Customers:
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# Table of Contents

# 1. Executive Summary

# 2. Project Description

Fish tank assistant, it is an algae detector, it is for people who own fish tanks that struggle with keeping it clean. It will detect algae using an optical system and notify the owner that they need to clean their fish tank.

## 2.1 Motivation

According to a 2019/2020 study (https://www.statista.com/statistics/198095/pets-in-the-united-states-by-type-in-2008/) fish are the 3rd most popular house pet with 11.5 million households in the U.S owning fresh water fish. It's not a surprise that Goldfish are the most common fresh water fish to own as a pet. It's tradition to win them at events and purchasing certain varieties can be of low cost. While acquiring a pet fish is fairly simple, keeping them alive doesn't seem to be. We've all heard a story about someone's fish dying at some point in our lives and one of those reasons could be due to Cyanobacteria blooms. While Cyanobacteria is commonly found in fresh water and marine water and under the right conditions, blooms can begin to form and inhibit the organisms in the habit. .

https://www.cdc.gov/habs/pdf/cyanobacteria_faq.pdf

Widely known as Blue-Green Algae, Cyanobacteria are single-celled microscopic organisms that thrive in warm, nutrient rich slow moving waters. In the case that the Cyanobacteria quickly grows, blooms will begin to form on the waters surface.. This could potentially create too much shade for the other inhabitants requiring sunlight for photosynthesis. Another problem is the production Cyanotoxins, which are a powerful natural poison, made up of 3 different toxins: neurotoxins, hepatotoxins and derma-toxins. Exposure to these toxins can cause an number of symptoms in both humans and animals and in some cases even death. While not all blooms are toxic, if a fish tank develops enough growth it can decrease the oxygen levels in the water and ultimately lead to illness or death.

Taking care of a pet can be tough especially when it is your first experience owning that species. Maintaining the proper environment is crucial when taking care of an aquarium. Finding out the best cleaning schedule and sticking to it can be difficult. Fish are seen as an easy pet but they do require a responsible owner to change/clean filters as well as changing a percent of the water regularly. Currently systems such as AlgaeTracker, provide measurements of green algae, blue-green algae, turbidity, temperature as well as sunlight, wind and rain, exist for large scale applications like waterways. The typical house hold method to test for blue-green algae in to use a test kit such as API Fresh Water Aquarium Master Test Kit. These kits consist of test tubes, test drops and a color card for manual testing.

In an effort to showcase our acquired knowledge and skills from our respective degree programs, we want to create an easy to use, affordable system that continuously

monitors home aquariums for signs of a dangerous environment. Cyanobacteria blooms aren't the only potential for harm, sudden shifts in temperature can severely impact their immune systems. **Fish Tank Assistant** will connect to the users smart phone and send alerts of harmful conditions in real time.

(https://www.thesprucepets.com/cyanobacteria-blue-green-algae-1378628)
(https://myfwc.com/research/wildlife/health/other-wildlife/cyanobacteria/)

The motivation behind this project is to fill the graduation requirements from the University of Central Florida as well as the opportunity to showcase the skills we've learned over the past 4-6 years. This is going to be the first time many students get the chance to work in groups over long periods.

## 2.2 Goals and Objectives

Provide a easy to use and cost efficient system. The goal is to design and build a fully functioning system that meets all project specifications.
Design a system that will dispense required chemicals after reading a test strip.

We want the system to be able to:

Read a dip and read test strip
Which test strip specifically?
Through what means?
Optics-lasers, sensors, lenses
How are we doing to have it read more than 1 color?

Dispense Chemicals according to reading
Flow sensor
Compact system.
Some questions to keep in mind:

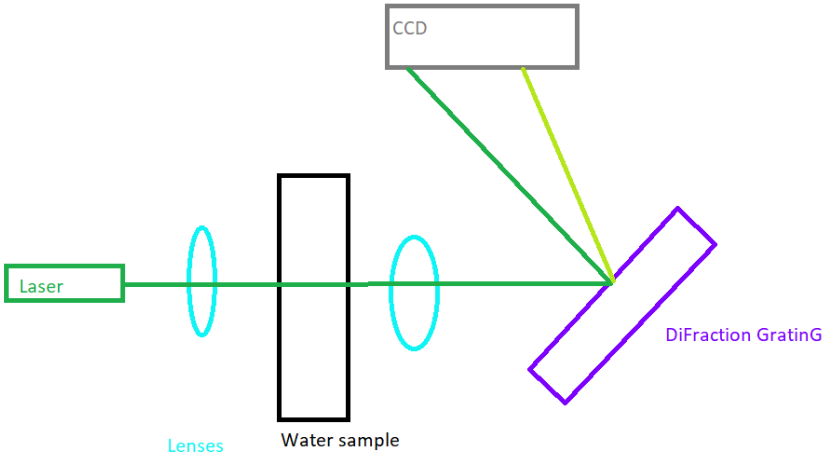
1. Do we want a system that pumps out the chemicals or a system that tells us the corrections?
2. If we are going to go the route of dip and read sticks could we use two sensors to read all 4 in order?

## 2.3 Functions

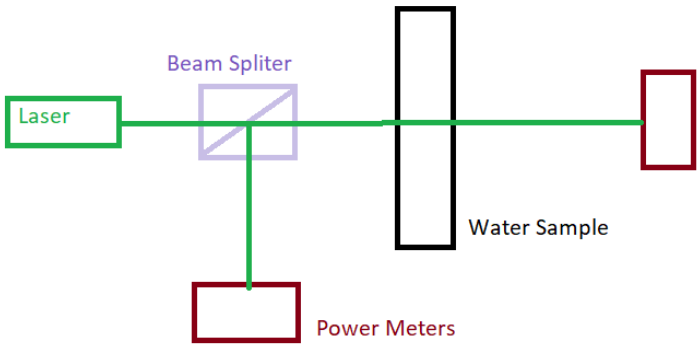
There are two methods of detecting algae in water. The first is to use a spectrometer the second is to utilize Beer's law.

A spectrometer works by a laser diode power from a source, in this case from a wall outlet, this laser light then passes through a focusing lens and then to our water sample. The output light from the sample then goes to another lens then to a diffraction grating. The grating separates out the beam into its different wavelength so that a waiting CCD camera

or a photodiode. After the CCD it will be passed to a micro controller to be put though some code to give the wavelength. See below.




Method 2, using the properties of Beer's Law. Again, we will start with a wall power supply that will then be passed to the laser diode. This beam of light will go to a beam splitter, with 1 beam going to a power meter, and the other beam going through the sample water. After the sample the beam will go to another power meter. The equation for transmitters is. Where P stands for power and I for intensity. So, we can either measure the power or intensity to get transmitters. Knowing the transmittance means we know the amount of light that gets through or how much algae is absorbing the light. See below.




For both of these cases we will need to select a Laser Diode at a specific wavelength of light. Looking at the emission spectrum for algae, most of them have the deepest valley at 540nm. So, that is probably the wavelength we want.

The system at its most basic level will be checking for to see how much algae is in a water sample.

## 2.3.1 Factors

The system at its most basic level will be checking to see how much algae is in a water sample. The more quantifiable components of the device are:

### Basic Features

- Small footprint, as big or smaller than 12X12 inches. So that it can fit on top of a fish tank or will not take up too much space next to the tank.
- Plugs in to the wall outlet. Almost everything on a fish tank plugs in so it makes the most sense to plug this in.

### Advanced Features

- Light weight, under 10 lbs.

### Stretch Features

- Durable, meaning it will not get damaged being around all the humidity of the fish tank.
- Will check the pH, meaning it will notify the owner when the tank is no longer at a safe pH level, 6.8-8, depending on the fish.
- Will check water temperature, 65-85 degrees Fahrenheit.

## 2.4 List of Requirements

Note: Client has not come to a consensus on their requirements yet.

1. Building an app for notification system
2. Build a sensor that would detect the algae using an optical system.
3. Lightweight and portable
4. User Friendly
5. Low cost  Provide a easy to use and cost efficient system.
6. Must be accurate

    - Long shot goal: build the system to be automated from the app rather than just notifying the user and they would have to clean it manually.

### 2.4.1 Physical Requirements and Operating Conditions

### 2.4.2 Electrical

### 2.4.3 Spectrometer

### 2.4.4 Software Requirements

## 2.5 House of Quality

Note: will be edited as we progress in the project

https://docs.google.com/spreadsheets/d/1abTKj57831dh0SMPcywg60KJaKgC8SDsIwgSINo33jc/edit?usp=sharing

## 2.6 Product Operation

# 3. Research and Background Information

## 3.1 Similar Products

### 3.1.1 Product 1

https://in-situ.com/us/hab-monitoring

HAB Monitoring or Harmful algal bloom monitoring

### 3.1.2 Product 2

https://www.ysi.com/exo?utm_source=HAB-Monitoring-Solution&utm_medium=Web&utm_campaign=Enablement

## 3.2 Hardware Research

### 3.2.1. Power Supply

*3.2.1.1 Product 1*

*3.2.1.2 Product 2*

*3.2.1.3 Product 3*

*3.2.1.4 Product 4*

*3.2.1.5 Product 5*

### 3.2.2 Charging Methods

### 3.2.3 Voltage Booster

### 3.2.4 Sensors

*3.2.4.1 Product 1*

*3.2.4.2 Product 2*

*3.2.4.3 Product 3*

*3.2.4.4 Product 4*

*3.2.4.5 Product 5*

*3.2.4.6 Product 6*

### 3.2.5 Development Kit

*3.2.5.1 Product 1*

*3.2.5.2 Product 2*

*3.2.5.3 Product 3*

### 3.2.6 Communication Mediums

#### *3.2.6.1 Product 1*

#### *3.2.6.2 Product 2*

#### *3.2.6.3 Product 3*

### 3.2.7 SD Card

### 3.2.8 Display

#### *3.2.8.1 Product 1*

#### *3.2.8.2 Product 2*

#### *3.2.8.3 Product 3*

#### *3.2.8.4 Product 4*

#### *3.2.8.5 Product 5*

## 3.3 Optical Research

### 3.3.1 Spectroscopy

#### *3.3.1.1 Product 1*

#### *3.3.1.2 Product 2*

#### *3.3.1.3 Product 3*

#### *3.3.1.4 Product 4*

### 3.3.2 Spectrometer

### 3.3.3 Light Source

#### *3.3.3.1 Product 1*

#### *3.3.3.2 Product 2*

### 3.3.4 Lens and Mirrors

#### *3.3.4.1 Product 1*

#### *3.3.4.2 Product 2*

#### *3.3.4.3 Product 3*

#### *3.3.4.4 Product 4*

### 3.3.5 Grating

#### *3.3.5.1 Product 1*

#### *3.3.5.2 Product 2*

#### *3.3.5.3 Product 3*

## 3.4 Sample

### 3.4.1 Sample 1

### 3.4.2 Sample 2

### 3.4.3 Sample 3

### 3.4.4 Sample 4

## 3.5 Software

#### 3.5.1 Software 1

##### *3.5.1.1 Language 1*

##### *3.5.1.2 Language 2*

#### 3.5.2 Software 1

##### *3.5.2.1 Language*

##### *3.5.2.2 Information*

#### 3.5.3 Additional Features

##### *3.5.3.1 Feature 1*

##### *3.5.3.1 Feature 2*

### 3.5 Housing

#### 3.6.1 Housing 1

#### 3.6.2 Housing 2

#### 3.6.3 Housing 3

##### *3.6.3.1 Material*

## 4. Constraints and Standards

### 4.1 Constraints

### 4.1.1 Economic

### 4.1.2 Environmental

### 4.1.3 Social

#### *4.1.3.1 Challenges*

### 4.1.4 Political and Ethical

### 4.1.5 Health and Safety

#### 4.1.5.1

#### 4.1.5.2

#### 4.1.5.3

#### 4.1.5.4

### 4.1.6

### 4.1.7

#### 4.1.7.1

### 4.1.8

### 4.1.9

## 4.2 Standards

# 5. Product Design

## 5.1 Hardware Design

### 5.1.1 Power Supply

*5.1.1.1*

5.1.2

5.1.3

## 5.2 Spectrometer Design

#### 5.2.1

#### 5.2.2

#### 5.2.3

### 5.3 Software Design

#### 5.3.1

##### *5.3.1.1*

##### *5.3.1.2*

##### *5.3.1.3*

#### 5.3.2 User Interface

##### *5.3.2.1*

##### *5.3.2.2*

##### *5.3.2.3*

#### 5.3.3 Data

#### 5.3.4 Optional Additional Features

## 6. Prototype Construction and Testing

### 6.1 Project Housing

#### 6.1.1 Project Enclosure

#### 6.1.2 Holder

### 6.2 Printed Circuit Board (PCB)

#### 6.2.1 PCB Design

#### 6.2.2 PCB Fabrication

##### *6.2.2.1*

##### *6.2.2.2*

#### 6.2.3 PCB Population

### 6.3 Hardware testing

#### 6.3.1 Power Supply Testing

##### *6.3.1.1 Power Supply Modification*

#### 6.3.2 Development Board Testing

#### 6.3.3 Sensor Testing

##### *6.3.3.1*

### 6.4 Optical Testing

#### 6.4.1 Testing 1

#### 6.4.2 Testing 2

#### 6.4.3 Testing 3

#### 6.4.4 Testing 4

#### 6.4.5 Testing 5

### 6.5 Sample Testing

#### 6.5.1

#### 6.5.2

#### 6.5.3

#### 6.5.4

### 6.6 Spectrometer Testing

#### 6.6.1

#### 6.6.2

### 6.7 Software Testing

6.7.1

6.7.2

6.7.3

6.7.4

6.7.5

### 6.8 PCB Testing

# 7. Administrative Content

## 7.1 Personnel

### 7.1.1 Team Members

### 7.1.2 Individual Responsibilities

## 7.2 Project Milestones

### 7.2.1 Project Management

#### *7.2.1.1 Scrum*

### 7.2.2 Project Construction

## 7.3 Budget and Financing

### 7.3.1 Suppliers

*7.3.1.1*

*7.3.1.2*

*7.3.1.3*

*7.3.1.4*

*7.3.1.5*

*7.3.1.6*

# 8. Appendices

## 8.1 Index of Figures

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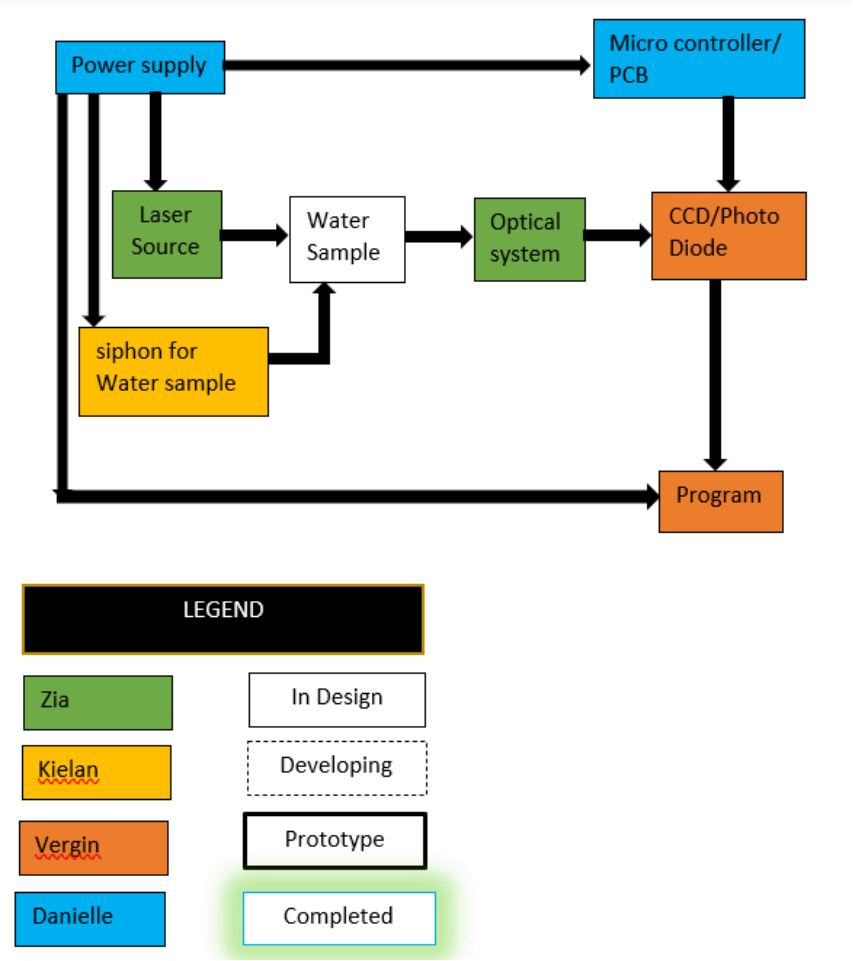
## 8.3 References

## 8.4 Copyright Permissions

8.5 Data Sheets

# Block Diagrams




## Estimated Project Budget

Estimated project budget and financing (All)

| Item | Price Estimate |
|---|---|
| Microcontroller- (Adruino, Miuzei, etc) | $1-$30 |
| Laser Diode (blue wavelength of light) | $90-$100 |
| Diffraction grating | $72-$80 |
| Lenses (1-2) | $30-$60 |
| Mirrors | $120 |
| Linear array CCD or Photo diode | $4-$14 (for diode), $10-$54 (for CCD) |

| | |
|---|---|
| PCB | $100 |
| Total (estimated range) | $392-$489 (this is just at our current state of knowing what we will need, there will dependently be more things that we will need, and the total cost will increase. |

## Milestones

(Danielle)

Initial Senior Design I Milestones

| Milestone | Target Week | Description |
|---|---|---|
| 1 | 2/4/2022 | Divide and Conquer |
| 2 | 2/18/2022 | Update Divide and Conquer |
| 3 | 2/25/2022* | Research Design and Specs |
| 4 | 3/4/2022* | Begin Report |
| 5 | 3/11/2022* | 30 Page Draft |
| 6 | 3/25/2022 | 60 Page Draft |
| 7 | 4/8/2022 | 100 Page Draft |
| 8 | 4/15/2022* | Finish Ordering and Testing Parts |
| 9 | 4/26/2022 | Final Document |

Initial Senior Design II Milestones

| Milestone | Target Week | Description |
|---|---|---|
| 10 | 5/13/2022* | Finish Power Supply Design |
| 11 | 5/27/2022* | Build Spectrometer |
| 12 | 6/10/2022* | PCB |
| 13 | 6/24/2022* | CCD |
| 14 | 7/11/2022* | Build Prototype |

| | | |
|---|---|---|
| 15 | 7/8/2022* | Begin Testing and Redesign |
| 16 | 7/22/2022* | Final Prototype |
| 17 | TBD | Peer Presentation |
| 18 | TBD | Final Report |
| 19 | TBD | Final Presentation |

## Decision Matrix

If appropriate, include a decision matrix which lists the projects under consideration versus any parameters that will help you pick the project. These might include, but are not limited to cost, sponsorship, familiarity with the technology, educational goals, and motivation

Educations goals:

1. To learn about the laser diodes
2. To have an optic concept in the project
3. To learn how to work as a team

Motivation:

1. This can help people who have homes with pools
2. This will make cleaning the pool much easier

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