Microcontroller Based Automatic Aquaponic System

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Abstract: **-Aqua phonics, the symbiotic integration of aquaculture and hydroponics, offers a sustainable solution for food production. However, maintaining optimal conditions for both aquatic organisms and plants is crucial for its success. This paper proposes a Smart Aquaponic System (SAS) leveraging Internet of Things (IoT) technologies to monitor and control key parameters in real-time. The system incorporates sensors to measure water quality, temperature, pH levels, and fish behavior, transmitting data to a central hub for analysis. Through automated actuators, the SAS adjusts environmental parameters, such as nutrient levels and water flow, ensuring optimal conditions for plant growth and fish health. Additionally, the SAS employs machine learning algorithms to predict system behavior, detect anomalies, and provide actionable insights for improved efficiency and productivity. By integrating IoT capabilities, the proposed SAS offers a sustainable and efficient approach to aquaponic farming, addressing the challenges of traditional methods while promoting environmental stewardship and food security.**

Keywords**: Aquaculture, Hydroponics, Food Production, Fish, Plants.**

1. INTRODUCTION

Aquaponics, the innovative combination of aquaculture and hydroponics, represents a promising approach to sustainable food production. By harnessing the symbiotic relationship between fish and plants, aquaponic systems can efficiently utilize resources while minimizing environmental impact. However, maintaining optimal conditions within these systems poses significant challenges, often requiring constant monitoring and intervention. The integration of Internet of Things (IoT) technologies presents a transformative opportunity to enhance the efficiency and effectiveness of aquaponic systems. By leveraging IoT sensors, actuators, and data analytics, a Smart Aquaponic System (SAS) can continuously monitor key parameters such as water quality, temperature, pH levels, and fish behavior in real-time. This real-time monitoring capability enables proactive management and precise control of environmental conditions, ensuring optimal growth conditions for both aquatic organisms and plants. Through the implementation of a Smart Aquaponic System (SAS), we aim to address the inherent challenges of traditional aquaponic farming, such as labor-intensive monitoring and suboptimal resource management. By providing real-time insights and automated control mechanisms, the SAS offers a sustainable and efficient solution to enhance food production while minimizing environmental impact. Additionally, the integration of IoT technologies paves the way for advancements in precision agriculture and promotes the adoption of innovative farming practices in the quest for global food security.

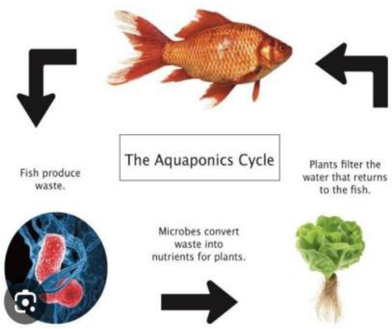

Fig. 1. The Aquaponics Cycle

2. LITERATURE REVIEW

The use of Raspberry Pi increases the project cost. On another work, implemented IoT based smart aquaponics to a water containing extra food nutrients utilized by the designed technology as source of nutrition from agriculture ponds. In this system, data was retrieved by the sensors and the internet assisted to access data transmitted by these sensors in real time with the help of Ubuntu IoT cloud server. The idea of designing and implementing an intelligent aquaponics system by and was to reduce electrical energy by integrating solar energy to make their system more economical and safer, as they produce chemical-free crops. The system used an Arduino UNO, motor pump, relay, servo motor and 12v battery. Arduino as the control unit, sends signal to LEDs, and if blue LED is ON water motor pump pumps water from fish tank into the aquarium tank but if red LED is on, servo motor operates, and it enables outlet water flow from hydroponics and sends back clean water into aquarium tank. They found out that to easily drain the system the solar panel have to rotate along with the sun or a high technology battery should be used to power up the pump. A report by state that a solar panel was used to power an automated aquaponics system that was implemented by the sultanate of Oman to sustain farming. It was an economical and environmentally system deployed for local communities of Oman. The units of the system were as follows: (i) a system that moves water between aquaculture tank and hydroponics beds; (ii) sensors, actuators, and GSM module are connected to microcontroller known as Arduino to form a system that controls and monitors aquaponics; and (iii) the sunlight was converted into electricity by solar panel to power the entire system.

3. EXISTING SYSTEM

Microcontroller Arduino AT328P is used as it contains inbuilt ADC and this project contains many sensors which need to be given to ADCs. Temperature Sensor gives the indication of the temperature inside the Greenhouse and maintains the required atmospheric condition inside the greenhouse. Moisture sensor full fills the requirement of the water to the plants in the precise manner in order to avoid additional wastage of water. Illumination sensor (LDR) gets activated in order to carry out Photosynthesis Process in the plants. Temperature, Humidity, Moisture is sensed and displayed on LCD and in Graphical form. According to the moisture senses pump to the field will get on/off. A relay that drives the pump is switched using switch. This pump will circulate the water between fish tank and field tank. 02 generators will be used for proper health of fishes.

4. PROPOSED SYSTEM

Aquaponics is a combination of aquaculture and hydroponic (soil-less plant culture) plant growth techniques. It doesn't require soil or any chemicals to produce a large amount of fish and vegetables in a small space. In aquaponics, the nutrient-rich water that results from raising fish provides a source of nutrients (Urea) for the nitrogen-consuming bacteria, which helps to clean the water where the fish live in by breaking down these compounds into nitrates, which then feed the plants and keeps them healthy. Aquaponic is a sustainable agriculture system in a symbolic environment combining aquaculture and hydroponics. An aquaponic system contains fish in tanks, whose wastewater is pumped to vegetables in grow beds with filter with gravel. The roots take up the nitrates and grow like crazy. The water returns to the tank, filtered clean. The organic vegetables and fish provide a complete diet, a good thing for an uncertain world. This system consists of Arduino Uno, sensor module, LCD as a local display, Central monitoring station, 2-stage rack, pump, hydroponic plants, fishes and bacteria. Arduino Uno control module is composed of 14 digital pins leads out I/O ports.

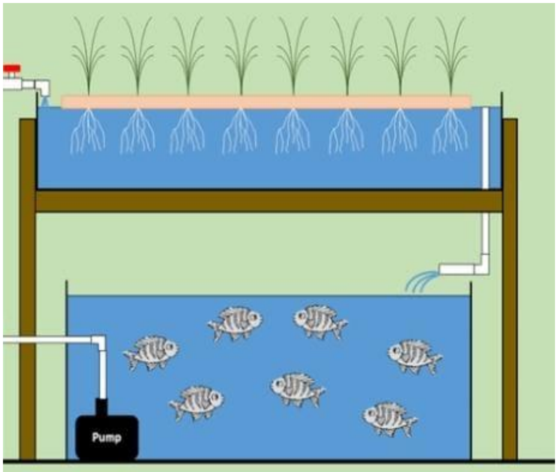

Fig. 2 Proposed Methodology.

5. BLOCK DIAGRAM

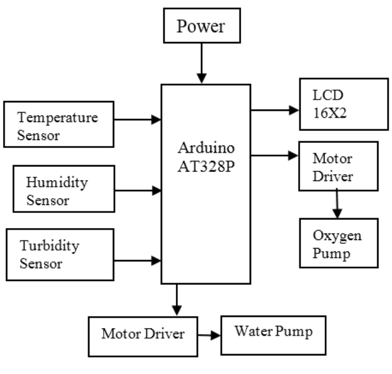

Fig. 3: Microcontroller Based Automatic Aquaponic System

6. HARDWARE AND DESCRIPTION

1. OXYGEN PUMP: -

Fig. 4: Oxygen Pump.

These are the most common tools used to introduce oxygen into an aquaponics system. Air pumps push air through tubing to air stones placed within the water, which release the air in the form of tiny bubbles.
Power consumption: 2.5
Flow rate: 180L/hrs.
Maximum head height: 30 CM
Suitable for salt water and fresh water.

2. TURBIDITY SENSOR: -

Fig.5: Turbidity Sensor

A turbidity sensor in an aquaponics system functions by measuring the "cloudiness" or haziness of the water, essentially detecting the amount of suspended particles present, which can indicate the level of solid waste from fish and thus the overall water quality within the system, allowing for adjustments to filtration or water changes as needed; essentially acting as a key indicator for maintaining a balanced environment for both fish and plants.

3. TEMPERATURE SENSOR: -

Fig. 5: Temperature Sensor

A temperature sensor's primary function is to continuously monitor and measure the water temperature, allowing aquaponic growers to maintain the optimal temperature range necessary for the health and growth of both the fish and plants within the system.

4. ARDUINO UNO: -

Fig. 6: Arduino Uno

Arduino Uno is open source microcontroller board that helps create interactive projects giving smart solutions by automation. It is based on the processor ATmega328p. It also comes with a variety of input and output pins that can be used to connect different electronic components.

5. LCD:-(Liquid Crystal Display)

Fig. 7: LCD (Liquid Crystal Display)

An LCD (Liquid Crystal Display) functions as a visual interface to display real-time data on key water parameters like Temperature and turbidity.

6. WATER PUMP: -

Fig. 8**:** charge controller

An aquaponics system, a water pump is crucial for circulating water throughout the system, ensuring that fish waste is transported to the grow beds where plants can utilize the nutrients as fertilizer, while simultaneously delivering oxygenated water back to the fish tank, effectively maintaining the delicate balance of the ecosystem by constantly moving water between the fish tank and plant grow beds.

7. FUTURE SCOPE

These systems are closed-loop, which means they conserve water by reusing it. Compared to traditional agriculture, aquaponics can reduce water consumption by up to 90%. Reduced waste Aquaponics systems reduce waste by creating a natural ecosystem where plants and fish work together to purify the wat Sustainable food production Aquaponics can produce fresh, locally-grown food in a sustainable way, with minimal environmental impact. Scalability Aquaponics can be implemented in a variety of settings, including urban environments, rural communities, and developing countries. Cost-effective Aquaponics can be cost-effective because it doesn't require inorganic fertilizers.

8. ADVANTAGES

1. Sustainable and intensive food production system.
2. Two agricultural products (fish and vegetables) are produced from one nitrogen source.
3. Extremely water efficient.
4. Does not require soil.
5. Does not use fertilizer and chemical pesticides.
6. Higher yields and qualitative production.
7. Higher level of Biosecurity and lower risk from outer contaminants.

9. CONCLUSION

Aquaponic System is certainly the best solution for growing Organic Vegetables at Homes in Crowded Cities as The Space and Water Requirement for This System Is Less. It Is an Eco-friendly Technology Which Can Be Improvised and Made Energy Efficient at An Individual's Convenience and Pattern of Usage. The Recirculation of Water. Makes the Water Requirement for Cultivation Less and Water Compensations Weekly Have to Be Made for Evaporation Losses Only.

10. REFERENCE

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