

July 20, 2020
Dr. Andrew Rawicz & Dr. Scratchley
School of Engineering Science
Simon Fraser University
Burnaby BC, V5A 1S6

RE: ENSC 405W/ENSC 440 Design Specification for Flud

Dear Dr. Rawicz & Dr. Scratchley,

Please find our ENSC 405W/ENSC 440 project proposal for Varia Technologies' Flud. This document will outline the necessary project measurements to deliver a successful product. Our goal for capstone is to use AI to detect lawn pests and to use sustainable and environment-friendly solutions in deterring the detected pests through water and light. Flud will use a camera as real-time lawn surveillance and a microcontroller to act upon unwanted pests.

This document's specifications will provide detailed logistics for the course project which includes the risks and benefits, market competition and cost considerations. This document will also cover the project planning throughout the duration of the course and company details outlining the team's strengths.

Varia Technologies features six confident and hardworking senior engineering students: Clifford Fung, Josh Baltar, Justin Tsang, Desmond Trang, Eric Wang and Miguel Taningco. With a diverse background of technical skills and experiences, and a variety of engineering concentrations, our group has extensive knowledge in software and hardware systems that will guide us in realizing our goal to completion.

Our team would like to thank you for your time in reviewing our project proposal. Please do not hesitate in contacting us via our designated contact person, Joshua Baltar. For any questions or concerns, you can reach him at jbaltar@sfu.ca.

Sincerely,



Clifford Fung
CEO
Varia Technologies
Enclosed: Project Proposal for Flud



Proposal: Flud

Team	Josh Baltar Clifford Fung Miguel Taningco Desmond Trang Justin Tsang Eric Wang	CTO CCO CEO CSO CIO CFO CDO	jbaltar@sfu.ca cfa38@sfu.ca mtaningc@sfu.ca dtrang@sfu.ca jta98@sfu.ca zyw3@sfu.ca
Submitted To	Dr. Craig Scratchley Dr. Andrew Rawicz School of Engineering Science Simon Fraser University		ENSC 405W ENSC 440
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Executive Summary

Lawn and garden care is a very popular pastime activity for homeowners in Canada and the rest of the world. According to Statistics Canada [1], more than half of Canadian households (57%) grew fruits, herbs, vegetables or flowers in 2013. Many homeowners put a lot of time, money and effort into producing food, a presentable lawn for their guests, a play space for their children, or simply for decorative pleasure. Unfortunately, all of the time and dedication a homeowner puts into their lawns and gardens can be quickly and unexpectedly ruined from damages caused by lawn pests. Pests like raccoons, birds, and deers are ready to ransack a homeowner's gardens at a moment's notice by chomping lush plants as well as stealing fruits and vegetables at the peak of ripeness.

To protect their gardens, homeowners may look for solutions currently available on the market. However, many solutions like barbed wire, wire cages, odor based repellents, and ultrasonic devices are difficult to set up, visually obtrusive, or only temporarily effective. One of the more effective pest deterrent solutions is motion activated deterrents that spray water to scare away invading pests. The issue with currently available motion activated devices like the Scarecrow [2], a motion detector sprinkler system that shoots a burst of water when the motion sensor is triggered, is that this sprinkler system is only able to target one specific area, and will target anything in the line of sight. Over a period of time, invading pests can learn about the device coverage and spray pattern and figure out methods of circumventing it.

Our team of experienced engineers at Varia Technologies is confident that our latest device, the Flud, will be the smartest and most effective garden pest deterrent available on the market. The Flud is programmed to deter common pests with varied usage of directed light and water sprays to maximize effectiveness on a per animal basis. The device features 360 degrees coverage, high customizability, subtle design, easy installation, sustainable water usage and many additional smart features. For homeowners who want the best in garden and lawn pest protection, there will be no alternatives to the Flud.

The market for gardening equipment in 2019 is valued at \$5.73bn, with expected growth of 1.5% yearly until 2024 [3]. In addition, home ownership is also expected to increase in the coming years. Therefore, the number of participants in garden and lawn care are expected to increase along with demand for pest deterrent systems. The Flud and future Varia products will fulfill the ever growing demand of homeowners looking for the most effective, user friendly, and sustainable method of garden and lawn maintenance and pest protection. From there, our team at Varia Technologies is committed to ensuring a clean and well maintained future.



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1. Introduction

Flud is a smart lawn pest deterrent that is programmed to deter any pests using sustainable and environmentally friendly mediums; for example, water and light [4]. The primary features include an AI infused camera that will recognize pests, a motion sensor that will point the camera to the direction of the pest, and a microcontroller to perform the actions required. The product will also include a companion app that will allow the user to monitor product activity, view lawn surveillance and allow the user to customize which pests to deter.

Varia Technologies emphasizes providing an AI approach solution to solve a continuous problem homeowners face without having to harm the environment and wildlife. This system will provide users a cost-effective solution for removing unwanted pests from lingering around their lawn in comparison to the options in the market already. Flud will be a tool for all homeowners and will provide excellent out of the box functionality to enhance user experience.

1.1 Background

For a majority of homeowners, landscaping activities consume a lot of time and resources, with an average of two hours a day spent maintaining lawn work [5]. These efforts may be for various reasons; for example, providing a presentable lawn for their guests, a play space for their children, or simply for decorative pleasure. Nonetheless, there is a large potential of different pests exposed to their lawn; and within a few minutes, a pest could quickly cause unexpected damage to their hard work.

Currently, the market offers various solutions in deterring lawn pests. Some examples include water based-sprinkler systems and high-pitched sound deterrents [6]. These systems are effective at targeting specific pests; however, we noticed that these systems not effectively target a wider range of pests, and may be a nuisance to the user in some circumstances with the constant ultrasonic high-pitched frequencies or the water spraying everytime the user makes any motion.

Therefore, after conducting market research on the current deterrent systems, Varia Technologies has decided to design Flud. The initiative of Flud is to deter any unwanted pests from the lawn using an eco-friendly manner, with a large range of view, and an AI recognition system to deter multiple pests while eliminating as much user intervention as possible.



1.2 Scope

This document outlines the project proposal for Flud to adhere in accomplishing the overall goal of the product. It describes the risks/benefits, cost considerations, planning stages, and market research for our product. It will also include the company details and the expertises of each team member. Moreover, some of these details in the project proposal may withstand some changes as a result of unpredictable hardships/issues or due to system improvement. With the project's research, planning and considerations in this documentation, Varia Technologies will have a strong reference in facilitating a prosperous solution for all homeowners.

1.3 Intended Audience

This document serves as Flud's project proposal for Varia Technologies' members, its potential clients/partner, Dr. Craig Scratchley, Dr. Andrew Rawicz, and teaching assistants. Any future revisions will be accurately drawn from this preparatory framework.

2. Risks

The first risk of our product is that it is not well advertised. As a new company with its first product, consumers will not be aware that our company or our product exist and may question the integrity of our product. One of our first challenges after the product has been developed is to make our product known to the consumers in the marketplace because many products fail to make the market or generate any revenue even when they have reached the market [7].

Another risk is that we need to look to stay connected and constantly hear feedback from our consumers to satisfy any of their concerns because a large portion of product awareness comes from family and friend referrals [7]. We will need to become aware of any consumer worries, either from reviews of our product or through surveys, and be able to address them in a timely fashion.

Because Flud is our company's first product, there is already a cost associated with investing in the development of Flud so our company requires a high rate of return to cover the initial cost and to ensure that the company stays afloat and makes sufficient revenue. Our company may be in the red initially since we don't expect to sell too many units in the first couple months that the product is initially released, but will gradually increase as more customers become aware of our product and company [7].



One variable that we hope to solve by our production stage product is the integrity and consistency of Flud in various weather conditions, i.e. wind, rainfall, storm, etc. We plan to account for mild wind speed by factoring it into the movement and aim calculations through the use of sensors but at the moment, we cannot guarantee that the aim will be as precise as when there is no external weather interference; we will consistently stress test our precision as we further develop our product.

Different cities have different water regulations that may control whether or not you are allowed to water your lawn. According to Vancouver, B.C, you are allowed to “watering trees, shrubs, and flowers excluding edible plants” up to stage 3 if you are using a hand-held hose with automatic shutoff device [8]. Some trees and shrubs require 2-3 gallons of water once per week to keep a 6-8 foot plant alive so we can assume that up to stage 3, we can use the same amount of water for our pest deterrent system as well [9]. Although we cannot say for certain, Flud should be safe to use even with water regulations in place because it uses less than 2 cups of water per usage, so it can activate up to 24 usages in a week.

3. Benefits

One of our potential benefits is addressed in the following section *Market*; Flud exceeds in functionality compared to other pest deterrents in the market by using a combination of a powerful water jet as well as artificial intelligence to correctly distinguish whether an object is a pest, making the product less intrusive by not spraying everything that moves and saving water at the same time. By being a better product in the niche market, we believe that we will be able to obtain a sizable market share that will be very profitable; more market analysis will be provided in Section 4 below.

Another benefit that comes with Flud will be the brand recognition and value; we look to stay as an innovative company that drives innovation and success in the marketplace, whether that is in lawn maintenance or in other marketplaces. By having our consumers know that we are an innovative company, customers will value our company many times more compared to if our company does not continually innovate new products [7]. By staying innovative, it will drive our profits and market share upwards while reducing the chance that our company will be bankrupt or bought out [10].

4. Market and Competition

Currently, there is a market specifically for deterring pests that ruin gardens and lawns. To have an estimate of the size and projection of the market, the lawn and garden equipment



manufacturing industry is analyzed. The current profit this industry brings in the US is \$446.7 million per year, in which supplementary products for lawn maintenance takes into account 28.6% of the industry, resulting in \$127.76 million per year. External factors such as homeownership rate and per capita disposable income are both expected to rise 1.3% over the next 5 years [3].

Generally two categories of solutions are offered to the public. One category of a solution is through prevention tactics like using household odour repellents, using pets, removing attractive features to pests or installing fences [11]. The other category is to use commercially available solutions specifically targeting pests like motion-activated water sprinklers, ultrasonic deterrents. These are used especially when the more passive solutions no longer work or the personal choices conflict with the options like not wanting to invest in a guard pet or choosing aesthetics over the overall benefit of removing features.

Ultrasonic deterrents provide a solution that uses sonic frequencies that go in the upper range of humans to the ultrasonic range. This type of deterrent is often marketed to be a solution that is lightweight, effective, easy to install, and not noticeable to humans. Evidence shows that it is neither unnoticeable by humans nor effective. One widely known ultrasonic deterrents like the Aspectek Yard Sentinel STROBE is known to have a sound frequency ranging from 15 kHz to 18 kHz [12]. The common stated range of human hearing is said to be 20 Hz to 20kHz [13] which makes it noticeable to the common human. Not only this, but there is no evidence to support that ultrasonic repellents drastically change animal movement nor do the effects last for long [14].

The motion detector sprinkler deterrent is also another commercial solution that uses motion activation and a sprinkler head to deter the pests. There is some evidence to suggest that motion activated sprinklers are both effective and ineffective. Due to the explosive start of a sprinkler, most animals will be scared off, however over time especially under predictable circumstances and a weak pressure, an animal can quickly get used to the sprinkler. Not only this, but some motion activated sprinklers activate due to wind or human movement [15].

Showing the issues of the solutions currently available to the public, there is a niche to be filled in the market for homeowners who want to preserve the aesthetics of their garden while using a cost effective solution that actively deters pests rather than only through prevention tactics. Fluid aims to address the problems currently unresolved by the motion activated sprinklers with the use of a powerful jet of water as well as artificial intelligence to determine the need to deter an object.

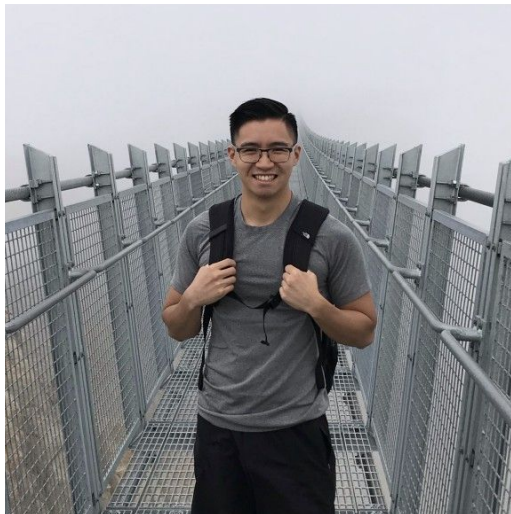
5. Meet the Team

Our company, *Varia Technologies*, is composed of several highly talented and skilled personnel that share the same goal - to conceptualize, design, and perfect *Flud*. *Varia Technologies* has chosen to incorporate a company logo that can be shown in Figure 5.1.



Figure 5.1 Company Logo of *Varia Technologies*

The team comprises of computer, electrical, and mechanical engineers which allow us to have expertise in different fields of product development. Each team member has one primary role, except that our CTO is also the CCO.



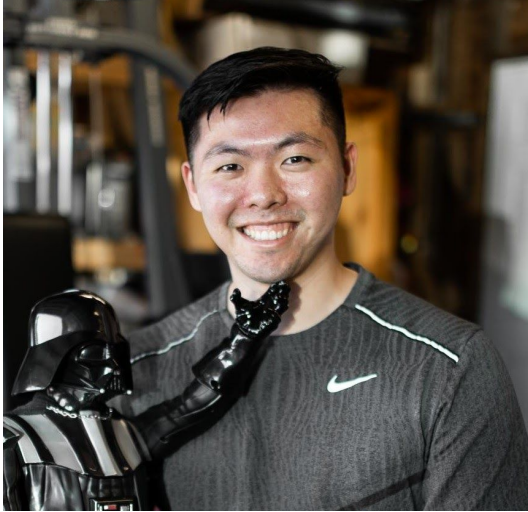
Clifford Fung is our *Chief Executive Officer* and his responsibilities include being the decision maker for major corporate decisions and overseeing the company operations and resources. Clifford is a *Computer Engineer* that has proficient skills in front-end and back-end development that he is able to use in his web development.



Joshua Baltar is our *Chief Technical Officer* and our *Chief Communications Officer*. Josh is in charge of overlooking our technical development to ensure that our programming is following the schedule and up to our coding standards. Also, he is our first point of contact to any third party source, whether that is another teacher or another company. Using his expertise as a *Computer Engineer*, Josh is in charge of developing our AI recognition software, an integral component of Flud.



Miguel Tanningco is our *Chief Strategy Officer*. Miguel is responsible for the various aspects relating to the growth of our company, such as development and execution of corporate strategic initiatives. Although Miguel is a *Computer Engineer*, his physics expertise allowed him to conceptualize and implement Flud's aiming and movement logic. Miguel also partakes in the development of Flud's web application.



Justin Tsang is our *Chief Financial Officer*; his main responsibility is to analyze and manage the company's financial situation and cash flow. With his skillset as an *Electronics Engineer*, Justin oversees all the electrical circuit designs and implementation for Flud. Justin ensures the circuit designs are robust and compliance are met.



Eric is the team's *Chief Design Officer*. As the company's *CDO*, Eric is responsible for managing all design implementations for the company's product through all stages of development. Eric is the team's sole *Mechanical Engineer* so his responsibility is the physical conception, material selection, and mechanical movement of Flud. Eric oversees the design to fulfill functional requirements and be optimal in size at the same time.



Desmond is our *Chief Information Officer*. Desmond's role as the *CIO* involves working together with Joshua, *CTO*, to support him by assisting in information technology and computer systems. As a *Computer Engineer*, Desmond is responsible for the backend of Flud's web application; specifically to ensure that the data being transmitted from Flud to our server is consistent and secure using WiFi.

6. Project Timeline

The production timeline of Flud is highlighted in this section where Section 6.1 Gantt charts provide a more detailed look into how we structured the Proof of Concept phase and Prototype phase. For a more general overview, we outline important milestones in Section 6.2 and finally any details on delays or uncontrolled events will be covered in Section 6.3.

6.1 Project Planning Gantt Charts

The developmental timeline for Flud is laid out by Figure 6.1.1 for its Proof of Concept phase and Figure 6.1.2 for its Prototype phase. Much of the timeline will be dependent on the planning and then the integration of all of the components. Veria Technologies has access to 3D printers for its casing, but expects to face delays due to COVID-19. Because of this, we have allocated 3 weeks for development of our major hardware, software and 3D printed components. The orange bars represent the time allocated for each of the tasks shown.



Figure 6.1.1 Gantt Chart of the ENSC 405W Proof of Concept

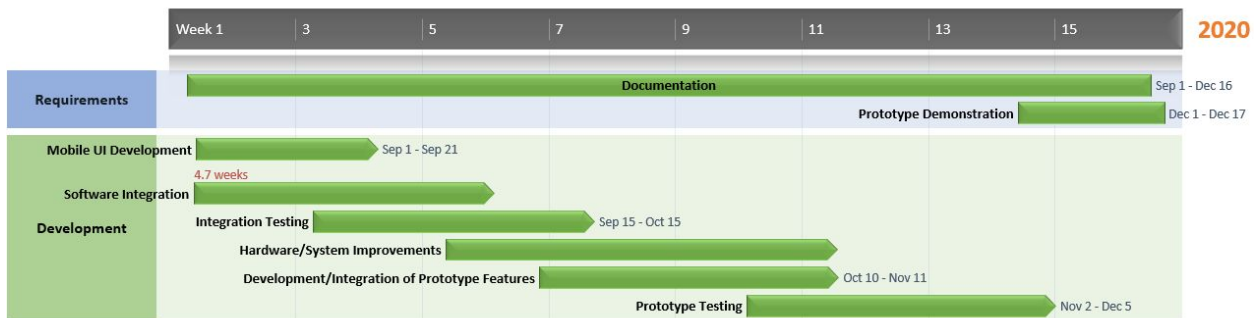


Figure 6.1.2 Gantt Chart of the ENSC 440 Prototype

6.2 Milestones

Important milestones for the Proof of Concept (ENSC 405W) and Prototype (ENSC 440) phases are shown below in Table 6.2.1 and Table 6.2.2. We will be keeping track of progress by using these rough estimates for our milestones and more detailed progress review in our gantt charts.

Table 6.2.1 Milestones for the Proof of Concept phase (ENSC 405W)

Mid May	End of May	Mid June	Mid July	Mid August
Project Main Idea Solidified.	Project budget draft finished.	Project 3D design finished.	Proof of concept parts printed and software component complete.	Finalize individual hardware and software components for
Project Requirements	Project design draft completed.	Project components		



Researched.		Purchased.	Beginning of testing and system integration.	the Proof of Concept. Present Flud as a Proof of Concept.
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Table 6.2.2 Milestones for the Prototype phase (ENSC 440)

Mid September	Mid October	Mid November	Mid December
System Integration of software and hardware components begin. System improvement design begins.	System integration of major parts complete. Begin features of prototype missing from PoC.	Begin testing and finalization of all major and minor features.	Present final prototype.

6.3 Delays and Uncontrolled Events

The outbreak of COVID-19 has affected our timeline greatly as 3D printing prototypes have not been as accessible as it was prior to March 2020, and it is also expected that there will be delays sourcing hardware components. As a result, we have split work on these components so that our members have been working hard individually and preventing delays due to restrictions in working in isolation.

7. Cost Considerations

Managing cost of development and manufacturing is critical for the projected success of *Flud* and *Varia Technologies*. *Varia Technologies* keeps track of all expenses of the proof of concept and prototype for *Flud*. We will contact a reliable and cost efficient PCB and injection mold manufacturer for *Flud*.

Cost during the development of *Flud* is expected to be high as there are many functional components that are used for the device. Some of the higher cost components include the microcontroller, Coral USB accelerator and motors. Table 7.1 details the complete electrical expenses of the proof of concept and prototype for *Flud*.



Table 7.1 Electrical Expenses for Proof of Concept and Prototype

Item	Quantity	Price (CAD)
Google Coral USB Accelerator	1	\$93.61
Raspberry Pi 3B+	1	\$48.95
Anker Battery	1	\$47.99
Smraza Camera Module	1	\$30.99
DRV8825 Driver Board	1	\$3.93
MT3608 Boost Converter Board	1	\$1.83
Jumper Wires Ribbon Cables Kit	120	\$9.88
HC-SR501 PIR Motion Detector	4	\$13.19
1kΩ Resistor	12	\$1.92
107Ω Resistor	1	\$0.15
1.96kΩ Resistor	1	\$0.15
100kΩ Resistor	3	\$0.45
100Ω	2	\$0.30
0.1uF 16V Cap	2	\$0.68
4.7uF 6.3V	1	\$0.37
0.22uF 16V	1	\$0.33
0.25Ω	1	\$0.15
10uF 16V	1	\$0.31
10uH	1	\$1.31



40.2k	1	\$0.15
TPS61165TDBVRQ1	1	\$3.37
BAT42-TR	1	\$0.58
SML-LX4014UWC-TR	2	\$1.60
NTD4808N-1G	1	\$1.24
VP3203N3-G	1	\$2.06
SLR-332MGT32	1	\$0.78
MMBT3904TT1G	1	\$1.58

The total expenses for the electrical section of the proof of concept and prototype is \$267.85. Table 7.2 details the complete mechanical expenses of the proof of concept and prototype for Flud.

Table 7.2 Mechanical Expenses for Proof of Concept and Prototype

Item	Quantity	Price (CAD)
Solenoid Valve	1	\$21.69
1/2 to 3/4 Brass adapter	2	\$32.98
Stepper Motor	1	\$15.88
Servo Motor	1	\$35.00
Water-Inlet Hose	2	\$42.28
Dixon 504-1212 Brass Swivel	1	\$19.00
Brass 90 Degree Elbow	1	\$11.59
Radial ball bearings	1	\$32.44
SJI-4BHNC Brass Nozzle	1	\$23.12

The total expenses for the electrical section of the proof of concept and prototype is \$233.98. The total expenses for the proof of concept and prototype is \$501.83. As mentioned before, the



cost is high during development, however we will see the expenses in production to be multiple times smaller. For example, a TPS61165TDBVRQ1 chip will cost \$0.73 with an order of 1000 units which is a 78% reduction in cost. We can expect all expense reductions in all components if ordered in high quantity.

Another method to reduce expenses is to design our own modules instead of using 3rd party PCBs. With this method we can utilize the component cost reduction realization from above. Additionally, we can design our own PCB assemblies and do not pay extra for a pre-made board from another company. Also we could search and use SOC that are better performing for our use, thus reducing the need to use 2 processors. In addition, we have more control in selecting components that we will use, for example, Flud does not require an audio processing or use of usb connectors, thus reducing cost of the system.

7.1 Retail Price

The price the customers will pay for Flud will depend on multiple factors, production costs, competition. The production cost will depend on quantity and the manufacturer selected. If the demand for Flud is high, we will manufacture more devices thus reducing cost per device.

Finally, competition can influence the price of the retail price of Flud. Varia Technologies want to set the price of our product to be more competitive while covering costs spent on production. A competitor, Contech ScareCrow Animal Deterrent, prices their water deterrent system at \$72 per unit, however the system provides less features compared to our product.

With all factors considered, we will set the price at \$200-\$300. Although the price is higher than competitors, the features we include in Flud far exceeds our competitors. We aim to have a profit margin of 25%-35%, thus the reason we provided a price range.

7.2 Source of Funding

SFU provides 3 sources of funding, Engineering Science Student Endowment Fund, Wighton Engineering Development Fund, and IEEE Student Project Funding. Varia Technologies will apply to all 3 sources.

8. Conclusion

Flud is the future of pest deterrents that utilizes an AI-based solution and is marketed for all homeowners with lawns. Flud is meant to be an efficient all-in-one solution for deterring lawn



pests while eliminating the majority of user intervention. Our device will provide an intuitive and user friendly experience while using unharmed methods in deterring unwanted pests.

Varia Technologies strongly believes that AI is a powerful tool that will eliminate and automate tedious tasks; thus, enabling consumers to maximize their productivity. To ensure product success, Varia Technologies has analyzed the market competition and extracted the advantages of each device to better our product. With this consideration, we have also minimized the risks while maximizing improvements in the benefits. With extensive research in cost considerations, we have analyzed a realistic budget for each of the major components; therefore, eliminating some of the financial barriers.

The company's ambitions and objectives are to solve real world problems with permanent solutions. With our organized project plan, our dedicated team of engineers will strive to deliver an impressive product that contains prominent requirements and specifications held at a high standard.

9. References

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