Automated Aquaponics System Using Arduino Microcontroller

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Abstract

The traditional way of farming consumes up to 70% of all the freshwater available. The frequent occurrence of droughts and floods have led to a decline in food security. An aquaponics system provides a sustainable way of growing plants and fishes as water is recirculated within the system multiple times. This study focuses on building an aquaponics system that can be implemented easily in a backyard.

Background

The main aim of this project is to build a prototype of the Aquaponics system that can be implemented in a backyard. The system must be easy to install, maintain and the user should be able to modify the system as per their needs.

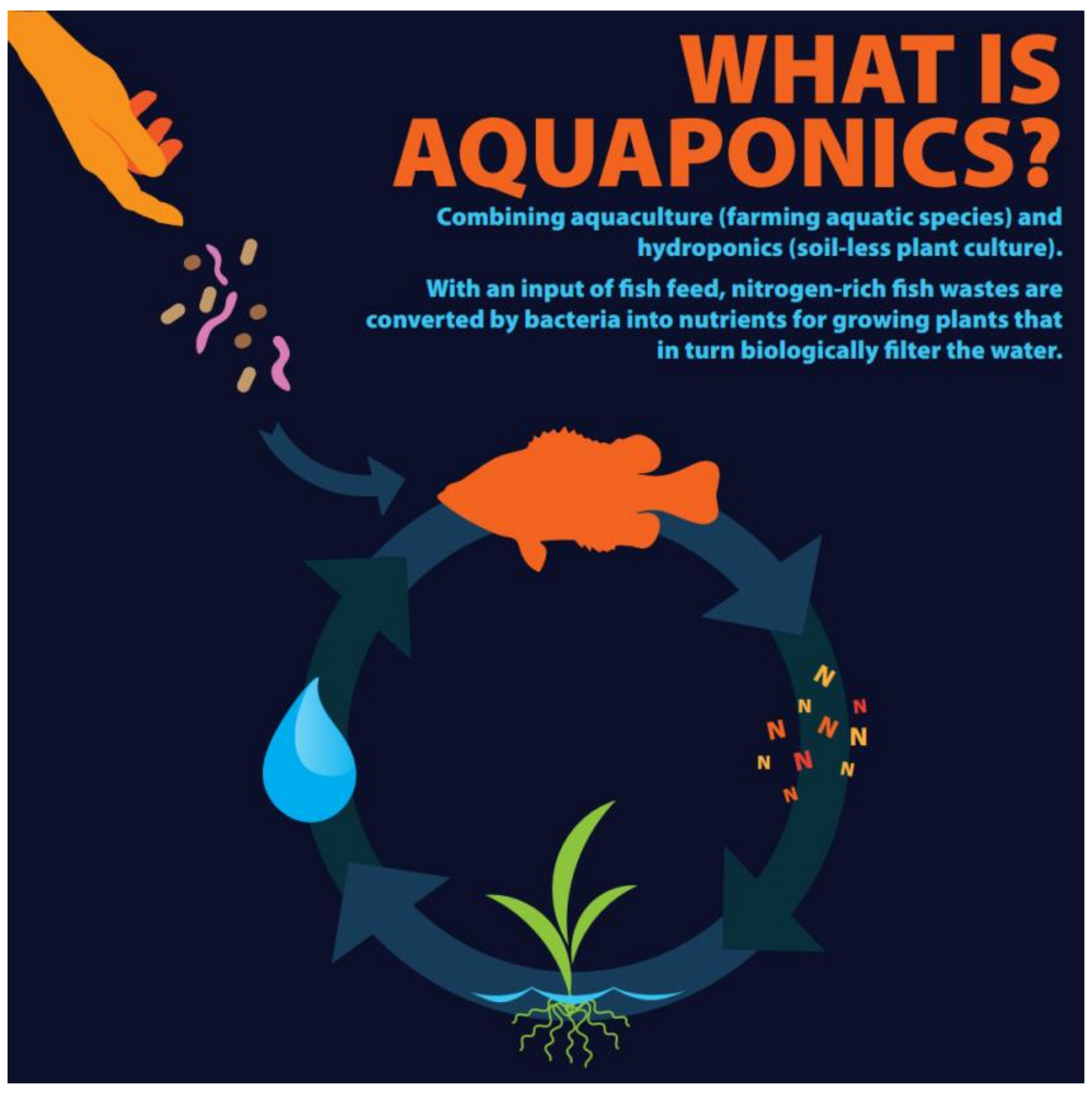

Fig 1: Aquaponics (Aquaculture Matters, 2015)

- The final system must be able to automate the routine process such as transfer of water between the two subsystems i.e. the aquaculture system and hydroponics system.
- The prototype should also allow the user to easily monitor the data.
- The existing researches have concluded that only 3.3% of the overall water used in the system was lost over a 4-month period time (Lian et al., 2013), moreover, the system had no negative effect on the yield of vegetables when implemented in a greenhouse in an arid region (Nagayo et al., 2017).

Methodology

A system engineering approach was used to design the final system.

1. **Requirement Analysis:** Different types of requirements such as stakeholder requirement, design requirements and performance requirements were generated that system must satisfy.
2. **Functional Analysis:** Functions that are required to be performed by the system were identified and described.
3. **Concept Generation:** Different ideas were brainstormed, those ideas that had the potential of being used in the final system were adopted.
4. **System Architecture:** The structure and behaviour of the final system were described, and the final design recommendation was made.
5. **Design & Testing:** The recommended design was built, and testing was conducted.
6. **Validation & Evaluation:** The final product was validated by evaluating its functioning and comparing it with the chosen requirements.

Figure 2: Systems engineering design spiral process

Results

The proposed system works as per the requirements with some minor exceptions. Different aquaponic parameters such as water pH and temperature, light intensity and air humidity and temperature can be easily monitored. Moreover, the system controls aspects like communication between two subsystems and water pump promptly.

Primary Outcomes:

- The current design allows more sensors to be integrated for future development.
- The total cost of building the system was less than $150.

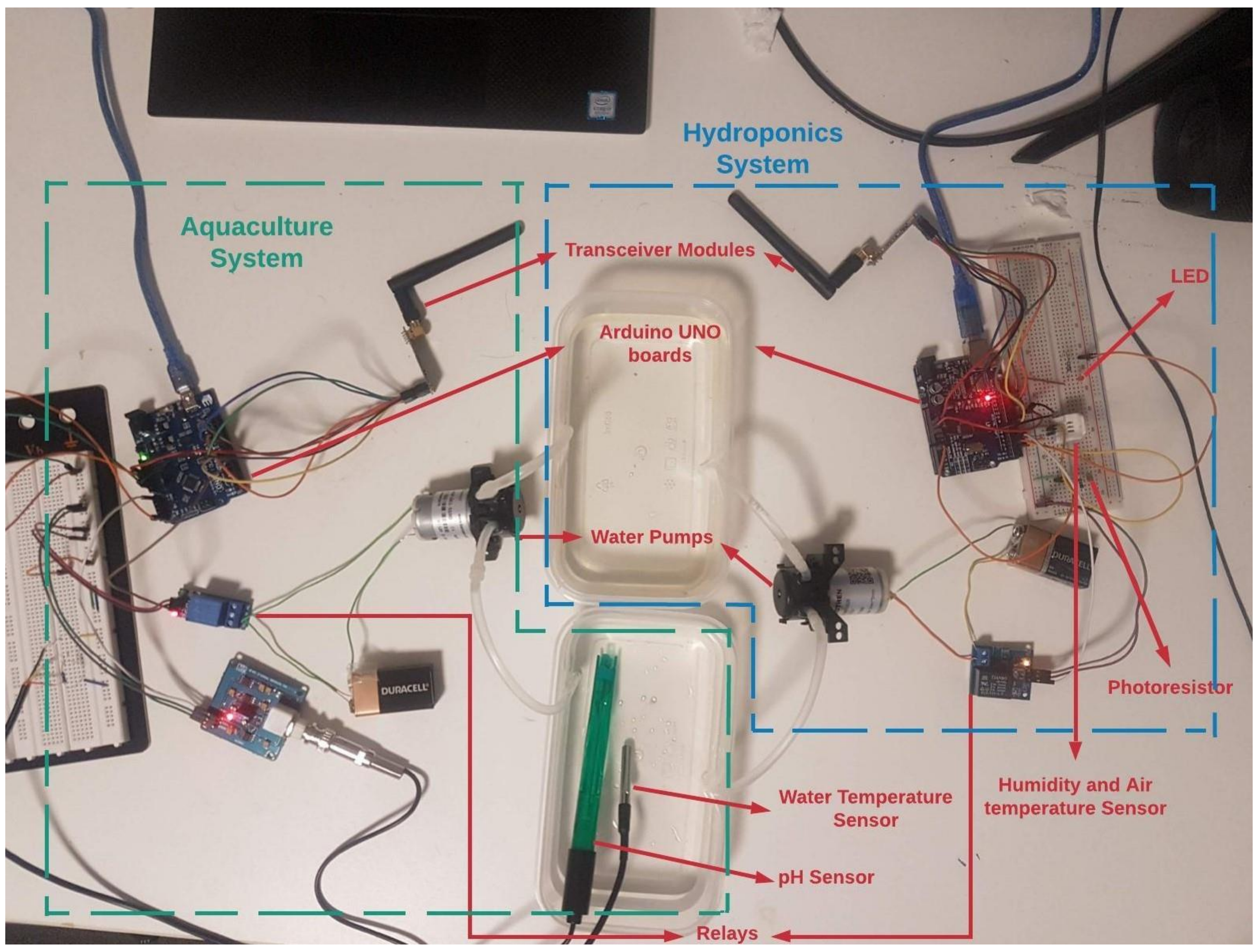

Fig 2 : Assembled System

Analysis

- The working of the sensors was validated however the accuracy of the sensors remains to be tested.
- The transceiver modules used to provide a range up to 50m.
- The system takes 60 seconds after being turned on to reach stable values on all the sensors.
- The sensors are responsive and immediately indicate any changes in the conditions.

Conclusions

The product currently lacks in several functionalities to be scaled up for commercial use. Integrating more sensors would greatly benefit the system. The addition of solar power and cloud storage of the data would make the system more convenient for the users to control. Furthermore, an IoT based system can be developed using the current system and can incorporate multiple systems.

References

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