Opto-Smart Pet Feeder

Senior Design I

Initial Project Document and Group Identification

University of Central Florida

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1.0 Executive Summary

There are many different types of pet feeders on the market today, but few employ the use of electronics to automatically dispense pet food and most of those products rely on simple timers and can only serve one pet at a time. With many people going back to the office after the COVID-19 pandemic, pets around the world are suffering due to a sudden change to their everyday dietary routine. This product helps eliminate the time, energy, and stress put on the pet owners to feed their pets while they're away from home. Using optics and electrons, the device ensures that the owner's pets are being routinely fed with their correct pet food, without the pet owner being physically present with them. Devices that autonomously feed pets do already exist, however, the use of optics to better ensure that the pets are routinely fed with the proper pet food is what differentiates our product from others that are already on the market today.

The opto-smart pet feeder contains two main and separate parts to properly feed the user's pets. The first main component is the tag on the collar the user's pets must always wear.

The tag on the collar that is initially described functions as a pet specific identification tag for the feeder to read and acknowledge to dispense the pet food for that specific pet. To do this, an LED light that is embedded inside of the tag's water-resistant plastic container emits a specific color of light that the pet feeder can recognize and dispense the correct pet food for that specific pet. This function is especially useful for houses with more than one pet, as the user's second and third pets can wear a collar tag that emits a different color of light than a color that is already in use to properly distinguish and recognize to dispense the pet food for that specific pet accordingly.

The second main component is the autonomous feeder that dispenses the pet's food. The pet feeder contains a compact camera inside the feeding system that monitors and searches the area for the predetermined color of light that is illuminating from the tag on the pet's collar. The user can further decide the specific time of day in which the pet feeder can scan and detect the light coming from the tag on the pet's collar. At that specific time of day predetermined and set by the user, if the selected color of the LED light is illuminating from the tag on the pet's collar and captured on camera for the system to detect, the pet feeder will dispense the appropriately set amount of pet food into the corresponding pet's bowl. Once the food has been dispensed to the pet's bowl, the correct lid will open, allowing the pet to eat its food from the bowl. Infrared LED's surrounding the bowl will constantly be providing the photodiodes as a signal. Once the pet begins eating from the bowl, the photodiodes will be blocked, causing the lid to remain open until the pet completely removes its head from the bowl. Once the detectors regain the signal from the infrared LEDs, a countdown to close the bowl begins. If something does not block the signal within the time the user selects, the lid will properly close automatically.

For the device to properly function and to fully accomplish all tasks mentioned above, several lines of functions and methods in code must be written and implemented into the microcontroller embedded inside the system. The code executed and complied into the microcontroller must be written well enough for the pet feeder to be able to correctly

identify and distinguish if the selected color of LED light shining from the tag attached to the pet's collar exists in the camera's point of view. Once the correct color of LED light is recognized and acknowledged by the system code in the microcontroller, the dispenser will release the proper pet food for the corresponding pet to eat. The written code must also dispense the accurate amount of food the users decide to feed for that specific pet. The code implemented will allow the user to enter in their exact amount of pet food desired to dispense to the bowl for that specific pet. This will directly correlate with how much food is dispensed, as well as the feeding time.

2.0 Project Description

The Opto-Smart pet feeder is a new type of pet feeder that employs the use of both optics and electronics to automatically feed the users pets when they are not around. Instead of worrying about getting home in time to fill a bowl users can breathe easily knowing their pooches and kittens are not being neglected.

This section contains:

- The background of the project.
- The goals and objectives during the starting design process of the device.
- A motivation discussion section detailing the influences the members had on choosing to work on this project.
- A specification list showing the necessary requirements and core, advanced and stretch features of this project.
- Marketing specifications listed inside of a house of quality diagram.
- Functional diagrams detailing how the optical components of this design will operate.

2.1 Project Background

In households with pet owners must be creative to make sure that their animals are fed every day and that they are keeping a routine schedule. When things come up in life such as working late or an unforeseen event, man's best friend may wind up being neglected. When this happens the pet owners' options are limited, they can either overfeed their animals which may lead to obesity and poor health or pick up an automatic pet feeder.

Another common problem in a household full of multiple pets is ensuring all pets are equally fed. Many times, one pet will rush to the pet bowl to eat their own serving as well as their sibling's dinner.

Many pets also have prescription food or medication. It is very important that the correct pet gets their full dose of medication. It can also be very dangerous if another animal gets hold of that medication. Owners need a way to ensure that they know which pet is eating out of which bowl.

Wet pet food is a healthy solution for many animal owners. One downside to it is that many times, if a pet is not quick to gobble down its food, it will harden. This will in many cases make the picky eater even less inclined to eat the meal. By having a lid on the bowl, the food will stay fresher longer. Making both the pet and owner happier.

An automated pet feeder can take the worry out of feeding a pet by dispensing food at the proper time each day. The only thing that the user must do is to make sure that the dispenser is filled with food when it starts to run low. These devices can take many forms from pre sized individual bowls that can open at a given time, to something more complex with motors, gears, belts, and Bluetooth functionality. One thing that these designs lack is the ability to feed multiple animals from one device.

In this project we want to take the principal idea of an automated pet feeder and add optical components to it to allow the pet feeder to "know" the difference between pet A, pet B pet C, etc. and then dispense that specific pet food. This will work thanks to a collar tag that the pet will always wear and will emit a specific color of light that the pet feeder can detect. Each pet will be assigned a color by the user that will act as that's pets' identity to the feeding system. When the onboard camera detects the correct color at the correct time of day then that pets' predetermined amount of food is dispensed.

We also want to make sure that other pets do not eat another pet's food so we will add a lid atop the bowl that can open and close using infrared (IR) LED's and photodiodes that that best detect IR light built into the pet bowl.

2.2 Objectives

With this project, our core objective is to create a product that feels simple and easy to use to the end user and to give a feeling of luxury through the smart use of the optical elements.

The main objectives of this project will be:

- Take the Stress Out of Feeding Your Pet
- Recognize if a Pet is at its Bowl
- Distinguish the Differences Between Pets

2.2.1 Goals

The goal of the Opto-Smart Pet Feeder is to deliver a high-quality product that is easy for busy pet owners to use even when they're away from their own home. Optics and Photonics will be used to recognize the pet and to further ensure that the owner's pets are being properly fed out of their own bowl.

2.2.2 Motivation

In the United States, many families work long hours to make ends meet and sometimes man's best friend is left out of the equation. This can lead to pets' ether being underfed from neglect or being overfed by people looking to make up not feeding their pets for days at a time, with both scenarios leading to misery for the pet. This is a key motivating factor in the design of this product. Not only to create something that can have a real-world impact but to also bring malnourished pets a better quality of life.

Pet feeders in general are mostly considered to be small plastic bowls that sit on the floor and the pet owner refills every day. Innovation is slow to come to this field, but it is starting to heat up with all the new "smart" devices flooding the market nowadays competing for space with all the other devices. The difference here is this device can make the difference between your pet going hungry or not. A device like this could be a step in the right direction for making sure that pets maintain a routine and stay happy. This device is not meant to completely replace the need to care for a pet, but to assist the busy workaholic type of person that sometimes works a double at the office.
This project allows us to demonstrate the knowledge each team member has learned here at the University of Central Florida. As well as showing that each team member can communicate effectively and to work as a team to accomplish a common goal this is a great experience to have before embarking on our future career paths. A mutual love for pets has also helped inspire us to create this project, we all have cats and dogs that would certainly benefit from a product like this. The hurdles and challenges presented in a project like this will be a fantastic experience for the "real world" projects we will encounter down the road. And a device like this one can change a pet's life for the better forever.

2.2.3 Design A

To design a pet feeder that integrates optics to identify targets to output predetermined user settings. Along with a computer-based program that allows the user to add, remove or edit various settings

2.2.4 Design B

To design a pet feeder that integrates optics to identify targets to output predetermined user settings. Along with an app-based program that allows the user to add, remove or edit various settings.

2.3 Requirement Specifications

The Opto-Smart pet feeder will be able to perform certain requirement specifications as shown in Table 2-1.

Table 2-1 Requirement Specification

1	Detectable Colors	3
2	Detectable Object Distance	> 5 Feet
3	Power Consumption	< 100 Watts
4	Response Time to LED Detection	< 10 seconds
5	Dispense Time	< 60 seconds
6	Survive Exposure to Mist	> 60 seconds
7	Lid Closure Time after Pet leaves	60 seconds ± 10 seconds
8	Dispensed Food Amount	± 10% of User Inputted Amount

- Demonstratable specifications

The role assignments for group 9 are defined in the block diagram below, Figure 2-1.

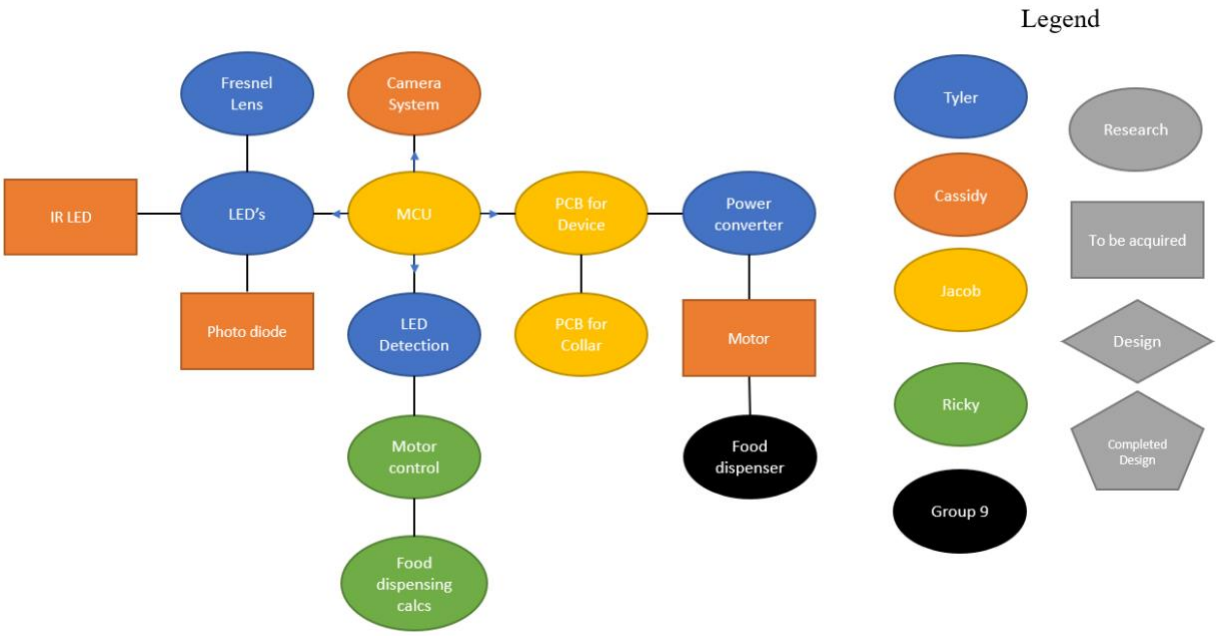

Figure 2-1 Opto-Smart Role Assignment Block Diagram

2.4 Features

2.4.1 Core Features

The following core features of the Opto-Smart pet feeder will be major aspects in our design and drive our product.

- Identification collar tag that will open corresponding Opto-smart pet feeder lid
- Camera will identify LED color on pets' collar
- Self-closing lid once pet walks away from opto-smart pet feeder bowl that will open
- Food is delivered to bowl

2.4.2 Advanced Features

The advanced features outlined below will help elevate our project and show a higher level of design implementation.

- User configurable settings to adjust pet size and time of feedings

2.4.3 Stretch Features

The following stretch features may be implemented if time, budget, and capability enable. These features we would like to achieve if possible.

- Multiple pet bowls to be used by different pets
- Using a webcam for owners to watch pets while owners are out and about

2.5 Marketing and Engineering Requirements

This House of quality diagram shows the relationship between the engineering challenges and the customer specifications for the Opto-Smart Pet feeder projects as shows in Table 2-2.

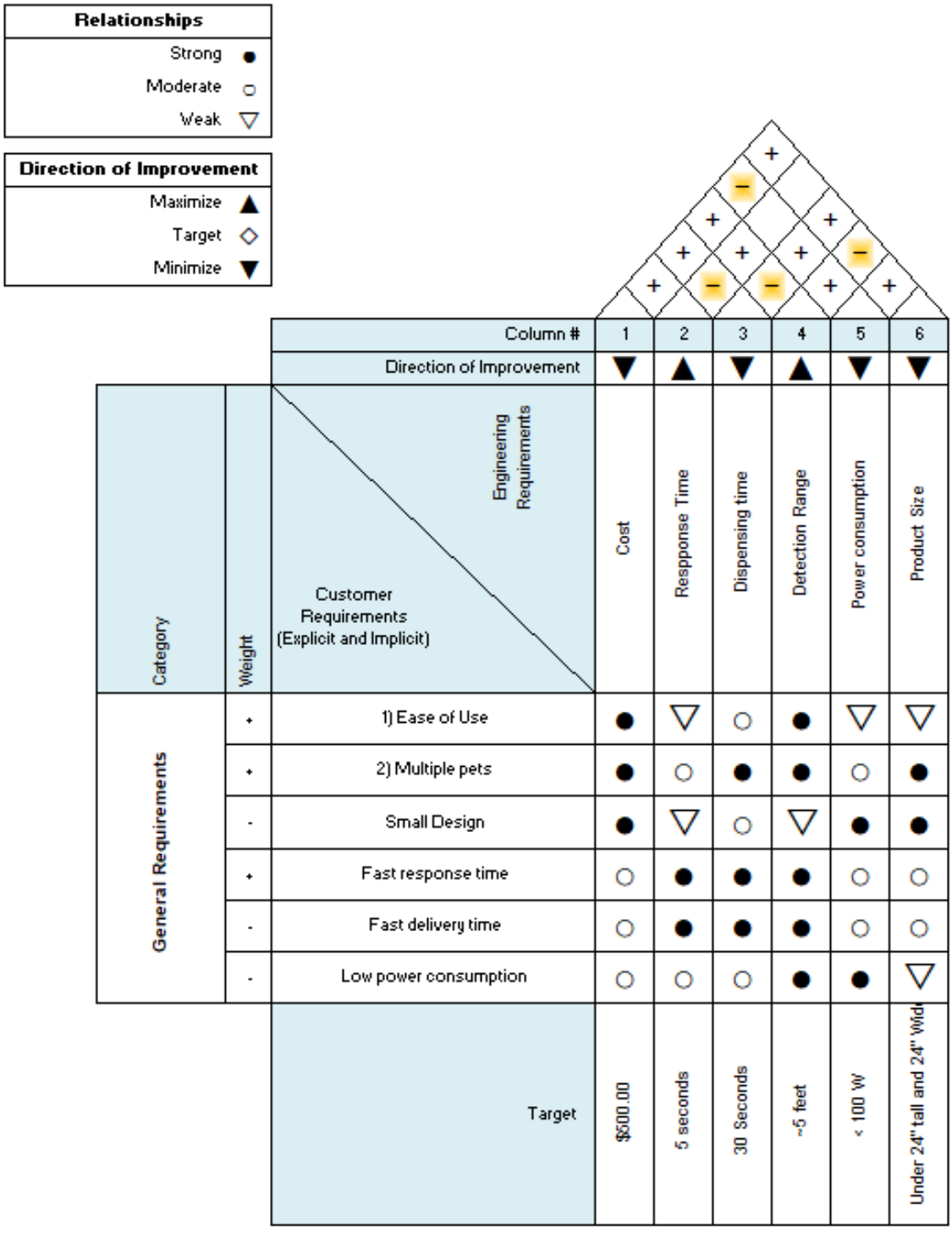

Table 2-2 House of Quality diagram

2.6 Functionality of the Opto-Smart Pet Feeder

In the normal state, all the photodiodes will be activated by the IR LEDS and the lid will remain closed as shown in Figure 2-2. In this state, there is no pet at the bowl.

Figure 2-2 Opto-Smart Self Closing Lid Block Diagram

The Opto-Smart pet feeder will be able to detect when the designated pet enters the area. As shown in Figure 2-3, the collar will have an attached colored LED and Fresnel lens. The Camera system will then be able to pick up which color LED is shining and recognize which pet is entering the area.

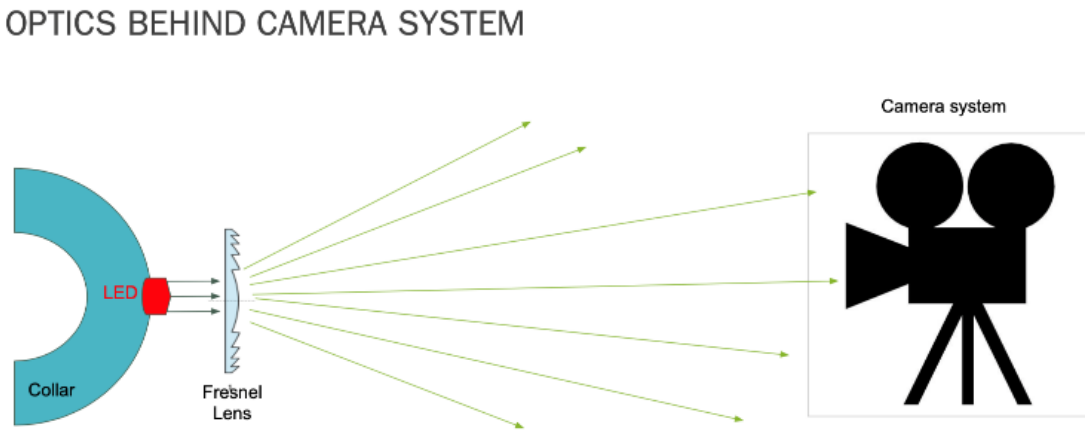

Figure 2-3 Opto-Smart Camera and Collar System

Once the camera system detects the pet waiting to get food, the lid will open. While the pet is eating, its head will block the signals of the IR LEDs. This will cause a drop in power

detected by the photodiodes. This process is shown in Figure 2-4.

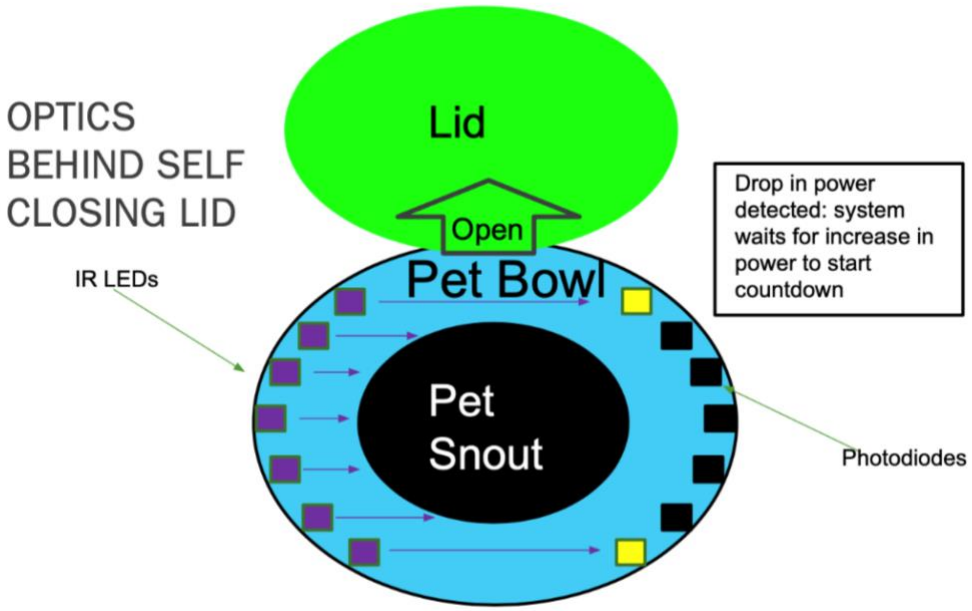

Figure 2-4 Opto-Smart Lid in Open Position, Activated by Pet

Once the pet is done eating, the photodiodes will gain an increase in power. This will start an internal countdown. If the photodiodes do not go through another drop in power before the timer is done, the lid will close. If the power does drop, the countdown process will repeat. This is highlighted in Figure 2-5.

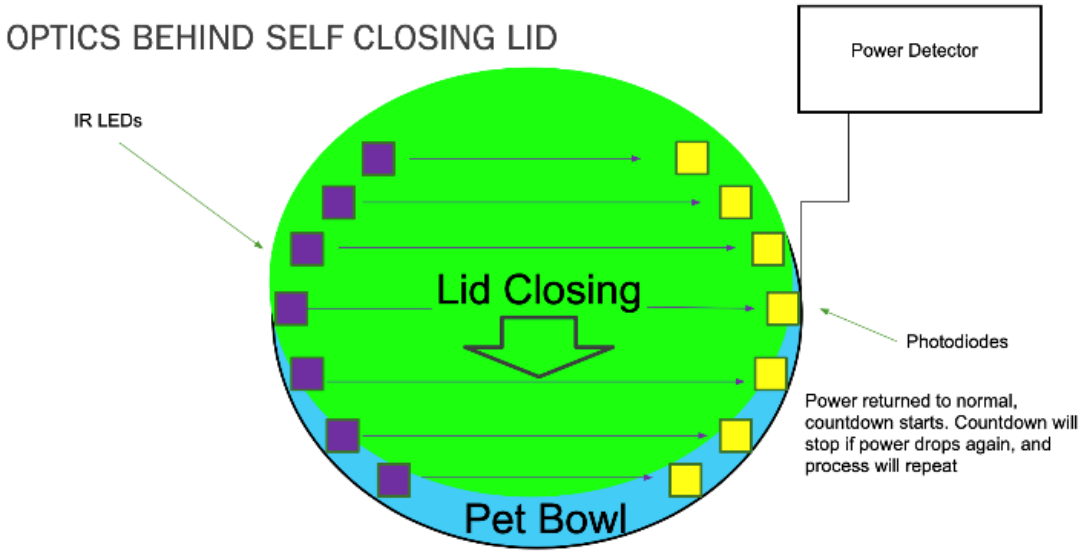

Figure 2-5 Opto-Smart Lid in Preparing to Close, No longer Activated by Pet

2.6.1 Website / App Functionality

The Opto-Smart Pet Feeder offers a webpage, and application functionality where users can remotely communicate with the device via Bluetooth, and Wi-Fi. This allows the user to remotely utilize the device to its maximum capability when they are on the go and away from their pets. The Opto-Smart Pet Feeder webpage first introduces the product to the user through its interactive homepage, presenting the product's features, explaining the product's goals and objectives, as well as further describing the creation team's overall motivation and drive answering the question "why are we creating this product?". After navigating through the homepage, users can direct themselves to either the sign-up page if they are a new user, or to the log-in page if they are a returning user. The new users must go through an online account registration process providing basic personal information such as first name, last name, email and password to create a secure online account associated with the product for users to access the Opto-Smart Pet Feeder functionality safely on the website. The online account registration is a very important part of the remote usage on our website, as the creation of the secure account will rightfully eliminate any hazardous and harmful security risks for all our online users. Once the online account registration process has been finished, with the user's email being verified, the new users and the existing users can now log into their newly created account which will direct them straight into the webpage dashboard that neatly displays all the Opto-Smart Pet Feeder's functionality for the users to fully control at their leisure. The application functionality for the users to utilize follows the same usage steps as the webpage, however, this application may be downloaded and used on your smartphone or tablet to make the remote access to the device conveniently accessible on your smartphone or tablet to all users.

2.7 Financial Considerations

Table 2-3 Component List

Component	Quantity	Total Cost Estimate
LED	1	$6.99
Fresnel Lens	1	$8
Camera	1	$20
Photodiodes	6	$105
IR LEDs	6	$5.28
Power Meter	1	TBD
PCB Prototypes	TBD	TBD
Microcontroller	1	$20
Dispenser Motor	1	$20
Battery (2032)	2	$4
Mechanical Dispensing Parts	TBD	TBD
Total		**$189.27**

With a current budget of about $500, we have approximately $300 left for further development of the Opto-Smart pet bowl. The prices listed above in Table 2 are estimated using online research. They may be adjusted slightly as the project gets closer to being produced. The final cost of the product will be evenly split between all the group members.

3.0 Research related to Project Definition

This section focuses on related research towards related technologies used with the Opto-Smart Pet feeder. This provides an opportunity to see an overview of the components and how they will function with the device.

The following section contains:

- A list of existing projects and projects pertaining to the development of the Opto-Smart pet feeder.
- An overview of the accessories and features related to the design.
- An overview of the general components used in the design

3.1 Existing Projects and Products

Automated pet feeders are not a new idea and there are those that perform either similarly or the same functions. There are existing technologies out there that can dispense food at predetermined times with very different design ideas.

3.1.1 Automated Feeder Design

There are many designs that employ the use of automation in a pet feeder. Because of this we know that it is possible to use motors and electronics to efficiently dispense food reliably each time.

Figure 3-1 Existing Automated Food Dispenser Design

Figure 3-1 shows a design that can dispense to two separate bowls at the same time. This feeder also allows the user to fill the device with up to 4 liters of food from the top. It uses gravity and some type of motorized dispenser to deposit food into the detachable bowl. This device runs on both battery and AC Power. The device also takes advantage of an app to automatically dispense food remotely and to change settings. A voice recording feature

is also employed to give your pets a personalized message to encourage them to eat from the feeder.

Figure 3-2 Existing Automated 5 Meal Feeder Design

Another design that we saw shown in Figure 3-2 used a motor that spun a tray around and could hold 5 meals for a pet. Each section holds one cup. Since this is a small feeding size, it is only recommended for extra-small breeds. The PetSafe Eatwell 5-Meal Automatic Dog & Cat Feeder is an interesting idea since it used a lid to cover up the food and allowed for portion control. And a quick and easy method to schedule meals using a very simple user interface consisting of 6 buttons and a double row liquid crystal display. The bowl automatically rotates to the next opening at a user designed time of day. It uses four D-cell batteries which will last up to a year. This design does not contain a lid that will recognize which pet is eating.

Figure 3-3 Existing Automatic Feeder Design with Self-Opening/Closing Lid

An existing design that includes a mechanical lid is shown in Figure 3-3. The SureFeed Microchip Small Dog & Cat Feeder can detect the designated pet by either programmable microchip. It works with up to thirty-two pets. The food must be put into the feeder by the pet owner at each meal. The bowl lid will open when the correct pet is at the bowl and close as they leave. The time the lid takes to close can be adjusted for pet comfort as well as to ensure other pets are not sneaking in. The system uses four C cell batteries which

should last for about six months. It is also only recommended for smaller pets and has a capacity of 1.6 cups. Contrary to our design the food does not automatically dispense the food into the bowl, and it can only be used for small pets.

3.2 Accessories

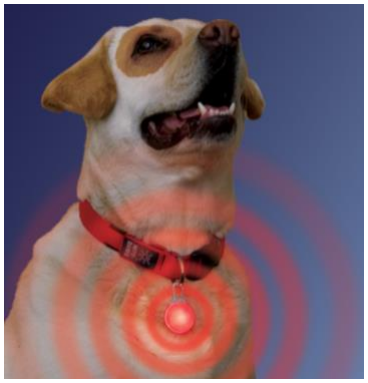

Figure 3-4 Existing LED collar design (Courtesy of puppykisses.com)

Figure 3-4 shows an LED collar tag for a dog that uses a small battery, an LED, and a plastic lens to disperse the light. This accessory is like what we want to create for our device to identify the users' pets.

3.2.1 Camera System

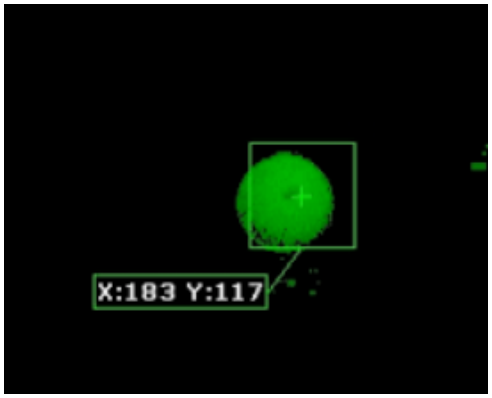

Figure 3-5 Example of color object tracking (Courtesy of roborealm.com)

The camera system that we will use will consist of a compact webcam that will fit inside of the feeder housing and record the environment and look for a specific color. This device will operate just as well in low light environments as environments with regular ambient lighting. This is due to the target being observed emitting its own light source. The camera will individually scan each row of pixels looking for a specific RGB value that is unique

to each collar tag as shown in Figure 3-5. Technology like this is useful in several different fields. From defense products in planes and missiles to industrial machine lines for packaging and consumer level applications like in toys and smart devices. This is a useful feature that can operate efficiently with nothing but off the shelf components and code.

3.3 Relevant Technologies

In this section, a brief overview of the technologies that will be used with the device is given along with a brief explanation of how these different components operate.

3.3.1 Fresnel Lens

A Fresnel lens allows for a lens with a large aperture and a short focal length without the weight or the cost of a traditional lens. The Fresnel lens reduces the amount of material required to operate and is more cost effective compared to a simple lens. These lenses can be molded from plastic into a circular disk and then milled with a CNC machine to produce the ridges required to focus light. This is a boon to this project since it is a low-cost alternative to a simple lens and a lighter lens is a benefit to the pet since they will be wearing it all the time. One downside to using a Fresnel lens is that the image quality decreases so this would not be suitable for high quality images but works fine for simple light diffusion.

3.3.2 Photodiodes

Our design integrates photodiodes, a device that converts light into an electrical current. When photons are absorbed into the photodiodes current is produced. This is something that can be used to detect either the presence or the absence of light. These devices can be purchased to operate at specific wavelength and thus operate like a bandpass filter. The light we are planning to use is 950nm light that is just out of the visible and approaching the IR spectrum of light. Another benefit to this technology is low cost so many can be purchased to increase for this the best device to use would be a photodiode that best operates at or close to 950 nm. This is something vital that we need for this project.

Uses of Photodiodes:

- CD Players
- Medical Devices
- CAT Scanners – X Ray Detection
- IR Remote Controls
- Camera light meters
- Automatic Shutter controls
- Smoke detectors
- Automotive headlight dimmers

From this short list it is apparent that photodiodes have many advantages that help many of our electronics "see". Photodiodes are the ideal low-cost option to determine the power output of this project.

3.3.3 LED's

An LED is a semiconductor light source that can emit light when current flows through it providing a cheap, low power way to provide light to the device. These devices can be found in just about everything from flashing emergency lights to children's toys. This is a device that can emit light for long periods of time without burning out like conventional incandescent bulbs or use toxic chemicals like CFL bulbs. This technology is perfect for the use of its previously mentioned advantages without the bulk or the hazards of other light sources.

3.3.4 Voltage Regulators

A voltage regulator can be used to convert a wide range of input voltages into a desired DC output voltage to be used to provide power to components within a circuit. There are multiple different variations of voltage regulators, including ones built with the use of diodes and separate integrated circuits that can be applied on their own. Voltage regulators are mostly utilized when there is a voltage input too large to be introduced into the circuit that is being analyzed. In this case, a voltage regulator can be used to convert the large voltage input into a smaller input that is a safe value for most microelectronics. Linear voltage regulator ICs are usually able to deliver a smaller output voltage from a large input voltage by dissipating the excess power as heat. This is normally an inefficient use of energy since most linear voltage regulators do not have a high efficiency value. Another type of voltage regulator is a switching voltage regulator which can convert the input voltage into the constant output voltage through the process of temporarily storing energy and then releasing it at the output (at an alternate voltage). Unlike the linear voltage regulator, the switching voltage regulator has a much higher efficiency value and can also usually accommodate a wider range of voltage inputs. These voltage regulators are perfect fits for applications in microelectronic devices, in which small, constant DC voltages are required to keep these devices safely within their recommended operating range.

3.3.5 Microcontroller

A microcontroller, also known as an embedded controller, is a small computer on a semiconductor integrated circuit. A microcontroller contains one or more processors along with RAM memory and a programmable input/output peripheral. There are several different types of microcontrollers available in the market today with different word lengths of 4bit, 8bit, 64bit, and 128bit. A microcontroller is manufactured to automatically control products and devices for them to function properly inside of an embedded system. Some examples of products and devices that contain a microcontroller are office machines, robots, home appliances, motor vehicles, implantable medical devices, remote controls, power tools, toys, etc.

3.3.6 MOSFETS

Metal-oxide-semiconductor Field-effect transistors (MOSFETs) are elements that are used in embedded circuit design to help implement electronic switches and amplify various electronic signals. There are two types of MOSFETs, which consist of enhancement and depletion types. Enhancement mode MOSFETs have no conduction when at zero voltage. As the gate voltage is increased to a value greater than the source voltage, a wider channel (for charge carriers to flow) is established. Enhancement mode MOSFETs act similarly to an open switch, and a gate-to-source voltage is needed to "close the switch" and turn the device on. Depletion mode MOSFETs act oppositely to enhancement mode MOSFETs, in that a gate-to-source voltage is need to "open the switch" and turn the device off. In contrast to enhancement mode MOSFETs, depletion mode MOSFETs act similarly to a closed switch. MOSFETs are a common choice for low-power motor-driving applications since they can be safely used at low voltages and currents. Additionally, MOSFETs can also provide relevant function at higher switching frequencies than other higher power options (such as Insulated-gate bipolar transistors).

3.3.7 DC Motor

DC motors are a simple type of motor that deliver a torque that is proportional to the current applied, and the rotational speed of the motor is proportional to the voltage that will be applied to the motor. These motors can be used in applications such as camera lenses, actuators, and instrumentation devices. At low speeds, DC motors can mostly provide better performance than their AC motor counterparts. Low-power DC motors have applications in PC hard drives and similar devices such as DVD players. Additionally, DC motors can be separated into brushed and brushless variants. Brushed DC motors make use of a set of brushes and a commutator which are replaceable parts that can also be worn down with continued use. Brushless DC motors are operated by switching the driving transistor on and off, instead of using a commutator and brush system. No replaceable brushes are utilized in the brushless design, making them more maintenance free and reliable.

4.0 Design Constraints and Standards

This section discusses the standards relating to the Opto-Smart pet feeder, as well as the realistic design constraints of the project. These constraints may be financial, ethical, technological, or legal constraints. These must be noted and observed accordingly for this product to be a success.

This section contains:

A list of design constraints relating to the Opto-Smart pet feeder.

Standards that apply to the product.

4.1 Standards and other Safety Concerns

In this section, various ethical and safety standards are addressed and examined. Also, there is a discussion pertaining to each standard and how it relates to our design. This section outlines the ethics of working with live animals (cats and dogs), and the safety protocols of working with soldering equipment.

4.1.1 Standards for Working with and around animals

The Animal Welfare Act, 7 U.S.C. § 2131 et seq. states the minimum requirements for the treatment and care of animals to be used in research applications. This Opto-Smart pet feeder will not require the use of animals during the research and construction of the device. To test the finished design of the pet feeder with either dogs or cats, our group will have to abide by the standards proposed in the before mentioned *Animal Welfare Act.* Any animals that may be used during the process of testing the designed pet feeder will be treated humanely and given any human care and treatment needed to keep the dog/cat in a healthy state. In order to test the Opto-Smart pet feeder without having to deal with any restrictions on working with real animals, artificial (stuffed) animals may be used to test the functionality of the LEDs on the collar. Most of the engineering requirement specifications will be able to be measured with the use of the artificial animals.

4.1.2 Soldering Standards

The National Aeronautics and Space Administration (NASA) published a national technical standard titled “Soldered Electrical Connections” that describes NASA’s process and requirements for soldered electrical connections. In this document, they discuss proper soldering techniques along with many useful diagrams which this document will utilize here to show how exactly solder should be applied to the PCB. This documentation goes into elaborate detail about reliable solder connections, tool control, correct materials, proper processes, and careful workmanship. Another key feature that is used in this process to mitigate stress relief is the use of a plated-through hole during the mounting configuration.

Another step to ensure professional soldering is the use of the correct soldering equipment. This NASA document alludes to the mandatory use of: (Not in any specific order) Mechanical strippers, thermal strippers’ chemical strippers holding devices, bending tools, conductor cutting tools, anti-wicking tools, cleaning tools, and thermal shunts. The documentation reveals that proper solder and flux are paramount for correct solder technique, they recommend flux covered solder of either composition SN60 or SN63 that contain flux type R or RMA for correct solder work.

Preparation of the surface that is about to be soldered is vital to a good soldering job. NASA created a table to show the safe and effective chemicals for removing oil and

debris. NOTE: These cleaners and solvents can potentially be hazardous and/or volatile. Before using any of the products listed below, please consult with manufacturer guidelines and any safety data sheets present.

Table 4-1 Solvents and cleaners

Solvent	Specification
Ethyl Alcohol	O-E-760, Types III, IV, or V
Isopropyl Alcohol	TT-I-735
Methyl Alcohol (see 3.12-2)	O-M-232, Grade A
Butyl Alcohol, Secondary (see 3.12-2)	ASTM-D1007
Cleaners	**Specification/Note**
Water	1 megohm-cm, minimum resistivity (see 6.13.3)
Detergent cleaners and saponifiers	(See 6.13.4)

Once the PCB has been cleaned properly, hand soldering may now commence. Molten solder must flow around the conductor and the termination areas, though one must be careful not to deposit too much solder or else the excess may flow to other terminals and cause a short. In this case de soldering must occur, and the work area must be cleaned before resoldering can take place.

5.0 Appendix

5.1 Acronyms

Table 5-1 Acronym List

DC	Direct Current
IC	Integrated Circuit
IR	Infrared
LED	Light Emitting Diode
MOSFET	Metal-Oxide-Semiconductor Field-Effect Transistors
NASA	National Aeronautics and Space Administration
RAM	Random Access Memory
RGB	Red Green Blue
TBD	To Be Determined

5.2 Project Milestones

Table 5-3 Project Milestones

Senior Design I	**Who is completing the task**	**Start Date**	**Due Date**	**Status**
Understanding the scope of the project	Group 9	8/26/2021	9/3/2021	Completed
Role assignments	Group 9	9/3/2021	9/3/2021	Completed
Identify parts	Group 9	9/10/2021	12/3/2021	In Progress
Project report				
Initial Document	Group 9	9/10/2021	9/17/2021	Completed
Updated initial document	Group 9	9/17/2021	8/1/2021	In Progress
First draft	Group 9	8/1/2021	11/5/2021	In Progress
Final draft	Group 9	11/5/2021	11/19/2021	In Progress
Final document	Group 9	11/19/2021	12/7/2021	In Progress
Research, documentation, and design				
Microcontroller	Ricky	9/17/2021	12/3/2021	Researching
Lens design	Tyler	9/17/2021	12/3/2021	Researching
Circuitry	Jacob	9/17/2021	12/3/2021	Researching
PCB	Jacob	9/17/2021	12/3/2021	Researching
Schematics	Jacob/Ricky	9/17/2021	12/3/2021	Researching
LEDs	Cassidy	9/17/2021	12/3/2021	Researching
Cameras	Tyler	9/17/2021	12/3/2021	Researching
Motors	Tyler	9/17/2021	12/3/2021	Researching
Dispensers	Jacob	9/17/2021	12/3/2021	Researching

Housing for electronics	Jacob	9/17/2021	12/3/2021	Researching
Photodiode	Cassidy	9/17/2021	12/3/2021	Researching
Gear Mechanisms	Jacob/Tyler	9/17/2021	12/3/2021	Researching
Code used for project	Ricky	9/17/2021	12/3/2021	Researching
Order and test parts	Group 9			
Senior Design II				
Build prototype		TBD	TBD	
Testing and redesign		TBD	TBD	
Finalize prototype		TBD	TBD	
Practice presentation		TBD	TBD	
Final Report		TBD	TBD	
Final Presentation		TBD	TBD	