Controlling Algae Caused By Eutrophication

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Abstract

Algae blooms on the surface of large water bodies are harming marine life and contaminating water supplies; we want to develop a device to reduce the economic and health impacts imposed due to the process of eutrophication.

I: Proposal

In this section, we will discuss the extent of the problems due to algae blooms and assess the market attempting to control it.

1.1 Problem Statement

As the population increases exponentially, there is growing pressure on agricultural industries to increase production yields and hence more fertilisers are used [1]. These fertilisers run off into large water bodies and it allows algae to reproduce rapidly. As Algae carry out photosynthesis, sunlight is blocked from reaching plants in the water bodies hence dramatically decreasing dissolved oxygen levels in water until eventually resulting in mass marine life death [2]. As global water temperatures are rising, this is creating an even better conditions for Algae to thrive [3].

1.2 Business Case for a Solution

Annually, algae blooms in Freshwaters are estimated to cost the USA at least **$1.76 billion** in economic losses in the tourism sector, fishing industry and due to cost of acute health effects [4]. In Australia, the Murray Darling basin had a **1700km** surface of algae which lead to the death of up to a million fish in two weeks the effects where so devastating the basin authority now produce weekly reports to monitor the situation[6]. The EU commissioned the joint research centre in 2016 to assess the economic impacts of algae blooms which concluded that for recorded algae bloom events between 1980-2015 there were **13 EU countries** in the top 20 countries with the most algae blooms while France are first [7]; however, specific data is currently very limited due to the cost of monitoring this; Australia alone are spending **$8.7 million** annually monitoring just one family of algae[8].

The statistics are clear, eutrophication has a staggering economic impact and toxin producing algae are contaminating water supplies[9].

1.3 Market & Competition Analysis

Commercially, there are vacuums available on the market used to clean the bottom of ponds and swimming pools, but these are:

- ⇒ Limited by storage requirements and vacuum too much water, impractical for large volumes.
- ⇒ Do not have any energy storage and difficult to use in isolated areas.
- ⇒ Do not have an efficient disposal system (Machine automatically stops until manually the 25-30L storage is emptied)

A small company named Weeders digest have utilised a **220V Oscillating fan** [10] which can be placed underwater to suck algae towards it which can then be manually collected. Although useful, this product costs in-between 1200-4350$, does not have an effective disposal system, needs to be mounted and remain stationary while in operation , prone to killing marine life and cannot be used in isolated area as it needs to be directly connected to a power supply and consumes a lot of power. This product is aimed to use for small ponds and docks and not for industrial purposes.

Sustainable Soil and Water LTD are **using Ultrasonic Algae control** [11] has been used which as well utilises transducers to emit ultrasound between 20 -99kHz that rapidly expands a certain species of Algae until it collapses and falls to the bottom of a pond. This product creates a lot of bio waste and its effect on wild life are questionable. It remains to be an untested product and costs between 750-1950 pounds. Judging by their financial statements listed on The Company House, their product is not successful [12].

Otherwise, **hydrogen peroxide** is often used to clean aquariums; however, this costs $976.00 /ton at 35% concentration [13] and cannot be used for large scale operations. In addition to this increase concentration of these chemical can be dangerous to fish.

Biological solutions such as introducing Algae eating fish and viruses into a new ecosystem are highly controversial and research has been completed on this to suggest that it poses too high of a risk and disadvantages to be used. [14]

Estimating the current market size for industrial algae removal devices is challenging since as it stands there are no commercially successful products of its kind. However, the chemical algae products market is worth over **$3.78 billion** and is predicted to grow at a **CAGR of 5.4%** [15] which suggest a large potential demand for algae removal devices.

II: Project Management

This section will discuss the project management.

2.1 Objectives regarding Proposal

The **Primary objective** is to develop a device which can remove the surface layer of algae on large water bodies to enable sunlight to reach plants and seaweed; enabling them to carry out photosynthesis and hence maintaining a higher level of oxygen in water bodies infested with algae blooms. This will maintain a healthier ecological system and reduce the contamination of our water sources with harmful toxins. The device must also:

⇒ Be able to operate for different species of Algae.

⇒ Be able to operate in remote locations with no direct access to electricity.

⇒ Efficiently dispose of Algae collected from the device for possible use in bio fuels or animal feed.

⇒ Pose no harm or significant disturbance to marine or aquatic life.

⇒ Float on water and endure harsh wet conditions.

2.2 Resources and Expertise

Designing, testing and producing a prototype device will require a lot of specialised resources and information:

⇒ **Imperial College Advanced Hackspace:** [16] This space will allow us to rapidly prototype our design during our development stage. This includes 3D printers, CNC cutters and other equipment which is readily accessible.

⇒ **Murray darling basin authority and EE Joint Research centre:** [8][6] They have collected years' worth of data and research on algae blooms and could be a useful source to consult for our project.

⇒ **Imperial College Robotics Society:** [17] The society offers a large area to carry out any practical work as well as 3D printers Laser printers, soldering stations and access to CAD software.

⇒ **Ruislip Lido Beach:** This site contains a water body with algae, and we can request permission to test the product here.

2.3 Technical Mapping to Modules

The development process will require technical skills from a broad range of modules we have covered so far.

⇒ **Power distribution** from a central energy storage. This may require DC-DC boost convertors and other switching devices.
- Analogue Electronics
- Semiconductor devices
- Analysis of Circuits
- Power Electronics

⇒ **Energy storage** for use in isolated areas
- Mathematics
- Energy conversion
- Power Electronics

⇒ Integrating a **Propulsion system** to the device
- Propulsion and Turbomachinery
- Analysis of circuits

⇒ **Wireless control** and communication with the device using a remote control
- Signals and communication
- Software engineering

⇒ System to **remove algae from water surface** which can include sensors and Algorithms to insure it is near the water surface
- Control Engineering
- Algorithms and Data Structures
- Analysis of circuits

2.4 Project Planning & Management

We will divide this project into the following stages:

1. Research then design and test circuit schematics for each system using CAD.
2. Evaluate all designs as a group ensuring systems are integrable and order components needed.
3. Design and order PCBs. Solder components and test.
4. Integrate systems
5. Produce casing for the product ensure it is durable and water proof.
6. Assemble product and undergo further testing in different conditions.

2.4 Timeline and Upcoming Tasks

A timeline of our expected progress throughout the coming months is detailed below.

Start	End	Task	Members
1/10/19	9/10/19	Group Formation	Listed in header
9/10/19	20/10/19	Work on the proposal of the three problems	Split into 3 teams.
20/10/19	31/10/19	Work on feasibility study	Everyone
31/10/19	7/11/19	Response to Feasibility study	Split into Everyone into team
7/11/19	11/11/19	Work on Product Design Specification	Input from Everyone
11/11/19	27/12/19	R&D on Power distribution	Issa,Umut and Pavan
		R&D on Energy storage	Xia and Alp
		R&D on wireless control	Arman and Lukas
		R&D on Removal system	Issa, Xia and Lukas
		R&D on Propulsion system	Lukas, Xia and Umut
27/12/19	2/12/19	Meeting with Team to evaluate designs	Everyone
28/12/19	3/12/19	Refine Designs according to meeting	Everyone
3/12/19	13/2/20	Testing all desings from the R& stage	Everyone
13/2/20	11/3/20	Prep for Poster presentation and Demo	Everyone
6/3/20	19/3/20	Work on Video and Final Report	Everyone

III: Referencing and Citations

This section includes the documentation referenced and cited in the above texts.

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[13] Wholesale prices of hydrogen peroxide [Online]. Available: https://www.kemcore.com/hydrogen-peroxide-35.html [Accessed 18 October 2019].

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