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Automated Hydroponic Drip Irrigation Using Big Data

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Abstract— **Modern Agricultural lands are renovated through Smart Farming using the IoT and Big Data technologies which help farmers to reduce the usage of natural resources to increase efficiency. This technological growth is driven by continuous improvements in digital tools and data. The traditional irrigation monitors and controls the involved variables for the cultivation of the crops which are the actions that farmers should implement in their crops to save water resources and assessing their growth. Hydroponic drip irrigation systems defined as growing plants and crops without the soil. Conversely, hydroponic irrigations systems have the potential of saving the water and other nutrients by dripping the water slowly to the roots of the plant. The present irrigation system provides only soil moisture and the surrounding temperatures with sensors. In this paper, the system is used to record the sensor values and can manipulate the nutrient values when required. This work is all about the drip control and applying it to hydroponic farming by developing an interface between human and software which allows a continuous monitor of pH and all sensors, including the position of the plant by capturing via camera and monitoring via mobile application. Using big data, the supply of nutrient values gets tracked and recorded. This recorded data gets useful to automate the irrigation system further.**

Keywords—Drip irrigation, Hydroponic, Smart Farming, Big Data, IoT

I. INTRODUCTION

The term HYDROPONICS refers to "Water Working". It got derived from the Greek words "Hydro" means "Water" and "Ponos" means labor. Basically, Hydroponics is a way of growing plants without using soil. When it comes to providing food and water to the plants, it becomes the best way. As a note, plants usually don't use soil – they need only the food and water present in that soil. The main work of the soil is to supply the nutrients and makes the plant's root to anchor the supplies easily. In a real scenario, it's difficult to find the area(soil) where the soil is nutrient full and keep the crop away from pests. Crops mainly damaged because of low valued solutions like Benzene Hexa chloride which are banned by WHO applied to them. Sometimes the water flow won't be in control that leads the crop to drain. There are times when rainfall is more such that the water flow becomes higher and may lead the crops to drain. It may lead the crops to drain. For a large harvest, a large amount of area is needed.

But in the case of hydroponic drip irrigation, all the nutrients are monitored and provided accordingly without using soil. As the food and all nutrients dissolved in water and directly provided through roots, plants grow faster and get ready for harvest.

Many Smart Farming technologies are booming now which is a blend of IoT, Big Data, and Agriculture that is capable of automating the drip irrigation. Sensors play a major role in the implementation of IoT integrated Hydroponics Drip Irrigation. For example, to determine the temperature at which the plants change the weather conditions is recorded by the Temperature Sensor.

This paper is based on a prototype which was developed in-house as part of the academic project in Amrita School of Engineering, Bengaluru. It explains about the proposed method of implementing the Automated Hydroponics Drip Irrigation System which works with the notion of Big Data technology. It is feasible to develop as multiple systems at small levels that will also allow testing different kind of techniques and decides which works the best. A smart application allows monitoring all the sensor values using Raspberry Pi. By connecting it to Raspberry Wi-fi, can log in to the website using the specified login which already created.

II. RELATED WORKS

The data is everywhere in our basic life. Nowadays all things get connected to the internet. Irrigation becomes one of the main objectives of this. The author Jirabhorn [1] explains the integration of data fusion centres to reduce the amount of information exchange between the sensors and the control system. Somchoke [2] the author designed a cloud-based system using MQTT client-broker server. The author Victor [3] proposed a greenhouse based system using Arduino. Padma [4] brings out HOMMONS model to monitor the system continuously by using Arduino and raspberry pi both. Robert [5] the author, implemented a Cyber-physical social system where a telegram messenger is used to display the results of the raspberry pi microcontroller. The author Miss Komal[6], explained about the Nutrient Film Technique which helps to recycle the used fertilizer solution again to the system. Jumras Pitakphongmetha[9], the author implemented an automated hydroponic system using NodeMCU and Blynk server

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which also helps to create a mobile application to monitor all the sensor data that got collected by a raspberry pi.

[1] Jirabhorn Chaiwongsai: The proposed system in this paper is designed by reducing the amount of information exchanged between the sensors. The proposed system consists of 3 parts: Sensor node, Sensor with data fusion and data fusion result. The sensors like humidity, temperature, water level sensors send the raw data to the data fusion centre. Through the mobile application, the User can read the data fusion centre results. On the other hand, the User cannot send the instructions to the system.

[2]Somchoke Ruengittinun: Hydroponic Farming Ecosystem designed using Arduino Uno, Wi-Fi shield and the MQTT server [Message Queuing Telemetry Transport]. Arduino Uno acts as the main microcontroller and the data from the sensors like Humidity, Temperature and pH level gets transported to Arduino. This data processed into a JSON file and sent to the server through MQTT. The MQTT Broker is a data sending and receiving intermediary. There are 3 aspects to it.

Firstly, the JSON file gets transferred directly mobile device through the MQTT broker. Secondly, details get submitted to the server by the MQTT Broker. Third, the mobile application receives the data and sends them back to the system through a server. The server is used to store and save all data values within the database.
The drawback of the system is the user has to subscribe to the MQTT server where he/she can access all the data requirements.

[3] Victor H. Andaluz: This paper proposes a continuous monitoring hydroponic system based on Arduino microcontroller. A tunnel type greenhouse got constructed to grow tomatoes. Sensors are installed by doing perforation next to the plant. Sensors like Humidity, Temperature and water level sensors are deployed and gets connected to Arduino. A Mobile application was created in free software to read the data that got collected at Arduino.

This system is very complicated to build. The Greenhouse effect can be designed under the lab environment only.

[4] Padma Nyoman Crisnapati: Hydroponic management and monitoring system [HOMMONS] is designed based on an Arduino microcontroller and the web broker. This system uses nutrient film technique to collect the data from the different kinds of sensors includes Temperature, Humidity. By using the ESP8266 WIFI module, Arduino gets connected to the webserver. Raspberry pi also used as a minicomputer to access the webserver. User can access the data from the server using the IP address provided.

This system is using both Arduino and the Raspberry pi to work on the server IP address but our system works on the only Raspberry pi to do both monitors and manipulate the sensors.

[5] Robert Eko Noegroho Sisyanto has designed a system which uses Cyber-Physical Social System and the raspberry pi to monitor the Hydroponic system via Telegram Messenger. CPPS is a combination of both Physical and Social architectures which delivers through the Cyber or internet link. The sensors, actuators and all the sensor devices fall under the Physical network while the Social system called Telegram serves as the user to the Hydroponic system bridge. Here the Raspberry pi helps to monitor the hydroponic system and sends the data to telegram messenger which is received from all the sensor nodes. User can monitor the system by checking it in Telegram messenger.
Drawback: This Framework cannot take the user inputs as the end application is a social media application, it can record the values and publish.

[6] Miss Komal explained about the controlled hydroponics in Urban infrastructure. By using the Nutrient Film Technique and the closed Hydroponics system. The Nutrient solutions that feed the system are recycled and reused. Here the entire Architecture works in the Analog circuits where all the sensors are connected to the microcontroller AT89S52 which is codded in C.

This system was coded in C and using the old version of microcontroller where the processing speed is very low. In our system, Raspberry pi 3 is used to have a high processing speed.

[8] Naim Karasekreter explained about the development of agricultural technology system that compatible with National energy efficiency policy. In this method, the meteorological data such as soil moisture, temperature, wind speed are transmitted to the communication channel. Control channels work on the statistical algorithm to take decisions over the system. Meteorology station works as the communication channel and do the data transferring via 902Mhz – 928Mhz porter frequency and Yagi antenna.

[9] Jumras Pitakphongmetha developed a Hydroponic smart farm system using NodeMCU, DHT11 sensors and the Blynk server. Blynk server is an open-source platform that is a modified version of Arduino IDE with internet-controlled Android devices. By using the Blynk server the drag and drop option creates a mobile application. The machine can read the temperature and the weather values and show on the mobile device by clicking on the button.

[10] Saaid developed a Deepwater culture technique to perform Automated pH control system for Hydroponic cultivation. A mustard green used as a plant sample. The Arduino Mega 2560 microcontroller, pH level sensor and all the required sensors are used to monitor the system. The pH values can be increased or decreased automatically by using Arduino.

[11] Rohini Shete has proposed a system to monitor Urban Climate based on IOT using Raspberry Pi. Raspberry Pi, Sensors such as DHT22, BMP180 and BH1750 are used. The Raspberry Pi collects the values from all sensor nodes. Adafruit IO is the proposed server for this system. The client structure of MQTT serves to send and receive the data. The user must subscribe to the MQTT server, and then the user can access the data. The data from the sensors is released to the user via MQTT server.

[12] S Charumathi has proposed an Optimization of Hydroponics Agriculture based on IoT. This system consists of Arduino Atmega 328, Temperature, Humidity, Light intensity, pH sensors. Arduino collects the data from all the sensors and sends to the mobile application provided. User can view the sensor graphs over Mobile application.

[13] R Rajkumar proposed a novel approach for Smart Hydroponic farming based on IoT. NodeMCU, Temperature, weather, Ultrasonic, water level sensors are deployed in the system. A mobile application called Blynk created and communicated through the ESP8266 Wi-fi module. The User can send and receive all the data through Blynk application.

[14] Chavan Akshay proposed an IOT based Hydroponic system. The Microcontroller receives the data from all the sensor nodes such as Temperature, Water level, Light sensors. A wi-fi module installed to communicate with the user. By using the URL, the user can view the sensor data. User can turn ON/OFF the water pumps when requires remotely.

[15] This paper explains about the implementation and the data visualization of the data collected from the system. Sensors like humidity, temperature and air quality are integrated into the system. Raspberry pi acts as the main microcontroller and receives the data from the sensors installed. A web-based interface is designed using HTML and Java. Raspberry pi sends the data to the User interface. By using the Dimple JS library on the web, graphs get generated and shown.

This system only shows the data received from the sensors and can't store the previous data. In our system, data gets stored up to a month to have better data visualisation.

[17] Gokul Anand suggested a sustainable agricultural production system for Hydroponics in which the temperature, humidity, ultrasonic sensors are incorporated into the system. Arduino collects all of the data from the attached sensors. The water pumps are opened and closed for a fixed period, depending on the threshold values. MQTT client-server used to control device functions by the user. User needs to get subscribed to the MQTT client to view all the information.

[18] Mrs Rupali Hande suggested a method of growing plants through a medium which does not include soil usage but includes a nutrient solution. A smart vertical farm designed where plants are grown in a vertical pipe using hydroponics. The temperature, moisture inside the device is monitored continuously using sensors. By using magnetic float switches the liquid level inside the pipes is tracked and controlled. The system's water supply is from a central water tank, watering and humidity control is achieved using a microcontroller kit connected to the wireless sensor network with an internet that senses humidity, temperature and water level.

III. Proposed Work

To overcome all the drawbacks of the above system, the proposed system mainly operates over a raspberry pi, where the Wi-Fi module is internally available for it. It reduces the usage of Wi-Fi module separately. DHT22 sensors are used instead of DHT11 sensors for performance measures. Instead of leaving the data that gets produces from the system, data gets stored over the cloud and big data helps to arrange the whole data and gets the water and fertilizer plan for a year. This helps to make the systemgo automated.

IV. System Architecture

Fig 1 provides the overall architecture of the system, which consists of multiple sensors, Raspberry pi 3 B+, Relay and the mobile application. The Raspberry pi is the main controller of the whole system. Raspberry Pi gathers all the data from the sensors then process the data.

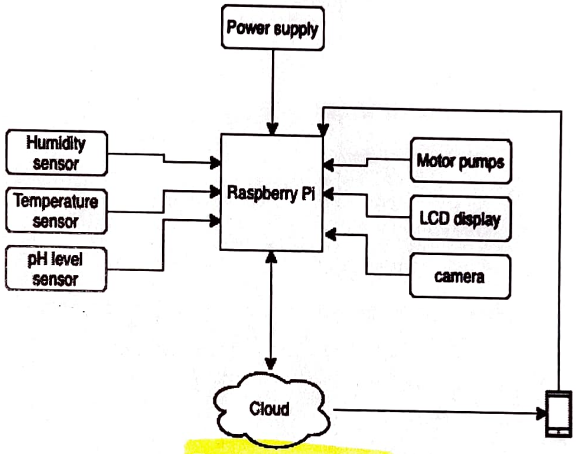


Fig 1: System structure

Power supply: To turn on the Raspberry pi, at least 5V of power supply is needed.

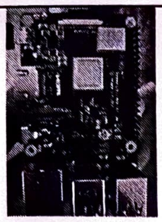
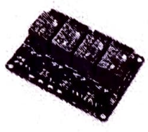
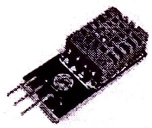
Motor pumps: Pumps are installed to pump water to plants over the system. These are connected to the Raspberry pi such that, Motor turns on/off based on raspberry pi instructions.

LCD Display: LCD shows which sensors are in use at a particular moment.

Cloud: All the Data collected at Raspberry Pi, stored in a cloud. Through IP address, the stored data can be accessed.

Mobile Application: A mobile application developed to monitor the systemresults through mobile.

V. COMPONENTS

Device	Description
	This is a new model of raspberry pi which has inbuilt Wi-fi and USB boot capabilities. Compared to all other processers, Raspberry pi B+ process works faster and give better results
	It is an electrically operated switch. There are different kinds based on a number of relays available. LED's are planted over the circuit to show the status of the particular relay.
	A humidity sensor and thermistor.
	A pump which helps to transport the solutions to all the plants arranged.
	Webcam involves capturing the position of the plant. It takes a snap of that particular time.

VI. SYSTEM OPERATION

The Hydrosys software imaged over an SD card of size minimum of 8GB. The system consists of all the overview details required. Imaging the SD cards varies from one operating system to another system. Imaging can be done by pushing the files as patches.

Username	Password
Pi	raspberry

Table 1: Login details

The imaged SD card inserted in Raspberry pi. Once the raspberry gets connected to the monitor, need to login to the raspberry system using the credentials provided in table 1. The monitoring of data provided by all the sensors can be done over the web application. Connecting relay to the circuit helps to monitor the multiple sensors.

Web Application

The mobile user can route to the Ip address provided using any kind of browser. The user can log in to the portal by the given username and password. After logging into the system, the user can access the data provided by the system. The Read/Write command has been provided to the user. Temperature, moisture, Humidity, Pressure and light sensor values are displayed on the screen. Each and every sensor value can be accessed by clicking on the individual tabs provided. There is a "Menu" option with that can help to view the features in Fig 2
Settings option available which helps to read the values and test the sensors to check whether the sensors are working properly or not. Clicking on settings option, all the sensors data is provided in the first section. The actuator checking present in the second section.
The instructions whatever given to the system stored in the cloud as a scheme. The amount of water that the system allowed the plant gets stored as a monthly plan. Fig 2 explains the scheme representation. The data can be manipulated whenever required which helps the system to go automated while releasing the water to the plants. In the same way, for the fertilizers also. It gets counted and stored in the cloud. Here also can read and write values if needed. At the max, can record up to 3 different fertilizer values.

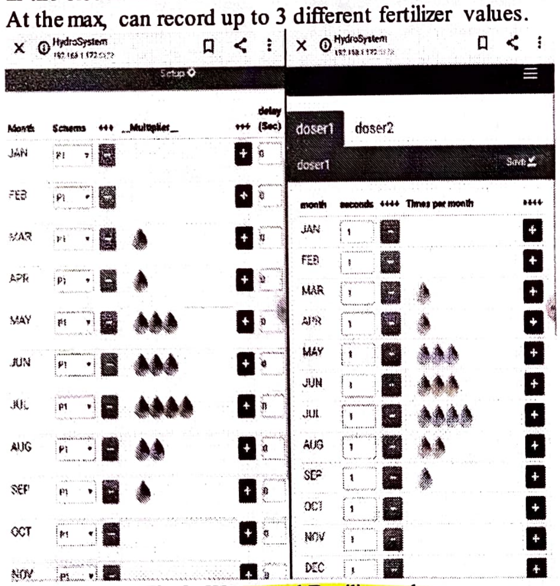


Fig 2: Water and Fertilizer plan

VII. TEST CASES

The system is tested bypassing the water for 2 Seconds in Actuators Test. Bypassing the input the results can be viewed in Home screen "Water" display. The Test case results are displayed in Fig 3

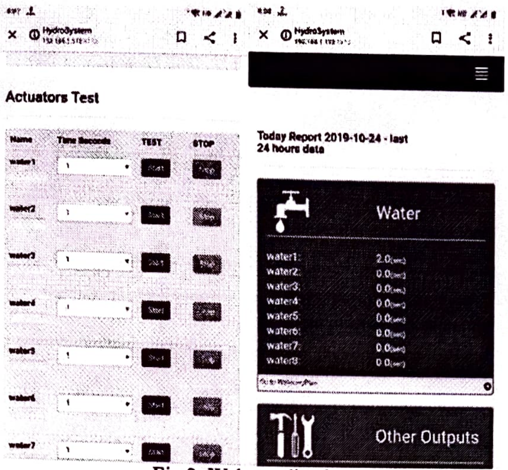


Fig 3: Web application screen.

VIII.. Results

With the minimal cost, a demo piece is made for an automated hydroponic drip irrigation system. By using this system, can test and record the values provided and can monitor and upload the pictures accordingly. Data can be monitored based on weekly, monthly and yearly manner.

By using this system, the plant humidity and the temperature values can be monitored continuously. The motor is also connected so that the water pumping can be done by setting up the values in the mobile application. A Scheme gets recorded for both water and fertilizers provided for the particular month. The system gets automated while provided the amount of water and fertilizer to the plants.

The webcam also enabled. By clicking on the test, the picture can get took by the cam. The webcam installed to check the plant position and to make sure the plant is growing fine.

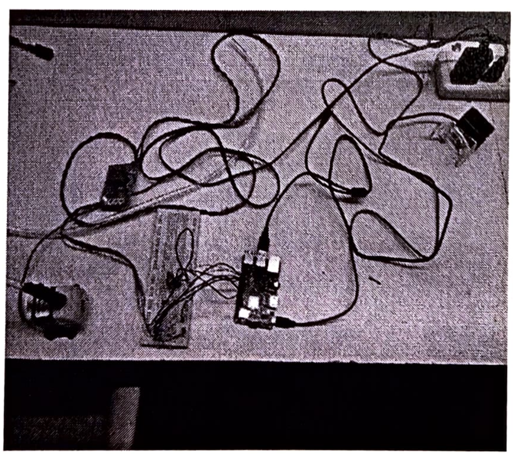


Fig 4: System connections

Conclusion and Future Work

This paper implies a Drip system that will help the user to monitor the Hydroponic system and make changes online if necessary. A large variety of plants and herbs are suitable for hydroponics to provide control over the supply of nutrients and water. When the system is running, it operates alone until the user updates the values of the nutrients.

Future work includes replacing wired sensors with wireless sensors to avoid cable misconnections.

good point

By using the image processing the plant can be analyzed through the pictures taken by the webcam.

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