

March 18, 2019

Dr. Andrew Rawicz  
School of Engineering Science  
Simon Fraser University  
Burnaby, BC, V5A 1S8



**DoggyGo Inc.**

Re: ENSC 405W/440 Project Proposal for an Automatic Animal Ball Launcher

Dear Dr. Rawicz,

The document attached with this letter is the project proposal for the Automated Pet Entertainment Toy which my group and I have put together. The goal for this Capstone Project is to create a product that will entertain our pets when we are not able to accompany them by providing them with a game to play indoors and outdoors. The device will only require an empty indoor space in auto mode and allows flexibility for outdoor use with the remote control in manual mode.

The objective of the project proposal document is to provide a high-level overview of our product. This will include: an early-stage prototype design; projected risks and benefits associated with the product; a preliminary analysis of the market with a focus on where we see our product positioned; a list of tentative component and material costs required to produce our initial prototype; and lastly, a project schedule to illustrate the expected work-flow.

DoggyGo Inc. consists of 5 outstanding and creative senior engineering students: Hongbin Lin, Junchen (Steven) Wang, Curtis Cheung, Mancie (Maggie) Song and Danfeng (Sherlock) Sheng. Coming from 3 different engineering concentrations, our team has extensive hardware and software experience to aid us in realizing this proposition. Detailed profile biographies are provided at the end of this proposal

Thank you for taking the time to review our project proposal. If you have any inquiries regarding the document, please contact our Chief Communications Officer, Junchen (Steven) Wang, by phone (778-321-1907) or by email ([junchenw@sfu.ca](mailto:junchenw@sfu.ca)).

Sincerely,

Danfeng (Sherlock) Sheng  
Chief Executive Officer  
DoggyGo Inc.

Enclosed: Project Proposal for an Automatic Animal Ball Launcher



# DoggyGo Inc.

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## Project Proposal

Automatic Animal Ball Launcher

Solo Carnival for Pets

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**Project Members:** Hongbin Lin  
Junchen (Steven) Wang  
Curtis Cheung  
Manci (Maggie) Song  
Danfeng (Sherlock) Sheng

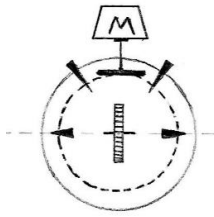
**Contact Person:** Junchen (Steven) Wang  
junchenw@sfu.ca  
778-321-1907

**Submitted to:** William Craig Scratchley (ENSC 405W)  
Dr. Andrew Rawicz (ENSC 440)  
School of Engineering Science  
Simon Fraser University

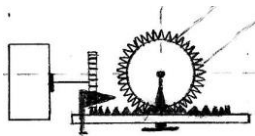
**Issue Date:** March 18, 2019

@DoggyGo Inc. 2019

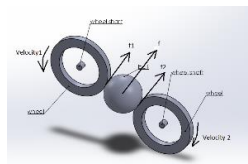
# Executive Summary



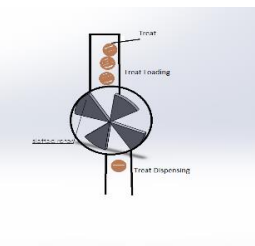
(a) Main Gear



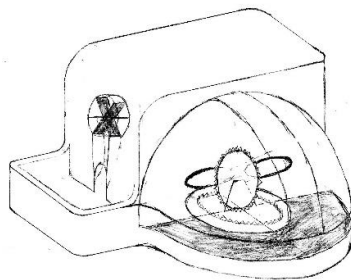
(b) Build-on Gear



(c) Launcher



(d) Dispenser



(e) Prototype

Figure 1: Prototype Stage

Entertaining dogs shall be a simple and interesting procedure, so the product shall be easily operated.

Our prototype, DoggyGo, aims to automate the procedure in order to help pets cutting the boring time when they are staying home lonely. And it shall satisfy the requirement below:

The prototype shall be enclosed to avoid unexpected access of inside of the product.

The prototype shall have smooth edges and corners, to not hurt pets.

The prototype shall clearly detect the launching area to avoid breaking anything.

In Figure 1, it illustrates the different components associated with our prototype:

The main gear (Figure 1a) will be driven by a motor to adjust the horizontal angle of launching, the adjusting range is from  $-60^{\circ}$ ~ $60^{\circ}$ . And the build-on gear (Figure 1b) will rotate with the main gear and adjust the vertical launching angle base on the horizontal angle, which range is  $30^{\circ}$ ~ $60^{\circ}$  (both angle adjustments have unit step angle  $15^{\circ}$ ).

The launcher (Figure 1c) will be driven by two high speed wheels to accelerate the ball and launch it. The launching distance can be select between 1m to 9m. The treat dispenser (Figure 1d) is a rotating box, which is a circle divided by 6 small boxes, the tube at bottom to release the treat in the bottom box.

The final prototype (Figure 1e) will be put into an enclosed shell with smooth edges and corners.

DoggyGo Inc. is made up of 5 highly motivated Engineering students that have extensive hardware, software, and hands-on experience. We plan to continuously work on the prototype for next 5 months. With all the planning and designs out of the way, nothing can stop us from this innovation.



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## Glossary

<b>ABS</b>	Acrylonitrile butadiene styrene, or ABS, is a common type of plastic used for 3D-printing. Lego is an example of ABS plastic.
<b>Arduino</b>	An open-source hardware and software company which allows users to develop digital devices that are able to accept sensor inputs and outputs.
<b>Servo Motor</b>	A motor that can perform precise control of motor rotation through the use of position feedback circuit.
<b>Time Stepper</b>	A time counter which is used to record the idle pulse and sending the command when the function is called
<b>Ultrasonic Sensor</b>	A sensor that uses an ultrasonic transmitter and detector to detect the distance of an object based on the time between transmission and reception of the transmitted ultrasonic signal.

# 1 Introduction

In the past few years, the popularity of pet keeping have been cultivated as a universal trend. It is true that an abundant of researchers has indicated that people who keep pets will be healthier in both physical and mental activities compared to those who do not live with pets. Pet keeping is a very effective way to allow people who are under stress to relax. Therefore, in the recent years, there are more and more households willing to raise pets.

However, with full-time day shifts for most people, keeping the pets entertained will be very difficult. To make pets can entertain themselves and to provide another way of fun when owners staying with their pets, we introduce DoggyGo, a market version of the prototype described in this proposal. DoggyGo will automates the procedure of pets' entertainment at a safe and easy-operated level.

DoggyGo aims to make friends with dogs and their owners while they are out of work. DoggyGo combines several similar products that are found on the market into a single system. DoggyGo can fire a tennis ball from the launcher and provide treats to dogs. This system has the ability to be controlled in both automatic mode and manual mode. The most attractive feature of DoggyGo will be its great sustainability and high safety standards. To accomplish this goal, DoggyGo will have a complete detection system constructed with sensors to inspect the surrounding launching zone. If there are objects that are obstructing the launcher path, DoggyGo will stop its launch sequence. Users also can control the launcher and treat system manually as opposed to automated launch and dispense operation sequences. This will allow the user to adjust the angle, strength and direction of the launched ball.

The purpose of this proposal is to provide a high-level overview of our product and prototype, as seen in Section 2. In Section 3, the risk and benefits associated with our product are outlined. Additionally, a comprehensive analysis of the market and possible competition is provided. In Section 4, we list the costs for each component in the prototype to provide a rough estimate of the required funding. Lastly, Section 5 provides a schedule at which each stage of the project will be completed.

## 2 Scope

The scope of the Capstone project will provide an overall overview of DoggyGo. The goal for DoggyGo is to create a product that is able to entertain dogs while their owners are not at home. To achieve this task, DoggyGo's prototype will combine the following key features that are usually found on ball launchers that are found on the market today:

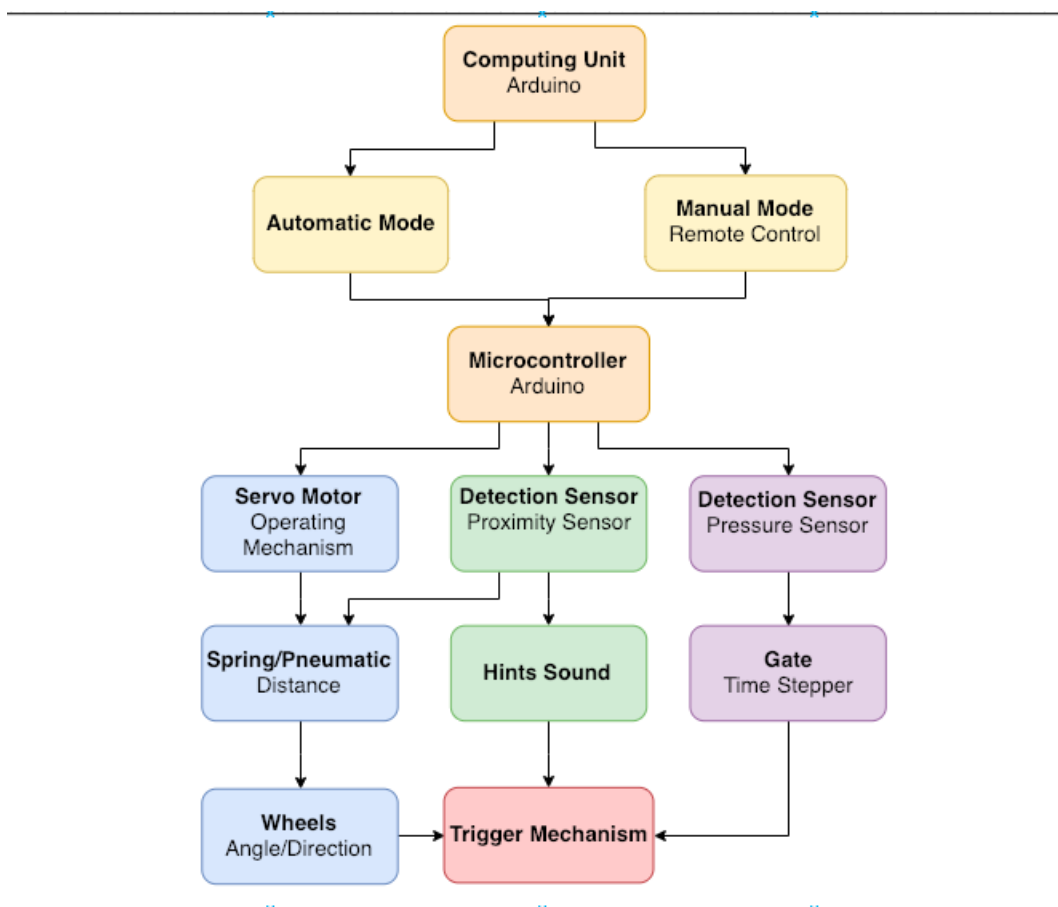
1. Launch tennis balls safely and efficiently for the dog to easily fetch.
2. Dispense treats when launched ball is returned.

3. Ability to control the ball launcher manually (distance, launch angle, treat dispensing) using a wireless remote in manual mode.

DoggyGo will achieve the following features efficiently and effectively through the following mechanisms:

1. Small physical footprint to allow easy transportation for the end user
2. A gear system to control the vertical and horizontal launch angle
3. A launcher system consisting of two high speed wheels to launch the ball
4. Ultrasonic sensors to ensure that the launch path is free of obstacles and animals
5. Tamper-resistant covers where the treats are contained

The prototype for DoggyGo will be 500\*350\*275 mm (W\*D\*H). In order to minimize our material costs, a proof of concept containing the key functionalities of ball launching and treat dispensing will be produced to allow us to verify the feasibility of the project before proceeding onto a prototype.



*Figure 2.1: DoggyGo's System Overview*



Figure 2.1 provides a high-level overview of DoggyGo's hardware and software design. The figure contains the subsystems that are necessary to form a prototype for our product.

## **2.1 Risks**

With a project that will last for 8 months, risks will exist throughout our project progress. The main task in constructing the prototype will be the launcher type we will be using to launch the ball. Being only provided with similar products, determining the best method of launching the ball will involve a lengthy amount of testing and research.

Besides determining the best launcher type for our product, safety is an important aspect. DoggyGo will contain error and exception handling in software as well as hardware failover mechanisms to avoid causing injury to nearby objects or animals. The software will be thoroughly tested using a suite of test cases we have designed, sensor calibration testing, and user testing to ensure that the product is able to operate with real life use-cases without any misbehaviours. For hardware, the power source will contain short circuit and over current protection to ensure the safety of the end user. As an animal product, our electronic components that we will use in this project must be enclosed in a durable enclosure to ensure that the animals or the end user do not damage the internals of the product, causing injury and affecting the functionality of the product.

Being a fairly complex product with gears (for launcher rotation) and a variety of motor types such as servos and DC motors (for treat dispensing and ball launching), there will many points of mechanical failure. Our goal is to perform as much testing as possible to ensure all of our components are able to sustain continuous use for an extended period of time.

## **2.2 Benefits**

DoggyGo is a product designed to entertain dogs when the owner is away and also having the ability to interact with the product when the owner is at home. Even though the project that we have proposed may contain some risks, we look to outweigh them with the benefits that the product offers. The goal is to have a good balance between development cost and future profits to allow our product to succeed.

### **2.3.1 Portability**

Being an animal toy, portability is an important aspect. In order to allow the user to easily transport the device for indoor and outdoor use, keeping the weight to a minimum is necessary. In our proof of concept, we will use materials of lower cost such as wood or similar in exchange for more weight to save on development cost. The final product shall be made of durable plastic such as ABS or similar and will contain a handle to minimize the net weight of the product and to allow the user to easily transport the device.

### 2.3.2 Feature Set

There are many ball launcher products for dogs. With DoggyGo, our intent is to combine features that are found in ball launchers varying in different costs in a single package. The common ball launcher only contains the ball launcher mechanism (without any detection sensors) and does not have abilities to dispense treats. By having a wider feature set and improve on safety of the launcher, our product is able to have a wider consumer audience as each consumer will be more likely to find a feature attractive.

### 2.3.3 Two Modes of Operation

Being a toy that can be used inside and outside, customizability is an important factor. Compared to other ball launchers, DoggyGo contains two modes: automatic and manual. In automatic mode, the user is able to automate the process of ball launching and treat dispensing. The ball will be launched with a predefined launch angle and strength when in automatic mode. When the launched ball is returned back into the catcher, the machine will automatically dispense treats for the dog to enjoy. In manual mode, the user is able control the launch angle and distance as well as dispense treats manually, increasing the interaction between the end user and their pets when they are at home.

## 3 Market

From 2016 to 2018, the Canadian pet population has continued to grow. Dog population figures for 2018 increased to 8.2 million, up from 7.6 million in 2016. Overall more than half – about 52% of households in Canada have a pet, and approximately 41% of Canadian households include at least one dog. [1][2] Also, the role that pets play in our households is indeed changing nowadays. Pets are no longer viewed by their owners only as companions, guardians or hunters. Most people perceive their pet as a member of the family. According to ‘Packaged facts pet shopper survey April-June 2014’, more than 60% people agree that their pets are important to their physical health, and more than 70% people agree that their pets are important to their mental health. [3]

Based on that, the amount people are willing to spend on their pets are increasing. The Canadian pet industry is estimated worth about \$7 billion, including food, supplies and services, according to Package Fact’ most report. The market in US is more positive and broader than Canada. Figure 3.1 shows the pet spending in US from 2002 to 2018. [4] We can see the pet spending has been growing rapidly from \$30 billion in 2002, to \$70 billion last year.

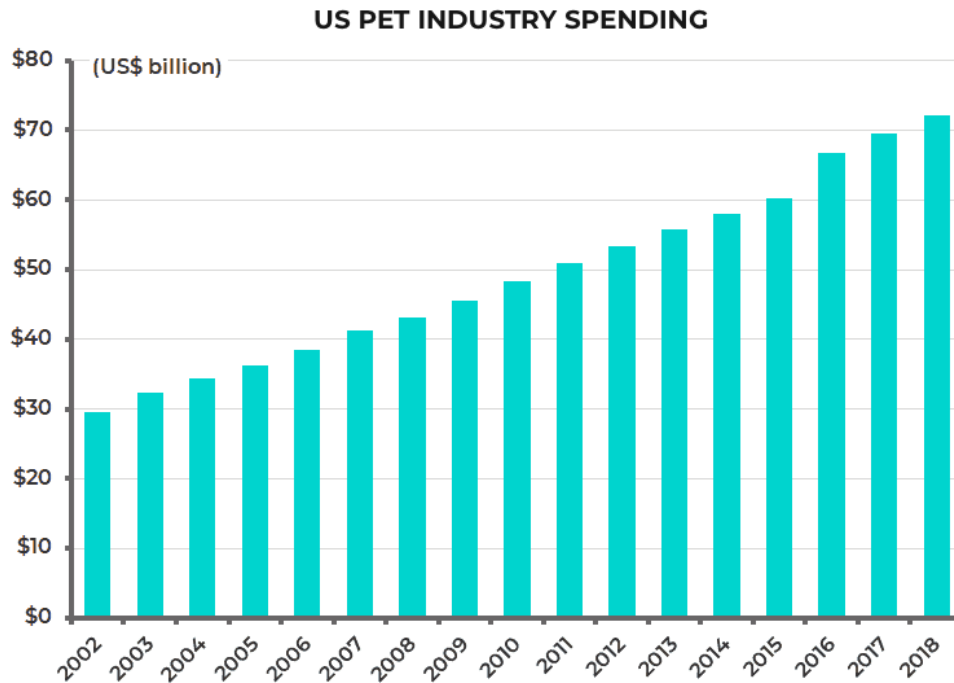


Figure 3.1: Pet Industry Spending Statistic

### 3.1 Cost Considerations

Estimate of Costs for DoggyGo’s prototype is summarized in the tables below:

Table 3.1: DoggyGo’s Prototype Estimate Cost

Name	Quantity	Estimated Price (CAD/Unit)	Subtotal (CAD)
Wheel	2	2.5	5
Arduino Uno	1	15	15
Ultrasonic Sensor	5	3	15
L298 Motor Driver	2	10	20
Push Button	3	1	3
Buzzer	1	5	5
Motor	5	5	25
Shell and Chassis (3D print)	1	50	50
Battery	1	12	12
Treats	1	5	5
Basic Components (screws, nuts, etc.)	30	0.3	10
Ball	3	2	6
Remote Controller	1	8	8

Gear	4	1	4
Shipping	1	10	10
<b>Total (before tax)</b>			178
<b>Total (After 12% tax)</b>			199.36

### 3.2 Funding Sources

Three most helpful sources of funding that engineering students can use for their Capstone project are listed below:

1. Engineering Science Student Endowment Fund

The Engineering Science Student Endowment Fund is provided by SFU's Engineering Science Student Society (ESSS). There are four categories of awards that the fund offers. We are going to apply the category B (Entrepreneurial) when the application period starts.

2. Wighton Development Fund

Wighton Engineering Development Fund is administered by Andrew Rawicz. The fund will assist the project with some additional funding that other fund sources aren't covered. We will apply Wighton Development Fund during next semester.

3. Personal Funding

If the funding opportunities we applied are unavailable, our team will contribute the total costs that we need in order to constructing our products' prototype successfully.

## 4 Competition

Throw-and-fetch is probably the most popular activity for dog. Currently, there are a number of dog ball launchers and throwers in the market. However, some of them can be used only manually. Although it is a good interactive activity between dogs and their owners, our target market includes those dog owners who are busy at work and would like to look for a toy which dogs can play with when they are home alone. There are some automatic ball launchers as well. However, hardly any of these products can operate in both manual and automatic modes. Moreover, DoggyGo can adjust vertical launching angle as well as horizontal angle, which is a unique and innovative feature. The following discusses some of these potential competitors.

### iFetch/iFetch Too

iFetch is an automatic ball launcher pet toy for small to medium sized dogs. It can launch mini size tennis balls and adjust three preset launch distance. iFetch Too is a big version of iFetch and

it is designed for medium to large sized dogs. It can launcher standard-sized tennis balls and featured three preset launch distance plus a random distance setting for different range. However, both of them do not include function of changing launch angles. And the price is relatively expensive compared with similar products. iFetch is CDN\$190 and iFetch Too is CDN\$350. [5]

## PetSafe

PetSafe is a premium automatic dog tennis ball launcher that offers lots of flexibility with nine distance settings and six vertical angle setting. It supports both standard and mini sized tennis ball. One of the highlights of PetSafe is the that it features a front-motion sensor to prevent accidental ball launching in the front and a two-second motion detection delay and audible tone alerts before launching. [6] It is noticeable, however, some customer reviews mentioned “unresponsive safety sensor” from Amazon. [7] Another highlight is the product has a carry handle on the top for easy transportation. The price is CDN\$ 200.

# 5 Project Plan

This project comprises two four-month phases. The first four-month phase will be dedicated to completing the project proposal, design requirement and the product specification. We will purchase all the materials and tools for DoggyGO. In the end of phase 1, a proof of concept for DoggyGo will be shown. The other four-month phase, phase 2, are contributed to completing the final product. The eight-month project will be broken down into several sprints with the specific milestone respectively. Each sprint will be divided into small subtasks that can be assigned to each member to achieve goals more efficiently. Each sprint includes the expected achievement times, the deadlines of the necessary documentations and milestones. Figure 5.1 shows the Gantt chart which lays out the team’s schedule for the duration of ENSC 405W, phase 1, including milestones throughout the term. The final version of the phase 2 plan will be mapped out as phase 1 being completed. We will work on the ENSC 440 plan when we are in the end of phase 1.

## 5.1 Documentation

Due to the fact that we have completed the design requirement and product specification documents, our planning should start from the project proposal. All internal completion date for the project proposal draft will be seven days prior to the official deadline. It will provide us the adequate flexible time to allow us to deal with any last-minute changes and emergency situations.

## 5.2 Proof of Concept

### Project Proposal - Automatic Animal Ball Launcher

Once the design is completed and all the documents are finished, the construction of the proof of concept can be worked on. We will purchase components based on our product specification. This includes ordering the necessary components and constructing necessary systems of DoggyGO as determined in the design phase. At this sprint of development our focus is on creating each subsystem of the DoggyGO rather than the integrating each subsystems to a final final working product. The completion of the proof of concept signifies the next project milestone.

The planning of the phase 2 will base on the sprint of proof of concept.

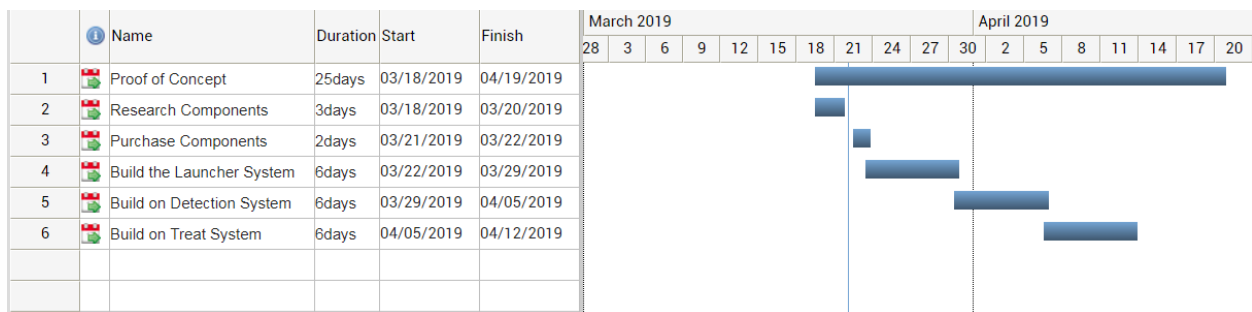
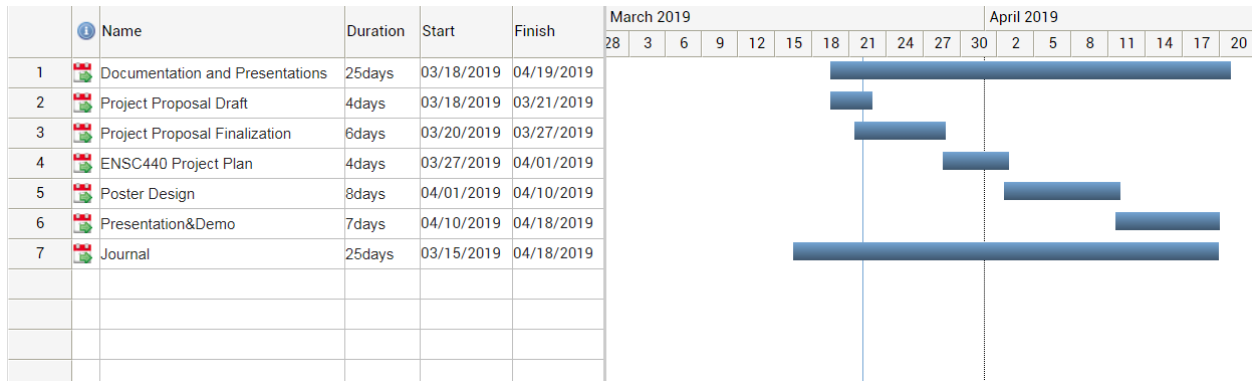


Figure 5.1: Gantt Chart for DoggyGo

## 6 Company Overview

Formed on Jan 10<sup>th</sup>, 2019, DoggyGo Inc. aims to make the pets' entertainment market having a great change and make lonely pets at home have their own way to play, by using the fully automatic prototype, DoggyGo. With DoggyGo, pet owners will only need to place the produce at somewhere relatively empty, then they can leave without worries about their pets will feel boring. And also, it can be operated manually to provide an amazing interaction between owners and pets.



## 6.1 Meet the team



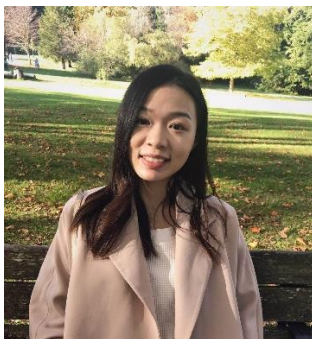
**Danfeng (Sherlock) Sheng**  
[danfengs@sfu.ca](mailto:danfengs@sfu.ca)  
Chief Executive Officer

Sherlock is a 5<sup>th</sup> Electronic Engineering student at Simon Fraser University. He worked at professor Ash M. Parameswaran's lab for a 4-month Co-Op as a computer communication engineer and worked at EYEXPO Inc. for an 8-month Co-Op as a VR developer. The Co-Op experience improved his communication skills and problem solving ability. He honed his software skills in C++, VHDL, MATLAB and Linux. He honed his hardware skills in circuit design, circuit analysis, PCB layout and Arduino connection.



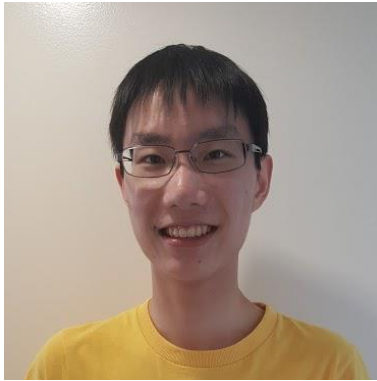
**Junchen (Steven) Wang**  
[junchenw@sfu.ca](mailto:junchenw@sfu.ca)  
Chief Communications Officer

Steven is a 5<sup>th</sup> year Electronics Engineering student, with rich working and research experience. For the past 8 months, Steven worked as a research assistant (USRA) for 4 months at SFU's Cleanroom Laboratory for Dr. Michael Adachi, researching the 2D-Material Semiconductor Fabrication and building the Piezoelectric Inductive Signal Amplifier (Ultra High Multiples). He then found another Co-Op for 4 months in FPInnovations cooperating with UBC, as a Process Control Specialist, working on Arduino programming, VBA based system optimization and Python image writing. As he has lots of experience in communicating with different people and has extensive reporting skills, Steven will keep our documents at a high standard and make our communications with others to be really efficient.



**Manci (Maggie) Song**  
[mancis@sfu.ca](mailto:mancis@sfu.ca)  
Chief Financial Officer

Maggie is a 4<sup>th</sup> year student pursuing a Systems Engineering degree. Her previous work experience as a software product manager gives her solid understanding about Agile development cycle and teamwork. She has just completed 4 months Co-Op at Verathon Medical as a Test Engineer. She will apply her knowledge of systems testing and quality assurance to ensure smoothing development of the company.



**Curtis Cheung**  
[ccc43@sfu.ca](mailto:ccc43@sfu.ca)  
Chief Technology Officer

Curtis is a 4<sup>th</sup> year Computer Engineering student with experience in C++ and Python. His previous Co-Ops involved IT support and QA, which involved developing test scripts for automation and hardware verification). He has previously worked with Arduino projects in his first-year courses. He hopes to apply the knowledge that he has gained throughout the curriculum to build this product.



**Hongbin Lin**  
[hongbinl@sfu.ca](mailto:hongbinl@sfu.ca)  
Chief Operating Officer

Hongbin is a 5<sup>th</sup> years Electronic Engineering student in SFU. He has experience in the website design, virtual tour building and also mechanical design. During his Co-Op career, he also gained lots of experience about communicating with the clients, project management and market trading. He represented the company to attend the World of Concrete 2017 and 2018 and did the business deals with the merchants. He acted as the project management assistant and succeed in the one-month China International Import Expo (CIIE) project. And then he became a project manager for the FLORENTIA VILLAGE. He does hope his background experience can help to make this product amazing and attractive.



## 7 Conclusion

Currently, the project is delivered on all this scope, such as detail design and dynamic system research and selection. The goal of DoggyGo Inc. is to extend these advantages to the pet toy market by providing a product that would automate the entertainment procedure for lonely pets or when they are staying with owners.

To accomplish this task, DoggyGo will utilize two gears (one for horizontal rotation and another for vertical rotation) for launching angle adjustment. The two-wheels accelerator will work for launcher to shoot the ball at different distances by changing the accelerator's rotating speed. The treat dispenser will react with the ball return and release the treat as award for pets. And a remote controller is designed for manual operation.

The members of DoggyGo Inc. are excited to propose and build an ambitious but practical product for our Capstone project. With competition in the current market, we believe our project really make a great innovation, in pets, entertainment procedure, also has the potential to achieve market viability as a product.

We would like to thank William Craig Scratchley and Dr. Andrew Rawicz for organizing, running and overseeing ENSC 405W and, next semester, ENSC 440 – as well as for their support and encouragement in guiding us through this important chapter in our undergraduate career. We look forward to working with you and learning all we can from your insight and experiences.

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