Tools for Detecting and Control of Hydroponic Nutrition Flows with Esp8266 Circuit Module

Poltak Sihombing, Muhammad Zarlis, and Heriyance, Nadia Alkarina

Fac. of Computer Science and Information Technology, Universitas Sumatera Utara, Medan, Indonesia
Email: poltak@usu.ac.id

Abstract. In hydroponic plants, adequate nutrition and environmental temperature stability of nutrients are most important to maintain the fertility of the hydroponic plants. By monitoring nutrient flow and environmental temperature stability for hydroponics automatically, it will be easier for a farmer to monitor all of hydroponic plants. This paper, propose a tool for detecting and controlling the flow of food nutrients on the hydroponic plants using the ESP8266 circuit. First step, the sensor will detect the high nutrient solution and temperature around the hydroponic plants, then forward to microcontroller. By the microcontroller will be forwarded to the ESP8266 circuit module and send it to the Android Smartphone. The detection results of the proximity and temperature sensors that sent via ESP8266 will be used as parameters for flowing nutrients or not, and the parameters for turning on the cooling fan or not. The detection results of those sensors are sent to the smartphone by the ESP8266 circuit module, and then forwarded to the Android smartphone in real time. The data sent by ESP8266 module to thinskpeak.com and android application has an average delay of 2.8 seconds on thinkspeak.com and 4.2 seconds on android application. This difference delay occurs because of the data entry is influenced of internet signals hotspots.

1. Introduction

In hydroponic plants, adequate nutrition and environmental temperature stability of nutrients are the most important to maintain the fertility of the hydroponic plants. By monitoring nutrient flow and environmental temperature stability for hydroponics automatically, it will be easier for a farmer to monitor all of hydroponic plants. The Farmer need a tool to communication automatically to detect and control the height of nutrient and the temperature of hydroponics environment. With the development of computer science especially on microcontroller, so that the flow of nutrition automatically to watering the hydroponic plant is very possible to do.

Base on the description above, is needed a revolution in agriculture industry. In related with this description. We proposed the project of automated tools model by using an Arduino Uno Microcontroller. The microcontroller will monitor the hydroponics plants. It will be assisted by proximity sensor (Ultrasonic HC - SR04) to detect the height of water and the temperature sensor (LM-35) to control the temperature around the plants. By those sensor, we can know the height of water and the temperature that showed on the monitor of microcontroller. To do this model, we propose the module ESP8266 tolls to communicate all of data between microcontroller and the Android smartphone.
2. Related Work
In previous research related to hydroponics, found in Hydroponic Grow System, Journal of Agriculture, Food Systems, and Community Development by David Moriarty [1], created a flow system to maintain the growth of hydroponic plants. He was proposed an electric pump that is turned on manually to drain liquid nutrients to the hydroponic place. However, this method has weaknesses, if turning on and turning off the pump has not been done automatically.

In other literature, Kumar and Cho write that hydroponics as the alternatives for plants on narrow land. They have suggested how the hydroponic plants systems work. To supply hydroponic plant nutrients is very appropriate if done by using microprocessors for nutrient control [2]. Kumar and Cho write that waste nutrients from hydroponics plants can be reused [3]. In terms of processor-based hydroponic growth spaces, it is more easily controlled via a virtual instrument controlling system [4].

Other previous research as found in Mark Griffiths, 2014 [5], proposed the Implementation of hydroponics Control System. He has created the hydroponic controller, in order to monitor and control the environmental of hydroponic growing.

The other works for watering hydroponic has been performance by Devika et al [6], where the humidity sensor will detect the soil moisture level, if the soil is not moist / dry then the system will automatically do the watering [7]. There are also in other studies, by reducing the heat in tunnel of hydroponics can improve the quality of hydroponics [8,]. In [9,10,11], Sihombing P., et al proposed the using of Arduino Uno microcontroller to control the nutrition flow of hydroponics automatically.

The next related in R. L. Mishra, P Jain [12], wrote their works about automatic addition of nutrients by using electrodes as a benchmark to count the number of nutrients, then if the nutrients under of the standard value condition, then pump will turn on until get a standard value. Their work is very good, but there are weaknesses, they have not involved an automatic microcontroller and communication with smartphones in this project.

Other research is related to the nutrition flow of hydroponic wrote by Yang C et all [13], they said that solution control system and factor analysis that influences it. This paper also addresses the difficulties of control that occurred during automation [13].

Another paper was developed an automatic nutrition detection. This paper wrote a basic of hydroponic nutrition culture. This paper also describes the how to measure pH values of nutrition [14], and Shaijupaul, et al wrote home based Android automatically by using Raspberry Pi [15].

To overcome the weaknesses of previous research, through this study a method and tool was provided to detect and control the watering of nutrients and the temperature of hydroponic environment automatically using the ESP8266 circuit module.

3. Brief description of the study
This study aims to address to provide a more complete of nutrient flow and temperature controlling of hydroponics plants. By utilizing the proximity sensor (ultrasonic) HC-SR04 and LM35 temperature sensor, it will be easier to know the hydroponics plants. We will use the microcontroller and Raspberry pi as a server. Furthermore, we use the ESP8266 circuit module as a connection of Raspberry Pi to the smartphone. By the smartphone, we can monitor the condition of nutrient flow and temperature around hydroponic plants.

3.1 Brief Description of the General Architecture
In figure 1 is pictured the ESP 8266 circuit module, used to mediate the smartphone communication of the hydroponics control system. In figure 2 is shown the general architecture model of control system, with a brief description as follows:

a) Proximity sensor (ultrasonic) HC-SR04 will detect the height of the nutrient. The LM35 sensor will detect the temperature around of the hydroponics plants;

b) Microcontroller will collect the results of sensor detection in hydroponic place;

c) Raspberry Pi will forward the detection results to the ESP8266 circuit module and forward to the Android smartphone;

d) All of the monitoring resulted can be viewed in real time by an Android smartphone.
3.2 ESP8266 Circuit Module Testing
The ESP8266 circuit is a packet module for communication uses the application of ThinkSpeak.com. This package module consists of a microchip Wi-Fi with full TCP / IP, produced by the manufacturer Expressive Systems in Shanghai. While "ThingSpeak" is an open-source application of Internet of Things (IoT) and API (Application Programming Interface), which is useful for storing and retrieving data from devices that use HTTP protocols over the Internet network. With "ThingSpeak" it will enable the creation of sensor recording applications, location tracking applications, and social networks related to status updates. Furthermore, the ESP8266 module will facilitate the communication of sensor detection resulted to the Android smartphone application. The time delay resulted by ThinkSpeak.com will be compared to the resulted of Android Application.
3.3 The Program Module of Microcontroller

The program module of the microcontroller is made using the C programming language in the Arduino IDE editor, and be stored with the program extension in the form of ".ino". To be uploaded to the Arduino Uno microcontroller using a USB downloader. The module has embedded in Arduino microcontroller is shown in the figure 2.

![Arduino IDE Editor](image)

**Figure 3.** The Program Module of Microcontroller.

4. The Experimental set up and Result

Implementation of this application is made using a Virtuino application. This application contains information about nutrient height and temperature around hydroponics plants. The main function of this application is to be a panel of information in a real time. This application will send the data resulted from the sensor to the thinkspeak.com web panel that was created previously. The application prototype is shown in Figure 4.
4.1 Toll of sensors resulted
The water sensor serves to control the nutrition pump. Pumps that drain nutrients depend on the
detection of the water sensor. There are 3 pumps in this flow system, the three pumps are 220 Volt
pumps whose functions are:
   a) Pump 1, this pump is not connected in the main circuit, because this pump will always live as
      long as it is electrified. Pump 1 works as a circulation diverter of hydroponics vessel.
   b) Pump 2, this pump is located in the main device circuit. Pump 2 functions as watering of
      nutrition into vessel.
   c) Pump 3, this pump is also located in the main device circuit. Pump 3 functions as a suction
      nutrition whose quality is not good anymore, the nutrition will be emptied from the vessel.
Temperature sensor testing is done to determine the temperature that enters the LCD, thingspeak.com,
and Android is appropriate or not suitable. Temperature will be detected at any time. Here will be a
comparison of temperature sensor data for 6 hours once a day.
4.2 The ESP 8266 Module Resulted
The ESP8266 Wi-Fi module will send the height value of the nutrient fluid and the temperature around
the hydroponics, then it will compare its compatibility with thingspeak.com and the Android
application. As a benchmark suitability data is on the LCD monitor, because in the LCD
communication data enters directly from the sensor to Arduino. The comparison is shown in table 1
and figure 5.

Figure 4. The Android Applications developed.
The data sent by ESP8266 module to thinkpeak.com and android application has an average delay of 2.8 seconds on thinkpeak.com and 4.2 seconds on the android application. This difference delay occurs because of the data entry is influenced of internet signals hotspots.

Table 1. The ESP8266 Circuit Module Resulted.

| Number of tests | Time     | Benchmark (LCD monitor) | Thingpeak.com | Android App |
|-----------------|----------|-------------------------|---------------|-------------|
|                 |          | Temp.                   | Height (Cm)   | Temp.        | Height (Cm) | Delay/Second |
|                 |          | 27,30°C                 | 0             | 27,30°C      | 0           | 3           |
| 1               | 06.00    |                         |               |              |             |             |
| 2               | 12.00    | 34,41°C                 | 5             | 34,41°C      | 5           | 2           |
| 3               | 18.00    | 29,20°C                 | 4             | 29,20°C      | 4           | 3           |
| 4               | 00.00    | 25,10°C                 | 5             | 25,10°C      | 5           | 1           |
| 5               | 06.00    | 26,12°C                 | 5             | 26,12°C      | 5           | 3           |

Table 2. Delay Time of Data of ESP8266 Resulted.

| Time (seconds) | Thingspeak.com (seconds) | Application (seconds) |
|---------------|--------------------------|-----------------------|
| 06.00         | 3                        | 5                     |
| 12.00         | 4                        | 6                     |
| 18.00         | 3                        | 4                     |
| 00.00         | 1                        | 2                     |
| 06.00         | 3                        | 4                     |
| Average       | 2.8                      | 4.2                   |

Figure 5. The Delay Time on ESP8266 Circuit Module Application.

5. Conclusions
This research is presented ESP8266 circuit module as a toll for Automatic Nutrition Detection for hydroponic nutrition flow and the temperature of hydroponics area. By ESP8266 circuit module, we
can monitor the nutrient flow and temperature for hydroponics automatically. It will be easier for a farmer to monitor all of hydroponic plants by this circuit module. The ESP8266 circuit can transmit the data from microcontroller automatically to the Android smartphone. The proximity sensor will detect the high of nutrient and the temperature sensor will detect the temperature around the hydroponic plants, then send it to the Arduino Uno microcontroller. By detection resulted of this sensor will decide whether or not to drain nutrients and whether to flush the air conditioner or not. Furthermore, the detection results from those sensors are sent to the smartphone by the ESP8266 circuit module, and then forwarded to the Android smartphone in real time. The data sent by ESP8266 module to thinkspeak.com and android application has an average delay of 2.8 seconds on thinkspeak.com and 4.2 seconds on android application. This difference delay occurs because of the data entry is influenced of internet signals hotspots.

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