International Journal of Synergy in Engineering and Technology Vol.1 No.2 (2020) 131-140

International Journal of Synergy in Engineering and Technology
IJSET

IoT monitoring in NFT hydroponic system using blynk- an android platform

Farah Hanan Azimi[1*], Suzanna Ridzuan Aw [2], Raja Siti Nur Adiimah Raja Aris [3], Lia Safiyah Syafie[4], Khairul Irwan Fikri[5] , Wan Raihan Wan Shafie

[1]Faculty of Engineering Technology, University College TATI, Jalan Panchor, Teluk Kalong, 24000 Kemaman, Terengganu, Malaysia
*Corresponding author: farah_azimi@tatiuc.edu.my

KEYWORDS

IoT
hydroponic system
NFT
Electrical conductivity
pH.

ABSTRACT

Intelligent farming is seen as the future of the agriculture industry by producing better cultivation quality. In order to create intelligent farming and informed decisions in time, modern farmers must be equipped with precise management and monitoring of the crop system with access to field environment data. Massive data can be analysed by using the Internet of Things (IoT) via the access and connection of different devices. In order to transmit and display system information online, IoT devices and software applications were integrated. In this study, we have developed an intelligent hydroponic system using nutrient film technique (NFT) with pH, electrical conductivity. Temperature and flow rate measurements monitored by the IoT system. Sensors were installed to monitor the parameters of the nutrient solution. The BLYNK application was used as an interface that enabled users to monitor NFT hydroponic agriculture. The result shown the consistency of each parameter's reading by showing a great display of data acquisition where users could always monitor the parameters of the nutrient's solution in every minute.

1.0 INTRODUCTION

In this recent years, some hydroponic farming techniques are becoming popular in urban agriculture practices. Hydroponic cultivation was planted by utilizing water and do not use soil as medium of its planting with emphasis on the need's fulfilment of nutrients for the plants. The word 'hydroponics' is originated from Greece, which hydro means water and ponos means work [1].

Hydroponic systems are considered as an essential tool for plant production especially vegetables in indoor farming. It is a method of growing plants using mineral nutrient solutions in

Received 20 October 2020; received in revised form 20 November 2020; accepted 25 November 2020.

water without soil. Hydroponic systems help farmers increase their ability to produce continuously over a period of short production, require fewer storage and are capable of producing any crop wherever in small areas with a controlled environment for growth [2]. One of the main hydroponic systems used are the Nutrient Film Technique (NFT) system. The system uses rich oxygen nutrient solution that flows through grow tray, back to its reservoir and recirculate again in the same direction [3]. It enters the grow tray fighting gravity through the force exerted from a water pump and constantly flows around the root.

The IoT (Internet of Things) is a network of Internet enabled objects, together with web services that interact with these objects. Basically, the idea is that every physical things or system in the world can becomes a form of computer that can communicate remotely anywhere and anytime as long as there is an internet connection. In the context of technologies it is aimed to increase agriculture yields and respond to problems such as climate change, environmental friendliness and food security, progress and technological development over the years resulted in the introduction of IoT in urban farming [4].

Nutrients play a crucial role in the quality of the product produced using a hydroponic system. Thus, a balanced implementation of nutrient is vital in determining the quality of the product. In traditional gardening, it is hard to maintain the specific requirement for specifics plant manually. As ion concentrations are changing with period creating a nutrient imbalance in the solutions of nutrients, thus, nutrient control systems are required to quantify each nutrient in real-time. However, such systems are still not commercially available [5]. An automatic hydroponic garden with a real-time monitoring system can be a solution to this constraint where everyone can remotely monitor anytime and anywhere as long as the internet is around.

Thus, instead of just creating a smart automatic hydroponic (NFT) system that can maintain and control the pH values and EC of the nutrient solution, this project is proposed to design a monitoring system consisting of IoT technology where the users can always monitor particular parameters by using smartphones. Continuous sensor data uploaded into the internet makes it extremely reliable for the users to independently monitor the system all day, seven days per week. The main objective of this research paper is to develop an online monitoring system that provides real-time statistical data of the hydroponic garden directly to users via smartphones. An automated scheduling concept realizes a fully integrated and automated NFT hydroponic system. This system is flexible in applying to many types of leafy plants using the NFT hydroponic system.

2.0 EXPERIMENTAL PROCEDURE

The system can be divided into two main parts. The first part is an automatically control system used to continuously regulate two important elements in the nutrient solution of a hydroponic system. Those two elements are pH value and the nutrient concentration (EC). The values are continuously being sensed by their respective sensor to maintain the nutrient solution in the right condition for lettuce growth.

The second part of the system is where the technology of IoT is practiced. With the special features of ESP32 microcontroller, the data from four sensors (pH, EC, temperature and flow rate) can always be transferred into web hosting and database server. This paper will be focused on the second part of the system; the monitoring system.

2.1 Block Diagram

The design of the control block diagram is proposed as an open loop control system as shown in Figure 1 and Figure 2. As this project's objective is to continuously deliver real-time measurement of all sensors, the values measured by the input sensors are primarily gathered and process by the microcontroller. All required data was sent into web hosting and data-base server via Wi-Fi. This type of continuous control system works in which the output has no influence or effect on the control action of the input signal. Regardless of the input, an open-loop system has no knowledge of the output condition hence finally as result, users can always monitor the current measurement of the sensors using a smartphone installed with an application as an interface without being able to control the output. By using internet, users could always able to monitor the current data measurements but without the features to control the output of the system.

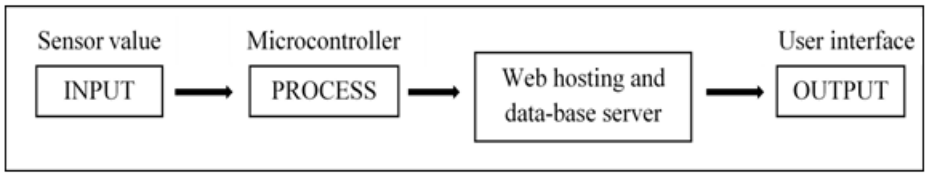

Figure 1. Block diagram of monitoring NFT hydroponic system

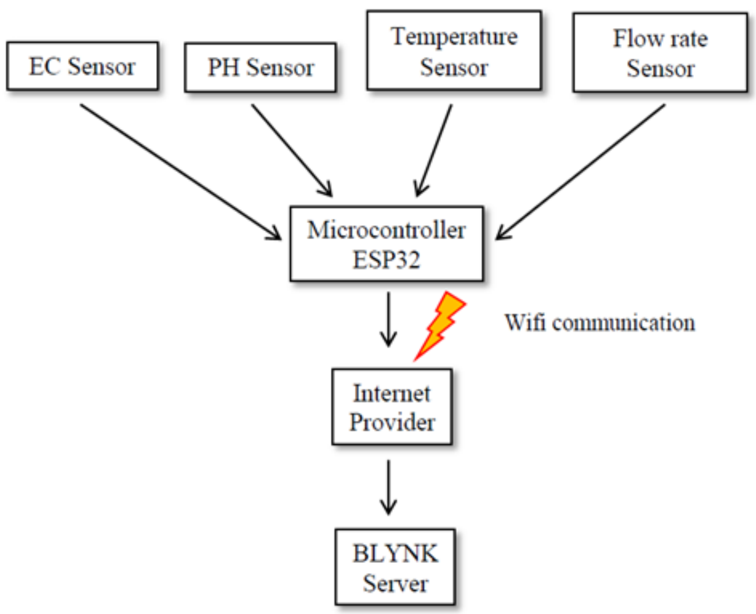

Figure 2. Data acquisition method

2.3. Flow Chart

Figure 3 shows the overall system flowchart of this project. It generally shows how the data acquisition flow occurs from the input to the output of the system. The system will begin to read data or measurement taken from pH and EC sensor. Next, all data or measurement from the sensors will then transferred into web hosting and data-base server. ESP32 microcontroller is initially connected to the internet by using Wi-Fi communication and all data transferred from the microcontroller to the web hosting or server by using Wi-Fi communication. The microcontroller will process a decision making statement by comparing the current EC and pH measurement with the reference value. Respective solenoid valves will be actuated if the current values of pH and/or EC less or exceeded the reference value.

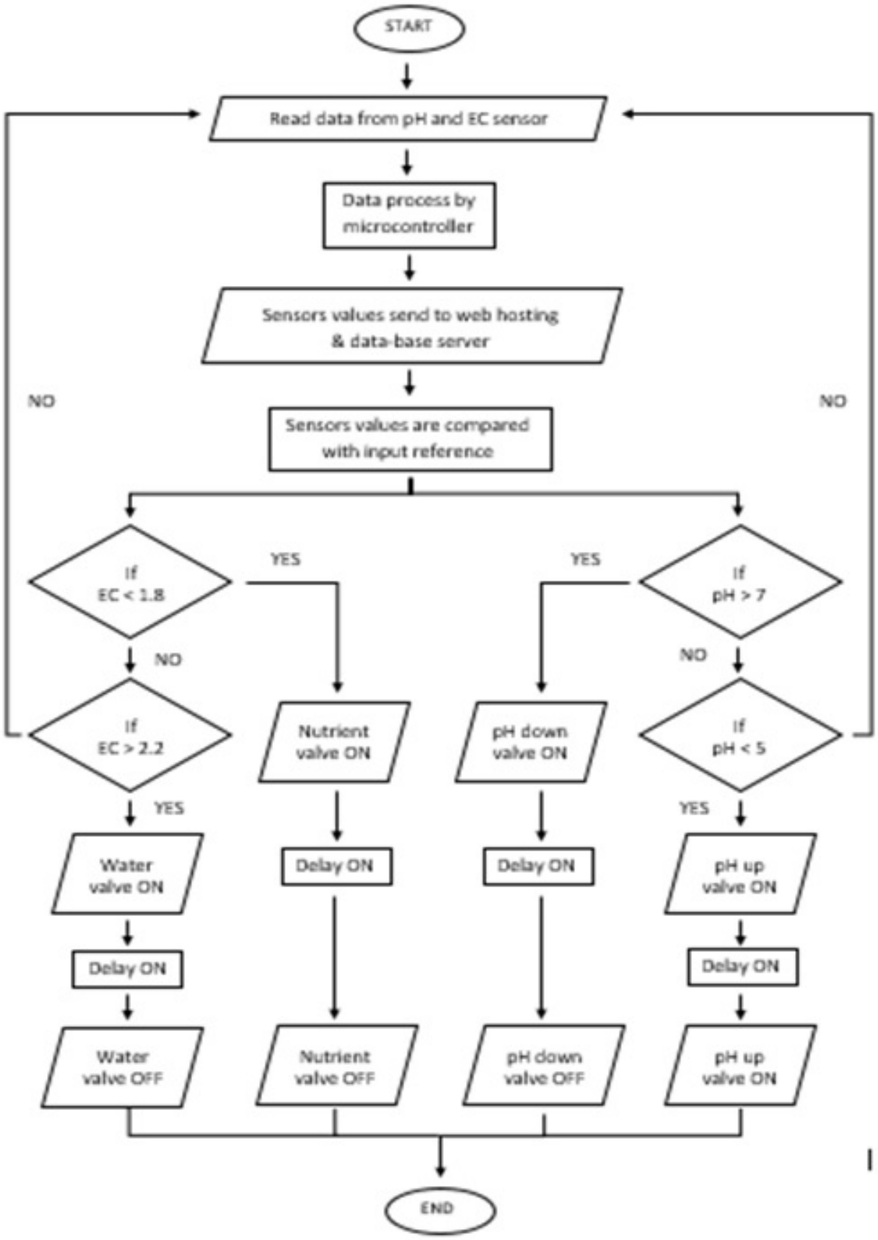

Figure 3. Flow chart of the overall system

3.0 RESULTS AND DISCUSSION

All data acquired were graphically transformed into line charts where the data could be easily read and understood with organized and interpreted numbers. Each sensors measurement was compared between the two data acquisition design of weekly average data and an hour data of every minute.

The dashboard system in Figure 4 shows a real time monitoring of the system that can be accessed by using smartphone. The dashboard interface uses IoT cloud platform called BLYNK. The value displayed in the dashboard are designed for the purpose of easy accessing and monitoring for the targeted users, which are large-scale farmers who only required to view the desired values of each parameter. The dashboard is designed to be user-friendly and simple for monitoring purpose. Blynk platform allows user to view and monitor real-time sensors data and the system will automatically controlling individual valve according to the parameter. All parameters recorded and converted into time series chart and presented in a form of line charts for four parameters which are electrical conductivity (EC), pH, temperature and flow rate of the nutrient solution. All the parameters were taken for two days (Day 1 and Day 2).

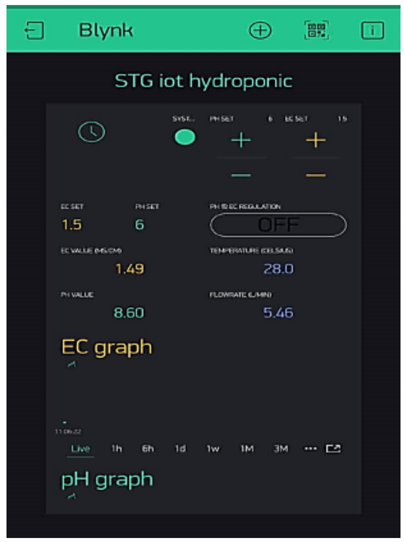

Figure 4. Dashboard of the system

The data taken from any two different days in a whole week of system operation. From the two days of observation, only an hour data from the day and the night is taken as raw data. The data acquisition is taken from 12.30 to 13.30 pm during the day, and from 10 to 11 pm in the evening. Data from the BLYNK server was taken on every minute during that particular an hour data acquisition. There were 60 data for every hour, which mean a total accumulation of 120 sensor data per day for each sensor.

The system also acquired data for all sensors during the whole week, hourly every day, started from 12 am to 11 pm in the evening. The data was only taken for every hour hence accumulating a total of 24 data for each sensor every day. For the whole week, a total of 672 data are gathered before the mean/average value for each sensor for the whole week is calculated.

3.1 Electrical Conductivity (EC)

In this project predetermined values of the EC was set between 1.8 to 2.2 mS/cm as it is the best electrical conductivity in planting the lettuce. EC values was recorded in two random days in a week to make comparison at two different hours. By referring to Figure 5, EC value for day 2 in overall was higher than day 1 data. The highest EC recorded in day 1 was at 1.22 (ms/cm) and lowest at 0.98 (ms/cm) consecutively at 12.30pm and 13.06pm. For day 2 collection of data, the highest EC was 1.26 (ms/cm) at 13.25pm. In contrary, the lowest was 1.12 (ms/cm) at 12.32pm and 12.52pm.

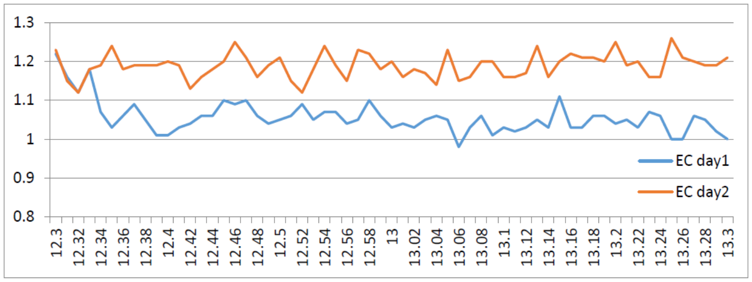

Figure 5. EC value (12.30 to 13.30pm)

Similar pattern was shown in Figure 6, where the overall EC value of day 2 is higher than day 1. Significantly, Figure 3 shows that the highest EC of day 1 was 1.72 (ms/cm) at 10.46pm and with big gaps, the lowest EC was 1.02 (ms/cm) at 3 different times; 10.15pm, 10.36pm, and 10.56pm. Meanwhile, the EC values taken in day2 from 10 to 11pm show a very stable pattern of measurement. The highest of its EC was 1.19 (ms/cm) at 6 different times and slightly different value as the lowest was 1.14 (ms/cm) at 10.55pm in the evening.

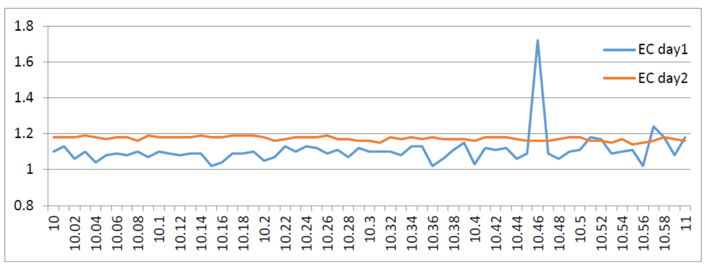

Figure 6. EC value (10.00 to 11.00pm)

3.2 pH Value of Nutrient Solution

pH pre-defined value was set 6, which means in range of 5.5 to 6.5 in pH value. As seen in Figure 7 and Figure 8, both charts show quit similar pattern with only slight differences between the two graphs.

Figure 7 provides the highest measurement of pH at 7.94 for day1 and 7.36 for day 2 at 13.01 pm and 13.19pm, consecutively. Significantly, the figure also compares the lowest pH measurement for both days at 6.20 for day1 and 6.30 for day2. The lowest measurement for day1 was taken at 13.05pm and same lowest measurement taken at 13.29pm and 13.30pm for day2.

Figure 8 shows that the highest pH was measured on day 1 with 7.06 pH value. Data acquisition from day 2 start with lowest PH at 5.97 at 10.02pm, gradually increase to highest peak of 6.99 at 10.24pm before decreasing again.

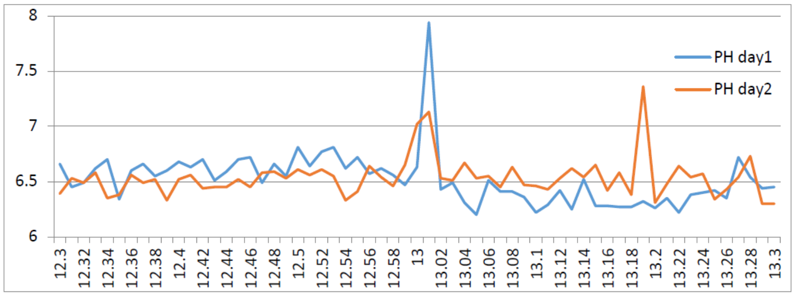

Figure 7. pH value (12.30 to 13.30pm)

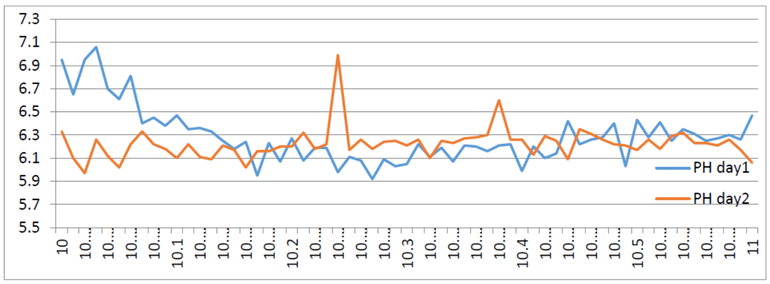

Figure 8. pH value (10.00 to 11.00pm)

3.3 Temperature of Nutrient Solution

The nutrient's solution temperature was one of uncontrolled parameter in this project and analysis. Nutrient's temperature is one of the elements which is quite difficult to be measured in this project. Undoubtedly temperature plays a vital role in defining the measurement of both EC and pH of the nutrient solution. The measurement from the digital temperature sensor shows a steady line but with some anomalies.

Figure 9 indicates both data collected for both day1 and day2 from 12.30pm to 13.30pm and Figure 10 presents a data collection for the two days from 10 to 11pm. Highest temperature recorded from Figure 9 was 29.06 degree Celsius at multiple point from 13.12 to 13.15pm for day 1 and 28.23 degree Celsius at 13.30pm for day2. Meanwhile, Figure 10 displays 27.03 degree Celsius at 10.29pm for day1 and 29.53 degree Celsius at 10.28pm for day2 as the highest measurement of temperature. Both figures show that anomalies in the temperature sensor measurement indicate the lowest point for the data of temperature collected.

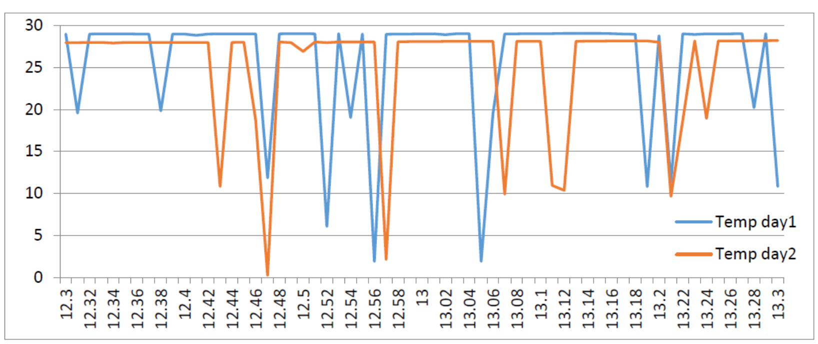

Figure 9. Temperature reading (12.30 to 13.30pm)

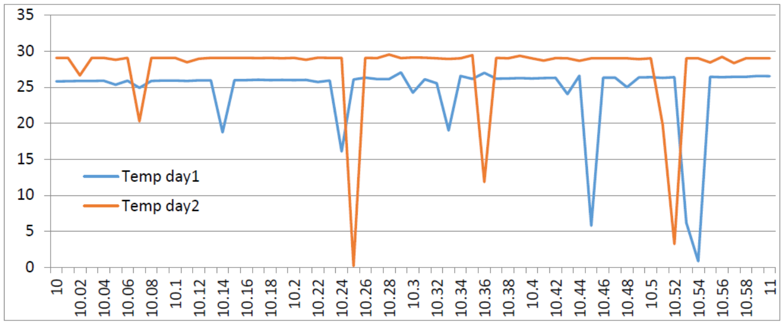

Figure 10. Temperature reading (10.00 to 11.00pm)

3.4 Flow Rate of Nutrient Regulation

Figure 11 and 12 show a nearly similar pattern of steady results of flow rate measurement from 2 different hours for two different days. Both line charts displayed by both figures strongly suggested that a steady flow of measured data by sensor and data acquired from the online server, indeed the graphs also gives a perspective of a high consistency and stability of the data acquisition.

Figure 11 shows a result from 12.30pm to 13.30 pm, and Figure 12 shows a data acquisition from 10 to 11pm for two days (Day 1 and Day 2). With slight differences, the highest measurement of flow rate during daytime for day1 was 4.19 L/min at 12.48pm & 13.00pm and the lowest was 4.07 L/min at multiple points of (12.36, 12.38, 12.43, 12.59, & 13.21pm). Consequently, for day 2, 4.2 L/min was the highest flow rate recorded at 13.22pm and the lowest measurement was 4.09 L/min taken at 12.31 and 12.42pm. Without any irregularity in the graph of Figure 12, the highest measurement for both days was taken at 4.2 L/min & 4.11 L/min at 10.07pm & (10.20, 10.29 & 10.56pm) consecutively for day1 and day2. Oppositely for the lowest point, data taken in day1 was 4.09L/min at (10.45, 10.46 & 10.54pm) and for day2, the measurement was 4.02 L/min at 10.44pm in the evening.

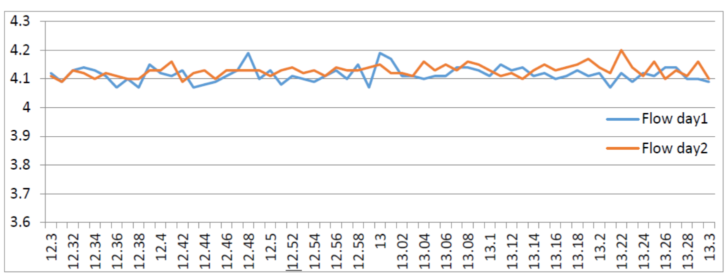

Figure 11. Flow rate reading (12.30 to 13.30pm)

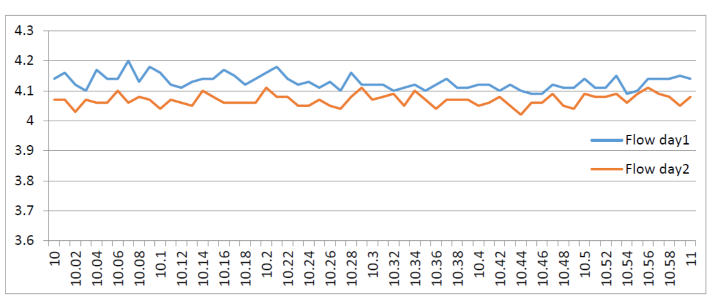

Figure 12. Flow rate reading (10.00 to 11.00pm)

4.0 CONCLUSION

This project is developed in purposes to help users in improving the way of sustaining their life specifically when growing own personal food. A user should always have the upper hands in controlling what they plant and that way, they are able to obtain the highest precocity of harvest. The overall instrumental system developed in this project proved to be efficient in monitoring and fixes pH and conductivity of the nutrient solution of the hydroponic specifically for lettuce. Instead of just EC and pH, users could always monitor the nutrient's temperature and the flow rates of the nutrients regulation throughout the system. To reiterate, this project was set out to build an automatic NFT system in regulating the EC and pH value of hydroponic nutrient solution and to develop an online monitoring system.

With the development of personal BLYNK apps interface, android users could simply download the software and have the power to control and continuously monitor the real time growth of the hydroponic plant. Once that monitoring takes place continuously, corrections can also be done instantly leading to higher productivity, allowing the producer to adjust the parameters set on the EC and pH value of the nutrient's solution.

For future improvement, this system can be more reliable with the use of industrial type sensors. The application of industrial type sensors could overcome several issues such as the calibration cycle of sensors and the durability of the sensors itself when needed to be used for a long period of cultivation time.

ACKNOWLEDGEMENT
This research is fully supported by UC TATI Short Term Grant, 9001

REFERENCES

P. N. Crisnapati, I. N. K. Wardana, I. K. A. A. Aryanto, and A. Hermawan. (2017). Hommons: Hydroponic management and monitoring system for an IOT based NFT farm using web technology. 5th Int. Conf. Cyber IT Serv. Manag. CITSM 2017.

M. Drahansky et al. (2016). We are IntechOpen , the world ' s leading publisher of Open Access books Built by scientists , for scientists TOP 1 %. Intech, vol. i, no. tourism, p. 13.

M. G. Mahaidayu, H. Helmy, A. Nursyahid, T. A. Setyawan, and A. Hasan. (2017). Nutrient Film Technique (NFT) Hydroponic Monitoring System. J. Appl. Inf. Commun. Technol., vol. 1, no. 1, pp. 1–6.

T. Namgyel et al. (2019). IoT based hydroponic system with supplementary LED light for smart home farming of lettuce. ECTI-CON 2018 - 15th Int. Conf. Electr. Eng. Comput. Telecommun Inf. Technol., pp. 221–224.

J. E. Son, H. J. Kim, and T. I. Ahn. (2015).Hydroponic Systems. Elsevier Inc.

M. I. Alipio, A. E. M. Dela Cruz, J. D. A. Doria, and R. M. S. Fruto. (2019).On the design of Nutrient Film Technique hydroponics farm for smart agriculture. Eng. Agric. Environ. Food, no. December 2017, pp. 0–1.

M. V Shewale and D. S. Chaudhari. (2018).IoT based Plant Monitoring System for Hydroponics Agriculture: a Review. Int. J. Res. Appl. Sci. Eng. Technol., vol. 887, no. Ii, pp. 2321–9653.

U. Nurhasan, A. Prasetyo, G. Lazuardi, E. Rohadi, and H. Pradibta. (2018).Implementation IoT in System Monitoring Hydroponic Plant Water Circulation and Control. Int. J. Eng. Technol., vol. 7, no. 4.44, p. 122.

M. Mehra, S. Saxena, S. Sankaranarayanan, R. J. Tom, and M. Veeramanikandan. (2018).IoT based hydroponics system using Deep Neural Networks. Comput. Electron. Agric., vol. 155, no. October, pp. 473–486.

V. Palande, A. Zaheer, and K. George. (2018). Fully Automated Hydroponic System for Indoor Plant Growth. Procedia Comput. Sci., vol. 129, pp. 482–488.

F. Francis, P. L. Vishnu, M. Jha, and B. Rajaram. (2018).IOT-based automated aeroponics system. Lect. Notes Electr. Eng., vol. 492, pp. 337–345, 2018.

D. Yolanda, H. Hindersah, F. Hadiatna, and M. A. Triawan. (2017). Implementation of real-time fuzzy logic control for NFT-based hydroponic system on Internet of Things environment. Proc. 2016 6th Int. Conf. Syst. Eng. Technol. ICSET 2016, pp. 153–159.

