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Automated Hydroponic Farming using IOT

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Abstract - The agricultural sector is undergoing a significant transformation with the integration of modern technologies. One of the most influential technologies in this regard is the Internet of Things (IoT). The use of IoT in hydroponic farming is examined in this research, with a particular emphasis on remote monitoring and control systems. The report delves into the benefits, challenges, and potential future developments of utilizing IoT for efficient and sustainable agricultural practices. The integration of Internet of Things (IoT) technology further elevates hydroponic farming, enabling precise monitoring and control of crucial parameters such as nutrient levels, temperature, humidity, pH balance, and light exposure. The abstract highlights the benefits of IoT in hydroponic farming, while also addressing the challenges posed by connectivity, data security, and cost.

Keywords: Hydroponic Farming, Internet of things (IoT), crucial parameters, connectivity, monitoring, control system, crop.

1. INTRODUCTION

Agriculture is vital in India, where a significant portion of the population depends on it for economic sustenance and development. Traditional farming faces challenges such as unpredictable weather and crop diseases, necessitating modernization. Hydroponic Farming, aided by devices like NodeMCU, allows for controlled cultivation environments. Distant monitoring and control are becoming common in business and academic research nowadays. IoT can be used to implement this. IoT has been employed in hydroponic farming by a number of researchers.

With the help of extra nutrients, plants are grown hydroponically without the need for soil. The roots of the plants are directly exposed to the mineral nutrient solution. This guarantees the plant's continued, healthy growth. The irrigation system, and crucial parameters such as temperature, humidity, moisture and pH balance are just a few of the ways in which IoT can be used in hydroponic farming.

Fig -1: Parameters of Remote Monitoring and Control in Hydroponic Farming

Traditionally, agricultural operations required significant physical presence, making it challenging for farmers to monitor vast fields or address issues promptly. With IoT-enabled remote monitoring, farmers can gather real-time information about soil moisture levels, temperature variations, crop health, and livestock conditions without being physically present on the field. Moreover, IoT enables remote control, allowing farmers to adjust irrigation systems, apply fertilizers, and even manage automated machinery from a centralized location. This technology promotes sustainable agriculture by reducing chemical reliance, enhancing crop yield, and offering disaster prevention capabilities.

2. LITERATURE REVIEW

Dr. Asawari Dudwadkar, et al. This research focuses on designing a hydroponic system which ensures higher growth rate with controlled environment. The main function of hydroponic system is to monitor and to control parameters with the help of actuators present in the system. Apart from that, remote monitoring and controlling of the artificial environment is also done using IoT based applications[1].

Rachana Reddy, et al. "Overview on precision agriculture using IoT technology". It explores how sensor data, including temperature, and light levels, can be collected and processed for optimized irrigation and fertilization [2].

Aditya Vishwakarma, et al. This research focuses on an IoT-based smart greenhouse system for monitoring and controlling environmental factors. It covers aspects like temperature, humidity, light, and irrigation control through sensor integration and remote access. The data collected from all the sensors are converted into digital signals and given to the NodeMCU module for processing [3].

Dileep Kumar, et al. This research helps in understanding the scope of this project and how it is used to control the environmental parameters which affect the crop and to monitor the system remotely using a wireless network connection. It consists of micro controller, sensors and actuators for processing. It may be used to provide required environmental variables for cultivation of the non-seasonal crops. The provision of suitable environment will also improve crop production [4].

Akshaya Krishna, et al. A project report on an automated hydroponic system with IoT integration that includes remote monitoring and control capabilities. The report provides insights into system architecture, sensor selection, and the user interface[5].

Smith, J., Johnson, A., & Williams, B. "IoT-Based Smart Hydroponic Systems for Sustainable Agriculture". This paper discusses the implementation of IoT technology in hydroponic systems, focusing on remote monitoring and control. It presents a case study of a hydroponic farm where IoT sensors and actuators are used to optimize resource utilization [6].

Garcia, R., Martinez, E., & Perez, T. "Wireless Sensor Networks for Precision Agriculture in Hydroponics". This research paper explores the use of wireless sensor networks (WSNs) for data collection and control in hydroponic farming. It emphasizes the importance of real-time data in making informed decisions for crop management [7].

Amjad Rehman et, al. This research investigates IoT in agriculture, focusing on its applications, advantages and monitoring technologies. It seeks to enhance crop yield and resource management, including water irrigation, crops, and fertilizers[8].

Patel, S., Sharma, A., & Gupta, R. "IoT-Based Automated Nutrient Delivery System for Hydroponic Greenhouses". This paper focuses on the design and implementation of an IoT-based automated nutrient delivery system for hydroponic greenhouses. It discusses how IoT technology can enhance nutrient management for improved crop yields [9].

Kumar, P., & Kumar, S. "A Review of IoT Applications in Agriculture". While not specific to hydroponics, this review paper provides an overview of IoT applications in agriculture. It highlights the role of IoT in enhancing precision agriculture and remote monitoring in various farming practices [10].

Das, S., & Bhattacharya, S. "IoT-Enabled Smart Greenhouse: A Review of Recent Developments". This review paper discusses recent developments in IoT-enabled smart greenhouses, which are closely related to hydroponic farming. It covers various aspects, including remote monitoring and control [11]

3. PROPOSED METHODOLOGY

3.1 Monitoring System

The hydroponic system's ability to monitor and control the system's settings is one of its many uses. In addition, one of the key objectives is to collect, store and analyze the data, and provide a user interface. The entire system can be divided into two subsystems: Hardware and the Software.

The hardware assembly is responsible for the processes and control over the system. This includes circuitry which contains sensors like temperature and humidity sensor, pH sensor, moisture sensors, all of which will determine the condition of water and the environment where the plants are kept. Along with sensors, the circuitry also consists of actuators like the water pump, etc. A microcontroller known as NodeMCU is attached to each sensor and actuator. NodeMCU Esp8266 is a development kit which can connect with a wifi network and process the data collected by the sensors. It looks after the control of the system.

The software part of the system includes a cloud server and a controller which is connected to the microcontroller. This cloud server can also be connected to an online database which updates the sensor values and status of the actuators. Because of this, the system can be monitored and controlled from a distance. All this data can be seen and controlled on our Android Application.

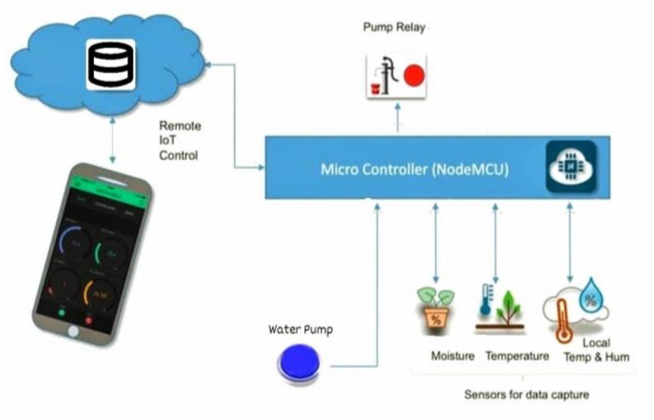

Fig -2: System Overview

3.2 Sensors

1. Digital Humidity and Temperature (DHT11) sensor: DHT11 is a basic, low-cost digital temperature and humidity sensor. It uses an electrical phenomenon humidity detector and a semiconductor device to measure the surrounding atmosphere and then displays a digital signal on the data pin. In this system, it is used to keep a check on the temperature and humidity in the artificially concocted environment.

2. pH sensor: A pH sensor is typically used to check the quality of water or any other solution. It measures the amount of alkalinity and acidity in solutions. When used correctly, pH sensors can also be used to check the quantity of impurities in the solution. In hydroponics, a pH sensor is used to measure the acidity and alkalinity of solution showing a value between 0-14. pH value and what it indicates:

• A pH of 7 indicates that the solution is neutral.

• If the pH is between 0 - 7 then the solution is acidic.

• pH is between 7 - 14 then the water is alkaline. In our system, the pH value of the water will help us to determine the quantity of nutrients present in water.

3. Moisture sensor: Moisture sensor is used to measure water content. It consists of two probes for passing current through the coco peat, and it senses the resistance in order to acquire the moisture level from the peat.

4. Node MCU: Node MCU (Node Micro Controller Unit) is a microcontroller which is used to process data that is read from sensors and send it to the cloud platform or database. The system's wifi functionality and overall operation are provided by Node MCU.

5. Relay Module: Used to regulate high voltage or high current loads, such as a water motor that serves as an actuator. It is made to communicate with microcontrollers like the NodeMCU, among others.

Sensors	Model	Input Voltage	Output (Range)
Temperature	DHT11	3 to 5v	0 to 50° C
Humidity	DHT11	3 to 5V	20 to 90% RH
Moisture	SEN0114	5V	0 to 4.2V
pH	SEN0161	5V	0 to 14pH

Table –1: Sensor Specification

3.3 Software Section

This section gives the details about the software being used in this system to compile the program on which the system is working. The software we are going to use is Arduino IDE which is a cross-platform application working over a different platform like Windows, Linux, etc. which are used to write the functions in C and C++ programming language.

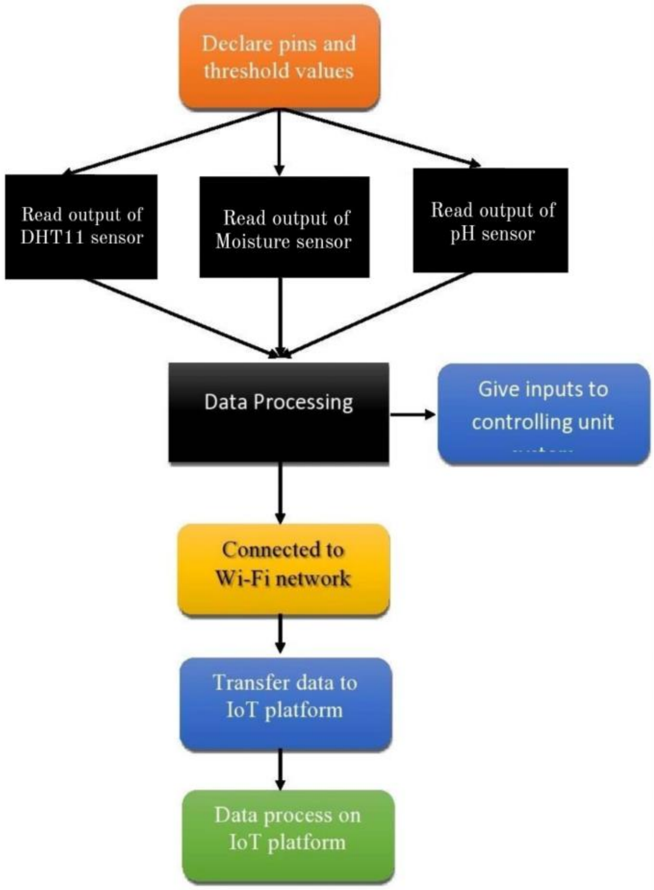

Fig –3: Flowchart of Program

3.4 End User Application

To monitor all the system parameters distantly, we aim to develop a web application using web technology. This application comes with an interactive-secured interface. When we open the application we will find a login/signup page. The page will have a 'User Interface'. This login process will ensure proper security for the data in the system. After entering the required credentials, the user will be redirected to the next page the Application. The next page will consist of menus for different parameters i.e. Temperature, Humidity, PH-level, moisture level which we will be monitoring for the plants growing in the system. Each parameter will show the corresponding reading.

4. APPLICATIONS

1. Urban and Indoor Farming:

In urban and indoor farming setups, where space is limited and environmental conditions are critical, this project can be invaluable. It ensures optimal conditions for plant growth without relying on traditional outdoor farming.

2. Remote Farm Management:

The remote monitoring and control aspect is particularly beneficial for farmers who cannot be on-site all the time. They can monitor and manage their hydroponic systems from anywhere with an internet connection.

3. Education and Training:

Educational institutions and hydroponic training centers can utilize this project as a teaching tool to educate students and train future hydroponic farmers

4. Large-Scale Commercial Hydroponics:

Commercial hydroponic farms can benefit from this system by optimizing resource usage, reducing operational costs, and maximizing crop yield and quality.

5. Sustainable Agriculture:

The system's resource efficiency features align with sustainable agriculture practices by reducing water and nutrient waste, making it an eco-friendly solution.

5. CONCLUSION

The integration of IOT in hydroponic farming, particularly in remote monitoring and control systems, holds immense potential for addressing the challenges of modern farming. By providing real-time insights, optimizing resource usage, and improving overall efficiency, IoT can contribute significantly to sustainable and productive agricultural practices. This can be implemented in hydroponic farming which helps in faster growth of plants. This system not only breaks through the traditional methods of farming and improves the entire process but also makes it self-sufficient enough to produce anything at any time of the season. The software is integrated to the hardware of the actual system such that it displays the various parameters like Temperature, Humidity, pH levels etc. on the application that can be downloaded on the smartphones which provide the possibility of distance monitoring and controlling the system using IoT. However, addressing challenges related to connectivity, data security, and affordability will be crucial to realizing the full benefits of IoT in hydroponic farming.

6. FUTURE SCOPE

The objective of this system is to produce an effective, efficient, and economical model for successful monitoring and controlling the vegetation parameters such as moisture, humidity, and inside temperature. Some future work can also be done to further optimize the model.

1. Every model needs some energy to run. Rather than working on the direct electricity available, a small separate non-conventional renewal power plant can be set up to provide energy, such as a solar or wind power plant.

2. Apart from the DHT11, and soil moisture sensor used in this project, some other sensors can be further introduced such as sensors to detect the composition of air content.

3. Irrigation technique used in this project is related to normal water flow through the pump. But to further enhance the system various irrigation techniques can be adopted such as drip irrigation, etc.

4. The proposed model here in this project is just a small prototype, but this technique can be utilized in small scale organic home farming to large scale acres of farming land.

5. Analysis of the results can be done to further get a more accurate result, analyzing data suitable for getting the desired outcome will be the prime motto after the successful establishment of the mode.

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