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Smart Aerophonic and Hydroponic Farming Using ESP8266 Module with Mobile Application

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Abstract

This paper examines the creative use of ESP8266 modules in mobile application-controlled smart aerophonic and hydroponic farming systems. An extremely productive and resource-efficient kind of soilless growing is provided by hydroponic and aerophonic farming techniques. The connectivity required to remotely monitor and control these systems is provided by the inexpensive Wi-Fi microcontroller known as the ESP8266 module. Farmers may ensure ideal growing conditions by controlling environmental factors like pH, temperature, humidity, and nutrient levels by utilising mobile applications. Precision agriculture is improved by this technology integration, which results in higher yields, more economical use of resources, and environmentally friendly farming methods. It is specifically acknowledged that healthy soil is not a prerequisite for productive agriculture. Furthermore, plants only require a small portion of the entire spectrum, not pure sunshine. The real needs are good seeds, water, and nutrients, according to recent study and its implementation. Around the world, improved techniques for producing food in soiless cultures while using less area and water have produced some encouraging outcomes. The current situation has made hydroponics and aeroponics more relevant based on this concept.

Keywords: Aeroponic system, Wi-Fi controller, hydroponics, natural forces

Introduction

All people on the planet must be able to be supported by agriculture. The percentage of farmed and arable land is steadily declining because of increased urbanisation, industrialization, and other man-made and natural forces. The world's population is also continuously growing at the same time. Approximately two people could be fed by one hectare of arable land in 1960. Today, that number is four, and by 2050, it is predicted to reach 6.25. Because of these two considerations, it is anticipated that the same area of land will be able to feed an increasing number of people as the population grows. These conditions indicate that the open-field agricultural production paradigm that is currently in place will make tomorrow exceedingly challenging. It is very conceivable that feeding everyone on the planet will become unfeasible soon. It is frequently believed that to meet this ever-rising demand for agricultural products, there must be an abundance of sunlight, water, and soil. These factors all contribute to more productive farming. While this has generally been true throughout human history, several more recent and advanced technological advancements have shown that this is not always the case in the present period.

Another option for those with limited area to grow plants is hydroponics or aeroponics. An

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enclosed environment of water, nutrients, and air that promotes quick plant development without soil or media, little water, and direct sunlight is known as an aeroponic system. It uses 95% less water than conventional farming methods and requires less space, making it an efficient and successful means of cultivating plants.

It has also been demonstrated that plants produced in hydroponic and aeroponic systems absorb more vitamins and minerals, which may result in healthier and maybe more nutritious plants. All of the available oxygen and carbon dioxide are delivered to the roots, stems, and leaves of the suspended aeroponic plants, which speeds up biomass growth and decreases rooting. The increased biomass yield of aerial components from the aeroponic treatment suggested that other crop types should also be taken into consideration for this production strategy, not just root crops. Additionally, because aeroponics almost eliminates plant-to-plant competition for nutrients and water, planting densities can be raised. Because the microenvironment of an aeroponic system can be precisely controlled, any type of plant can be grown in one.

Aim and Objectives

Aiming for smart aerophonic and hydroponic farming is an excellent approach to modern and sustainable agriculture. With the help of these clever farming techniques, crop yields may be greatly increased while resource and environmental impact can be decreased. Minimise water waste: Hydroponic and smart aerophonic farming methods use water more effectively than conventional soil-based farming. Reduce the amount of land needed: Because these systems may be installed in constrained areas, they can be used in urban agriculture, which eliminates the need for large amounts of farmland. regulated setting Maintaining ideal plant development conditions in terms of humidity, temperature, and illumination will increase resource efficiency.

The main objective of this project is to provide consumers with a product that enables them to reap the benefits of their system and grow their own organic food in the comfort of their own home, with unparalleled accessibility to their system. The project will address the drawbacks of agriculture and promote soilless cultivation. Hydroponic gardening requires a mere 20 percent of the water used in conventional planting.

- Hydroponic system requires small space.
- Provide highest yield per area.
- Plants grown using this system are chemical free.
- Plants grow faster in hydroponics system than in the traditional gardening.
- Climatic changes do not affect hydroponics gardening.
- Plants grown in hydroponics system are less affected by pests and diseases.
- Hydroponic gardening requires less manpower.

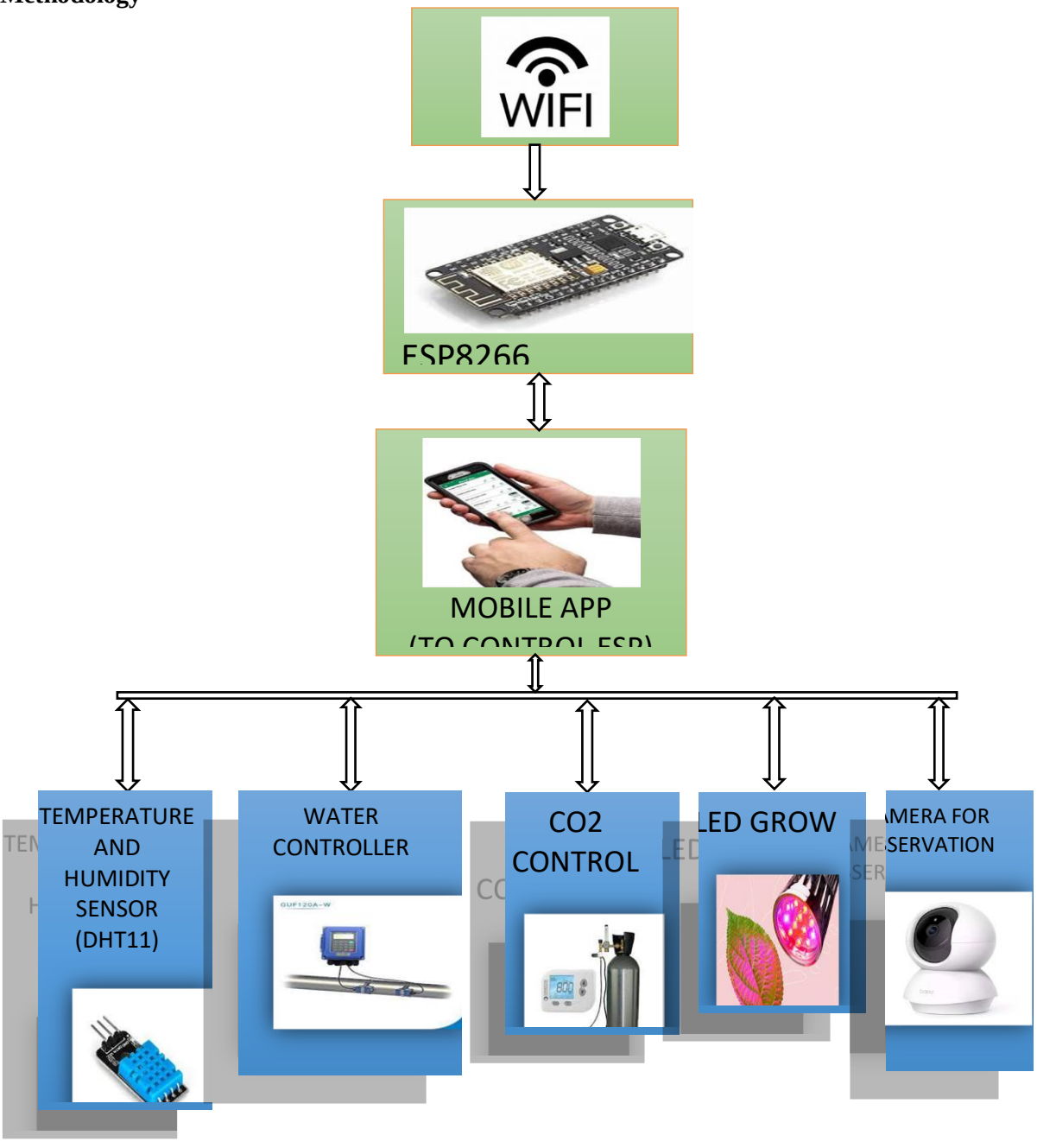
Literature Review

An overview of hydroponics and related technologies for medium- and small-scale operations given by Gonzalez et al. Aerial imagery, GPS, temperature and moisture sensors, machineries, and other innovations in electronics technology have revolutionised farming and brought about quick changes to modern farms and agricultural operations. The notion of industry in the field of agriculture was born in 2017, where concepts such as artificial intelligence (AI), Internet of Things (IoT) and Big Data (BD) were integrated to autonomous food production systems for precision irrigation, pest control, plant disease identification, and production management [1] An upcoming and innovative way of future farming. Although it may not hold a significant portion of the market, hydroponics is the agricultural industry segment with the quickest rate of growth. [1]

In the future it is projected to dominate all the world's food production. As more and more land is destroyed by misuse and bad farming management, leading people to look for more cutting-edge and creative ways of producing food, hydroponics is expected to flourish. [2]

Because of its scarcity of arable land and growing land prices as an island nation, certain nations, like Japan, have already taken a proactive approach to these technologies. Japan's hydroponics is for the most part done with NFT or sand/gravel techniques. To produce rice hydroponically, the Japanese have developed newer and more productive plants using bio-technical techniques, such as hydroponics. Instead of the customary one harvest per year, four harvests can be carried out in a single year due to environmental control. With the growing urbanisation of the world's population, cities. [3]

Methodology



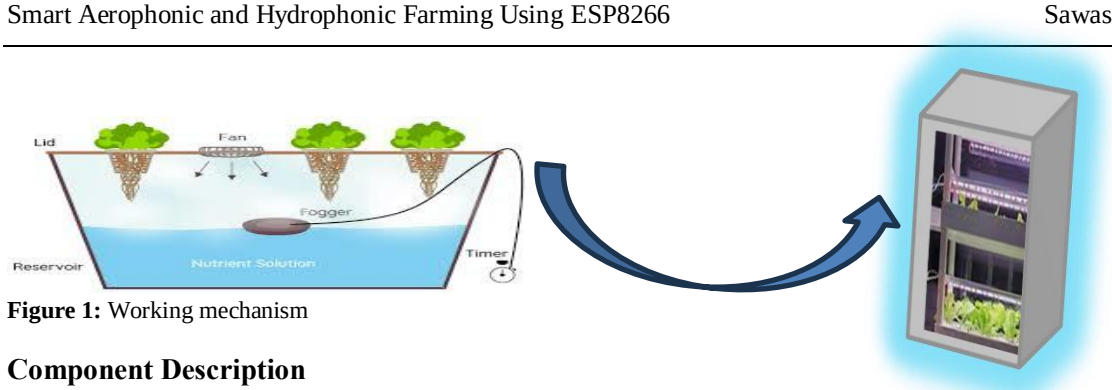


Figure 1: Working mechanism

Component Description

The user interface for viewing and managing the farming systems is a mobile application. The software lets users change settings remotely, issue alarms when circumstances go outside of ideal ranges, and display real-time sensor data. For example, the user can use the mobile app to activate the nutrient pump in a hydroponic system if the nutrient levels are low.

Esp8266

This paper explores the benefits and implementation method of integrating ESP8266 modules with smart aerophonic and hydroponic agricultural systems. One of the main parts in developing smart agricultural systems is the ESP8266 module. It can connect to the internet and communicate with other devices thanks to its Wi-Fi functionality. The ESP8266 can monitor environmental elements including temperature, humidity, light, pH, and nutrition levels when it is integrated with sensors and actuators. The characteristics of the ESP8266 are discussed in table 1.

Table 1. ESP8266 characteristics

Components	value
Microcontroller	ESP-8266 32-bit
Operating Voltage	3.3V
Input Voltage	4.5V-10V
Digital I/O Pins	11
WiFi	In-bulit

DHT11

Because of its affordability, ease of use, and sufficient precision for the majority of farming applications, the DHT11 sensor is preferred in smart farming applications. On example is shown in figure 2. Important characteristics consist of as discussed below in table 2.

- Range of Temperature Measurement: 0 to 50°C, Accuracy ±2°C.
- Measurement range for humidity: 20% to 90% RH, accuracy ±5% RH.
- Low Power Consumption: Fit for devices that run on batteries.
- Digital Output: Microcontrollers such as the ESP8266 are easily integrated

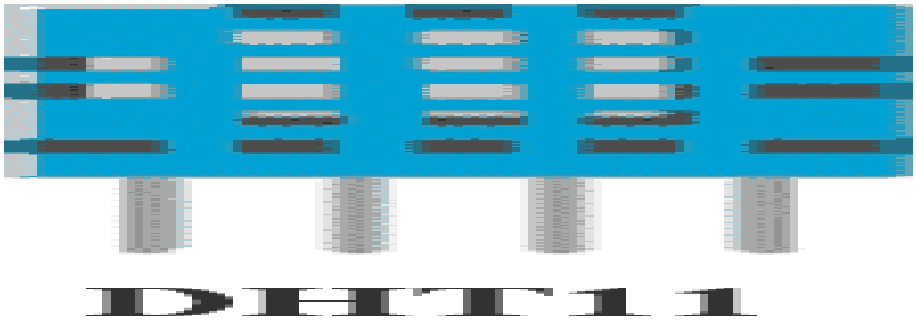


Figure 2: DTH11

Table 2. Characteristics of DTH11

Components	value
Operating Voltage	3 to 5V
Max Operating Current	2.5 Ma max
Temperature Range	0-50º C± 2º C
Humidity Range	20-80% / 5%
Sampling Rate	1 Hz (reading every second)
Advantage	Low cost

Water Pump

- Operating Voltage: 3 ~ 6V
- Operating Current: 130 ~ 220mA
- Flow Rate: 80 ~ 120 L/H
- Maximum Lift: 40 ~ 110 mm
- Continuous Working Life: 500 hours
- Driving Mode: Dc

Figure 3: Water pump

Humidifier

- Work Voltage:DC 4.5V~5.0V
- Work Power:2W
- Work Frequency:108KHz(+/-3KHz)
- Come with a driver
- Power-ON trigger work
- 108KHz high frequency oscillato

Figure 4: Humidifier

Smart aerophonic and hydroponic farming refers to innovative and efficient agricultural techniques that utilize advanced technology to cultivate plants without soil. In aeroponic farming, plants are grown in a mist or air environment, while hydroponic farming involves growing plants in a nutrient-rich water solution. These techniques provide several benefits, including improved control over growing conditions, lower water consumption, and higher crop yields.

They are considered "smart" because they often incorporate automation, data analysis, and remote monitoring to optimize crop growth. Because they can address issues with food security and lessen the negative environmental effects of traditional agriculture, these sustainable farming methods are becoming more and more well-liked.

Methodology

Aerophonic and hydroponic farming are innovative methods of growing plants without soil, utilizing air or water as the medium for delivering nutrients. These systems are commonly referred to as vertical farming or soilless cultivation. Here's a methodology for implementing smart aerophonic and hydroponic farming Aerophonic and hydrophonic farming are innovative approaches that have gained significant attention in recent years due to their potential to revolutionize agriculture. These methods harness the power of air and water to cultivate plants without the need for traditional soil-based farming. The smart integration of technology and sustainable practices into these systems offers numerous advantages, including increased crop yield, reduced resource consumption, and environmental sustainability. This methodology aims to provide a comprehensive framework for the successful implementation of smart aerophonic and hydrophonic farming, ensuring efficient and productive outcomes.

- Site Selection: Choose an appropriate location with access to electricity, water, and climate control options. For accurate monitoring of the environment, indoor facilities are appropriate.
- Design the System: Design an efficient and modular aerophonic and hydroponic farming system. This includes selecting appropriate structures, containers, and support systems.
- Environmental Control: Implement environmental control systems, including temperature, humidity, and lighting. Smart sensors and automation can help maintain optimal conditions.
- Plant Selection: Select plants that can be grown hydroponically or aeroponically. Herbs, petite fruiting plants, and leafy greens are frequently excellent options.
- Seedlings and Transplanting: Start with healthy seedlings or clones and transplant them into the growing medium. Take care throughout the procedure to avoid damaging the roots.
- Irrigation and Nutrient Delivery: In hydroponics, use a drip or flood-and-drain system for nutrient delivery. In aeroponics, mist the roots with nutrient solution regularly.
- Remote Monitoring and Control: a. Enable remote access to your farming system via a web or mobile app. b. Monitor and control key parameters remotely, allowing for quick responses to any issues.

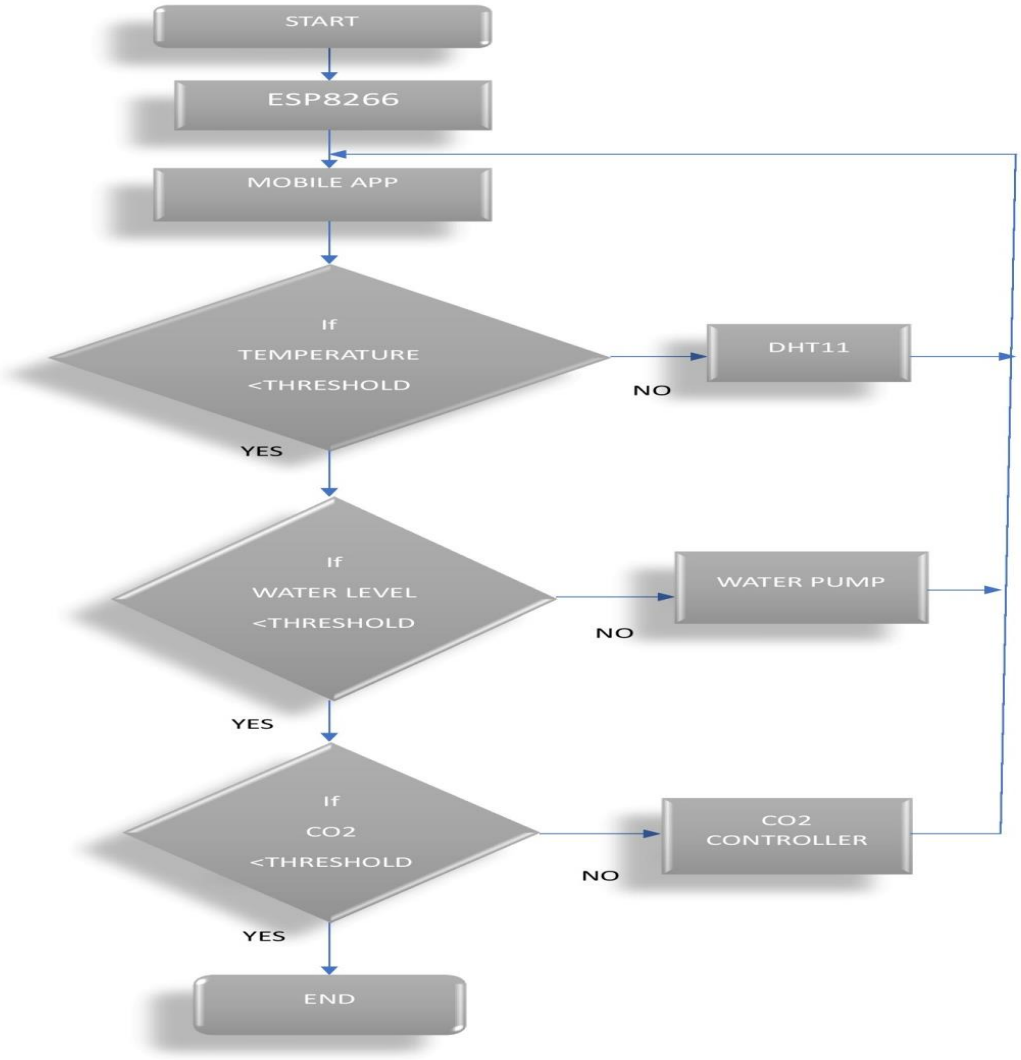


Figure 5: Flow chart of the algorithm

Results

Water Efficiency

Comparing hydroponics and aeroponics to conventional soil-based farming, both techniques consume a great deal less water. They recirculate water and nutrients, reducing water wastage.

Space Efficiency

Increased yields of crops in a smaller footprint can be achieved by using these techniques in vertical farming installations and smaller locations.

Reduced Pesticide Usage

Controlled environments in aeroponics and hydroponics systems can reduce the need for pesticides and herbicides, leading to potentially cleaner and more sustainable food production.

Faster Growth

Higher crop yields and quicker growth are possible in these systems because of the regulated environment.

Year-Round Production

Production of crops can occur year-round in indoor or conservatory hydroponic cultivation systems, regardless of the outside weather.

Reduced Soil Dependency

These methods can be used in areas with poor soil quality or in locations where soil contamination is a concern.

CONCLUSION

Both smart aerophonic and hydroponic farming systems offer sustainable and efficient methods of agricultural production with several advantages. The choice between the two depends on factors like available space, resource availability, crop type, and local environmental conditions. These systems can play a vital role in ensuring a consistent and environmentally friendly food supply in the face of global challenges, such as population growth and climate change.

Advancements And Future Scope

Increased Efficiency

Smart technologies, including IoT (Internet of Things) sensors, automation, and data analytics, can enhance the efficiency of aeroponic and hydroponic systems. Precise control and optimisation are made possible by real-time monitoring of plant health, nutrient levels, and ambient variables. This results in higher crop yields, less usage of resources, and more sustainability all around.

Sustainability

Aeroponics and hydroponics are inherently more sustainable than traditional soil-based farming because they use less water, reduce the need for chemical fertilizers, and can be implemented in urban environments, reducing the carbon footprint of food production. As the world faces growing concerns about water scarcity and climate change, these methods offer a sustainable solution.

Urban Agriculture

Smart aeroponic and hydroponic systems are well-suited for urban agriculture and can be integrated into vertical farming facilities and other small spaces. This can lessen the need for produce to be transported over great distances, therefore lessening its impact on the environment.

Crop Diversity

These systems offer the versatility needed to cultivate a variety of crops, such as leafy greens, herbs, and even certain fruiting plants.

In the future, there may be increased interest in expanding the range of crops that can be successfully grown using aeroponics and hydroponics, further diversifying the market.

Integration with Renewable Energy

To lower energy costs and their negative effects on the environment, smart aerophonic and hydeophonic farming can be combined with renewable energy sources like solar power. Combining these technologies can create highly sustainable and self-sufficient farming operations.

Research and Development

Developments in nutrient formulations that are disease control, and system design will result from ongoing studies and developments in this area. Innovations such as the use of nanotechnology and genetic modifications may also play a role in advancing these farming methods.

Education and Training

With the growth of smart aeroponic and hydroponic farming, there will be a need for education and training programs to teach farmers and technicians how to operate and maintain these systems effectively. This could lead to job opportunities and educational programs focused on modern agriculture.

Consumer Demand

Growing consumer well-being and environmental consciousness may lead to a rise in demand for free of pesticides, locally grown produce. Smart aeroponic and hydroponic farming can meet these demands by providing fresh, high-quality food year-round.

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