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Future of Kitchen Garden Using Connected Hydroponics

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***Abstract*: This paper presents a Hydroponics Management System (HMS) that can automate the process of providing suitable environment for plant growth by maintaining the humidity, temperature, pH level, the inflow and outflow of water and nutrient solution intake. The significance of hydroponics is to provide a faster and efficient way to grow plants in a soilless medium. Maintaining air temperature, heat index, relative humidity, nutrient level of the water, PH level, proper lighting and water supply is critically important in hydroponics which can be done using this HMS. Therefore, with the help of HMS that monitors these factors is valuable and will ensure higher success and efficiency rates of plant growth. HMS enables users to control certain mechanisms like lighting and many more through the web/mobile application and can also monitor the air temperature, pH level, water level and relative humidity, which is the data collected from the sensors. Data from sensors are collected in a microcontroller and sent to the dashboard. Detection of diseases also plays an important role which is done using some image processing algorithms.**

***Keywords*: Hydroponics, Gateway, Image processing, MQTT, Thingsboard, Raspberry-Pi.**

1. Introduction

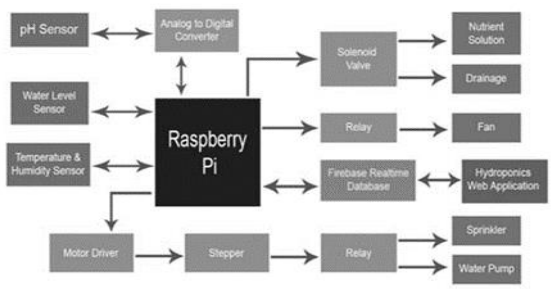
Agriculture plays a very important role in the development of the country. Plants grown in traditional methods require frequent monitoring and the significant decrease in agriculture land has paved way for different methods of growing plants. Hydroponics is one such method where plants are grown in a soilless medium i.e., using water. Special attention to several parameters such as the water temperature, water level, acidity (pH), and the concentration of the nutrient (EC/PPM) in the hydroponic system. We first collect the data about all the parameters of a particular plant and then analyse the plant growth. Lamentably, it is still controlled in a traditional way (human), for example the nutrient concentration has to be checked at least once a day, so much time is wasted in maintaining ambient conditions for the growth of plants. So we have developed a hydroponics management system where all the critical parameters can be monitored and controlled without human efforts using sensors connected to the ESP32(Wi-Fi module) and Raspberry Pi which acts as a gateway from where the data is sent to the web application. Each ESP32 acts as a node and each node can communicate with the webserver (broker) to figure out whether plants are getting required nutrients. We also use Image Processing algorithms to monitor the health of plants and to recognise whether the plants are affected with any diseases so that immediate and necessary precautions can be taken so that other plants are also not affected by the disease.

2. Literature Survey

The following survey consists of different techniques to automate the hydroponics management system, which mainly consists of technologies such as MQTT, Digital image processing, Gateway, and Hydroponics setup.

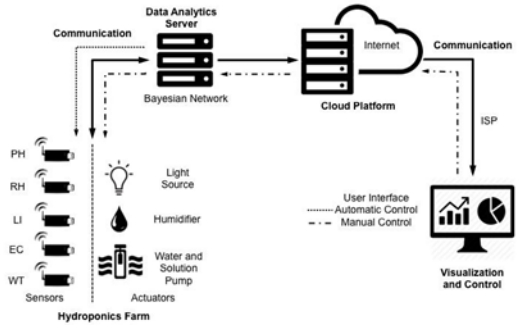
A. Hydroponics setup

In this paper the author proposed a closed Hydroponics management system using fan and sprinkler for easy control of relative humidity and temperature. The sprinkler had finer holes to produce finer moist that could increase the relative humidity and the water pump had great pressure for sprinkling the water over a larger area. The fan was used to decrease the relative humidity of the area. The data such as pH, EC, water level, temperature and humidity were sent to the web application and it could control the fan, drainage, water pumps and sprinkler [2].

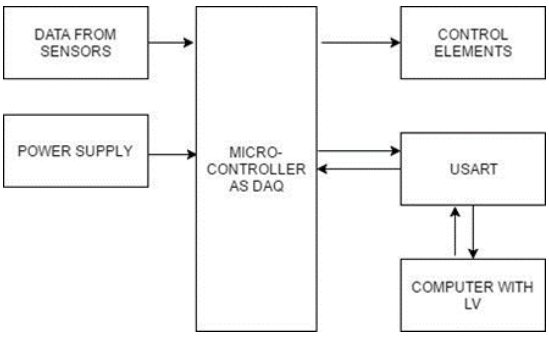


In this paper, the author proposed a smart Nutrient Film Technique(NFT) hydroponics farms using Bayesian Network.

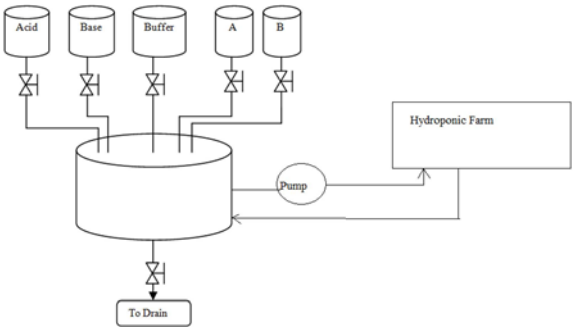
Smart farming was implemented using the Internet of Things (IoT). Data sent from the sensors were analysed and these datasets were gathered and then the BN's performs the predictive analysis to control the system. The crops yield from this automatic process was better than manual control [7].



In this paper the author proposed an automated hydroponics system using minimum resources and cost. Smooth control and great stability was gained by using proportional integral derivative (PID) algorithm. Low cost AVR microcontroller was used to import real time data and to monitor and control the process NI Labview was used. LV provides easy rendering of the user interface and real time data handling and processing with great flexibility to edit and modify the code at any time. The whole setup was automated and required no man power. The crop yield from this process was more productive than the one without any automated system [10].



In this paper the author proposed an effective control system for the hydroponics nutrient solution using genetic algorithms. They made use of EBB and flow technique. The nutrient solution for hydroponics was controlled by a fuzzy inference system(FIS) and this method was designed using Matlab tools. Labview was used to simulate the virtual hydroponics nutrient control setup for analysis purposes. The virtual system had five containers containing acid, base, nutrients A and B and neutral water which is used as a buffer. The genetic algorithm was designed to achieve better quality nutrient solution with minimal wastage [15].



The author proposes the advantages and disadvantages between hydroponics and normal cultivation. He also proposed different methods of cultivation using hydroponics like circular and non-circular methods. He has mentioned the list of various crops which can be cultivated using hydroponics with their prerequisites. He has also mentioned different nutrients to be supplied for the plants for better growth. These nutrients provide the same minerals that plants absorb from the soil [17].

B. MQTT

The author proposes a MQTT based monitoring system for urban farms. Different sensors like temperature, humidity, ph are used to collect the data from the farm. The sensors are controlled by using ESP32 which is a Wi-Fi module. The ESP32 acts as nodes. Many different sensors are connected to the ESP32 and multiple ESP32 are placed in different parts of the farm. All the nodes are connected to Raspberry-Pi which acts as a gateway for the wireless sensor network. All the data from the ESP32 are sent to the gateway. All the processing is done in the gateway. Then from the gateway the data is sent to the user using MQTT protocol ny using MQTT Publish. The data can be analysed by the user through the MQTT dashboard through which the user can control any mechanical devices by sending the data from the dashboard. The plants can be monitored from any device [3].

The author describes MQTT-S as an extension of the open publish/subscribe protocol Message Queuing Telemetry Transport(MQTT) to Wireless Sensor Networks(WSN). The advantages of the MQTT over the other protocol in WSN is discussed in this paper. It can be implemented for low cost and also for the devices which runs on the battery with less storage and less processing. MQTT acts as a broker between the sensor nodes and the user. The data from the sensor is sent to the MQTT broker through MQTT Publish and that data can be read by the user using MQTT dashboard. Electronic devices can be controlled by the user by subscribing the data using MQTT Subscribe. MQTT is more suitable for WSN as it is a lightweight protocol and requires less energy. If there is a complexity then gateway can be used for the data transfer so that the nodes do not require to spend more energy. The author has also implemented a working MQTT-S client and gateway to study MQTT-S behaviour in real time on real system by using ZigBee as the client i.e., the data is collected from the sensors using ZigBee[19].

C. Digital Image processing

The author proposed a method to detect and identify whether the plants are affected by any diseases. A block diagram is proposed of various steps that should be followed in order to detect and identify the disease that the plant is affected. The steps in this method are color transformation, masking, segmentation, color co-occurrence. After all these steps texture analysis is done to compute the texture features like contrast, energy, local homogeneity, cluster shade and cluster prominence for the Hue. Genetic algorithm is used as a classifier to classify the plants as diseases affected or not. All these data is sent to a microcontroller where the processing takes place and the prediction is given whether the plant is affected by disease or not. The results were not much faster and accurate in this methodology [4].

The author proposes a methodology to identify the plants by considering the color, shape and texture of the leaf as the key features. Along with these leaf vein, apices, leaf margins, leaf bases are also considered. All these features are combined to identify the plants. It is also said that if they increase the features then more accurate results can be obtained and image processing algorithms can be used for better results. By increasing the number of features the speed of recognition reduces which can be solved by using proper image processing algorithms [9].

The author proposes a method for the detection of unhealthy plants and the disease that the plant is affected by analysing the plant leaves using image processing and genetic algorithm. First the images of the plants are taken using a camera. Different processing steps are also proposed in this method which includes image acquisition, preprocessing of the image, segmentation. MATLAB is used as a tool to perform the image processing steps. Then by comparing the processed image with the sample image analysis is done whether the plant is affected by the disease or not. The test has been conducted on many different plants and has got good results with very less computational efforts. This method can be improved by using Artificial Neural Network, Bayes classifier, Fuzzy Logic and other hybrid algorithms [14].

D. Gateway

The author proposes that nodes can communicate with any protocol to the gateway, but the gateway proposes heterogeneity, where in the gateway communicates with all the nodes depending on the nodes connectivity and the proposed method can communicate with three different protocol and the data is pushed to the dashboard or cloud and comparison is drawn out between Wi-Fi, bluetooth and zigbee [1].

The author proposes an IoT gateway which can emulate to any protocol for hobby projects. This proposed gateway can communicate with any type of protocol with the connected nodes in any type of cellular network or LAN connectivity where the cost of setup is less when compared to others [8].

The author proposes a gateway where in the nodes communicate with low powered protocol and the gateway tries to communicate with the internet by using wireless or wired connectivity. This is achieved by having a convertor which will try to establish communication between 802.11 and 802.15.4. This can consume low power when compared to the communication without the convertor [13].

The author proposes the concept of wireless sensor network architecture where in each node collect data remotely from all the other nodes by using a low powered connectivity and that node will act as gateway and uses high powered connectivity like Wi-Fi and pushes the data to the cloud or any database [18].

In this paper the author proposes the concept of wireless sensor network architecture, features, application, advantages

Table 1
Literature survey

Author's	Year	Technique	Advantage / Scope
Delphi Hanggoro, Lukman Rosyidi, Riri Fitri Sari	2019	Heterogeneity gateway	It can communicate with any type network
Chris Jordan G. Aliac, Elmer Maravillas	2018	Raspberry-Pi based control system	Control over different parameters like temperature, humidity etc.
Ravi K Kodali and Aditya Valdas	2018	MQTT based monitoring system	Controlling and monitoring the sensors
Arya M S, Anjali K & Mrs.Divya Unni	2018	Genetic algorithm	Plant disease detection
MelchizedekAlipio, Allen Earl M. Dela Cruz, Jess David A. Doria and Rowena Maria S. Fruto	2017	Bayesian Network	Low man power
Kanchana Rajaram, Sushanth G	2017	Emulated Heterogeneity gateway	Low powered heterogeneity gateway
Jibi G Thanikkal, Ashwani Kumar Dubey, Thomas.M.T	2017	Image processing technique	Different Plant detection
Saket Adhau, Rushikesh Surwase	2017	proportional integral derivative (PID) algorithm	Low cost and minimum resources
Shengrong Yin, Qiang Li, Omprakash Gnawali	2015	Gateway convertor	Communication happening between bluetooth and wifi
Vijai Singh, Varsha & Prof. A K Misra	2015	Image acquisition and segmentation	Plant health and disease detection
Lenord Melvix J.S.M , Sridevi C	2014	EBB and flow technique	Better growth by nutrient control setup
Mamta D Sardare, Sharddha V Admane	2013	Different hydroponics methods	Hydroponics as regular cultivation method
Philip Angove, Michael O'Grady, Jer Hayes, Brendan O'Flynn	2011	Communication with wireless sensor network	Algorithm used to collect data and publish to the database
Hunkeler, Hong Linh Truong, Andy Stanford	2009	MQTT-S in wireless sensor network	Real time data monitoring
Jennifer Yick, Biswanath Mukherjee & Dipak Ghosal	2008	Wireless sensor network	Connectivity using low powered wireless sensor network

and disadvantages of wireless sensor network [20].

3. Conclusion

The idea of providing Highly efficient, cost effective and fully automated hydroponics setup by building an IoT gateway and using MQTT protocol and Digital image processing. To build a hydroponics management system on a small scale to implement in small areas like terrace, balcony of the apartments.

4. Future scope

Hydroponics is the fastest growing sector of agriculture, and it could very well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and aeroponics to create additional channels of crop production. Hydroponics techniques produce a yield much greater than that of regular way of cultivation. Hydroponics can be completely automated with minimum man power. Plants' health can be monitored automatically, hence preventing diseases.

References

[1] Delphi Hanggoro, Lukman Rosyidi, Riri Fitri Sari, "Design and Implementation of Multi-Protocol Gateway for Internet of Things", 2019.
[2] Chris Jordan G. Aliac, Elmer Maravillas, "IOT Hydroponics Management System", 2018.
[3] Ravi K Kodali and Aditya Valdas, "MQTT Based Monitoring System for Urban Farmers Using ESP32 and Raspberry-Pi", 2018.
[4] Arya M. S, Anjali K. and Divya Unni, "Detection of Unhealthy Plant Leaves Using Image Processing and Genetic Algorithm with Arduino", 2018.
[5] Espressif Systems "ESP32 Technical Reference Manual", 2018.
[6] Lucio Tommaso De Paolis, Valerio De Luca & Roberto Paiano, "Sensor data collection and analytics with thingsboard and spark streaming", 2018.
[7] Melchizedek. Alipio, Allen Earl M. Dela Cruz, Jess David A. Doria and Rowena Maria S. Fruto, "A Smart Hydroponics Farming System Using Exact Inference in Bayesian Network", 2017.
[8] Kanchana Rajaram, Sushanth G, "Emulation of IoT Gateway for Connecting Sensor Nodes in Heterogeneous Networks", 2017.
[9] Jibi G. Thanikkal, Ashwani Kumar Dubey, Thomas. M. T, "Whether color, shape and texture of leaves are the key features for image processing based plant recognition? An analysis", 2017.
[10] Saket Adhau, Rushikesh Surwase, "Design of Fully Automated Low Cost Hydroponic System using Labview and AVR Microcontroller", 2017.
[11] Murat Dener, "A Gateway node for wireless sensor network applications", February 2016.
[12] Jumras Pitakphongmetha, Nathaphon Boonnam, Siriwan Wongkoon, Teerayut Horanont, Deeprom Somkiadcharoen and Jiranuwat Prapakorn Pilai, "Internet of Things for Planting in Smart Farm Hydroponics Style", 2016.
[13] Shengrong Yin, Qiang Li, Omprakash Gnawali, "Interconnecting Wi-Fi Devices with IEEE 802.15.4 Devices without Using a Gateway", 2015.
[14] Vijai Singh, Varsha and A. K. Misra, "Detection of unhealthy region of plant leaves using Image Processing and Genetic Algorithm", 2015.
[15] Lenord Melvix J. S. M, Sridevi C, "Design of Efficient Hydroponic Nutrient Solution Control System using Soft Computing based Solution Grading", 2014.
[16] Andrew Banks and Rahul Gupta, "MQTT Version 3.1.1", October 2014.
[17] Mamta D. Sardare, Shraddha V. Admane, "A Review on Plant without soil - HYDROPONICS", March 2013.
[18] Philip Angove, Michael O'Grady, Jer Hayes, Brendan O'Flynn, "A Mobile Gateway for Remote Interaction with Wireless Sensor Networks", 2011.
[19] Hunkeler, Hong Linh Truong, Andy Stanford, "MQTT-S – A Publish/Subscribe Protocol for Wireless Sensor Network Wireless Sensor Network Survey", 2009.
[20] Jennifer Yick, Biswanath Mukherjee and Dipak Ghosal, "Wireless Sensor Network Survey", April 2008.