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An IoT - based automated nutrient management in vertical hydroponics

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Abstract
Due to increasing population and urbanization, agricultural lands are converted into housing and industries. But the demand for fruits and vegetables are keep on increasing. Therefore, there is a need for a new agricultural model. Hydroponics is the science of growing plants using nutrient solution as media. In order to use a hydroponic system for indoor plantation, fluid parameters such as pH, Electrical Conductivity (EC) are to be monitored and controlled. This research was conducted to develop an automated nutrient monitoring and control system in vertical hydroponics. Mint was cultivated in the developed system. pH and EC of the nutrient solution were monitored and controlled automatically. The water use and nutrient use efficiency were found to be 43.46 kg/m³ & 2.83 kg/kg respectively. The results showed that the developed system was found to be efficient and can be used for the cultivation of high-value crops to get more profit.

Keywords: Hydroponics, automation, pH, electrical conductivity (EC), efficiency

1. Introduction

The world population is expected to increase between 9.4 and 10.2 billion by 2050 (Chakraborti *et al.*, 2019) [1]. Urbanization and infrastructure development are also expanding rapidly. These cause a decrease in open land, where land is needed as media to grow plants and maintain the food supply for the world population (Adidrana and Surantha, 2019) [2]. Therefore, to answer the problems of lack of agricultural land and to feed millions of mouths in the country, one of the hi-tech cultivation techniques used by people today is hydroponics. Hydroponics is the solution to the shortage of space for cultivation and challenging environmental conditions by growing plants using the nutrient solution as media instead of soil (Boopathy, 2020; Helmy *et al*., 2016) [3, 4]. Water and nutrients that flow to the plant replace the role of soil. One of the prevalent hydroponic techniques used is the Nutrient Film Technique (NFT).

To use NFT system in greenhouse, microclimatic parameters such as temperature, relative humidity, light intensity and fluid parameters such as pH, Electrical Conductivity (EC) are to be monitored and controlled (Prabha and Sarala, 2020) [5]. For this, we require an intelligent (automation) system that can be utilised as a maintenance tool and that operates automatically to determine the status of nutrient solution and management in a hydroponics system. The pH and EC sensors will measure and collect the necessary data, which will then be processed by the system to produce the right result. Utilizing Internet of Things (IoT) technology, the collected data will be stored in the cloud and accessible online. An intelligent system is expected to assist hydroponics owners in monitoring the condition of the nutrient solution and to perform automatic maintenance on the crop being grown anytime and wherever (Saputra *et al*., 2017) [6].

2. Materials and Methods

2.1 Experimental setup

The experiment was conducted in the naturally ventilated poly house, located at KCAET, Tavanur, Kerala. The Temperature, Light intensity and Relative humidity were measured on daily basis.

2.2 Design of Vertical Hydroponics system

The system consists of four horizontal pipes arranged in vertically stacked layers with slope (1 - 3%) was installed, instead of farming on a single level. It is a closed loop system, where four

PVC pipe was placed one above the other. The depth of flow inside the pipe of 1 - 1.5 cm was maintained throughout the period. The flow rate of the nutrient solution of 0.5 - 2 L/min was maintained. There was one water tank, nutrient mixing tank and overhead tank. Four water bottles fixed with solenoid valves for pH up, pH down, nutrient solution A and B. All four bottles and water tank were connected to the nutrient mixing tank through the solenoid valve. Agitator was fixed inside the nutrient mixing tank.

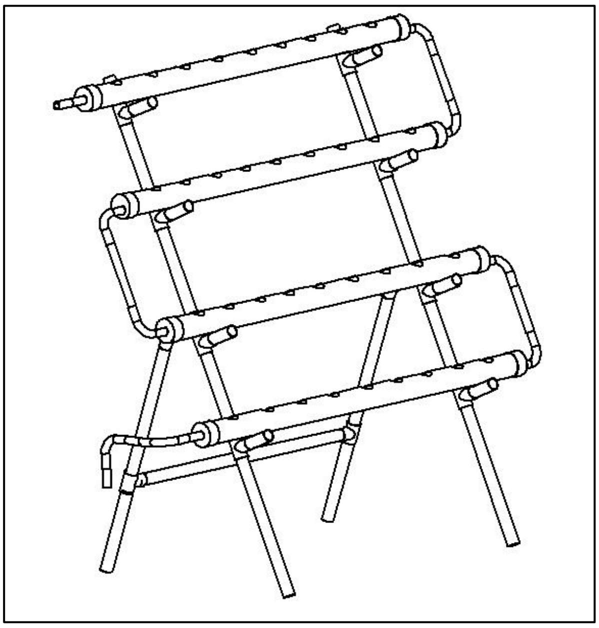

Fig 1: Experimental design of hydroponic system.

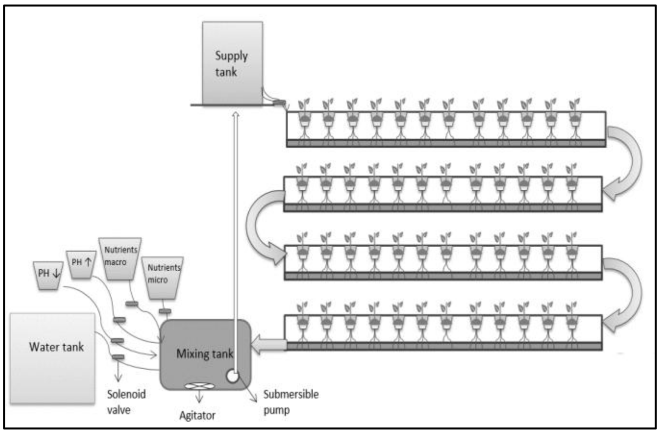

Fig 2: Schematic diagram of hydroponic system.

2.3 Installation of Automation system

The Arduino microcontroller acted as the tool's brain, monitoring the hydroponics plants and detecting the height of water with the help of an ultrasonic sensor. To maintain the water quality, a pH and an EC sensor were used. The program module was embedded in this system to allow it to execute. The Arduino was used in real-time monitoring and controls the system to activate the pump and solenoid valve using relay, when required.

The sensors readings, such as water level, flow rate, pH and EC were sent to a web server through a Wi-Fi module. The Wi-Fi module was linked to the microcontroller, which collects data from the sensors and sends it to ThingSpeak (IoT platform).

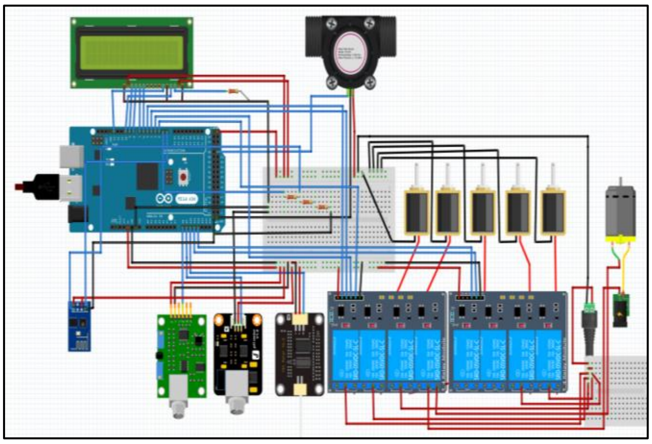

Fig 3: Circuit connection for automation system.

3. Results

The Relative humidity, Light intensity and Temperature observed were observed on daily basis and found to be 63%, 16046.4 lux and 33°C, respectively which was well within the range required for a hydroponic system. Mint was grown in the developed hydroponic system. Each week plant height, length, width and Number of leaves were observed.

Fig 4: Plant growth after 6 weeks.

A constant pH range of 5.5 - 6.5 was maintained throughout the cultivation. EC of the solution was changed according to the growth stage and maintained in the range of 1.4 - 2.0 mS/cm. Solenoid valves of the bottles and water tank were opened by the relays to adjust the pH and EC.

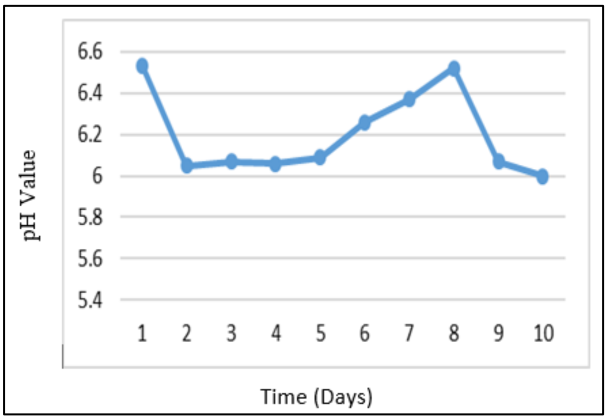

Fig 5: pH value of the Nutrient Solution

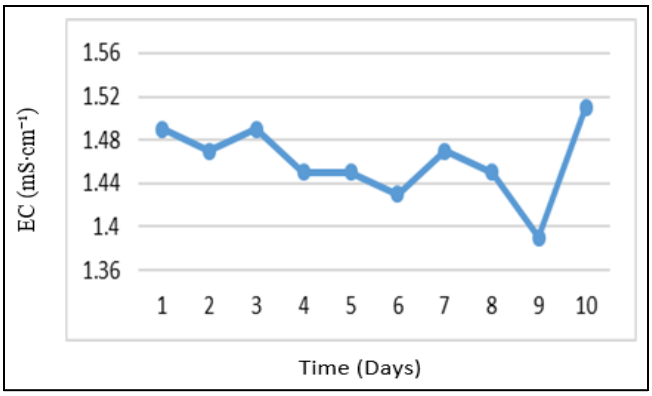

Fig 6: EC value of the Nutrient Solution

User can see all the parameters in the mobile application by connecting Wi-Fi module to the microcontroller. Mint was harvested in 6th week and yield was calculated by taking the weight of each plant.

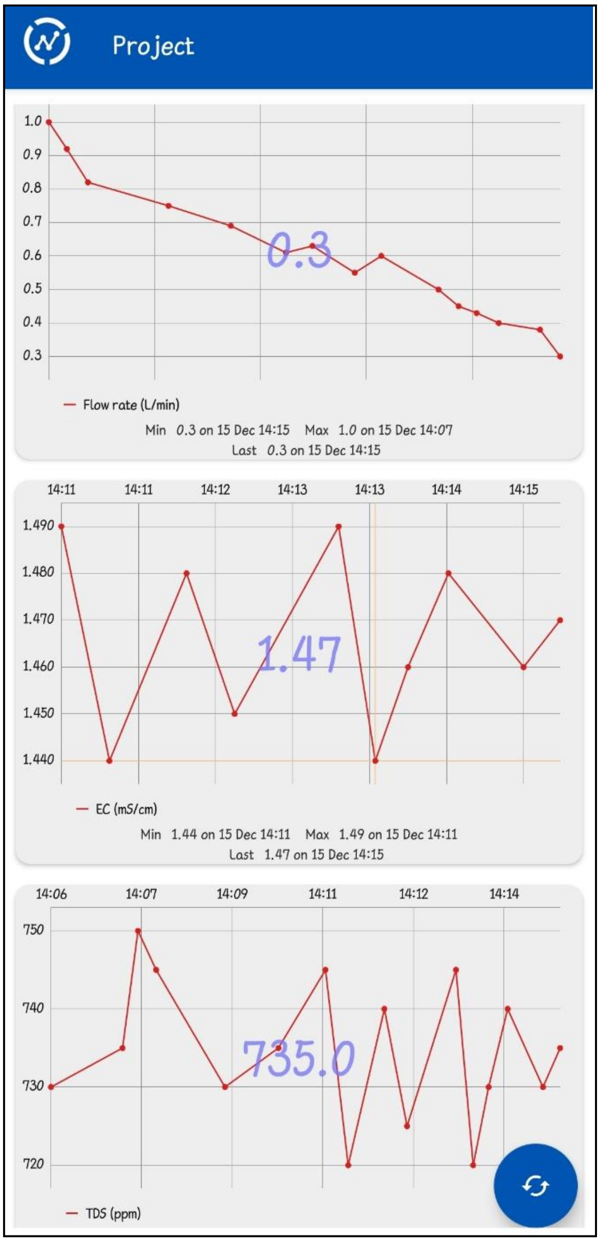

Fig 7: Display of Nutrient parameters in ThingView app.

The total yield, water used and nutrient used at the end of 6 weeks were 308.6g, 7.4 L and 109g respectively. Water use efficiency. and nutrient use efficiency were found to be 43.46 kg/m^3 and 2.83 kg/kg respectively.

Fig 8: Harvested mint

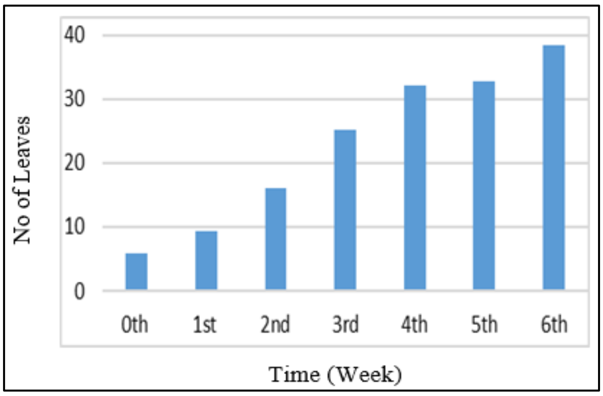

Fig 9: Number of leaves in each week

Table 1: Biometric observation of mint at the end of each week

Time (Week)	No. of leaves	Leaf length (cm)	Leaf width (cm)	Plant length (cm)
0th	6	1.1	0.6	7.9
1st	9	1.7	0.9	12.5
2nd	16	1.9	1.2	18.3
3rd	25	2.2	1.4	26.3
4th	32	2.5	1.7	29.2
5th	33	2.7	1.8	30.1
6th	38	3.0	2.0	35.7

4. Conclusions

The results of this study show that the developed automated system provides complete control over the nutrients that plant require. Mint was cultivated in the developed system for 42 days (6 weeks). Due to the automated feeding of nutrient solution and maintaining the nutrient solution parameters (pH & EC) within the specified limit, the hydroponic plants have grow taller and produced more leaves faster than the plants growing in normal soil. The average number, length, width of the leaves and height of the crop were 38, 3 cm, 2 cm and 35.7 cm, respectively. Water use efficiency and nutrient use efficiency were 43.46 kg/m^3 and 2.83 kg/kg respectively, which is higher than the conventional method. It is an IoT-based automated system, which provides smart monitoring system to the user. So, that the user can access the graph and the current state of the system through the android application and make it easier to grow the plants in homes. Since, it was a trial to evaluate the developed automated system, Low value crop was cultivated. High-value crops can be cultivated to get more profit.

References

1. Chakraborti RK, Kaur J, Kaur H. Water Shortage Challenges and a way Forward in India. Journal American Water Works Association. 2019;111(5):42.
2. Adidrana D, Surantha N. Hydroponic nutrient control system based on internet of things and K-nearest neighbors. In: 2019 IEEE International Conference on Computer, Control, Informatics and its Applications (IC3INA), 23-24 October 2019, Tangerang, Indonesia, 2019, 166-171.
3. Boopathy S, Anand KRG, Rajalakshmi NR. Smart Irrigation System for Mint Cultivation through Hydroponics Using IOT. Test Engineering and Management. 2020;83:13706-13714.
4. Helmy H, Nursyahid A, Setyawan TA, Hasan A. Nutrient Film Technique (NFT) Hydroponic Monitoring System. Journal of Applied Information, Communication and Technology. 2016;1(1):1–6.
5. Prabha PV, Sarala SM. Robust smart irrigation system using hydroponic farming based on data science and IoT. In: 2020 IEEE Bangalore Humanitarian Technology Conference (B-HTC), 8-10 October 2020. Vijiyapur, India, 2020, 1-4.
6. Saputra RE, Irawan B, Nugraha YE. System design and implementation automation system of expert system on hydroponics nutrients control using forward chaining method. In: 2017 IEEE Asia Pacific Conference on Wireless and Mobile (APWiMob), Bandung, 2017, 41-46.