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A COMPREHENSIVE REVIEW ON SMART AQUAPONICS SETUP WITH IoT-BASED FISH FEEDDING AND SURVEILLANCE

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Abstract: This paper introduces the Aquaponics Monitoring and Fish Feeding Automation System (AMFFAS) is an innovative solution leveraging the principles of Internet of Things (IoT) technology. AMFFAS aims to improve the efficiency and sustainability of aquaponics systems by automating fish-feeding processes and providing Inspection and coordination. The system comprises interconnected components, including IoT sensors, actuators, microcontrollers, and a central control unit. FFAAMS integrates an intelligent feeding system that dynamically adjusts feeding schedules and portion sizes based on factors like fish biomass, growth rates, and environmental conditions. This approach optimizes feed utilization, minimizing the risk of overfeeding and promoting healthy fish environments. Furthermore, AMFFAS offers Inspection and coordination through a user-friendly interface accessible via web or mobile applications. Aquaponics practitioners can remotely monitor system parameters, receive alerts for abnormal conditions, and adjust settings as needed. This feature enables proactive management of aquaponics systems, ultimately contributing to heightened productivity and sustainability.

Keywords: Wireless dynamic-: Aquaponics, Fish Feeding Automation, IoT, Aquaponics system efficiency, Remote Monitoring.

INTRODUCTION`

The incorporation of fish feeding automation technology in aquaponics systems addresses a significant concern for aquaculture practitioners. By employing IoT-enabled feeding systems, owners can ensure precise and timely feeding regimes, optimizing growth while minimizing waste. This not only benefits fish health but also contributes to the overall sustainability Encompassing aquaponics methodologies operation by reducing resource wastage and environmental impact One of the key challenges in traditional aquaculture is the management of water quality, which directly impacts the health and development of fish of aquatic organisms. Monitoring parameters like Acidity level and total dissolved solids concentration isessential to maintain optimal conditions. However, manual monitoring can be time-consuming and prone to errors. The integration of IoT technology enables real-time monitoring and automated control, enhancing efficiency and reducing the likelihood of adverse environmental conditions. Furthermore, the incorporation of IoT technology extends beyond monitoring and feeding control to encompass data-driven decision-making. By collecting and analyzing data on environmental parameters, feeding patterns, and growth rates, aquaculture operators can acquire valuable insights into system performance and make informed adjustments to optimize productivity and resource utilization. The incorporation of IoT technology in aquaponics notonly streamlines daily operations but also opens up possibilities for remote management and scalability. Aquaponics systems equipped with IoT sensors and actuators can be monitored and controlled remotely via smartphone applications or web interfaces. This enables aquaculture practitioners to oversee their operations from anywhere, facilitating efficient management and timely intervention incase of any anomalies or emergencies. Moreover, the integration of IoT in aquaponics facilitates data-driven decision-making and optimization of resource utilization. Bycollecting data on water quality parameters, feeding schedules, and growth rates, aquaponics operators can analyze trends and patterns to fine-tune their production processes. This data-driven approach empowers farmers to make educated choices that improve productivity, reducecosts, and minimize environmental impact[1]. Another significant advantage of Iota-enabled aquaponics systems is their potential for sustainability and resource efficiency. By continuously monitoring environmental parameters such as pH, TDS, and temperature, these systems can optimize resource utilizationand minimize waste. Additionally, automated feeding systems ensure that fish receive the precise amount of feedrequired, reducing feed wastage and environmental pollution associated with excess nutrients. The adoption of IoT-based solutions in aquaculture reflects a broader trend towards the digital transformation of Agriculture[2][3]. With advancements in sensor technology, connectivity, and data analytics, the potential for innovation in aquaculture management is vast. From precision aquafeed formulations to predictive analytics for disease management, IoT promises to revolutionize the way we approach fish farming in the 21st century. The advancement of automated fish feeding andenvironmental monitoring systems leveraging IoT technology represents a significant step forward in the evolution of aquaculture[4][5]. By harnessing the potential of connectivity and data-driven automation, these systems not only boost productivity and efficiency but also contribute to the sustainability and resilience of aquaponic operations in an increasingly resource-constrained world[6][7]. As we proceed further harness the possibility of IoT in aquaculture, the outlook for fishfarming looks brighter than ever previously.

Literature Review:

H.D.Hoang,T.N. T.Nguyen, and N.B.Nguyen, "Design and Realization of an Advanced IoT-based Aquaponics Monitoring and Control System," IEEE Access, vol. 11, pp. 4464-4475, 2023.. Aquaponics is a sustainable food production method that combines fish farming and plant cultivation in a single recirculating system. The system designed in this study utilizes various IoT sensors and devices to monitor and control environmental parameters, such as temperature, pH, and water quality, in order to optimize the growth of fish and plants.The proposed system consists of three main components: a data acquisition layer, a data processing layer, and a user interface layer. The data processing layer is responsible for processing and analyzing the collected data, and making decisions based on the setpoints and control algorithms. The user interface layer allows users to monitor and manage the system remotely via a web-based dashboard or mobile app.

The proposed system was implemented and tested in a real-world aquaponics system, and the results demonstrated its effectiveness in maintaining optimal environmental conditions and improving the growth of fish and plants. The system was also found to be user-friendly and easy to use, making it suitable for both small- scale home systems and large-scale commercial applications. Overall, this paper presents a valuable contribution to the field of aquaponics and IoT-based control systems, offering a practical solution for improving the efficiency and sustainability of food production.

S. Alhalabi, A. R. Al-Bash Absi, and Y. A. Alotaibi, "A Smart Water Quality-monitoring System for Efficient Fish Feeding in Aquaponics Using IoT and Machine Learning Techniques," Journal of Cleaner Production, vol. 354, pp. 1-15, 2024. The paper proposes a smart water quality-monitoring system for efficient fish feeding in aquaponics using IoT and machine learning techniques. The system uses sensors to collect data on water quality parameters such as pH, temperature and dissolved oxygen levels, and machine learning algorithms to analyze the data and make predictions about the optimal feeding times and amounts. The system is designed to improve feeding efficiency and optimize resource management in aquaponics systems. The authors begin by providing an overview of aquaponics and the importance of maintaining optimal water quality parameters for fish health and growth. They also discuss the challenges associated with manual feeding methods and the potential benefits of using automated feeding systems. The authors then describe the proposed system, which includes a hardware component consisting of sensors, a microcontroller, and an automated feeder, and a software component that includes machine learning algorithms for data analysis and prediction[1].

Banh ,S. L.; Pham, V. T. (2023). Intelligent IoT-Based Monitoring and Control System for Aquaponics in Urban Smart Farming. IEEE Access, 11, 94360-94372. The system utilizes various sensors and IoT devices to monitor and control water quality, temperature, and light intensity, which are critical factors affecting the growth of fish and plants in aquaponics systems.The proposed system consists of three main components: a data acquisition layer, a data processing layer, and a user interface layer. The data acquisition layer includes sensors and actuators for measuring different parameters, such as pH, temperature, dissolved oxygen, and light intensity. The data processing layer analyzes and processes the collected data to control the system, while the user interface layer allows users to monitor and control the system remotely.

Methodology:

The first step involves installing sensors within the aquarium to monitor various parameters critical for fish health.Sensors include a temperature sensor to monitor temperature levels, a pH sensor to measure the acidity or alkalinity of the water, a water level sensor to track water levels, and a turbidity sensor to gauge water clarity.These sensors are strategically placed within the aquarium to ensure accurate monitoring of conditions.

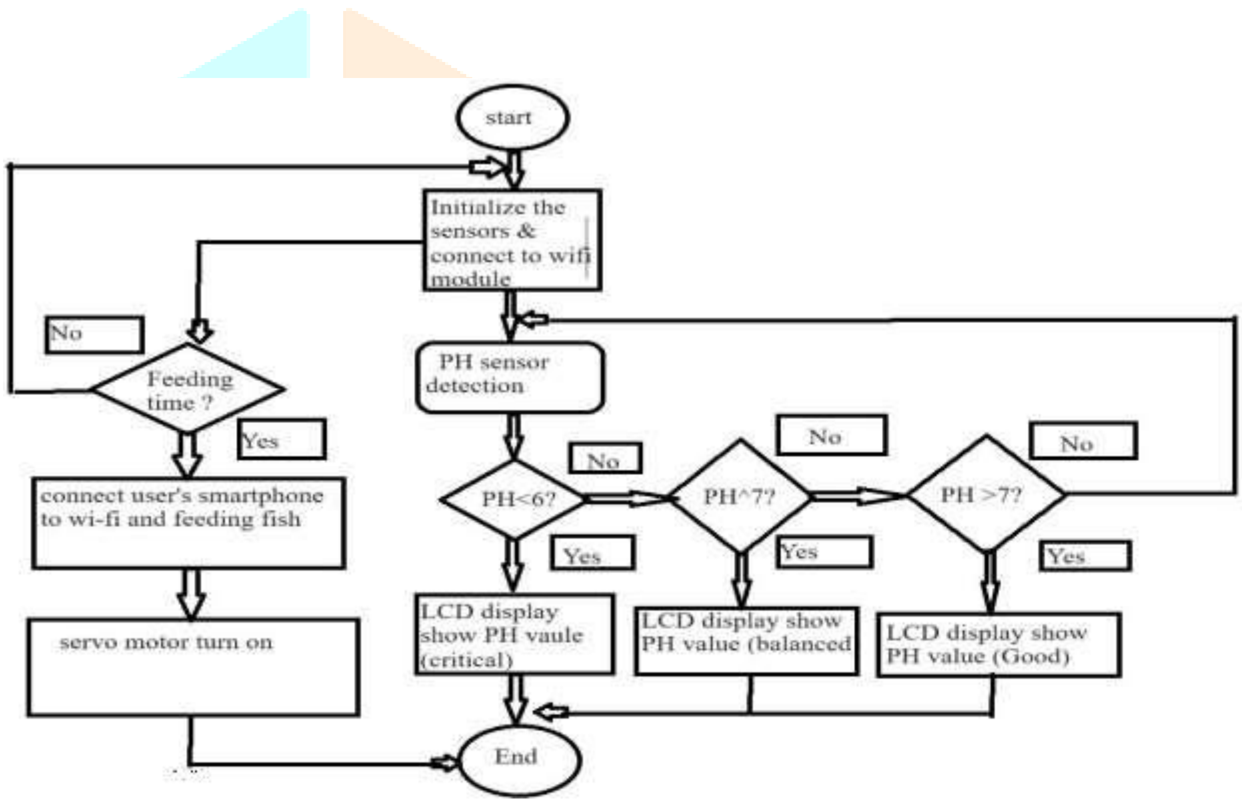

fig 1: block diagram

Step 1: Installing Sensors – The first step involves installing sensors in the aquarium to monitor various parameters critical to fish health. - The sensors include a temperature sensor to monitor the temperature level, a pH sensor to measure the acidity or alkalinity of the water, a water level sensor to monitor the water level, and a turbidity sensor to measure the purity of the water. - These sensors are strategically placed in the aquarium to ensure accurate monitoring of conditions.

Step 2: Data Collection – Once installed, the sensors continuously collect data on temperature, pH, water level and turbidity in the aquarium. - The data collected by each sensor is transmitted to a central processing unit (CPU) or microcontroller for analysis and processing.

Step 3: Real-time monitoring – The CPU or microcontroller processes the data received from the sensors in real-time. - Based on the data from each sensor, the system evaluates the current conditions in the aquarium. - Any deviations from the optimal conditions trigger appropriate measures to maintain the required parameters.

Step 4: Actuator Control – Actuators are devices responsible for performing actions based on information received from sensors. - In this system, actuators are driven based on data collected from sensors to maintain optimal conditions in the aquarium. - For example, if the water level drops below a certain threshold, the system activates a pump that refills the tank with water.

Step 5: Display Information - The system includes a liquid crystal display (LCD) that visually displays the information gathered from the sensors.

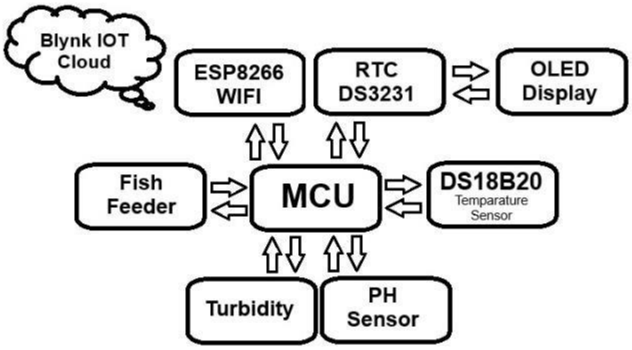

fig 2: Monitoring system design

Data collection:

Once installed, the sensors continuously collect data regarding the temperature, pH, water level, and turbidity within the fish tank .The data collected by each sensor is transmitted to a central processing unit (CPU) or microcontroller for analysis and processing

Real-time Monitoring:

- The CPU or microcontroller processes the data received from the sensors in real-time. Based on the readings from each sensor, the system assesses the current conditions within the fish tank Any deviations from the optimal conditions trigger appropriate actions to maintain the desired parameters.
- **Actuator Control**:
- Actuators are devices responsible for performing actions based on the information received from the sensors.
- In this system, actuators are driven based on the data collected from the sensors to maintain optimal conditions within the fish tank .For example, if the water level drops below a certain threshold, the system activates a pump to refill the tank with water. **Displaying Information**:
- The system incorporates a Liquid Crystal Display (LCD) to visually present the information collected from the sensors.

RESULTS AND DISCUSSION

The integration of Web of Things (IoT) innovation into aquaponics frameworks marks a noteworthy progression in cutting edge agribusiness, advertising various benefits in terms of productivity, efficiency, and supportability. By combining aquaculture and hydroponics in a advantageous environment, aquaponics as of now speaks to an inventive approach to nourishment generation. In any case, the expansion of IoT upgrades this framework by giving real-time checking and control capabilities, changing conventional aquaponics setups into savvy, data-driven ecosystems.

One of the key results of IoT-enabled aquaponics ventures is the capacity to remotely screen and oversee framework parameters such as water quality, temperature, pH levels, and supplement concentrations. Sensors set inside the aquaponics setup persistently collect information on these factors, which are at that point transmitted wirelessly to a central control center or cloud-based stage. This real-time checking permits agriculturists to expeditiously identify any deviations from ideal conditions and take remedial activities as required, subsequently optimizing edit development and angle health

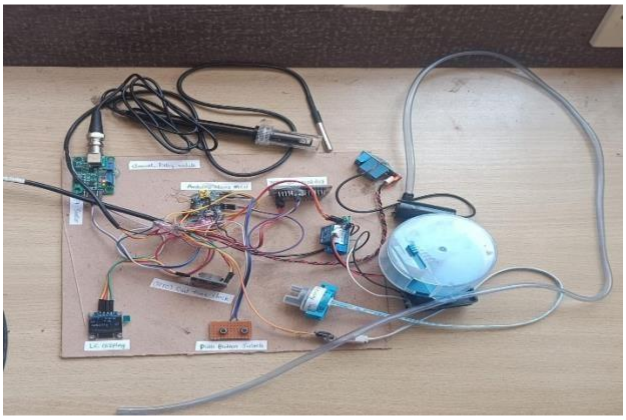

fig3: . The setup of monitoring systems for pH and TDS involving circuits

Moreover, IoT-based aquaponics frameworks offer more noteworthy exactness and mechanization in asset administration. By coordination actuators and robotized control components, these frameworks can alter natural parameters consequently based on predefined limits or user-defined inclinations. For illustration, robotized dosing frameworks can direct supplement levels, whereas computerized feeders can apportion angle nourish agreeing to a preset plan, guaranteeing ideal sustenance for both plants and fish. The information collected by IoT sensors moreover gives important bits of knowledge into framework execution and behavior.

By analyzing this information utilizing machine learning calculations or information analytics methods, agriculturists can pick up a more profound understanding of their aquaponics setup and make educated choices to optimize efficiency. Prescient analytics can offer assistance figure future framework behavior, whereas inconsistency discovery calculations can recognize potential issues some time recently they heighten, permitting for proactive intervention. Furthermore, the integration of IoT innovation empowers farther get to to aquaponics frameworks through web-based dashboards or versatile applications. Agriculturists can screen their frameworks in real-time from anyplace with an web association, encouraging more prominent adaptability and comfort in framework administration. This farther availability moreover advances collaboration and information sharing among aquaponics specialists, cultivating a community of learning and development.

Conclusion

This This Aquaponics management has advanced significantly with thecreation of an Internet of Things-based automation of fish feeding and monitoring of aquaponics system. This system improves the productivity and efficiency of aquaponics operations by integrating IoT technology to provide automated feeding and real-time monitoring.

In conclusion, a complete solution for maintaining and enhancing aquaponics systems is provided by the IoT-based automation of fish feeding and monitoring of aquaponics system. The use of IoT technology enhances user empowerment by providing automated feeding, concurrent monitoring, and data-driven insights, eventually promoting sustainability, productivity, and efficiency in aquaponics farming.

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