Automatized Aquaponics with Arduino

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1 Introduction

1.1 Motivation

1.2 Challenges

1.3 Context

2 Objectives

Decrease human intervation in an Aquaponics system via periodic events management automation. For example, the fish feeding is a periodic event, but the water's pH control is not a periodic event, instead it is classified as adverse.

3 Theoretical Fundamentals

3.1 Background

3.2 Technologies

3.3 Related work

3.4 Conclusion

4 System Proposal

4.1 Approach

4.2 Use Cases

Water cycle control	**Template test**
Scope:	System-wide
Level:	User-goal
Actors:	Microcontroller
Stakeholders and Interests:	• Stakeholder 1 name: his interests • Stakeholder 2 name: his interests
Preconditions:	• The Microcontroller must be installed in the system • Water pump and the PWM module are working normally
Postconditions:	The fish tank's water should be pumped to the vegetable media each quarter of an hour.

Main Success Scenario:

1. The Microcontroller executes a run cycle of 25% in the PWM in a 1 hour period.
2. The circuit sends this signal to a relay.
3. The relay activates the water pump at a 15 minutes per hour rate with the adequate voltage.

Special Requirements:

- R1: Operation Time Limit requirement
- second applicable non-functional requirement

4.3 Requirements

4.4 Systems Architecture

4.5 Prototype Implementation and Project Decisions

There are a lot of authors that have had experience with Aquaponics automation. Most of them chooses Arduino or Raspberry Pi as the main microcontroller.

Two great reasons for the Arduino's usage are: This work's author already has an Arduino UNO, but not a Raspberry PI. Besides the main reference of this work, the Kretzinger's guide Leatherbury 2014, who has many years of experience with Aquaponics and its automation and he uses the Arduino as microcontroller.

The chosen components have been based in the references.

4.6 Results and Rating

5 Conclusion

6 Future Work

7 State of Art

There are some automated aquaponics projects available on the Internet, but most of them doesn't have a reasonable good documentation. So it has been needed to grab parts of information among every material found on Internet. One of the best sources found was from a hackaday's post from Gareth Coleman 2014, which describes with decent detail how they achieved the construction of their Arduino-powered aquaponics system.

Lots of research have been done about aquaponics. In Goddek et al. 2015, the authors show high complexity problems involving mechanisms to achieve

pH equilibrium for optimizing the quality of life for the fish, plants and nitrobacterias. Since each living component of the system lives well in a certain pH-Range. So there is a challenge to separate the pH level by region.

7.1 Why people are interested in Aquaponics?

A great amount of the published projects has a commercial goal: to make an efficient and small-sized system that can afford to produce organic products in a large scale.

On other hand, in the Goddek et al. 2015 there is a try to address the sustainability aspect of the aquaponics This aspect stands for making a low and efficient nutrient input into the system and making a minimal environment footprint.

7.2 Differences between Hidroponics and Aquaponics

The Hidroponics is a system that uses a nutritive water to feed the plants. It is a inorganic system, where the addition of inorganic nutrients is needed and the main live component is the plant. On the other hand, the Aquaponics is a partly-organic system cite, where the fish is added to the system, and its waste, the ammonia, serves as a nutrient to the plants.

The great advantage of the Hidroponics over the Aquaponics is that the last may have some issues with human diseases, like the presence of snails with parasites in the fish tank or some water-borne disease.

7.3 Guidelines

A Do It Yourself (DIY) online magazine called Make, has an article that presents some rules to make a durable aquaponics.

8 Required Components

Arduino UNO

Some project authors recommends the Arduino MEGA because of its extra GPIO pins. But we only have the UNO version by now.

DC Motor

A simple DC Motor can be enough for this project. It could be used to feed the fish periodically.

There is a simple mechanism inspired by the video judoisonattack 2012, where the fish food is wrapped in a pot and rotated down just for a arbitrary short time, and then rotated back up. It can be controlled by sending electrical current timed by the Arduino.

Waterproof Temperature Sensor

This item is necessary for monitoring whether the fish's ambient is favorable for the fish.

Water Level Sensor

Water Pump
Needed to give potential energy to the water flow, being fundamental to the water's cycle.

pH and ORP probe
pH levelling is an essential feature of the system. The fish, the nitrobacterias and the plants needs to live in a specific pH-range ambient. With the probe, when the ambient is suffering with a pH decreasing, the system could automatically drop some amount of CaCO3 into the water to rise the pH from the fish tank, for example.

Relay Board
Some items, like the Water Pump, draws too much current if compared with Arduino's capacity. So one needs to use relays to connected another power source with the Arduino's output signals.

9 Proof of Concept

The initial idea is to make a emulated system as a proof of concept of the aquaponics system automatization. There are some softwares that can help the project to achieve its goals.

List of softwares:

Autodesk 123D Circuits `http://123d.circuits.io/`

Simulate and program Arduino and breadboard components. Test your Arduino code in our real-time simulation environment and see your designs come to life in the browser.

Node-RED `http://nodered.org/`

Node-RED is a tool for wiring together hardware devices, APIs and online services in new and interesting ways.

Fritzing `http://fritzing.org/home/`

Fritzing is an open-source hardware initiative that makes electronics accessible as a creative material for anyone. We offer a software tool, a community website and services in the spirit of Processing and Arduino, fostering a creative ecosystem that allows users to document their prototypes, share them with others, teach electronics in a classroom, and layout and manufacture professional pcbs.

9.1 Guidelines

A Do It Yourself (DIY) online magazine called Makezine, has an article Kretzinger 2015 that presents some rules to make a durable aquaponics.

Some common problems presented by this article:

- Some plant roots clogs the water outputs