UCF Senior Design

The AutonoMouse

Keep Your Pet Company While You're Away

Group 14

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Executive Summary

Pet owners often feel a sort of guilt when leaving their pets alone for extended periods of time. Cats are one of the main culprits of being left alone by their owners, sometimes for a couple days during travel. They're left food and water, and possibly the crinkle ball on the floor, or the battery-operated feather toy that shuts off automatically after ten minutes. The guilt adds up from leaving a pet alone unentertained. There are pet cameras to monitor these best friends while away and keep an eye on them to know they're safe, but it still leaves the pet bored. The solution to this is a toy that can be operated by the owner even while they're away.

Our goal with this project is to create a product that will leave pet owners guilt-free when leaving for days at a time while their pet stays home. The main objective in this is to satisfy the problem in every way possible. It's easy to create a laser pointer that can be monitored through your phone. But it's not as satisfying to play with a pet in that way. It's inactive and gets boring for the user as well. The way to fix this is to entertain both user and pet with an idea that combines fun with our initial goals.

The AutonoMouse was born from this idea, essentially a mouse shaped RC car that can be controlled through a phone or computer. The design is specifically shaped like a mouse to attract the predatory instincts of whatever pet may decide to play with it. It's an interactive way of playing with pets that will help any separation anxiety the owner might have being away from their pet.

Introduction

Many people own pets, and many of those pets are cats. These feline friends can be quite lovely companions, but they are also a hassle at times. With an innate instinct to hunt and test its abilities, a cat will get antsy if unable to perform. Usually, owners will get toys to play with and amuse the cat such as: string, feather on a stick, fake fish, and fake mice. While these are all nice, each one still requires some level of human interaction, movement is required to attract the animal's attention. Without someone being home, the cat has nothing to do.

Figure 1: Mouse Illustration

The AutonoMouse is a system that entertains a cat without the need for human interaction. It activates periodically throughout the day and travels on a path about the room to entice the cat into

interaction while the owner is away. Should the customer choose, it can also be controlled via web app.

The Mouse is a simple device with two wheels, a façade of a rodent to attract the cat. It is small, compact, and quick. The device will operate in three distinct modes:

1. Mode 1: The default mode. In this setting, the mouse travel around the room, avoiding obstacles in an attempt to get the cat's attention.

2. Mode 2: When the battery is at low power, the mouse will automatically attempt to reach the charging station.

3. Mode 3: User Control Mode allows the customer to control the Mouse via a web app even when not at home. This allows them to play with the cat should they choose to use either a computer or phone. They can see what is going on by using the camera with a live feed.

Figure 3: Mouse Communicating with Box

The mode can be chosen using the webapp, but by default the mouse will operate in mode 1, switching to mode 2 when the battery is low. Mode 3 is activated by pressing a button on the control panel at website: http://autonomouse.net/

The Box is a stationary section of the system. Its purpose is to charge and house the Mouse. It is plugged into a wall outlet for power so the device can run autonomously. While not activated, the Mouse component will remain inside the Box charging station, entering through a hole on the side.

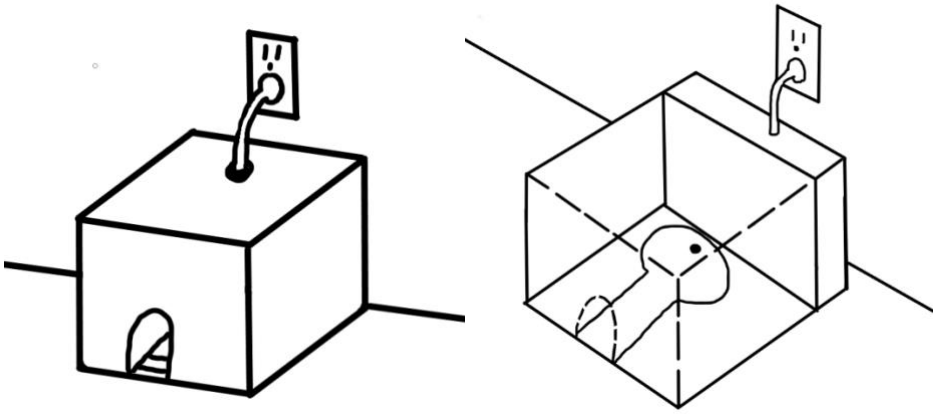

Figure 2: Simple illustration of outside and inside of the Box component

Project Description

Project Motivation and Goals

The motivation of this project is to create a functional autonomous cat toy using the engineering knowledge we have attained from attending the University of Central Florida. This device will test our skills in electrical and computer engineering as well as provide real world project, organization and time management skills that would not be attainable in a more confined lab environment.

Specifications

- 3 different modes (Charging, Active, User control)
- Box will recharge the Mouse, 15 Watt, and give instructions to the Mouse, which can run for 2 hrs.
- Mouse can rotate about its center axis 360 degrees
- Box and Mouse must wirelessly communicate within a radius of 20ft
- Box must be able to fully contain the Mouse unit
- Box dimensions must not exceed an area of 8 ft^3 and a weight of 30 lbs.
- Mouse dimensions should not exceed 8 x 4 x 3.5 in and a weight of 2 lbs.
- HD camera on Mouse to allow user to see where they are going
- Controllable via web app
- System can operate without human interaction
- Device is able to entertain a common housecat

Constraints

- Cost/Budget
- Construction Time
- Range that the mouse can travel
- Charging Time/Battery duration
- Motor power
- Size
- Weight

Parts

The following is a list of all the major components used in the AutonoMouse system:

Raspberry PI Zero W: Chosen due to its small size, low power requirements and ability to handle video streaming, the PI is the brain of the Mouse. The Zero W comes with a preinstalled wifi chip allowing for communication between the Mouse and the webapp for the user control mode. The Pi requires 5V if utilizing wifi. It has a size of 60mm x 30mm. An additional Pi will be used inside the box working with an Arduino to regulate the infrared emitter diodes.

OV5647: The OV5647 is OmniVisions CMOS image sensor. It can deliver 5-megapixel photography and videos at a high frame rate 720p/80(HD). The camera module size is 8.5 mm x 8.5 mm x <= 5mm. The OV5647 is built on 1.4-micron OmniBSI backside illumination pixel architecture.

MPU-6050: This 3-axis accelerometer and gyroscope combo will let the mouse know its orientation and movement. Its angular rate sensors can be set ±250, ±500, ±1,000 or ±2,000°/sec. The accelerometer functions can be programmed to range from ±2g, ±4g, ±8g and ±16g and comes with 16bit Analog to Digital converters for values. The input voltage can be 3.3 or 5V.

COM0805: COM0805 has an RPM of 420, a torque of 9.8mNm and operates at 5V DC. It is rectangular with a size of 10mmx12mm. The shaft of the COM0805 has a diameter of 3mm and the length of the shaft and bearing is 9mm. Two of these motors are used to move the Mouse.

TB6612FNG: This motor driver IC controls both the COM0805 motors. It is capable of taking up to 15V for motor voltage and uses 3V for the logic system. The max current it can put into a motor channel is 1.2A.

VL53L0X: This laser module lets the mouse detect obstacles as it approaches them using time of flight. It can operate with 3-5V and has a distance detection range of 50-1200mm. The VL53L0X uses I2C communication.

LI NCR18650: This rechargeable battery has a voltage rating of 3.6V, it has a total capacity of 3250mAh and is typically run at 0.2C making it capable of running the Mouse. This battery was chosen for its small size, 70mm long with a 20mm diameter.

MT3608: This boost regulator will turn the 3.6V from the 18650 battery into the required 5V that the motors, the Pi and the laser module require.

ADA 1901: A Qi standard receiver for wireless inductive charging, it outputs 5V, 1A. This component is 48mm x 32mm x 0.5mm and is on the underside of the Mouse.

ADA 2162: A Qi standard transmitter, it operates at 5V, 2A. Located on the Box charging station, this part has dimensions of 53mm x 53mm x 4mm.

PMC-05V015W1AA: A 5V, 3A ACDC converter, it will be used to power everything in the Box.

HiLetGo IR Module: This infrared device functions on 3.3V or 5V. It is ideal for line tracking systems and will be used to help the mouse find the box.

LM339N: A 4 comparator IC, it works with a series of voltage dividers and a logic shifter to create a simple ADC to tell battery level and charge state.

BOB-12009: The logic level shifter to be used with LM339N, it turns any 5V input into 3.3V.

Structure: The chassis, wheels, and charging station were all custom made on 3d printers.

Software Block Diagram

Figure 6 displays a general software logic diagram that shows how the three modes interact with each other. The programming for the AutonoMouse was done in python.

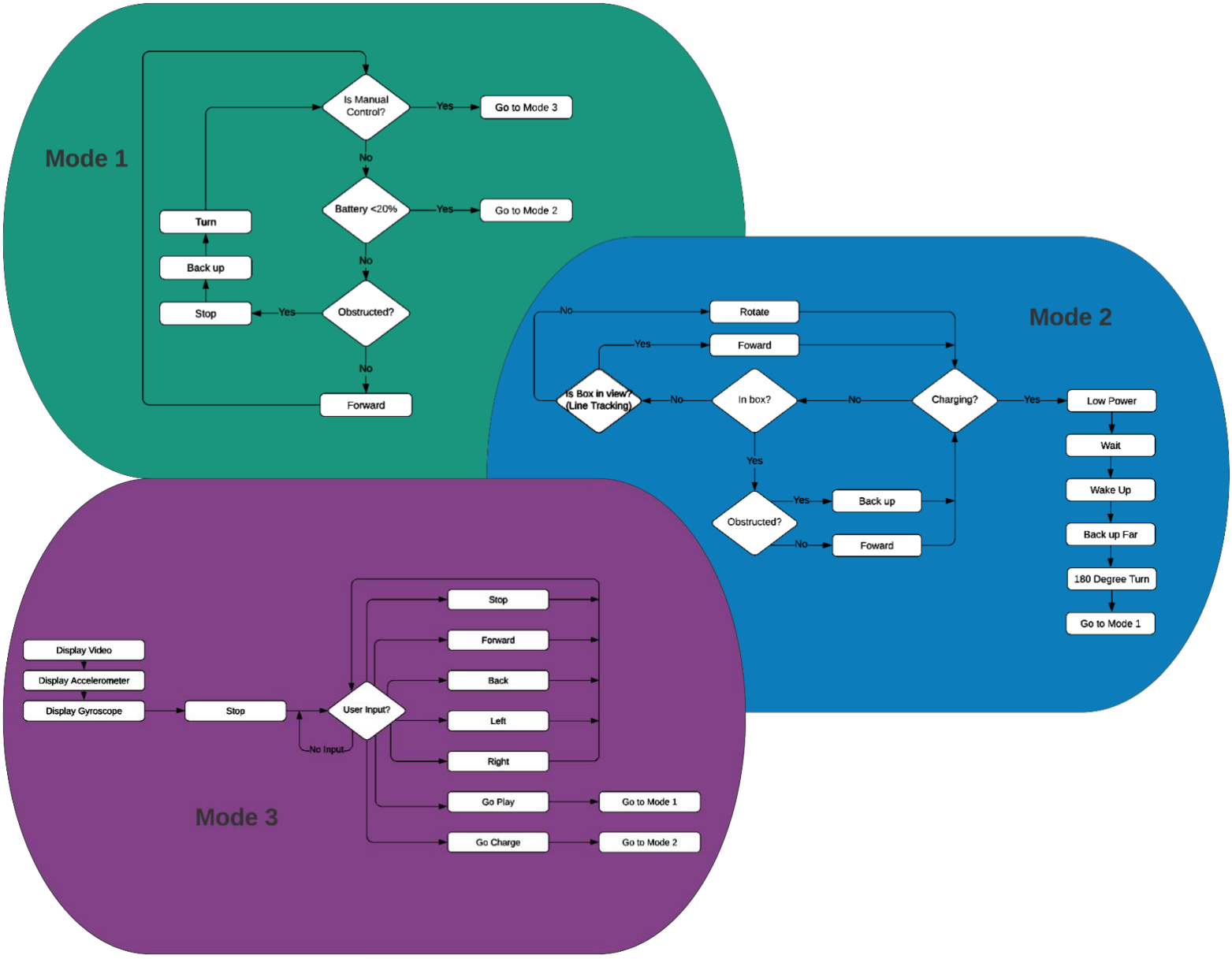

Figure 3: Software Block Diagram

Hardware Block Diagram

Figure 7 contains the required hardware, and some software routes involved in the project. The main objective of this diagram is to describe the communication between the box and the mouse, and the webapp along with their respective components.

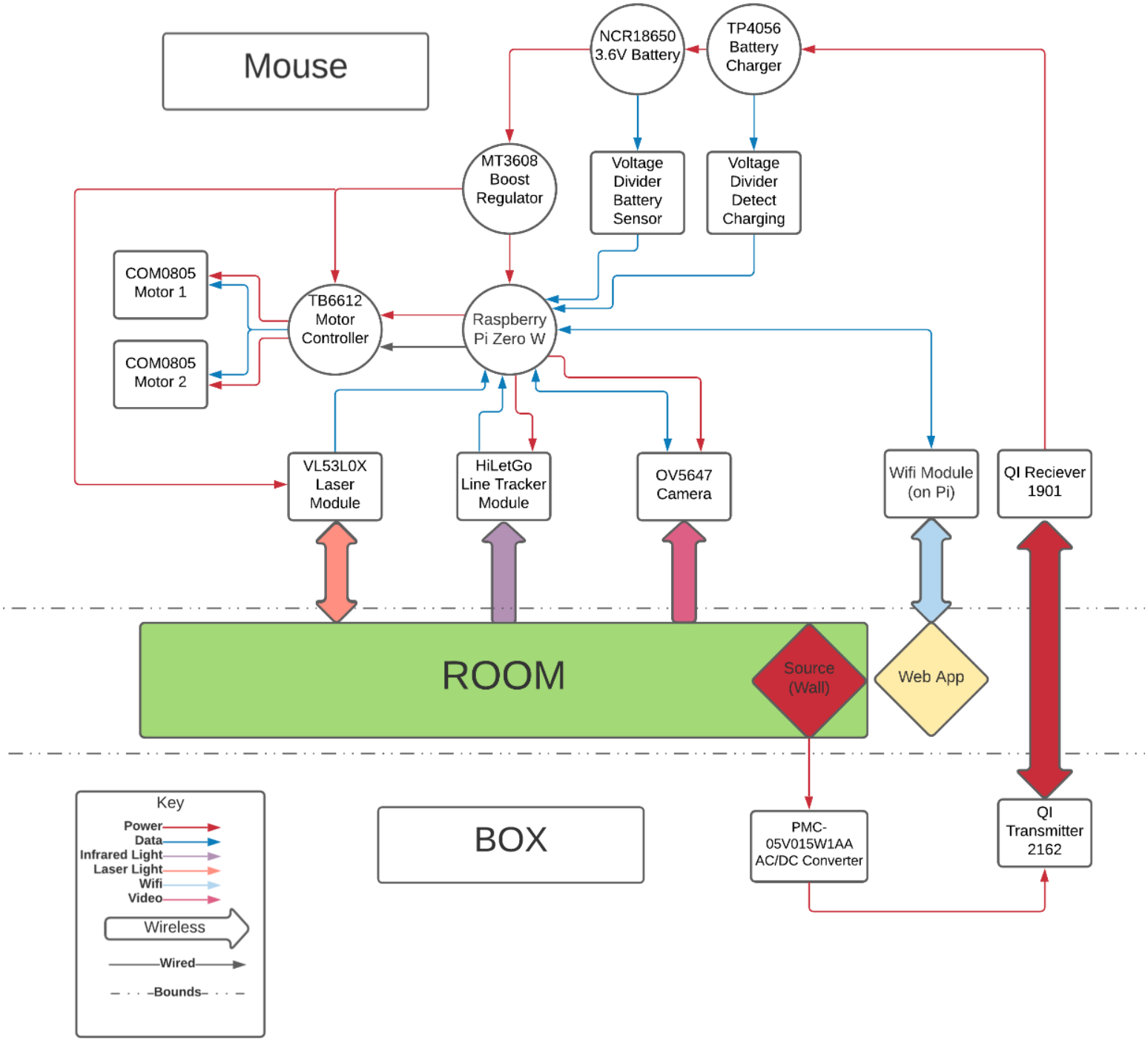

Figure 4: Hardware Block Diagram

House of Quality

HOQ, The House of Quality, is an excellent method for developing requirements. It is a design tool of quality function that identifies the customer's needs and their importance while correlating them with engineering requirements. Based on those correlations, objectives and priorities can be assigned. This process can be applied to a lot of systems that are in development. The output of this process looks like a matrix with the customer's needs in one dimension and the correlated requirements on the other dimension.

↑ = Positive Correlation ↓ = Negative Correlation	Engineering Requirements	Size	Weight	Cost	Range	Battery Duration	Motor Power
Marketing Requirements		-	-	-	+	+	-
Size	-		↑			↑	↑
Weight	-	↑				↑	↑
Cost	-				↓	↓	↑
Range	+			↓			
Battery Duration	+	↑	↑	↓			↓
Motor Power	-	↑	↑	↑		↓	
Quiet	+			↓			
Stylish	+	↓	↓	↓			
Targets for Engineering Requirements		8 x 3 x 2.5 in	> 2 lbs.	$405.00	40 ft	4 hours	25 Watts

Table 1: House of Quality

Finance and Budgeting.

The following prices in Table 2 are a rough estimate of the average cost of these components on the market. Many calculations were rounded up in order to have some leeway with the budget. In an ideal situation, the total cost would be lower than the amount shown, but that is impractical for a first-generation build. This project was self-financed, with each student paying for part of the system. Table 3 shows the general milestones and deadlines we hoped to achieve with this project.

No.	Part Name/Number	Description	Quantity	Extra	Unit Price	Total Cost
1	Raspberry Pi Zero W	Raspberry Pi Zero W	2	0	$ 10.00	$ 20.00
2	MPU-6050	Accelorometer	1	0	$ 8.95	$ 8.95
3	OV5647	Camera	1	0	$ 9.99	$ 9.99
4	COM0805	Motor	2	0	$ 7.67	$ 15.34
5	MT3608	Boost Converter	6	5	$ 1.43	$ 8.58
6	DRV8830DGQR	Motor Controller	1	0	$ 2.07	$ 2.07
7	LI NCR18650	Rechargable Battery	1	0	$ 17.13	$ 17.13
8	ADA 1901	Qi Reciever	1	0	$ 14.95	$ 14.95
9	ADA 2162	Qi Transmitter	1	0	$ 26.95	$ 26.95
10	PMC-05V015W1AA	AC/DC Converter	1	0	$ 17.26	$ 17.26
11	VS1838B	Infrared Sensors(with emitters)	1	0	$ 5.29	$ 5.29
12	Arduino	Arduino	1	0	$ 21.74	$ 21.74
13	VL53L0X	Laser distance sensor	3	2	$ 5.86	$ 17.58
14	COM0805	Motor	2	0	$ 7.38	$ 14.76
15	Lesser Componants	Resistors, Capacitors, Diodes	6	0	$ 0.50	$ 3.00
16	Protoboard	Protoboard	5	0	$ 2.21	$ 11.05
17	Structure	Chasis, wheels, Pad	1	0	$ 158.03	$ 158.03
18	8-input TTL converter	Logic Converter	1	0	$ 5.42	$ 5.42
19	LM339M	Comparator	1	0	$ 1.15	$ 1.15
20	PCBA (failed to arrive in time)	PCB Board+assembly	1	0	$ 75.00	$ 75.00
21	Name.com Registration Fee	For autonomouse.net name registration	1	0	$ 20.00	$ 20.00
22	Linode Server Fee	Linux Web Server	1	0	$ 25.00	$ 25.00
23	DNS Service Fee	DNS Service Fee	1	0	$ 20.00	$ 20.00
25	Additional Fees	Mistakes, Issues, Non-Part costs	1	0	$ 125.00	$ 125.00
					Total No Tax	$ 644.24
					Tax	$ 45.10
					Total	$ 689.34

Table 2: Finance and Budgeting

Week	Description	Due Date
	Senior Design I	
1--2	Project Selection	N/A
3	Initial Divide and Conquer Document	9/18/20
4	Project Approval	9/23/20
5	Updated Divide and Conquer Document	10/2/20
6--11	60-Page Draft of Final Document	11/3/20
12--13	100-Page Draft of Final Document	11/27/20
14--15	120 Page Final Document	12/8/20
	Senior Design II	
1	Ordering Parts	N/A
2-4	Breadboard Testing/Place PCB Order	N/A
5	CDR Presentation	2/11/21
6-10	Protoboard Testing	N/A
11	Begin Building Device	N/A
12	Midterm Demo	3/28/21
13-14	Finalize Product and showcase video	4/18/21
15	Conference Paper	4/20/21
15	Final Presentation	4/22/21
16	Final Report/All Documents	4/27/21

Table 3: Milestones