Nutrient Film Technique (NFT) Hydroponic Monitoring System Based on Wireless Sensor Network

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***Abstract*— Hydroponic is one of the farming method without soil, but it uses water that contain nutrition. Nutrient solution is very important to define the successful of hydroponic cultivation. One of hydroponic technique is Nutrient Film Technique (NFT). System NFT uses nutrient solution to drain on the root area. pH level which is good for lettuce is 6.0-6.5, meanwhile the Electrical Conductivity (EC) level which is suggested is 0.8-1.2. Factor of pH and EC need to monitor 24 hours during the growth period. Hydroponic system requires wide area. However, in urban areas, the hydroponic green house can't get a wide area only in one place. This system is used to solve the problem in the real time monitoring lettuce cultivation hydroponic NFT. The method in this system contains communication, planning, modelling, construction, and socialization. The result of experiment shows that pH sensor has an error level of difference is 0.4. There is an error of sensor Analog Electrical Conductivity Meter, that is 5.1 ms/cm.**

Keywords*— *NFT hydroponic, monitoring system, pH sensor, EC sensor.

I. INTRODUCTION

Development in the urban areas lead to various problems. One of them is conversion between agriculture land to housing and industry. As a result, agricultural land on the corner of city is being limited. Meanwhile, the needs of food urban community depend on agricultural production. To answer the problems about agricultural land, one of the famous cultivation technique used by people today is hydroponic. Hydroponic is a cultivation technique using nutrient solution [1]. The function of soil substitute by water, nutrition, and oxygen which flow to the plant [2]. One of hydroponic technique is Nutrient Film Technique (NFT). System NFT uses nutrient solution to drain on the root area. Nutrient solution is very important to define the successful of hydroponic cultivation [3].

Growth of lettuce depends on pH nutrition and Electrical Conductivity (EC). For example, pH level which good for lettuce is 6.0-6.5, meanwhile the level of Electrical Conductivity (EC) which suggested is 0.8-1.2 [4]. Factor of pH and EC needs to monitor 24 hours during the growth period. Many of growth period lettuce didn't monitor in real time, so it cause crop failure [5].

Hydroponic farming system requires a wide area. However, the hydroponic green house in urban area can't be placed only in one place, so it requires a system to monitor a large number of green houses at separate locations. A farmer may has more than one nutrition tank in that green house. So, the farmer needs more effort to monitor the nutrition tank and green house one by one on the different area.

The rest of the paper is organized as follows. In Section 2, related works are described. Then, in Section 3, the proposed method is described. In section 4, experimental result and discussion is presented in details. Then, in Section 5, there are several conclusion and future works.

II. RELATED WORKS

The idea that implements one of hydroponic system which is Deep Water Culture (DWC) [6]. pH sensor is used to measure pH level in water solution and transferred the compatible signal to microcontroller to process and provided an output signal to the valve to drop the pH adjuster solution. However, this system is only use pH sensor to monitor hydroponic. In fact, hydroponic crops need level EC to be controlled, because the level nutrition for crops is necessary.

The system that use pH sensor and EC sensor to measure in the water nutrition. But, both of these sensors can't be soaked in the water for a long time [7].

The idea that discusses about integrated system hydroponic for growing different of varieties of crops. pH sensor and water lever sensor are used in this system [8]. These sensors are used to monitor pH level of the nutrient solution and water level. However, this system is only for a single greenhouse.

In this paper, we propose system to facilitate a farmer to monitor green house without go to hydroponic green house one by one with build Nutrient Film Technique (NFT) hydroponic monitoring system based on wireless sensor network.

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III. Proposed Method

A. Hardware Configuration

Figure 1 shows the monitoring system for lettuce cultivation hydroponic outdoor type Nutrient Film Technique (NFT) using wireless sensor network. In this system, there are two hydroponic module called greenhouse. Greenhouse is used to be end node in the wireless sensor network system. Sensors will be placed in the nutrition tank.

There are five sensors which are used, for example temperature and humidity for greenhouse, pH, EC (Electrical Conductivity), water temperature, and water level. Temperature and humidity for greenhouse sensor takes value of temperature and humidity inside and outside greenhouse, pH sensor takes value of acid water level nutrition solution, EC sensor takes value of level nutrition which is soluted in the water, water temperature sensor takes value of water temperature in the nutrition tank, and water level sensor takes value of the height of water in the nutrition tank.

GBoard Pro is used to be microcontroller. The data sensor will be sent from each XBee end node to XBee coordinator. XBee coordinator will receive data sensors and continue to Raspberry Pi. Raspberry Pi as web server and database server will collect data sensors. Raspberry Pi is connected to WLAN Polines, so the farmer can access and monitor data sensor from local place. Then, data sensors are sent to hosting server, so the farmer can monitor data sensors in the outside of local using internet connection. Monitor can do on the website from PC or mobile phone.

B. Software Configuration

Figure 2 shows flow chart monitoring system program on the GBoard Pro. The function of monitoring process on GBoard is shown from water acid level (pH), Electrical Conductivity (EC), temperature and humidity greenhouse, water temperature, and water level. These conditions are resulted by pH meter, analog EC meter, SHT 11, DHT 22, DS18B20, and HC-SR04 sensors. Data from all of sensors are displayed on LCD shield and send to Xbee end node.

Figure 3 shows flow chart of XBee end node. End node is used to be receiver data. Data is resulted by microcontroller Gboard Pro, and then the data will be sent to node coordinator. The beginning process from end node is read data water acid level (pH), Electrical Conductivity (EC), temperature and humidity greenhouse, water temperature, and water level of hydroponic module NFT. After that, when there is a request from node coordinator, end node will send data sensors to coordinator to be collected.

Figure 4 shows flow chart of XBee coordinator. Coordinator is used to be a receiver which is collect data sensors from end node. Data water acid level (pH), Electrical Conductivity (EC), temperature and humidity greenhouse, water temperature, and water level of each hydroponic module NFT will be collected on the node coordinator.

Figure 5 shows flow chart of raspberry pi. Raspberry is used as web server and database server. After data sensors are sent by coordinator, Raspberry Pi will read data serial from XBee. When data is successed to be read, data sensors will save in the database Raspberry Pi and send to the router through WLAN Polines network. So, data sensors can monitor on the local area of network.

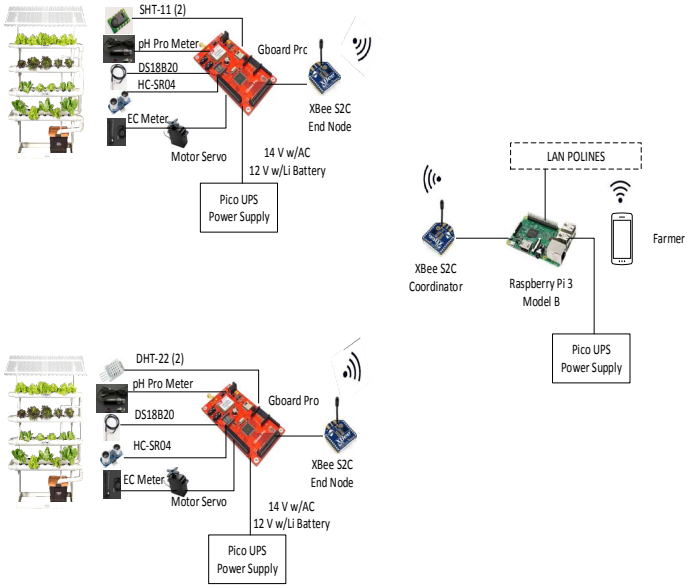

Fig. 1. Hydroponic NFT Monitoring System

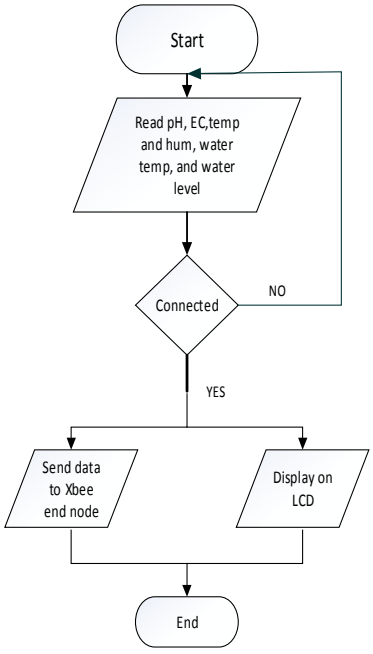

Fig. 2. GBoard Flowchart

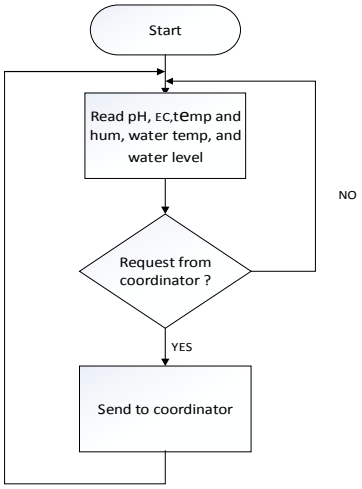

Fig. 3. XBee End Node Flowchart

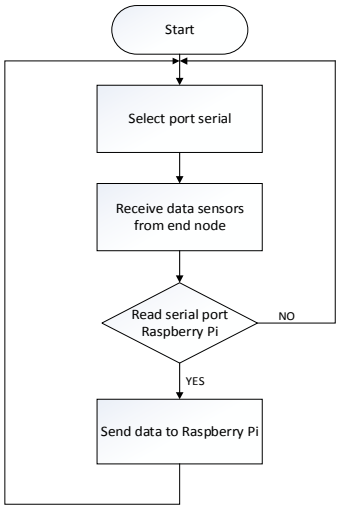

Fig. 4. XBee Coordinator Flowchart

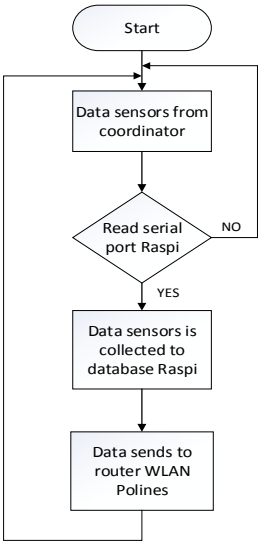

Fig. 5. Raspberry Flowchart

IV. Experimental Result And Discussion

A. Experiment of pH Sensor

Experiment of pH sensor is done with placing the pH sensor on the various of temperature. Sensor will be placed in the different room, then will be displayed on the LCD Display. For the comparison measurement of pH sensor is using pH meter. TABLE I shows measurement of pH sensor and pH meter on temperature 30 ^{0}C inside of room. TABLE II shows measurement of pH sensor and pH meter on temperature 30.5 ^{0}C inside of room with AC. TABLE III shows measurement of pH sensor and pH meter on temperature 28.7 ^{0}C outside of room.

From the experiment sensor pH, sensor pH which is used has error level of difference is 0.4. So, on the various of temperature condition can measure with maximal result or suitable with pH meter. Figure 6 shows the graphic of ratio between pH sensor with digital pH meter.

B. Experiment of EC Sensor

Experiment of Analog Electrical Conductivity Meter sensor is done with providing water which contains nutrition with the difference condition of EC. Sensor will be placed in the box of water and nutrition, then will be displayed on the LCD Display. TABLE IV shows measurement analog EC meter sensor and TDS meter.

From the experiment, there is an error of Analog Electrical Conductivity Meter sensor, that is 5.1 ms/cm. So, in the various of condition EC, can be measured with the maximal result or suitable TDS Meter. Figure 7 shows the graphic of ratio between EC Meter sensor with TDS meter.

TABLE I. Measurement Of Ph Sensor And Ph Meter On Temperature 30 ^{0}C

No	Time	Temperature	pH Sensor	pH Meter
1	3.22 PM	29.9 C	6	5.7
2	3.27 PM	30 C	6.1	5.8
3	15.32 PM	29.9 C	6	5.8
4	15.37 PM	30 C	5.9	5.8
5	15.42 PM	30 C	5.9	5.7

TABLE II. MEASUREMENT OF pH SENSOR AND pH METER ON TEMPERATURE 30.5 ^{0}C

No	Time	Temperature	pH Sensor	pH Meter
1	15.22 PM	30.7 C	6.1	5.9
2	15.27 PM	30.6 C	6.3	5.9
3	15.32 PM	30.6 C	6.2	5.8
4	15.37 PM	30.6 C	6.1	5.8
5	15.42 PM	30.7 C	6	5.9

TABLE III. MEASUREMENT OF PH SENSOR AND PH METER ON TEMPERATURE 28.7 ^{0}C

No	Time	Temperature	pH Sensor	pH Meter
1	15.22 PM	28.7	5.7	6
2	15.27 PM	28.7	5.8	6
3	15.32 PM	28.6	5.7	6
4	15.37 PM	28.6	5.8	6
5	15.42 PM	28.7	5.7	6

TABLE IV. MEASUREMENT ANALOG EC METER SENSOR AND TDS METER

No	Time	Analog EC Sensor	TDS Meter
1	16.00 PM	1,4 ms/cm	678 ppm = 1,06 ms/cm
2	16.01 PM	2,0 ms/cm	1000 ppm = 1,56 ms/cm
3	16.02 PM	3,2 ms/cm	1540 ppm = 2,41 ms/cm
4	16.03 PM	4,5 ms/cm	1930 ppm = 3,02 ms/cm
5	16.04 PM	5,1 ms/cm	2080 ppm = 3,25 ms/cm
6	16.05 PM	6,1 ms/cm	2210 ppm = 3,45 ms/cm
7	16.06 PM	7,1 ms/cm	2700 ppm = 4,22 ms/cm
8	16.07 PM	8,1 ms/cm	2820 ppm = 4,41 ms/cm
9	16.08 PM	9,6 ms/cm	3290 ppm = 5,14 ms/cm
10	16.09 PM	10,4 ms/cm	3390 ppm = 5,30 ms/cm

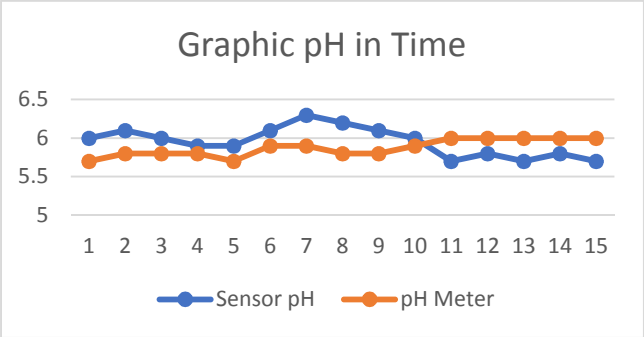

Fig. 6. Graphic of Ratio Between Sensor pH with Digital pH Meter

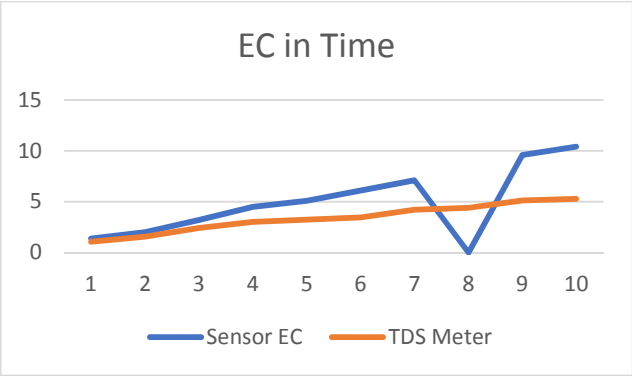

Fig. 7. Graphic of Ratio between Sensor EC Meter with TDS Meter

V. CONCLUSION AND FUTURE WORK

Monitoring System for Lettuce Cultivation Hydroponic Outdoor Type Nutrient Film Technique using Wireless Sensor Network is needed by the farmer to prevent crop failure and easier to monitor parameter hydroponic cultivation real time. So, the farmer doesn't need to go to green house one by one in different area. It makes monitoring process get easier than before. The result of pH sensor and EC sensor are used to know accuracy of each sensor, is good or not to measurement.

The next research for this system can be developed on the part of amount green house or nutrition tank more than two. So, the other plants in different green house can communicate each other and know the condition itself.

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