Project Serve-Your-Dog

An Automatic Wheelchair-Mounted Dog Treat Dispenser

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Faculty Supervisors: Dr.Nathalia Peixoto and Dr.Kristine Neuber

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Overview

- Purpose and Motivation
- Problem/Prior Art Analysis
- Technology and System Wide Requirements
- Technical Approaches
- Functional and System Architecture
- Preliminary Project Plan
- Potential Problems

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Mission Statement

The device shall assist people with disabilities to provide treats to their service dogs.

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Purpose and Motivation

- People with disabilities who are wheelchair bound and accompanied by service dogs account for .9 percent of the U.S. population [1].
- Dogs provide independence to their owners and are capable of completing a wide range of tasks.
- These dogs go through extensive training and annual tests.
- The main challenge users face is giving the dog a treat.
- Rewarding the dog is essential for it to maintain maximum performance!
- This project was undertaken at the request of The Service Dogs of Virginia due to the failure of several previous designs

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Problem Analysis and Design Limitations

Figure 1:Handheld Clicker

- Not yet commercially available.
- Difficult to reproduce.
- Require knowledge in electrical circuits and programming.
- Can not be mounted onto a wheelchair.
- Incorrect/inconsistent number of treats dispensed.
- The main frame of the dispenser being large and bulky.
- The materials used were not food safe, eco-friendly and durable.
- Did not include “click” sound, which the sound the dogs are accustomed to hearing prior to receiving a treat depicted in Figure 1.

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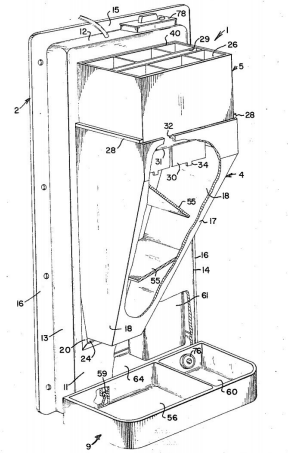
Patent Analysis/Need for Redesign

Problems with Previous Designs:

1. Too large [2], [6].
2. Mechanical [2-9].
3. Not food safe [11].
4. Not wheelchair adaptable [2-11].
5. Not easily activated [3-9].

[11]



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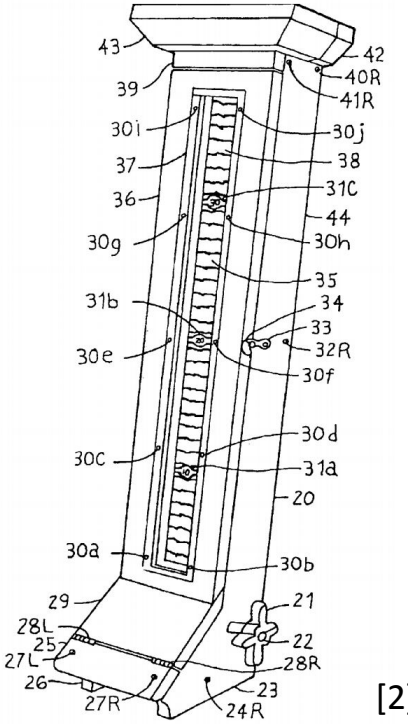

[2]

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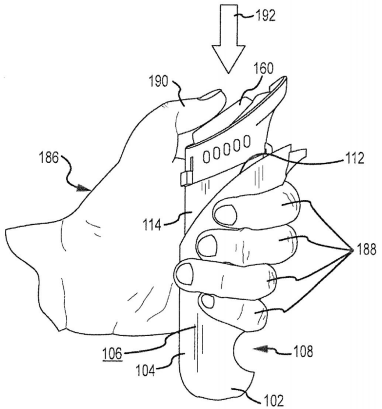
Patent Analysis/Need for Redesign

Elements in Common with our Design:

1. Button. [4]
2. Rotational Tray. [9], [10]



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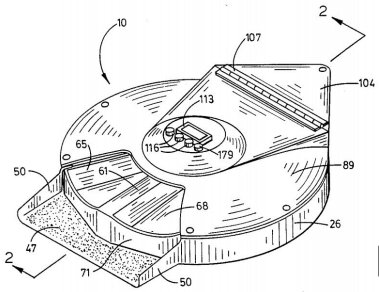

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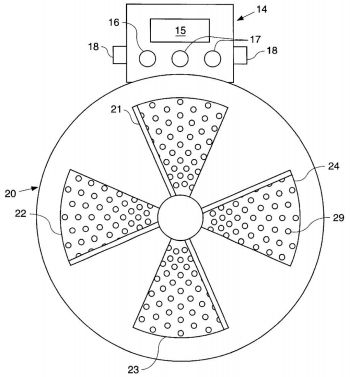

[10]

Using these common elements in combination with our design should not yield infringement.

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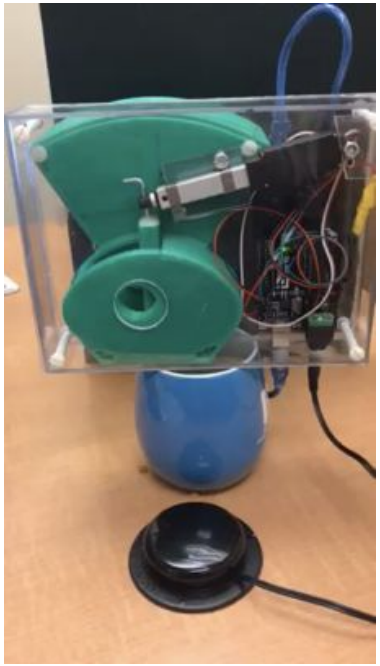
Past 492 Designs

This design at the food dispenser was met with the following issues

- Not food safe
- Difficult to reproduce and rebuild
- Prone to break easily
- Jamming



[12]

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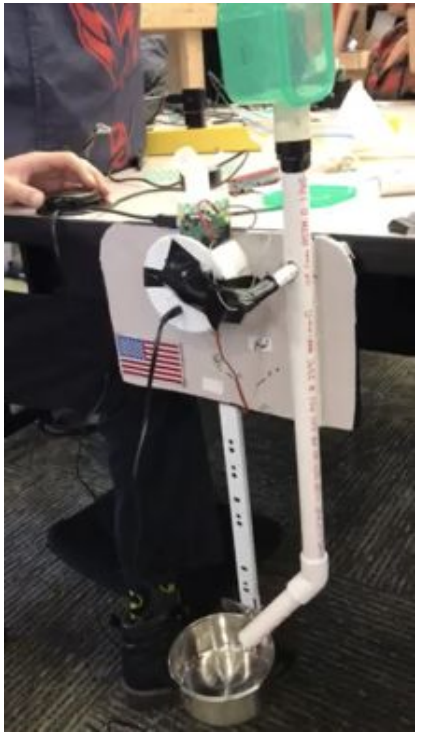
Past 492 Designs

This design at the food dispenser was met with the following issues

- Size itself was too large
- Difficult in controlling dispenser output

However this design's procurement was fairly simple and done all in one store.



[12]

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Past 492 Designs

This design at the food dispenser was met with the following issues

- Dispensed bowl size was fairly too small
- Coating the materials would incur a cost not available to the project team

However the design was successful in its placement in the wheelchair. And had a safe location for the arduino to be stored.

[12]

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Technology and System Wide Requirements

Operational Requirements:

1. The device shall dispense 2-4 treats with a simple click of a button or tilt of the head using an accelerometer.
2. The mounting mechanism shall be flexible and the dispenser will be integrated seamlessly to the wheelchair.
3. The device shall be simple enough for the owner or caregiver to use.
4. The materials used shall be food safe and eco-friendly .
5. The device shall be easy to take apart, re-assemble and clean.

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Technology and System Wide Requirements

Input / Output Requirements:

1. The device will accept input from the operator. The physical input device will vary, however, the interface with the primary device will be consistent no matter what.
2. The device shall hold up to a cup of dog treats into a storage container inside the device.
3. The device will output dog treats through a pipe system that will deliver the food to a food tray.

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Technology and System Wide Requirements

Technology Requirements:

1. Design A shall use active and passive circuit components.
2. Design B shall use a microcontroller in addition to active and passive circuit components.
3. Both Design A and B shall minimize power consumption.
3. Shall use some form of pipe to move food from storage to destination.
4. Shall use some form of circuit coating or hardening to ensure durability.

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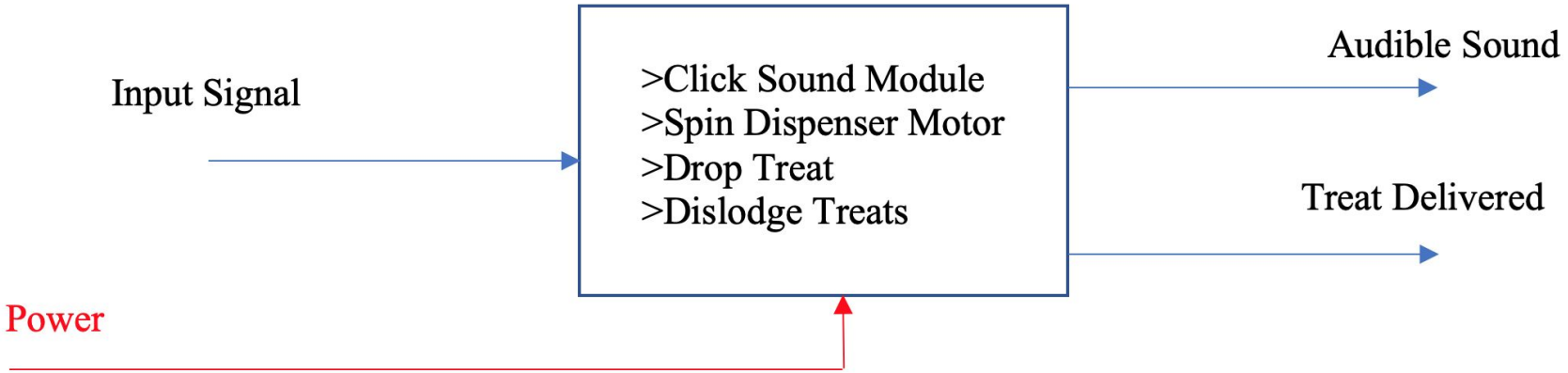
Functional Architecture-Level 0

Level 0



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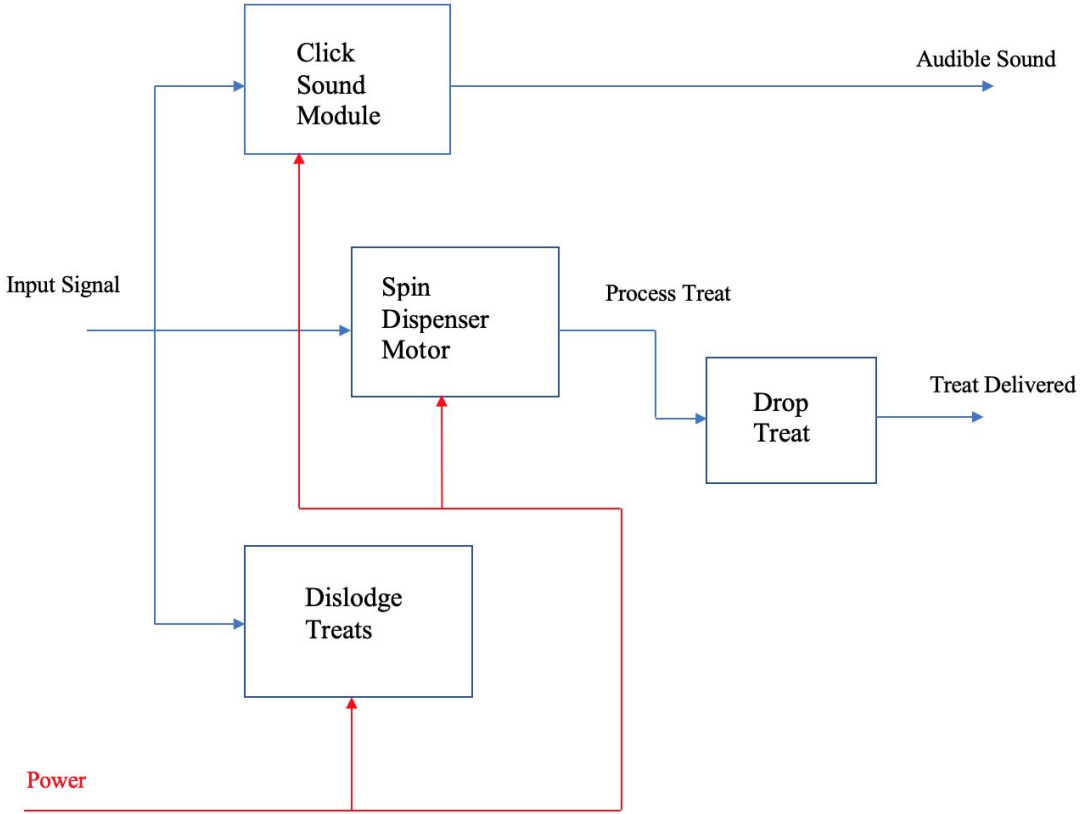
Functional Architecture-Level 1

Level 1



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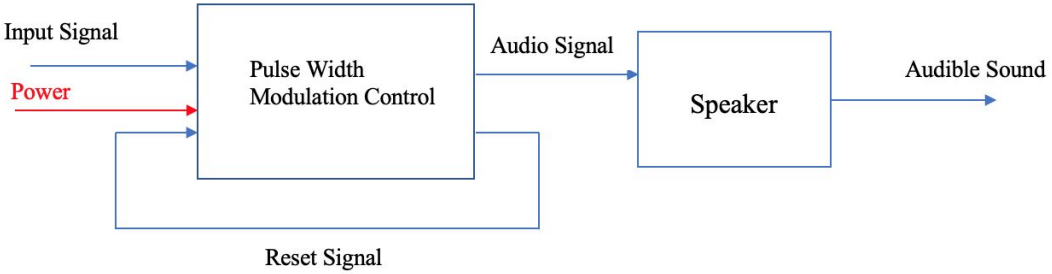
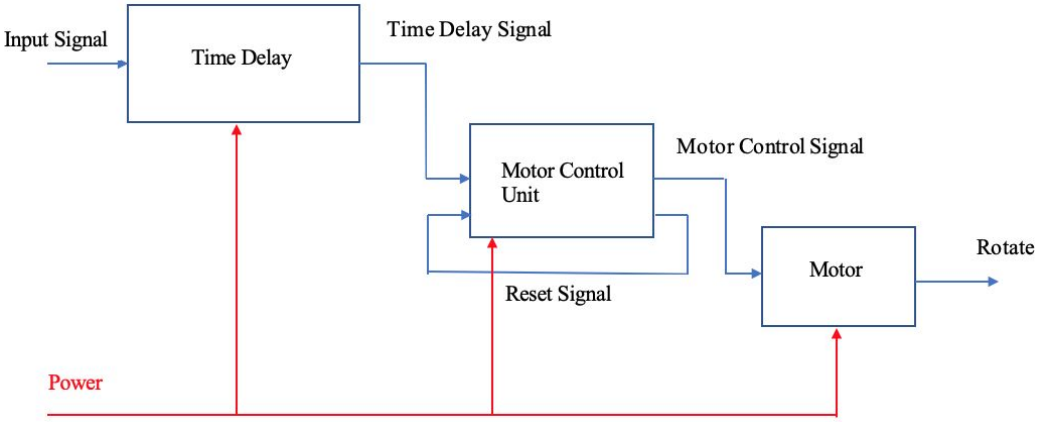
Functional Architecture-Level 2

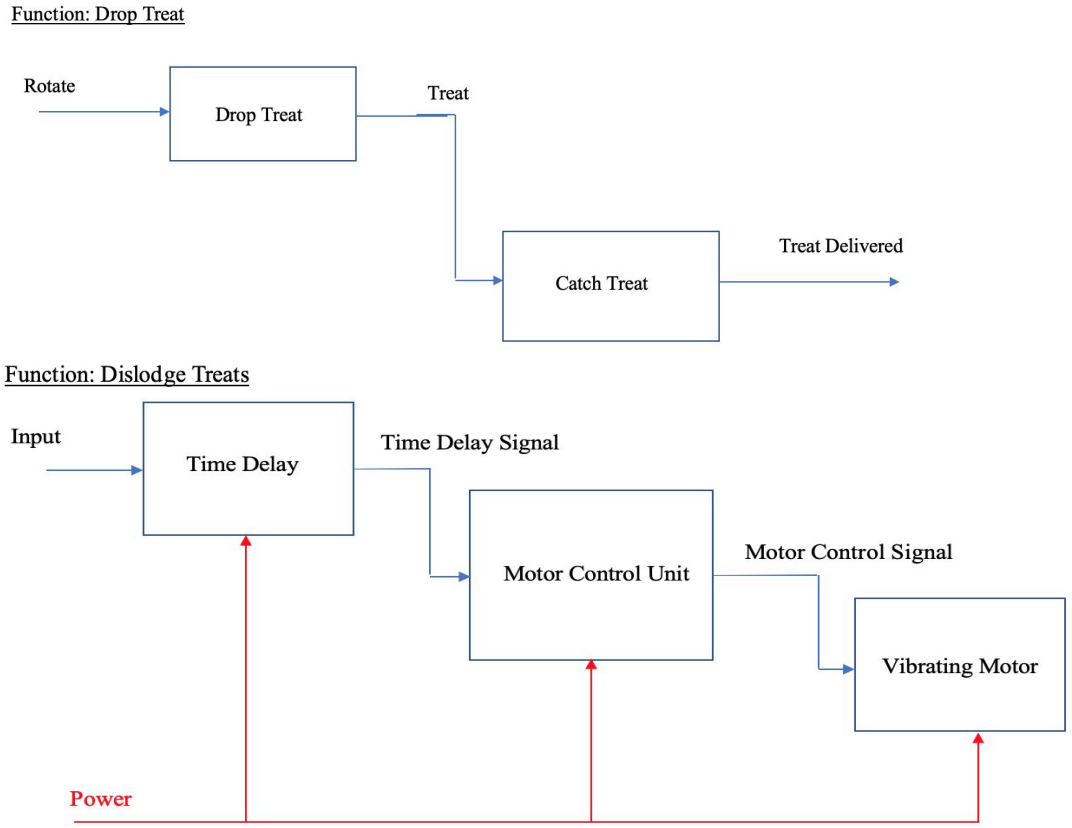
Function: Click Sound



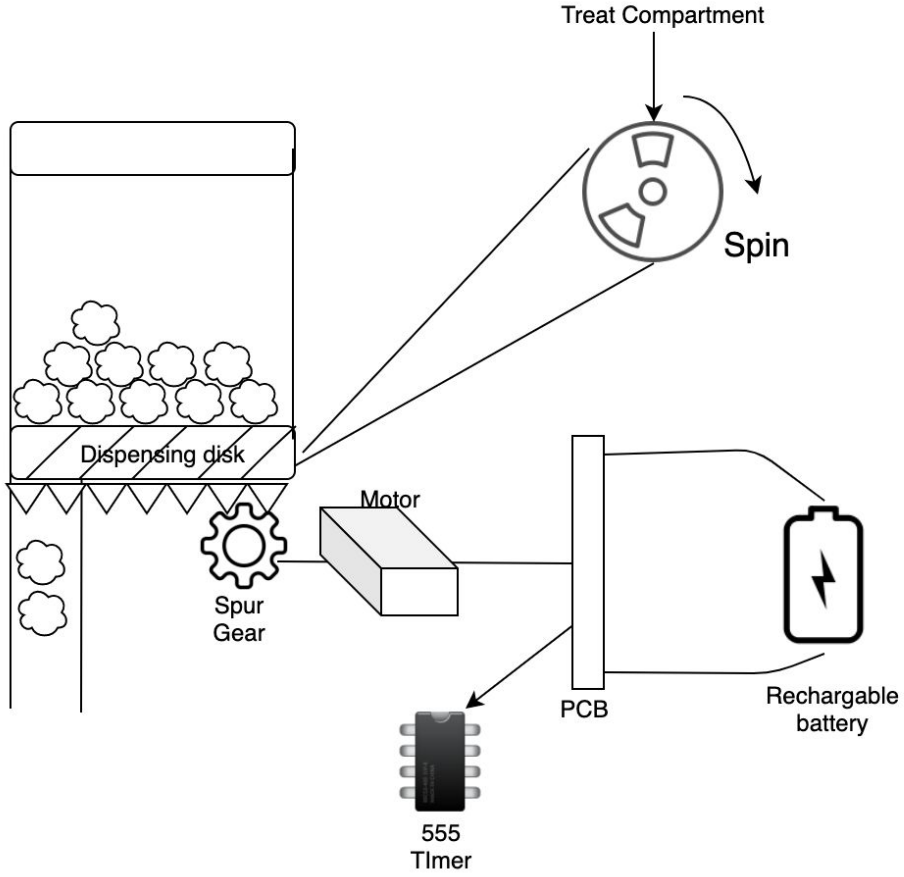
Function: Spin Dispenser Motor



Functional Architecture-Level 2



Technical Approaches-Design 1A



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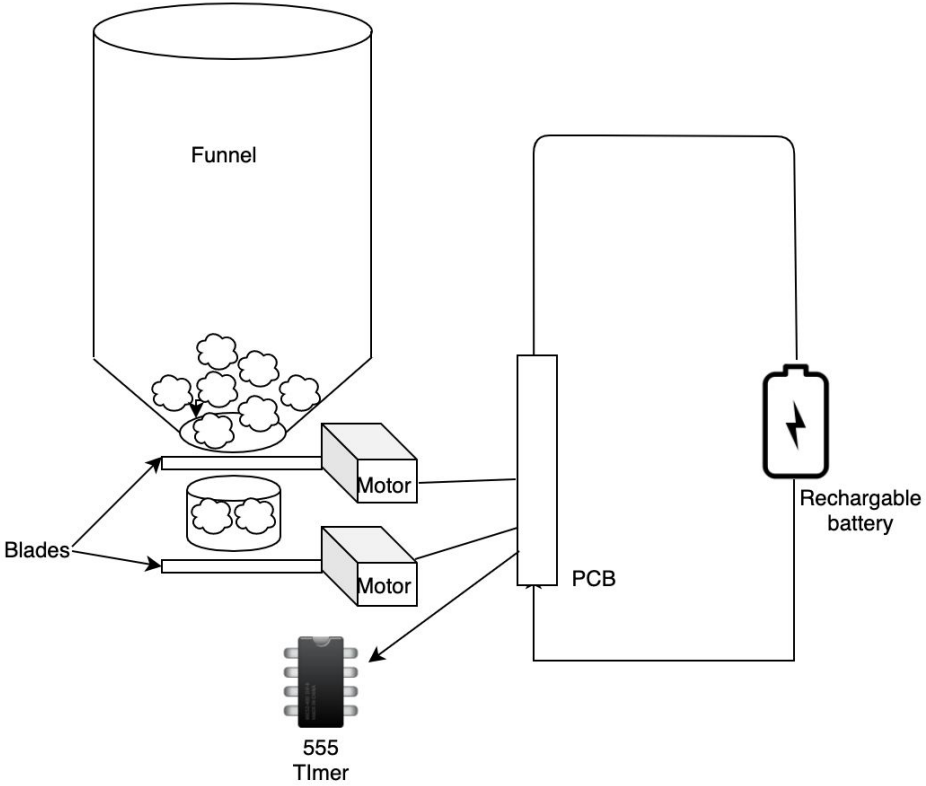
Technical Approaches-Design 1B



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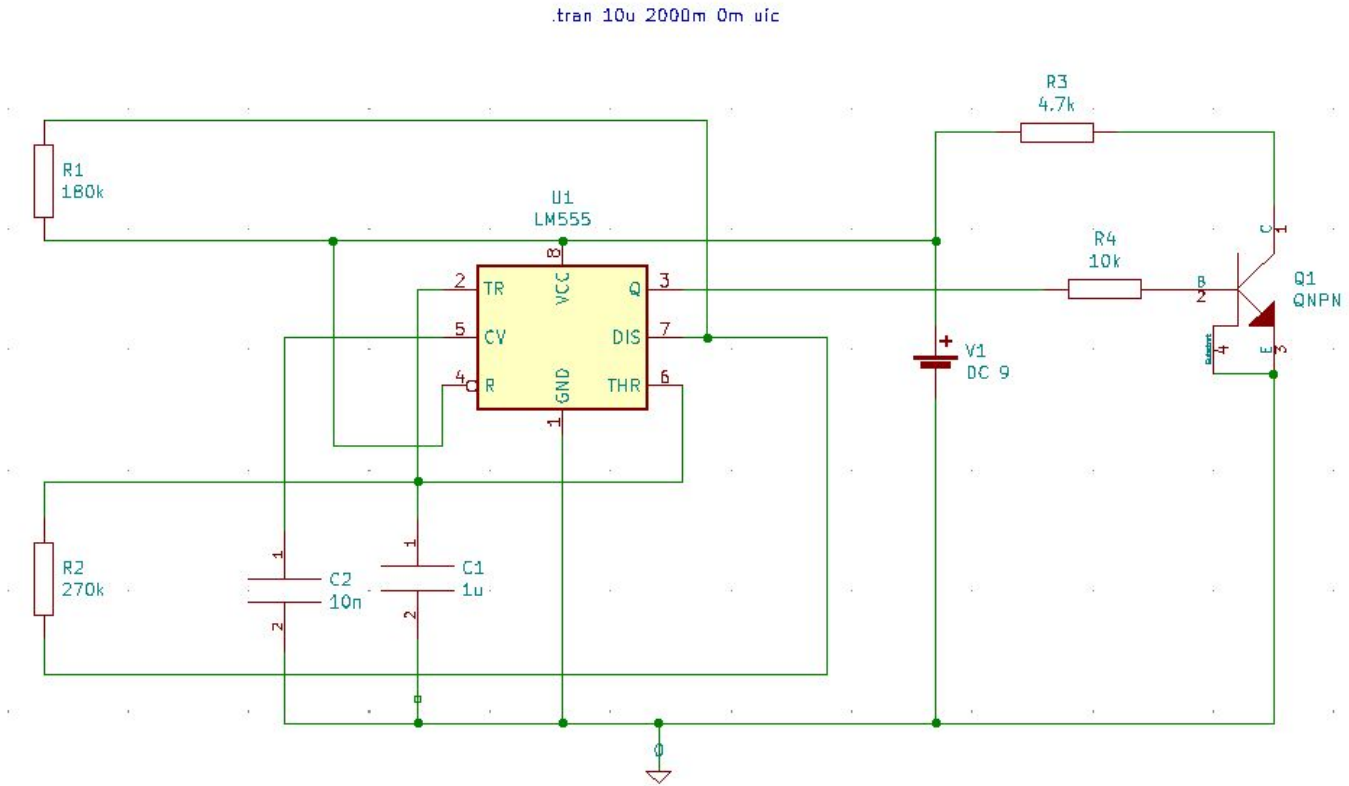
Technical Approaches-Design 1B



Circuit with 555 Timer

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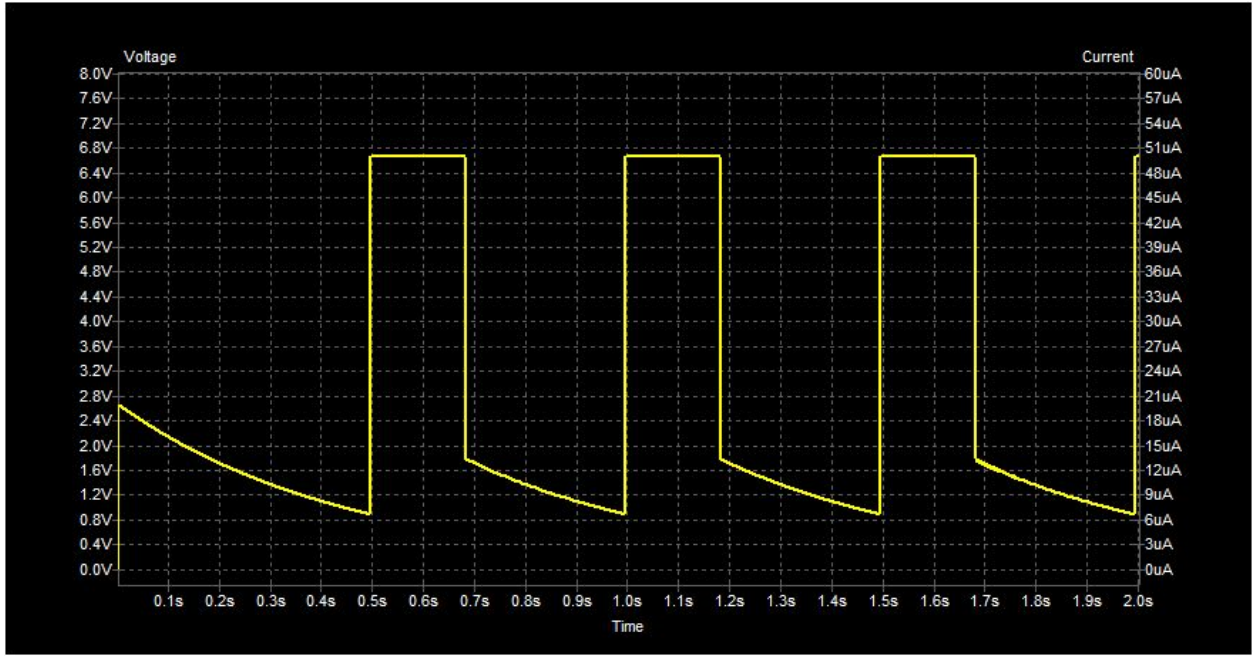
Technical Approaches-Design 1B



Waveform 1 for Circuit with 555 Timer

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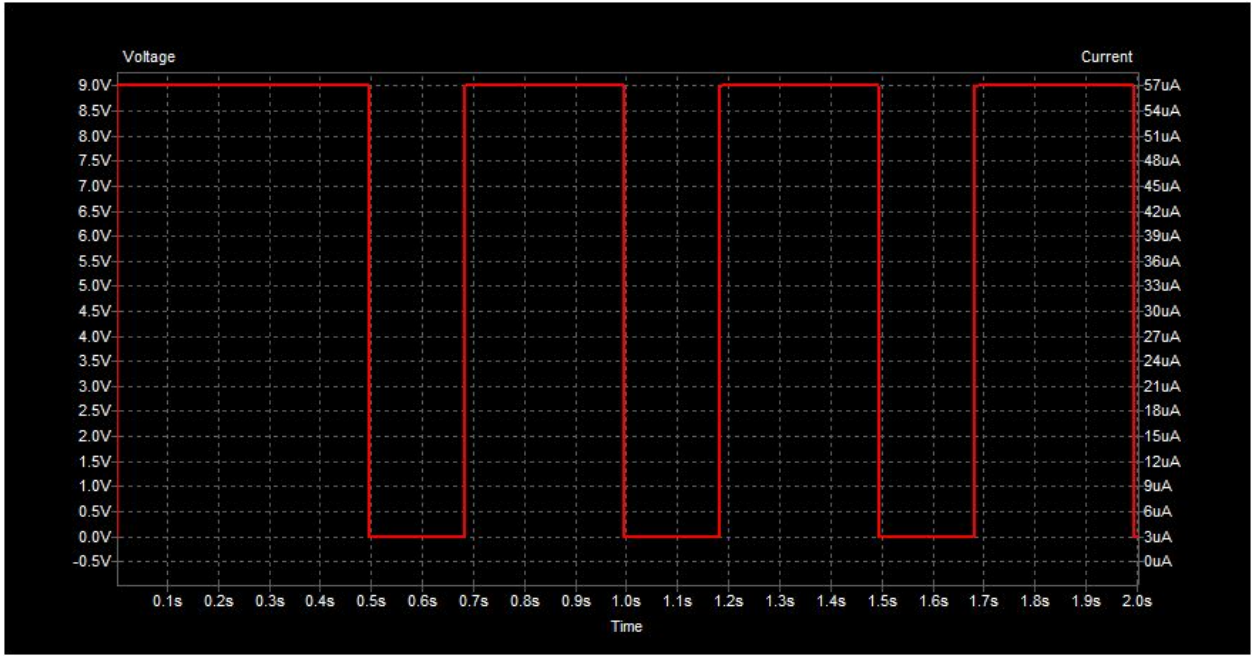
Technical Approaches-Design 1B



Waveform 2 for Circuit with 555 Timer

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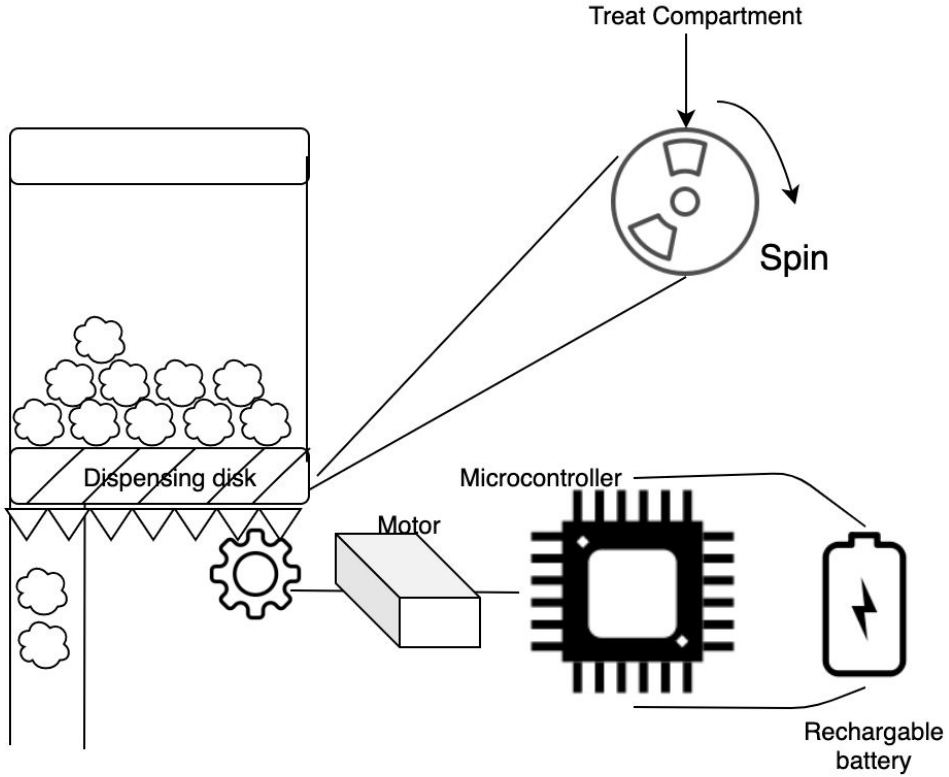
Technical Approaches-Design 2A



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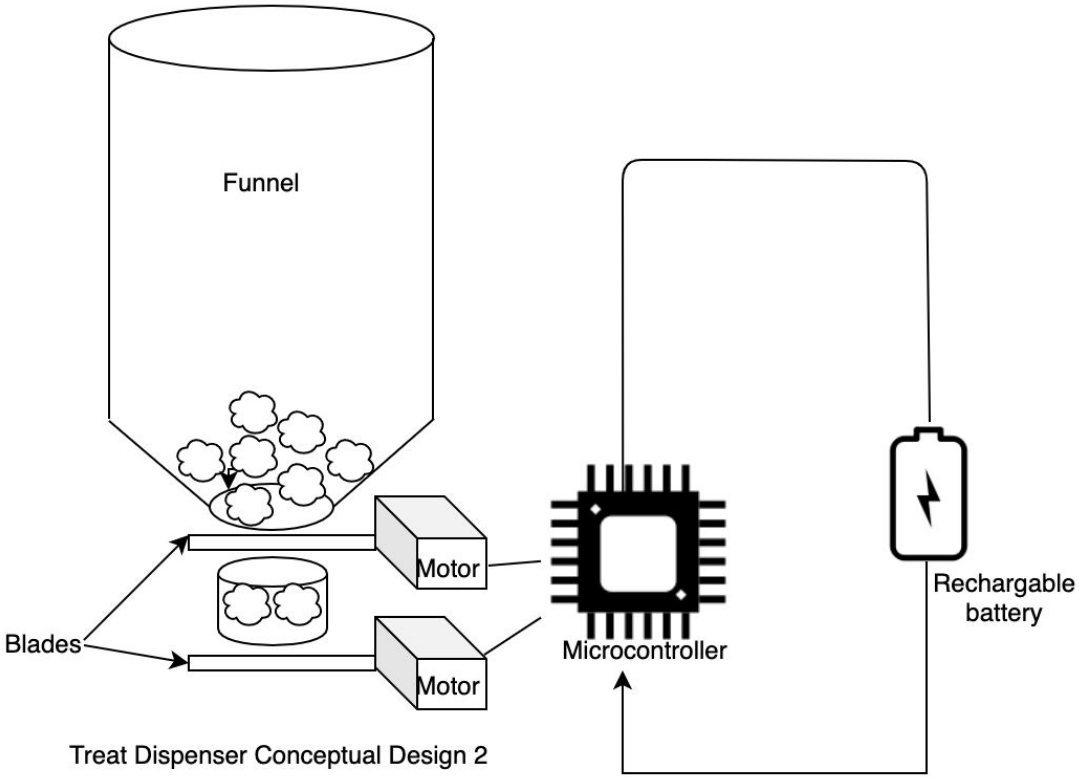
Technical Approaches-Design 2B



Treat Dispenser Conceptual Design 2

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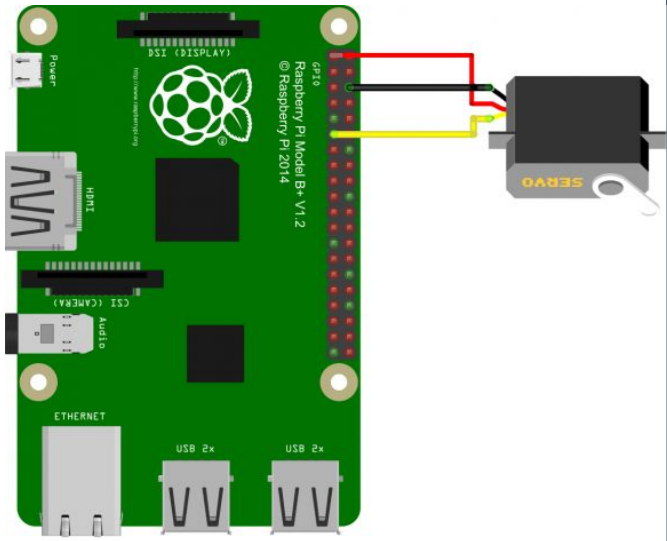
Technical Approaches-Design 2

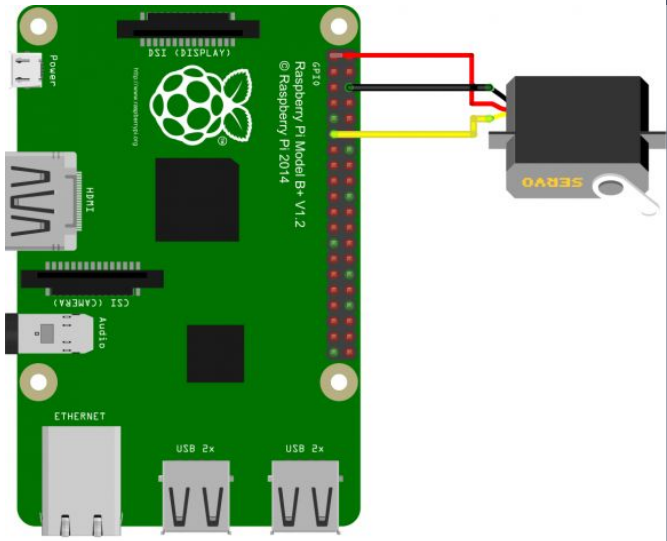
- The *Raspberry Pi* (a microcomputer) is better suited for software purposes than the Arduino (a microcontroller) which was used in previous designs.[14]]
- It is compatible with a motor that is strong enough to rotate the dispenser.
- It will be able to handle all of the features and functions of our design.



Servo Controlled by a Raspberry Pi

Technical Approaches-Design 2

- Cost of a Raspberry Pi is fairly cheap. As of today on Amazon and Micro Center the Raspberry Pi Zero (W) is $10.00 at MSRP.
- Leveraged by research groups like Los Alamos Lab [15]
- Raspberry Pi ZeroW minimum power input is 1.2A [16]



Servo Controlled by a Raspberry Pi

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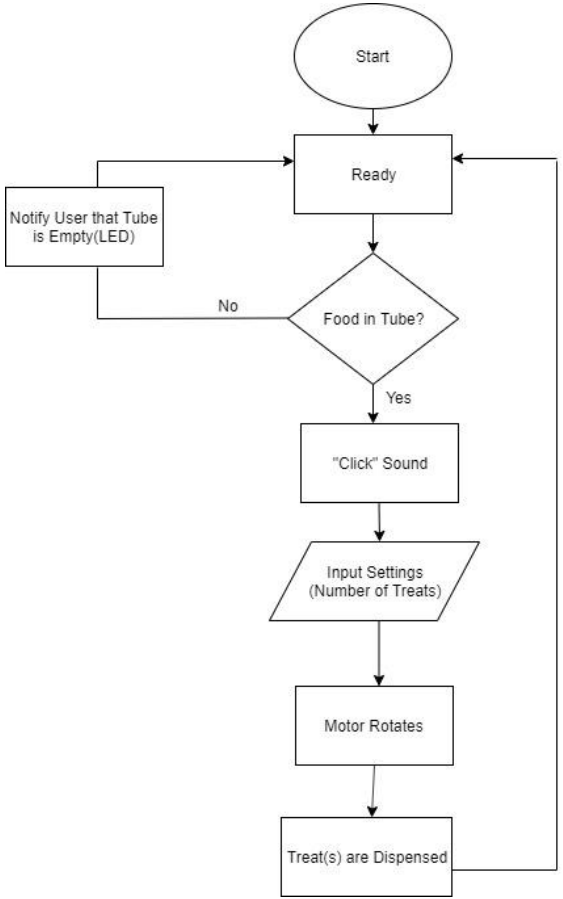
Technical Approaches-Design 2



Pseudocode for Raspberry Pi

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Power Requirements

Design A	Design B
• Waveform 1 was calculated to draw .5mW based off the 9V power supply and 50uA waveform • The motor will leverage is a FS90R which will draw 4W per activation of the motor [17]. • It has a maximum stall current of 650mA at 6V which will be at around 4W. • The final estimate of each sensor will add around 5W and the clicker activation will also draw around 5W as well. • The final estimation of the total power consumption will range from 20-30W total.	• The Raspberry Pi Zero W requires a 1.2A/5V Input which will draw 6W of power for the microcontroller [18]. • The team will also leverage additional LED's and sensors each estimating to be around 5W per addition. The final estimation of the total power consumption will range from 26-36W total.

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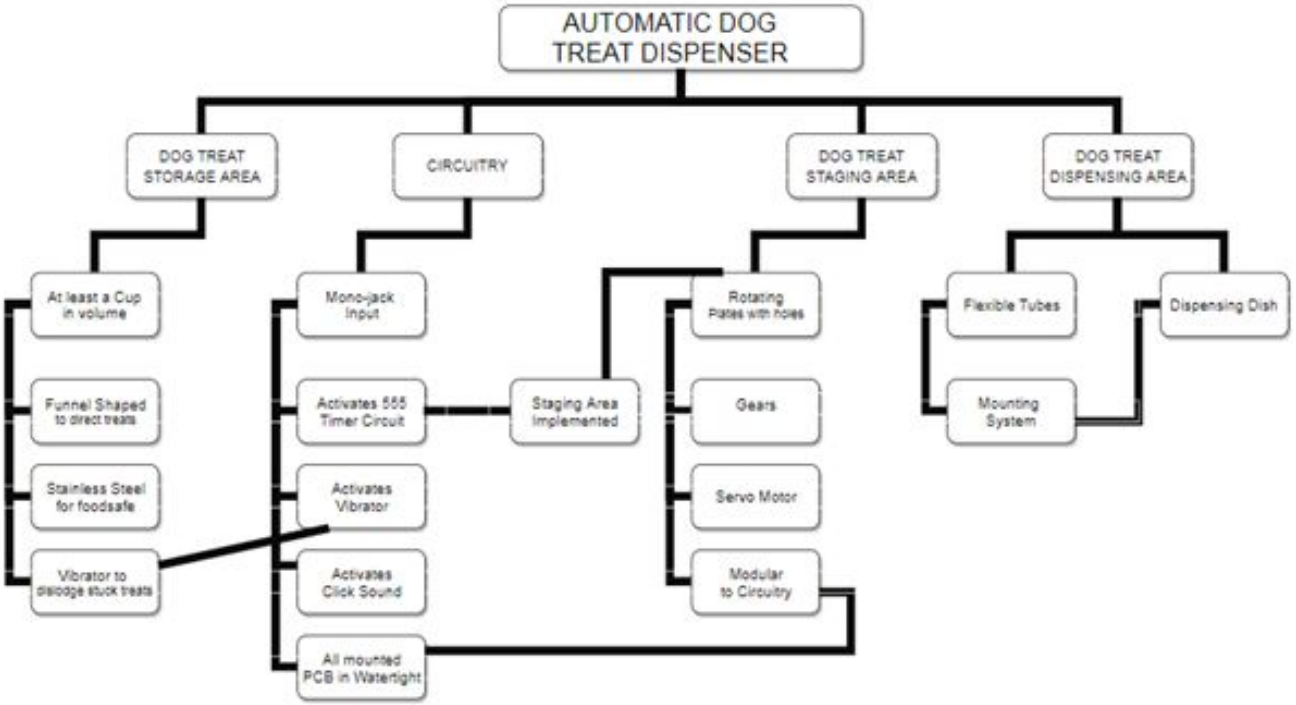
System Architecture



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Major Components

These components will act as the backbone of this project. Simplicity for reproduction.

- **555 Timer** ->Design 1
  (Power consumption 30 mW@5V)
- **Microcontroller**->Design 2
  (Raspberry Pi/ MSP430)
- **Servos/Motors**
  (1.5-5V DC)
- **Mono Signal Input**
  (3.5 mm Jack)
- **Food Safe Container**
  (Stainless Steel)

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Other Components

Rechargeable Battery
(Capacity: 3000-5000 mAh)

Food Storage Compartment
(Stainless Steel Funnel)

Stopper/Blades
(Stainless Steel)

Speaker
(1 Watt)

Mounting
(Universal Flexible Clamp)

Dispensing Disk
(Food Safe)

PCB
(Conformal Coated)

Dispensing Pipe
(Stainless Steel/ Food Safe PVC)

LED's
(Power Consumption 10-15 mA)

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Potential Problems and Design Considerations

CRITICAL

- Dispensed food must be stored in a food safe container at ALL times.
- Treat Dispenser must have self-unjamming method

IMPORTANT

- False positives cannot be tolerated to preserve dog-owner relationship.
- Multiple options for mounting dispensing device.

HIGH

- Modular parts that can be swapped out in the event that something breaks
- Dispenser battery life and having an easy to swap bay

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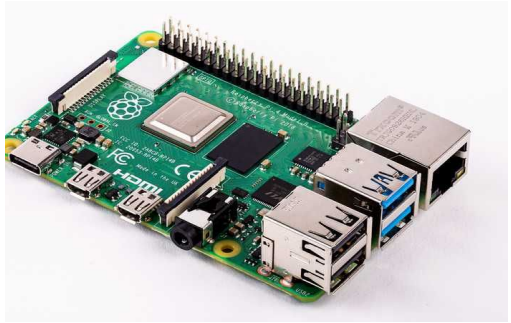
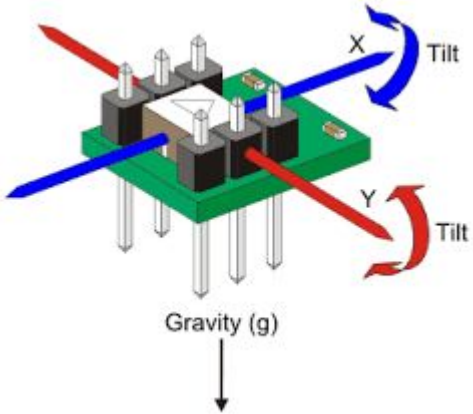
Skills to be Acquired

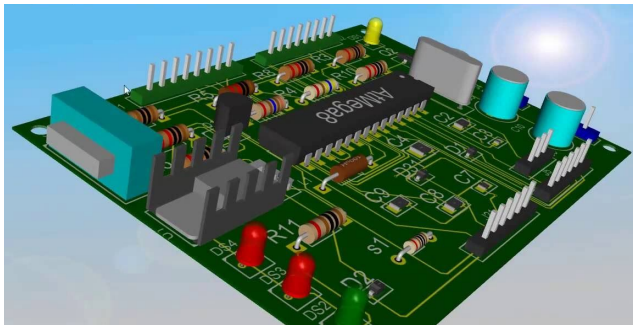
Microcontrollers

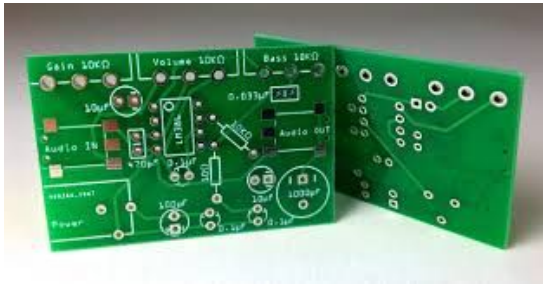


Sensor Analysis



PCB Design





Project Plan

To track this projects current status visit this website (http://treatdispenser.onmason.com/documentation-links/) and look at the Gnatt chart that will be updated with our progress every week.

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References

[1] "Disability Impacts All of Us Infographic | CDC." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html.

[2] J. D. Rutledge, "Animal Food and Treat Dispenser." U.S. Patent 6,988,464 B1, issued January 24, 2006.

[3] C. J. Brown, "Treat Dispenser." U.S. Patent 2003/0057228A1, issued March 27, 2003.

[4] Y. Y. Wang, "Treat Dispenser." U.S. Patent 2013/0233246A1, issued September 12, 2013.

[5] D. C. Franche, "Dog Food Dispenser." U.S. Patent 4,176,767, issued December 4, 1979.

[6] F. Depenthal, "Automatic Feeding Device." U.S. Patent 3,782,332, issued January 4, 1974.

[7] M. T. Johnson, "Pet Feeder System for a Handicapped Pet Owner." U.S. Patent 8,479,686 B2, issued July 9, 2013.

References

[8] W. Blaydes, “Dispensing Machine.” U.S. Patent 1,928,556, issued February 23, 1933.

[9] D. E. Robinson, “Automatic Animal Feeder.” U.S. Patent June 9, 1987.

[10] N. R. Lewis, “Pet Feeding System and Method of Using Same.” U.S. Patent 6,349,671 B1, issued February 26, 2002.

[11] K. Maclean, “Wheelchair-Mounted Dog Treat Dispenser,” *Wheelchair-Mounted Dog Treat Dispenser*. [Online]. Available: https://www.makersmakingchange.com/project/wheelchair-mounted-dog-treat-dispenser/. [Accessed: 16-Oct-2019].

[12] K. Neuber, “Treat Dispenser Project,” presented at the ECE 492 Initial Stakeholder Meeting, Aquia 235, 12-Sep-2019.

[13] M. Dzamab, “Device and Method for Dispensing a Treat.” U.S. Patent 2016/0227737A1, issued February 2,2016

[14] D. Patnaikuni “A Comparative Study of Arduino, Raspberry Pi and ESP8266 as IoT Development Board.” *International Journal of Advanced Research in Computer Science*, vol. 8, no. . 0976-5697, May 2017.

[15] “Scalable clusters make HPC R&D easy as Raspberry Pi.” [Online]. Available: https://www.lanl.gov/discover/news-release-archive/2017/November/1113-raspberry-pi.php. [Accessed: 22-Oct-2019].

References

[16] "FAQs - Raspberry Pi Documentation." [Online]. Available: https://www.raspberrypi.org/documentation/faqs/#pi-power. Accessed: 22-Oct-2019].

[17] "Continuous Rotation Micro Servo [FS90R] ID: 2442 - $7.50 : Adafruit Industries, Unique & fun DIY electronics and kits." [Online]. Available: https://www.adafruit.com/product/2442?gclid=Cj0KCQjw0brtBRDOARIsANMDykZM_o-SLs9Gf7AtLB_AFkEGiJs20nIDk34L36z1GMfcGGiof2Btzl0aAvcYEALw_wcB. [Accessed: 22-Oct-2019].

[18] "FAQs - Raspberry Pi Documentation." [Online]. Available: https://www.raspberrypi.org/documentation/faqs/#pi-power. [Accessed: 22-Oct-2019].

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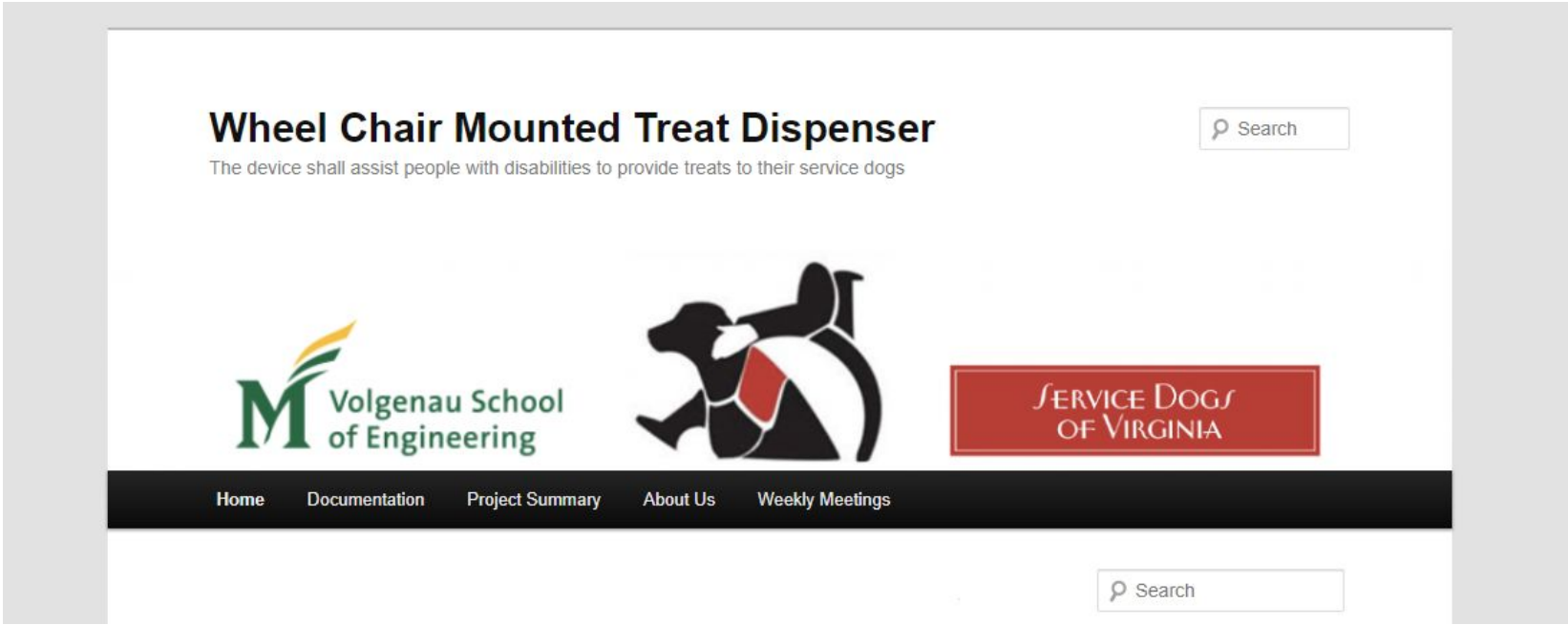

Website Link: http://treatdispenser.onmason.com/

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Acknowledgments

Dr.Nathalia Peixoto

Dr.Kristine Neuber

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