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Smart Farming with Aquaponic System Using Node MCU

Dr. Swagat M. Karve, Kedar Vishwanath Swami, Sonali Vijaykumar Patil, Pratiksha Chetan Kambale
SPVP's S. B. Patil College of Engineering, Indapur, Maharashtra, India

ABSTRACT

The emphasis of the aquaponics systems was on boosting the viability and economics of both indoor and outdoor fish farming. We must reevaluate agriculture sciences in light of factors like sustainability, growth, and economically efficient improvements to farmer health; this means that we must create environmentally friendly technology. Aquaponics is a new innovation created by combining aquaculture and hydroponics. It adheres to the principles of sustainable agriculture (wastewater bio-filtration by plants) and gives us the opportunity to increase economic efficiency by adding a second source of food production (organic vegetables) to create nutrient-rich food. The system incorporates a pH sensor for monitoring the acidity levels of the water, a raindrop sensor for detecting precipitation, a DHT11 sensor for measuring temperature and humidity, and a relay for controlling the water pump. The integration of these components enables real-time monitoring and control of crucial environmental parameters, facilitating optimal conditions for plant growth and fish health in aquaponics systems. The results demonstrate the effectiveness and reliability of the system in maintaining water quality, responding to environmental changes.

Keywords: Aquaponics, Aquatic Farming, IoT, Hydroponics, Aquaculture, Automation

I. INTRODUCTION

The phrase "aquaponics" is created by combining the terms "aqua" and "ponics". "Ponics" is a Latin term meaning "to work," and the growing process uses soilless media. Aqua alludes to aquaculture, which is the activity of rearing fish in a controlled setting. The need for food in the world has increased to the point of crisis in the modern era, with conventional agriculture unable to meet the demand and farmers grappling with problems including high fertilizer costs, scarce farming land, and insufficient water for irrigation. To solve these problems, a brand-new technique called aquaponics has been developed that combines automation and mimics a natural habitat. This is a contemporary, computer-driven methodology with enormous potential for automation and, consequently, aextensive use in the field of agriculture. This approach eliminates many other issues with traditional agriculture and is incredibly efficient, economical, and reasonable. Aquaponics is the fusion of conventional agricultural methods with aquaculture. The produced fish in this method eats its food and excretes waste, which is subsequently used as the perfect fertilizer for the crop that is so important. Aquaponics describes the relationship between water, the architecture of aquaculture, and nutrition. When plants develop in waterways, different components bio integrate to circulate power. The plants in aquaponics systems help filter and clean the fish water, and the waste from the fish provides the plants with nutrients.

Environmental elements like pH, temperature, humidity, and water flow must be well managed for the success of aquaponics systems.

As a result, they are very advantageous for the food system, and the majority of food crops obtained through conventional farming employ powerful pesticides that pose substantial health risks. Recirculating aquaculture and hydroponics are the two types of agricultural production that are combined in aquaponic systems. The main problems with these two systems are addressed by aquaponics, including the need for nutrient-rich water that can act as a fertilizer for hydroponically grown plants rich fish waste in aquaculture.

II. LITERATURE REVIEW

Rakocy JE, Hargreaves JA (1993) explored nutrient accumulation in a recirculating aquaculture system integrated with hydroponic vegetable production, shedding light on sustainable farming practices that enhance resource efficiency. [1]

Ms. Sabale Snehal Rajendra and Mrs. Shirkande Aparna Shrinivas (2022) presented a study on "Hydroponics Farming Using IoT" in the International Journal for Research in Applied Science & Engineering Technology. This work likely investigates the integration of IoT technology in hydroponic farming for improved monitoring and control. [2]

Martins CIM et al. (2010) discussed advancements in European recirculating aquaculture systems with an environmental sustainability approach, contributing valuable insights into enhancing the eco-efficiency of aquaculture practices. [3]

Shete AP et al. (2013) optimized the water circulation period for the culture of goldfish with spinach in an aquaponic system, offering insights into maximizing resource utilization in integrated aquaculture and hydroponic systems. [7]

Vijaysinh U. Bansude (2016) proposed a "Fingerprint Based Security System For Banks," addressing security concerns in banking systems through biometric authentication methods. [8]

S. T. Shirkande and M. J. Lengare (2017) optimized underwater image enhancement techniques, potentially enhancing the quality of underwater imagery for various applications such as marine research and exploration. [9]

Gaikwad, Yogesh J. (2021) conducted a review on self-learning-based methods for real-world single-image super-resolution, contributing to advancements in image processing and computer vision. [10]

V. Khetani et al. (2021) studied different sign language recognition techniques, aiming to improve accessibility for the hearing-impaired population through technological innovations. [11][15][16]

Vaddadi S et al. (2022) proposed an effective malware detection approach based on deep learning in Cyber-Physical Systems, addressing cybersecurity concerns in interconnected systems. [12][13]

Rashmi R. Patil et al. (2020) developed "Rdpc: Secure cloud storage with deduplication technique," contributing to the advancement of secure cloud storage solutions. [14]

Khetani V et al. (2023) conducted a cross-domain analysis of machine learning and deep learning, evaluating their impact across diverse domains, thereby contributing to the understanding of their applicability and effectiveness.

Khetani V et al. (2014) proposed securing web accounts using graphical password authentication through watermarking, enhancing cyber security in online platforms. [11][15][16]

Kale R et al. (2023) developed a CR System with efficient spectrum sensing and optimized handoff latency, aiming to improve the quality of service in wireless communication networks. [17][18]
Nagtilak S et al. (2020) conducted a survey on distributed attack detection using deep learning approach in the Internet of Things, addressing security challenges in IoT ecosystems. [18]
Mane, Deepak, and Aniket Hirve (2013) studied various approaches in machine translation for the Sanskrit language, contributing to the advancement of natural language processing techniques for under-resourced languages. [19]
Dr. S. M. Karve et al. (2023) presented an "Automated Aquaponic Farming Using Node MCU," showcasing advancements in automation technology for sustainable agriculture practices. [20]

III.BLOCK DIAGRAM

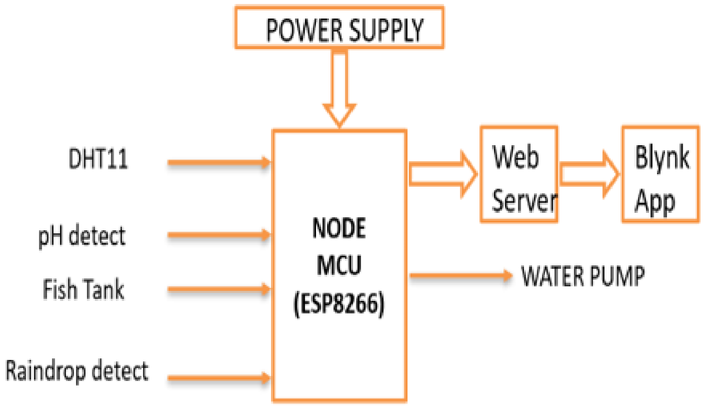

Figure 1. Block Diagram of Aquaponic automation System

Aquaponics is a closed-loop system that uses fish waste to fertilize plants. The plants filter the water for the fish, creating a symbiotic relationship. This method uses 90% less water than traditional farming and eliminates the need for chemical fertilizers and pesticides. Aquaponics can grow a variety of crops, including leafy greens, herbs, and fruits.

IV. RESULT AND DESCRIPTION

The intelligent aquaponics system demonstrated consistent performance in maintaining ideal environmental conditions for plant growth and fish health. Real-time pH monitoring enabled rapid modifications to the water chemistry, avoiding possible problems such as nutritional deficits or toxic accumulation. The raindrop sensor's integration allowed the system to respond dynamically to changes in weather conditions, conserving water resources and reducing environmental impact. Temperature and humidity data provided vital insights into the aquaponics microclimate, allowing modifications to improve growing conditions. The pH sensor built into the device gave precise and dependable measurements of water acidity. Throughout the experiment, the ESP8266 microcontroller continuously measured and recorded pH levels. Analysis of the pH data revealed oscillations within the recommended range for aquaponics (usually 6.5 to 7.5), indicating that the system's water chemistry was effectively controlled. When pH levels deviated from the specified range, the system quickly responded by starting the water pump and introducing pH-adjusting solutions such as bicarbonates or pH buffers. This dynamic pH control method contributed to stable circumstances for both plant growth and fish health, lowering the likelihood of pH-related stress or nutritional imbalances. The raindrop sensor performed an important role in detecting rainfall. Adjusting water management strategies accordingly. Upon detecting precipitation, the system automatically reduced the frequency and duration of water pump operation to prevent overwatering of the plants. By conserving water resources and minimizing runoff, this adaptive water management approach contributed to sustainable aquaponics practices and reduced environmental impact. Furthermore, the raindrop sensor facilitated real-time monitoring of weather conditions, enabling the system to anticipate changes in water availability and adjust irrigation schedules accordingly. The integrated smart aquaponics system performed well in terms of maintaining ideal environmental conditions for plant growth and fish health.

The system accomplished automatic monitoring and control of critical parameters by using IoT technology and sensor-based feedback mechanisms, decreasing the requirement for manual intervention and lowering the danger of human mistake. Continuous data logging and analysis allowed for long-term monitoring of system performance, providing insights into trends and patterns that could be used to inform future optimizations and modifications. Overall, the findings demonstrate the efficacy and feasibility of using smart technology solutions in aquaponics management, paving the way for enhanced efficiency, productivity, and sustainability in aquaponics farming techniques.

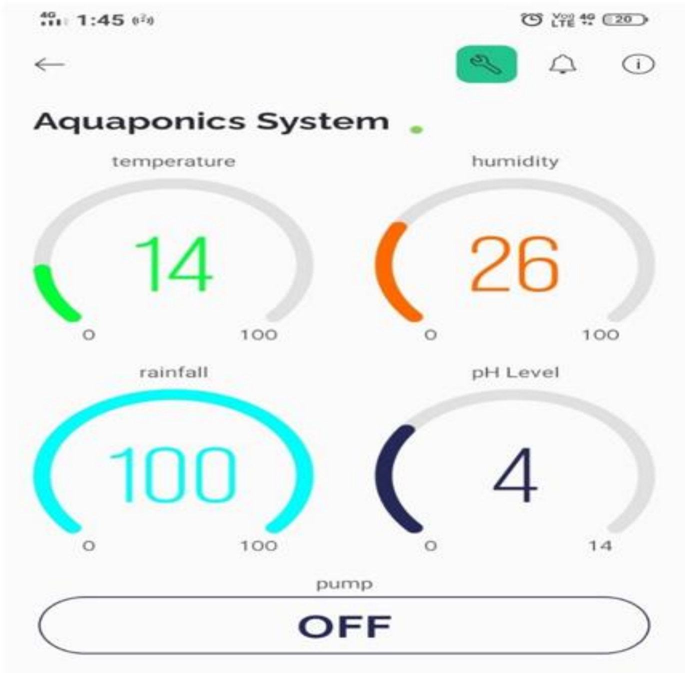

Figure 2. Home Page Dispaly of Blynk App (Before)

Figure 3. Actual project setup

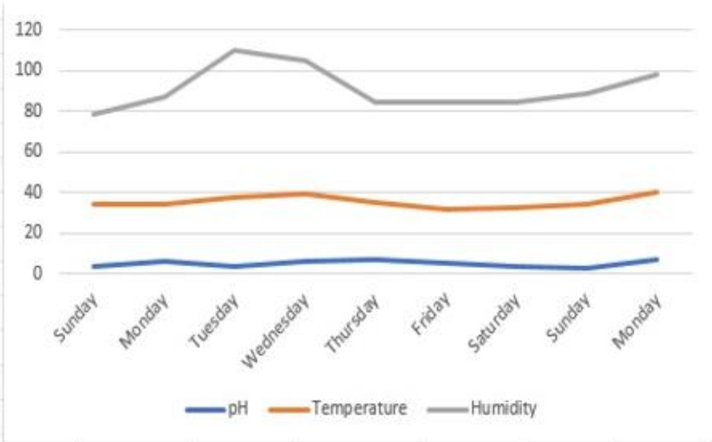

Figure 4. Graphical description analysis of project

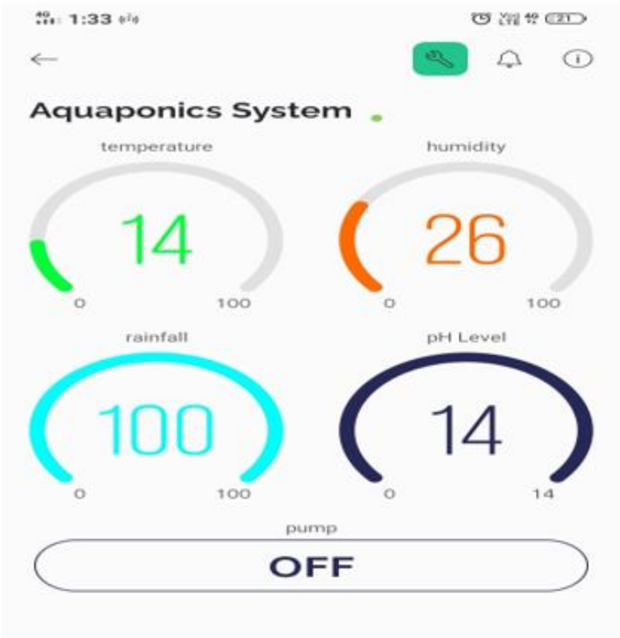

Figure 5. Home Page Dispaly of Blynk App (After)

V. LIMITATIONS AND EXISTING WORK

A. Limited Crop Varieties

The variety of crops that can be cultivated is limited by the fact that some plants are more suited for hydroponic growing than others.

Studies are being conducted to increase the number of appropriate crops and enhance growing conditions for a wider range of plants. Work on nutrient formulations and crop-specific environmental controls fall under this category. [17]-[21].

B. Control and Monitoring of the Environment

It can be difficult to keep the ideal environmental conditions for both fish and plants. It's important to regularly monitor and regulate factors including water temperature, pH, dissolved oxygen levels, and nutrient concentrations.

These characteristics can be managed with the aid of automated monitoring and control systems with sensors and actuators. Based on past data and current measurements, machine learning and AI algorithms are utilized to forecast and modify situations.

VI. CONCLUSION

The new design choices are anticipated to significantly improve water quality, which will favourably impact fish output and growth. Today's world faces a very real and serious challenge to food security. The capacity to address these challenges of resource conservation and access to a consistent and high-quality food source is what makes aquaponic food production so alluring. Additionally, because an aquaponic system is so straightforward and user-friendly, it may be able to assist families who are most in need.

Meeting the demand of the escalating food crisis at the lowest possible cost is the key problem facing the agricultural sector. The approach to be used should be user-friendly, effective, and trustworthy given the cost factors. Our data demonstrate that aquaponics can satisfy each need. As with any technology, there are a few very minor drawbacks and concerns with this approach, but when compared to conventional agriculture, the advantages are undeniably greater.

VII. REFERENCES

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