IOT CLOUD FOR HYDROPONICS SYSTEM AND AGRICULTURE

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Abstract:

The integration of Internet of Things (IoT) technology into hydroponic systems has revolutionized modern agriculture, enabling more efficient resource utilization and higher crop yields. This project proposes an IoT cloud solution designed to address the challenges of monitoring and managing hydroponic systems. By leveraging sensors to collect essential data such as temperature, humidity, pH levels, nutrient concentration, and light intensity, this solution facilitates real-time data transmission to a cloud- based platform. The platform stores, analyses, and visualizes the data, providing farmers with actionable insights through a user-friendly web or mobile interface. Key features include automated alerts for critical parameters, which enable timely interventions to prevent crop damage, and remote management capabilities, empowering farmers to optimize crop growth and resource use. This IoT cloud solution enhances the efficiency and productivity of hydroponic farming, contributing to more sustainable agricultural practices.

Keywords: Internet of Things (IoT) Hydroponic systemsReal-time monitoring Cloud platform Sustainable agriculture

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1 Introduction

The advent of Internet of Things (IoT) technology has brought significant advancements to various industries, and agriculture is no exception. Hydroponic systems, which allow plants to grow without soil by using nutrient-rich water solutions, have gained considerable attention due to their ability to conserve water and produce higher yields compared to traditional farming methods. However, the efficient monitoring and management of these systems pose several challenges, including maintaining optimal environmental conditions and ensuring the precise delivery of nutrients.

Traditional methods of managing hydroponic systems often involve manual monitoring, which can be time-consuming and prone to errors. In contrast, IoT technology offers a more efficient and reliable solution by enabling continuous, real-time monitoring and control of various environmental parameters. By integrating IoT sensors and actuators, data on critical factors such as temperature, humidity, pH levels, nutrient concentration, and light intensity can be collected and transmitted to a cloud-based platform for analysis and visualization.

This paper proposes an IoT cloud solution for hydroponic systems that leverages real- time data collection and remote management capabilities. The system aims to enhance the efficiency and productivity of hydroponic farming by providing farmers with the tools and insights needed to optimize crop growth, minimize resource wastage, and contribute to sustainable agricultural practices. Through automated alerts and notifications, the system also reduces the risk of crop failure by enabling timely interventions for any deviations from optimal conditions.in an immutable and transparent manner.

2 Literature survey

In this paper[1] S. Jan et al: The hydroponics system was successfully developed using ThingSpeak and Spreadsheet real-time data via the Internet of Things. The technology

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automatically controls the level of nutrition and offers a graphical user interface for simple maintenance and control.

In this paper[2] R. Rayhana, G. Xiao, and Z. Liu: This paper the hydroponics is extending

worldwide and such systems offer many new opportunities for growers and consumers to have productions with high quality, including vegetables enhanced with bioactive compounds. As it is possible to cultivate soilless culture in very low spaces with low labour and short time, so hydroponics can play a great contribution for the poorer and landless people.

In this paper[3] H. Andrianto, Suhardi, and A. Faizal: The results have shown that low-

cost IoT- based chlorophyll meter are functioning properly, which is able measure chlorophyll content, get location, display data on the LCD, store data in memory, and send data to the service system platform. A strong correlation was obtained between measurements of chlorophyll content using IoT- based chlorophyll meters, SPAD-502 and spectrophotometer.

In this paper[4] A. M. Ali, S. M. Ibrahim, and Bijay- Singh: Current general recommendation of fertilizer N for wheat in the West of Nile Delta of Egypt is not efficient. The at Leaf chlorophyll meter and GreenSeeker optical sensor are rapid reliable tools for predicting N uptake and grain yield of wheat measured at Feekes 6stage of the crop. Thus, these tools can be used reliably for managing fertilizer N in wheat on a field specific manner.

In this paper[5] I. Ahmad, S.E. Shariffudin, A.F. Ramli, S.M. M. Maharum et al: This proposed work is made to help the ranchers and make them reap affordable by aiding them in security reason voyaging side, school and for each body and so forthwork, the wastage of water and the utilization of force by engine can be diminished so, they are rationed for the future use.

In this paper[6] Li, L. Zhu, X. Chu, and H. Fu: An edge computing-enabled multiple data collection task strategy for WSNs is presented in this paper, aiming to achieve a higher volume of valid data and a lower data collection time. First, we develop a framework for WSN by merging the edge computing and model the data collection for multiple tasks and

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sensors in a WSN. Then, different tasks are completed at a lower data collection time, by a selecting WSN node and dynamic configuration of sensor nodes that close/open sensors according to the concrete tasks, within a set timeframe, by exploiting the edge computing.

In this paper[7] X. Li, Z. Ma, J. Zheng, Y. Liu, L. Zhu and N. Zhou: data collection is

studied to reduce data redundancy for a critical event and ensure the latency constraint and main information in smart agriculture with consideration of the edge computing and SDN. First, from the perspective of event-driven sensing, a four-layer framework for smart agricultural IoT is introduced. Then, a three- step strategy is proposed for effective data collection in smart agriculture. In the first step, the MI from a historical dataset is used to sort the related sensing data types of different events. In the second step, the event identification based on edge computing is conducted by computing the minimum variance of the sensing data.

In this paper[8] Gobalakrishnan Natesan and Arun Chokkalingam: This research paper emphasizes the dynamic solution of one of the most highlighted challenges of cloud computing, i.e., load balancing. Cloud computing is something that we all use the entire day without realizing. This tremendous increase in use adds exponential load relative to the cloud due to which its performance can suffer.

In this paper[9] K. Kularbphettong, U. Ampant, and Kongrodj: In this research, the researcher aims to make a convenience and productivity to users who need to plant hydroponic vegetable by using IOT and mobile phone to automatically control and monitor the automatic hydroponics vegetable system. The system can check and refill the nutrient by self-regulating and displays the graphic user interface to easy manage and control it.

In this paper[10] T. Munasinghe, E. W. Patton, and Seneviratne: This paper proposes a combination method of the Bluetooth module and the MIT APP Inventor 2 development platform to design the IoT APPs, which can remotely control the hardware device by the Android mobile phones. The experimental results show that the method is reliable, simple, efficient, and cost-saving.

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3. Existing system

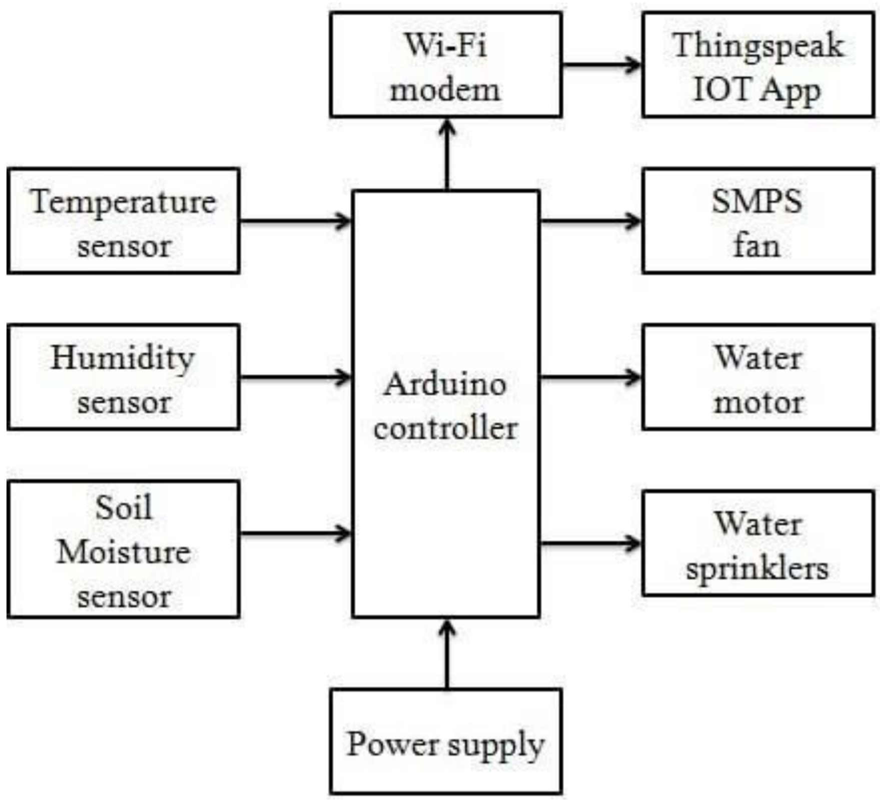

Figure 1: 1. Existing System

A number of IoT cloud platforms are currently available for usage with hydroponic agricultural systems. These platforms offer various features and services for remote monitoring and control of hydroponic systems. Among them are: AWS IoT: AWS IoT provides a full range of services for creating and overseeing Internet of Things applications. In addition to offering IoT-specific features like device administration, data intake, and analytics, it offers scalable and secure cloud infrastructure. You may link your hydroponic sensors and equipment to AWS IoT, gather data, and evaluate it to improve your system.

Microsoft Azure IoT: Another powerful cloud platform that makes it possible to integrate and manage IoT devices is Azure IoT. It provides analytics, storage, data ingestion, and device provisioning services. Azure Internet of Things.

Google Cloud IoT Core: This managed service enables you to safely connect, manage, and ingest data from devices that are dispersed throughout the world. It can be integrated with other Google Cloud services, such as Cloud Pub/Sub for real-time messaging and Big Query for data analysis. You can monitor and manage your hydroponic system with Google Cloud IoT, and you can use machine learning for more sophisticated analytics.

They used Blynk, which utilizes Java software, and ThingSpeak, which uses MATLAB software, in the current system. The users cannot obtain these softwares in an open source format.

3.1 Design

3.2 System architecture

Numerous sensors, including those for water levels, pH, temperature, and light intensity, are included with the hydroponic system. These sensors keep an eye on the hydroponic system's environmental parameters all the time. Microcontrollers or Internet of Things (IoT) devices that are connected to the sensors gather the sensor data. The devices use wireless communication protocols, including Wi-Fi, to send the data to the cloud platform. The Microcontroller W, the brains of our system, receives its 230v power supply from a 12v adopter. The submersible 230v AC motor is connected to the systems were integrated using their proprietary platform. The hydroponic system was not implemented using IoT instead, Arduino was utilized to implement the system in the current setup.

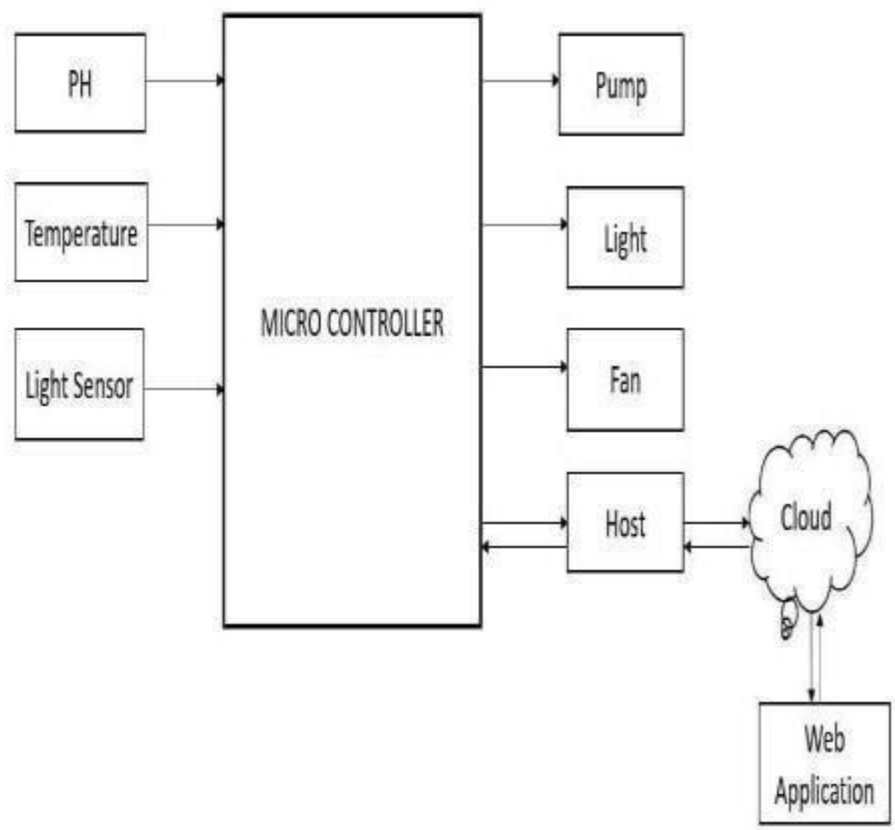

Figure 2: 2. System Architecture design

3 Proposed system

We are developing our own IoT platform in the suggested system using Python software, which is available to users as an open source project. In our project, we use IoT to construct hydroponic systems. The pH, temperature, and water level measurements from all the sensors were all received by the Raspberry Pi Pico W, which was also used to operate the system. Our IoT platform will get notifications about the plant's status from it.

Integration of many components would be necessary for a suggested IoT cloud-based hydroponic system for agriculture in order to facilitate remote control, monitoring, and data analysis

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of the hydroponic setup. Farmers and agricultural enthusiasts can obtain real-time insights on their hydroponic operations, optimize resource usage, and reap the benefits of using this suggested IoT cloud-based hydroponic system power supply via a 5v relay. The Raspberry Pi Pico W controls the motor by providing a time delay, allowing water to be pumped to the plant roots. All of the sensors are interfaced with the Microcontroller, including the temperature sensor, LDR module.

4 Data flow forhydroponics

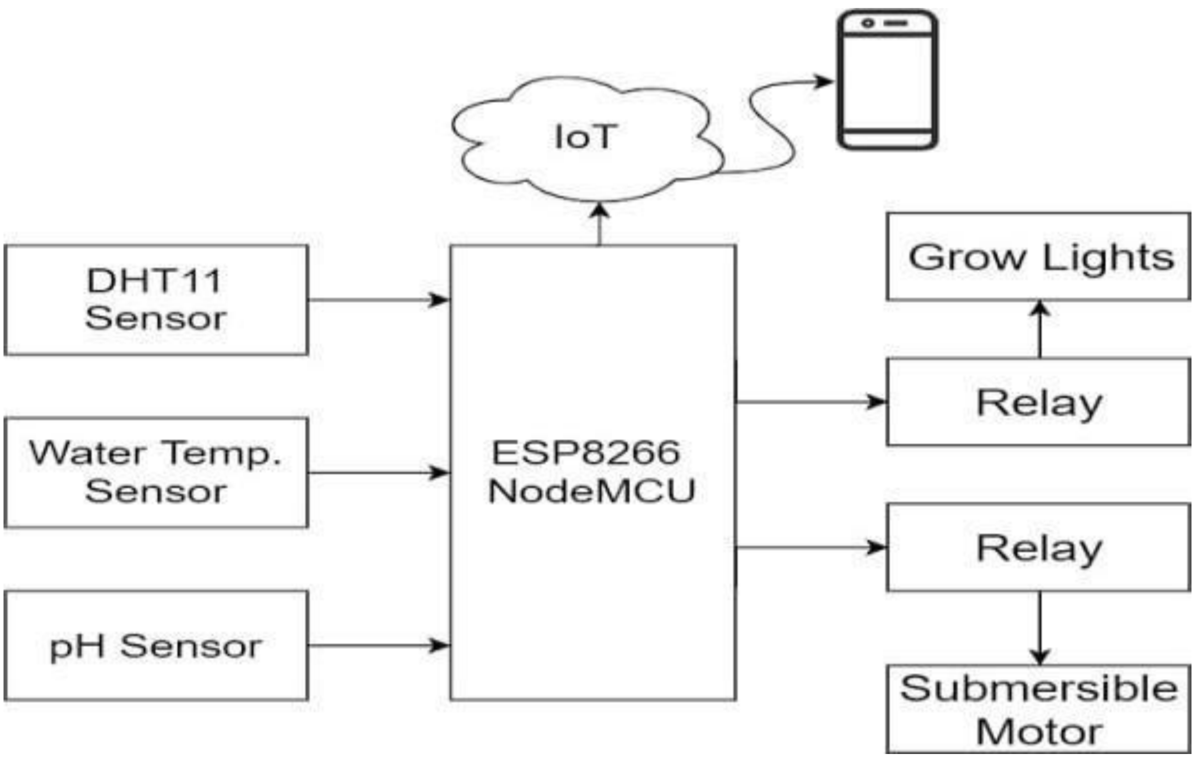

Figure 3: Data flow diagram

Using sensors, a gateway, and a cloud platform, the IoT cloud-based hydroponic system enables effective remote management and monitoring.Key environmental factors are measured by sensors, which forward the data to a gateway for Wi-Fi transmission to the cloud. The data is processed, stored, and analyzed by the cloud platform, which also offers historical analysis and

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insights in real time. Additionally, it notifies users of any significant condition variances, guaranteeing ideal crop growth and averting damage. The productivity, effectiveness, and sustainability of hydroponic farming are improved by this technology.

5 Implementation

I. Hydroponics Farming

Hydroponic spinach farming starts with soaking coco peat, then sowing seeds in a tray covered with polythene for germination. After sprouting, transfer to a hydroponic setup using net pots and leca clay. Monitor nutrient levels with pH, temperature, and light sensors, adjusting with a solenoid valve if needed to maintain optimal conditions. Hydroponics grows plants in water enriched with nutrients, bypassing soil for direct growth in nutrient-rich water.

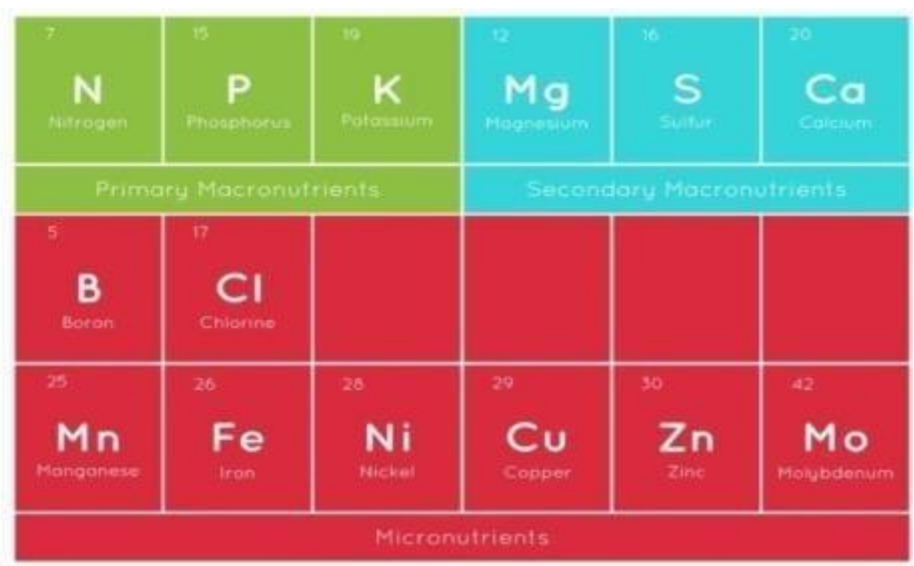

Figure 4: Periodic Table of Plant Nutrients

The Raspberry Pi Pico series presents a line of compact yet powerful boards utilizing the RP2040 microcontroller chip, conceived by Raspberry Pi in the UK. Boasting a dual-core Arm Cortex M0+ processor capable of flexible clock speeds reaching up to 133 MHz, the Pico offers

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264kB of SRAM and 2MB of on-board flash memory. Its versatile digital interfaces include USB 1.1 with both device and host support, alongside low-power sleep and dormant modes. Programming is made convenient through drag-and-drop functionality using mass storage over USB.

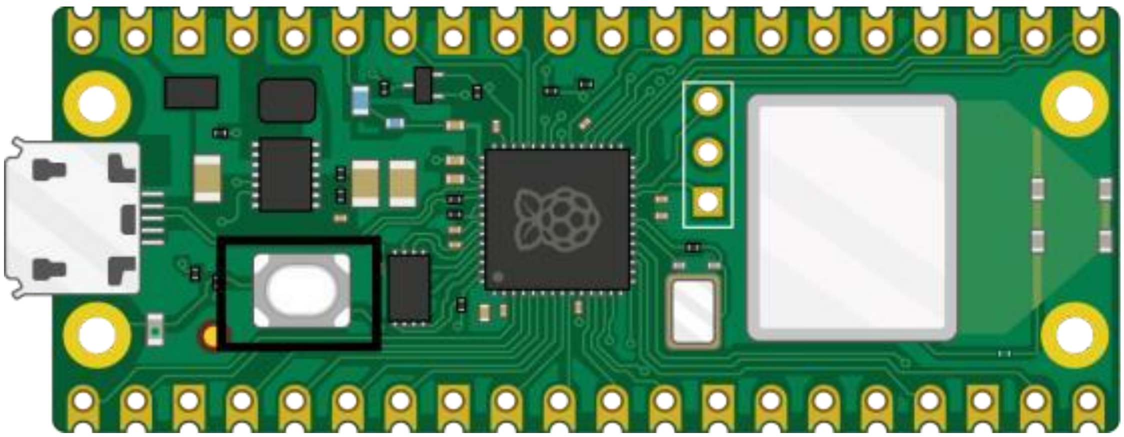

Figure 5: Raspberry Pi Pico

With 26 multi-function GPIO pins, as well as SPI, I2C, UART, ADC, and PWM channels, the Pico facilitates diverse connectivity and control options. Furthermore, it incorporates accurate clock and timer mechanisms on-chip, along with accelerated floating- point libraries, augmenting its utility across various applications.

6 Germinating Process

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Figure 6: Germinating process

In cold soil, lettuce seeds can take up to three weeks to germinate, but they typically do so in three to five days. Lettuce seeds need to soak in water for 30 minutes. It is not recommended to sow seeds in the soil for germination purposes, since this will make it Challenging to extract the roots of the plant without causing any harm once germination has occurred. Cockpit is utilized for this purpose. Breaking down coco-peat into little bricks is necessary. It needs to be submerged in water for at least an hour. The Periodic Table has allowed scientists to identify and understand the earth‘s elements, classify them by type and predict their properties and appearances. Using it, biologists have also been able to pinpoint 17 elements that are essential to plants These elements, known as nutrients, are the building blocks of plant life and making sure crops get enough of them, by using fertilizers to supplement what are already in the soil as required, and are at the heart of agriculture peat will absorb all of the water. This prevents the need for extra water during the whole germination process by keeping the seeds moist. The sowing tray contains a tiny quantity of coco peat that has While lettuce seed usually germinates in 3 to 5 days, freezing soil can sometimes cause it to take up to 3 weeks. Lettuce seeds need to be immersed in water for thirty minutes. Seeds should not be sown in the soil for germination purposes, since this will make it difficult to remove the roots of the plant without causing damage once germination has occurred. Cockpit is employed for this reason. Coco-peat needs to be crushed into little pieces. At least one hour should pass while it is submerged in water. Water will seep into the coco-peat fully. This ensures that the

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seeds stay moist during the whole germination process, negating the need for more water. A little bit of coco peat has been placed inside the sowing tray.

7 Conclusion

The hydroponics system was successfully developed using our own IOT platform and real-time data via the Internet of Things. Hydroponic cultivating has awesome feature in India, hydroponic may be a strategy to developing plants utilizing mineral, nutrient arrangement in water, without soil. In coming long time India truly needs such cultivating strategies it produces higher yields than the conventional soil-based agriculture. Hydroponic plants have a better bother resistance which dispenses with the higher utilize of pesticides. Compare to soil-based agriculture taste of this product is good. The technology automatically controls the level of nutrition and offers a graphical user interface for simple maintenance and control. In this study, data including pH, and temperature have been examined and validated to ensure they fit the criteria for Pak Choi's features. The testing method produced satisfactory findings, and the application is practical, which leads to an increase in production.

The integration of IoT cloud technology into hydroponics systems for data monitoring in agriculture has proven to be highly beneficial. By leveraging IoT devices, sensors, and cloud platforms, farmers and agricultural experts can gather real-time data on crucial parameters such as temperature, humidity, pH levels, nutrient levels, and lighting conditions, among others. This data can be analyzed to optimize the growing environment, improve crop yield and quality, and reduce resource wastage.

Data mining techniques and AI will be applied to evaluate and forecast data regarding the amount and quality of the plant as part of a future study that will expand the system to incorporate more beneficial and adaptable linked devices. The IoT cloud for hydroponics system and data monitoring has already revolutionized agriculture by enabling precise control, real-time monitoring, and data-driven decision-making. The future holds even more potential for advancements and innovations in this field, paving the way for sustainable and efficient agriculture practices.

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