Automation in Hydroponic System

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Abstract

Design and implementation of an automated hydroponics system by utilising internet of things. The circumstances to be solved with this system are the increasing demand of food in the world, the need of market of new and ease based method of farming by using the Internet of Things. The design was executed using Raspberry PI , Relay and sensors that were chosen during component selection based on required parameters and uploading it to the cloud to monitor and be processed. Firstly the prototype was constructed, programmed and tested, as well as sensors data between two different environments were taken and monitored on cloud-based web page with mobile application. There are some limitations which can be improved as future work such as including data science with the usage of the artificial intelligence to further improve the crops and get better outcome. Lastly to design end user platform to ease user interaction by using attractive design with no technical configuration involved.

Keywords: Hydroponics, Raspberry PI, Internet of things, Relay, sensors

1.Introduction

To ensure the availability of affordable and quality products to meet the increasing food demand, intensification of the growing practices is necessary. Agriculture is the foundation of human civilization and is responsible for the production of quality food for the human population.

By description, hydroponics is subset of hydro culture, the system of growing shops without the use of soil, using mineral nutrient solution in a water solvent . As defined, plants in hydroponics system are grown without the use of soil. Plants admit all the essential nutrients from a nutrient rich water based solution, whereby the water is mixed with the specified solution for the plant to be grown. Thus, there are a variety of hydroponic way or methods in which plants can grow in a non-soil medium or directly in the nutrient rich water based solution. These operations are controlled totally and thus tend to produce advanced than traditional farming. For the once couple of times this system has been enforced and used in civic areas to improve the access to a fresh food . The Internet of Things is an arising content of specialized, social, and profitable significance. Consumer products, durable goods, buses and exchanges, artificial and mileage factors, detectors, and other everyday objects are being combined with Internet connectivity and important data logical capabilities that promise to transfigure the way we work, live, and play.

2.Literature Survey

[1]Conventional soil-based crop cultivation has various drawbacks, such as access to land, poor soil quality, erosion, low efficiency of water utilization, pests, and the multiple environmental limitations associated with climate change. These drawbacks are exacerbated by a growing human population and associated increase in demand for cereals, fruits, vegetables, and other food crops. Thus, interest has grown in soilless cultivation research in the last two decades. Hydroponics, a form of soilless cultivation, has become popular because it can produce higher yields than traditional soil-based agriculture, it is conducted in a controlled environment that is free from climate and other environmental constraints, and crops can be produced with significantly lower use of pesticides than those grown conventionally. This paper provides a literature review of recent research on hydroponic crop cultivation (HCC), including the historical context, classification, requirements for HCC, and the latest technologies employed in this field. The review closes with an analysis of the challenges ahead for the development of HCC.. Biography: Boyang Lu is a second year PhD student in the Department of Environmental and System Engineering at the University of Virginia. He obtained BSc. and MSc. degrees in Industrial Engineering from Nanjing Unviersity and Univerisity of Arizona, respectively. His research interest is sustainable cultivation technology, which is mainly on hydroponics crop cultivation. Garrick Louis is Associate Professor of Engineering Systems & Environment at the University of Virginia. His research examines local capacity building for sustained access to essential human services in developing communities. He has BSc. and MSc. in Chemical Engineering and PhD in Engineering and Public Policy. Honors include; Presidential Early Career Award for Scientists and Engineers from National Science Foundation and 2006-7 AAAS Energy Environment and Natural Resources Fellow. He was a 2015-16 Jefferson Science Fellow in the Office of Global Food Security at the US Department of State, and is a Fulbright Specialist for the US Department of State

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3.Description

The automation system consist of raspberry pi as micro controller which triggers the relay basend on the configuration of python programme done on microcontroller so as to complete the execution of commands over the sensors , motors, camera and light connected to the relay .It is an android app based control system with server based interactions. It's a small closed looped system designed and setup according to the crop sowing to harvesting conditions and requirements, thereby creating an controlled atmosphere as per the specifications.

Client side

In order to cover real time parameters, the customer side must setup consequently, thus three stages must be considered. Programming the microcontroller with sensors and relay, include the initiating section whereby hydroponics has been anatomized consequently to gain the needed sensor to measure the different parameters similar as the pH position, Moisture and temperature of the room, temperature position when water is mixed with the solution and the horticultural lighting to give the right illumination for the plant at night. Followed up with the electrical wiring for the system and Raspberry PI designing whereby after the programming the senaors and the microcontroller together, all the wiring and power supply are assembled as one part with 5V, also the used method for the hydroponics is Nutrient Film Method.

Server side

The second stage of the system is to make the server side of the system. This substantially consists of two parts, setting the google firebase Put & Get server which is used to transfer the data from microcontroller to any android platform app that can read firebase data. Originally this was done to secure the data and enhance the effectiveness and the trustability of the data transferred and entered from and to the microcontroller from any possible third party to access to the data. In order to completely emplace the firebase server, host was needed thus a raspberry pi 3 has been used as the host for the server at harborage 1883 to access the firebase server authentication (username and password). This is done to ensure only applicable devices can be connected and read and write throughout the server. The second part of the second stage is the setup of the Internet of Things platform. Numerous platforms are available and give a wide variety of IOT services, but due to the price that will be needed with the time and according to one of the objects which was to reduce the cost of the system, a free IOT server has been stationed called firebase. Hence after planting the Firebase server, authenticating is done to secure the access to the server and password is encrypted to ensure the maximum quantum of security. Also, the alternate stage servers will

bear hosting to give availability from anywhere around the world thus a hosting is needed. For this system a dynamic domain name will be used to reroute the traffics to named domain name from the raspberry pi host.
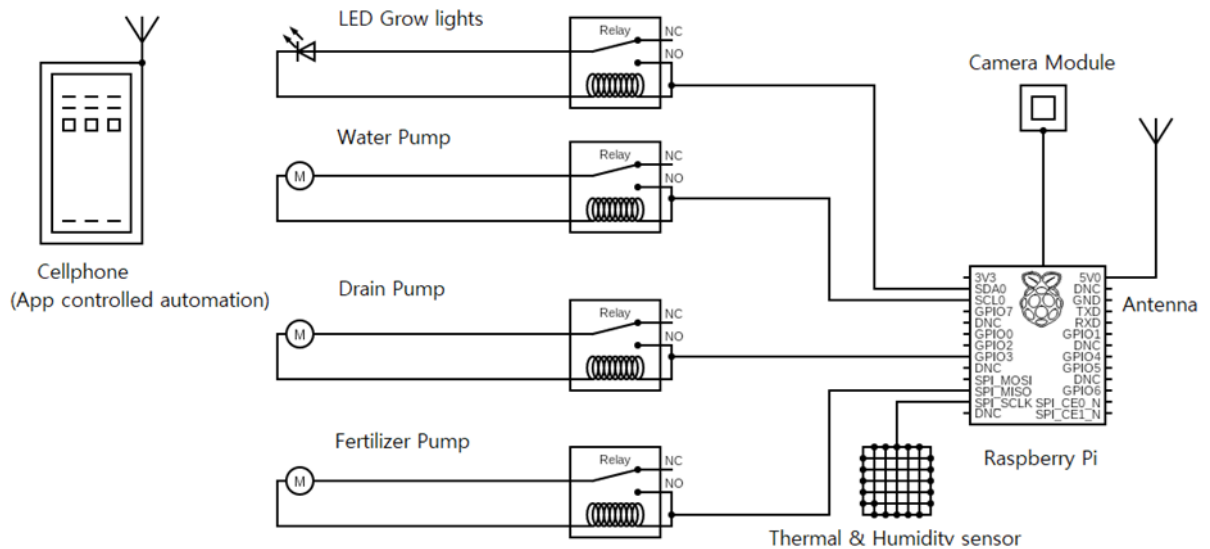
4.1Design

Figure 1Block Diagram

5. Components

- Raspberry Pi 3 (B+)

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT

The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market.

Figure 2Raspberry Pi

The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.

- Relay

4 Channel 5V Optical Isolated Relay Module

This is a LOW Level 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller. This module is optically isolated from high voltage side for safety requirement and also prevent ground loop when interface to microcontroller.

Figure 3 Relay 4 channel 5v

- **Humidity & Temperature Sensor**

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a highperformance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.
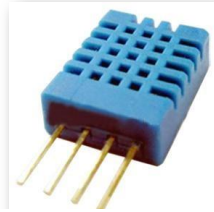
Figure 4Humiditty & Temperature sensor

- Water pump

Micro dc 3-6v micro submersible pump mini water pump for fountain garden mini water circulation system diy project dc 3v to 6v submersible pump micro mini submersible water pump 3v to 6vdc water pump for diy dc pump for hobby kit mini submersible pump motor this is a low cost, small size submersible pump motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220ma. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. The dry run may damage the motor due to heating and it will also produce noise.

Figure 5Water Pump

4.Conclusion

The proposed system in this paper is an automated smart hydroponics system, whereby this system will be suitable to add and apply Internet of Things conception and functionality to the current being hydroponics system. A Guided user interface that allows the user to control and monitor real time data has been successfully achieved by developing a user interface node for the firebase and linked with the real- time detector data. Internet of things conception is enforced to the system to ease the process of growing food hydroponically by easing the process of growing and monitoring via secure cloud. By adding the internet of things, it solves one the crucial challenges in automation today which is conservation, by furnishing a platform for covering the entire system from cloud, therefore reducing the cost of conservation by fraction. Lastly, the performance of the smart hydroponic system is estimated. The automated smart hydroponics system is designed for inner operation, for a bigger scale using Wi-Fi is n't the ideal wireless network, and the system is a success and enforced successfully. Still, future work that can be done further enhancement will be by Integrating Data Analytics to the system or machine learning to develop algorithms to peridict outcomes, add further detectors to get more accurate data and help the Artificial Intelligence system to peridict the outcome better and by using intel C1000 microprocessor which comes built in with image processing for the crops health.

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