5, temperature 28.33 and EC 2.3no / cm.

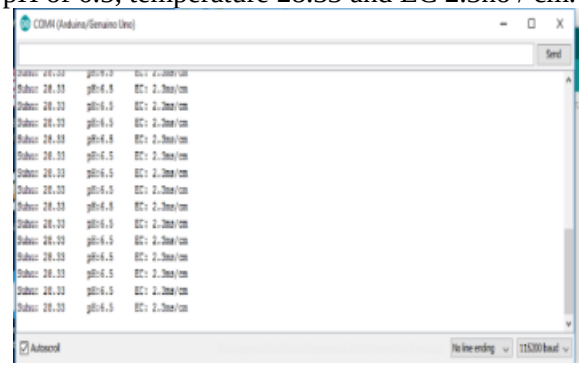

Figure 5. Testing Temperature Sensors, pH and EC

4. Conclusions and Recommendations

4.1 Conclusion

Based on analysis of the discussion with the testing process pH sensor it can be concluded that:

a. The test results obtained that PH sensor obtained PH is acidic.

b. Hopefully, by the automation system that was built to alleviate human tasks in terms of cultivation using hydroponic growing media.

c. Development of pH calibration system using analog and fuzzy logic methods how to keep within 1 bath hydroponics can be planted a few plants of different species.

4.2 Recommendations

Based on the results of research and discussion in the previous chapter there are some suggestions that can be given to the author for subsequent research:

a.Hopefully with the analysis of this study can be utilized by the user associated with the well.

b.Analysis of the previous chapter, the author may be implemented for future research.

c.The author realizes that this paper is not perfect, there are still a lot of shortcomings. for it is expected for other users to be able to develop it.

References

[1] Khayat, Zainal. Examples ofsettlement, *logic fuzzy.2013*

[2] Simajuntak Judge*http: // sistemoperasimobile. co.id/2013/04/pengertian-dan-contoh-makalah-fuzzy.html.April 2013*

[3] Syamsu Ida. *Land use by using a hydroponics system.* Faculty of Agriculture.2014

[4] SubandiM, Nella., Et al. *Influence of Different Values EC (Electrical Conductivity) on the growth and yield of amaranth (Amaranthus SP) on a raft floating hydroponic systems (Floating Hydroponics System).* Bandung: UIN Sunan Gunung Djati.2015

[5] Indra Saputra, Smith, et al. *Full System Temperature, Humidity and Water Level in hydroponic farming patterns.* Pontianak: Faculty of Mathematics, University of Tanjungpura.2015
[6] Wirawan, Arif. https://www.academia.edu/6628711/*Logika_Fuzzy*.
[7] Wibowo Sapto and arum asriyanti S. *Application Hydroponic NFT On Raising Pakcoy*. Banjarnegara: Agrotechnology Study Program Politeknik.2013