Automatic Cat Feeder

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Introduction

Problem Statement:

Cats are required to be on a consistent feeding schedule, which can be difficult to maintain when working long hours or traveling.

Our Approach:

Design an automatic cat feeder that keeps food cold and dispenses specific portion sizes periodically.

Key Design Points

Solution Reliability: Ensure consistent feeding schedule.

Temperature Control: Maintain food safe temperatures for cat food to last multiple days.

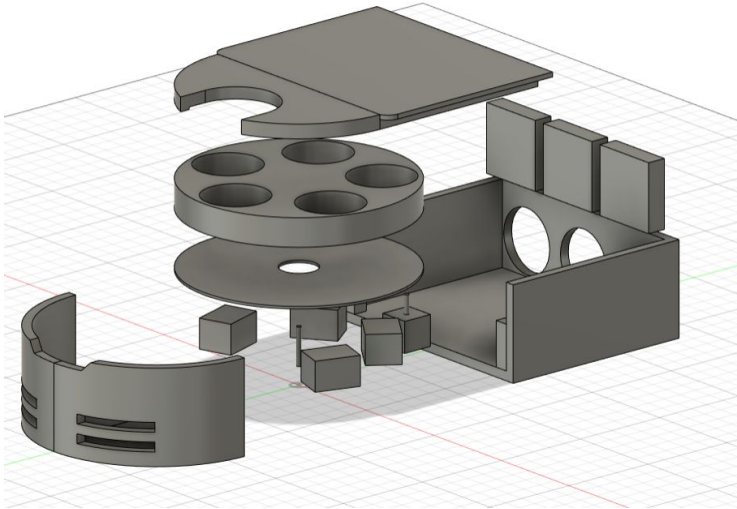
Quality Design & Build: Fits seamlessly into any home environment - long lasting construction.

Safety: Ensure no danger is present to animals during operation.

Project Summary/Steps Completed

Design & Manufacturing: Completed CAD modeling; begun woodshop work for the prototype housing.

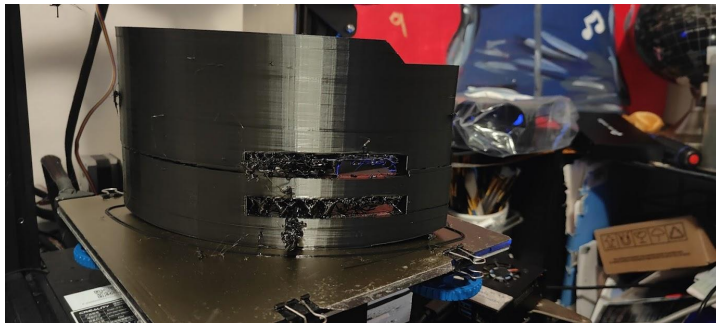
Electronics Setup: Wired Peltier devices in parallel for optimal power distribution. Wire disconnects have been added for testing purposes.



Steps Completed *(Continued)*

- Work is being conducted in the IME lab to CNC machine and assemble major portions of the prototype.

- Parts that can not be effectively made with subtractive manufacturing methods are made with 3D printing, such as the curved front of the housing.



Preliminary Testing

Ideal Height for Cat Feeder

Test Subjects:

- 95th & 75th weight percentile cats.

Procedure

- Fed cats in 2 different size groups at varying heights and observed which height was most comfortable for the cats to eat from.

Results:

- ~8”: both cats ate out of it with no issues.
- ~ 10.5”: 75th percentile cat did not eat; 95th percentile did eat. Cats had to extend uncomfortably to eat at 10.5”.

Conclusion: ~10” tall max, preferably 8” or below.

Cooling Rate of Pre-Built Peltier Fridge

Procedure:

- Measured the change in temperature and humidity inside the fridge, starting at ambient temperature, over a duration of 3 hours.

Results:

- Initial: 78.1°F, 44% RH
- Final: 44.1°F, 66% RH
- ΔT = 34.0°F, ΔRH = 22%

Peltier Data

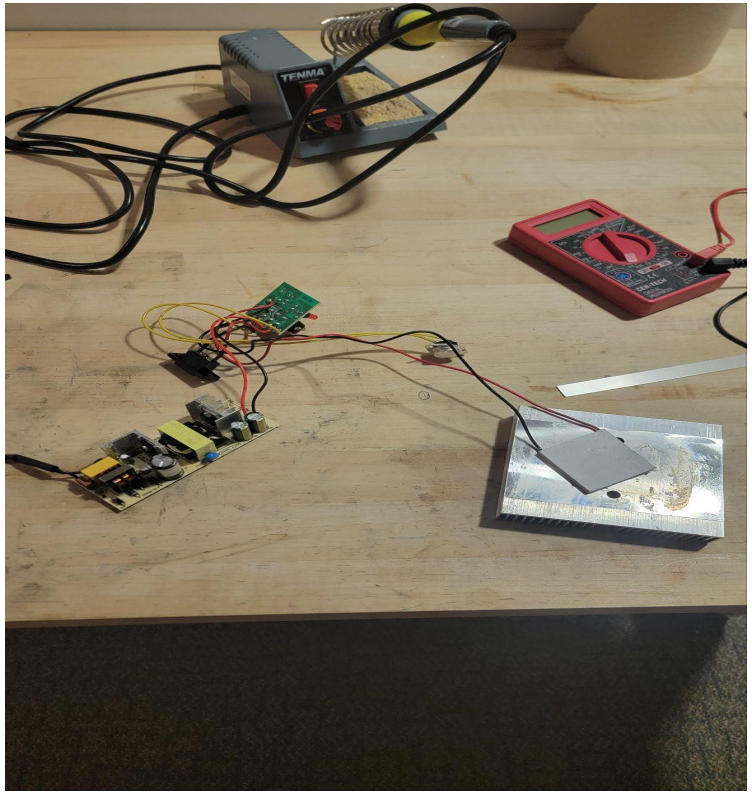
Peltier devices were recycled from fridges and connected in both series and parallel configurations to evaluate performance.

Series Configurations: 12V, 0.9A

Parallel Configurations: 12V, 2A

When connected in series, coolers overheated and drew significant overhead. Parallel was selected.

Acquired a 12V, 7A power supply to accommodate each Peltier device and all other components.

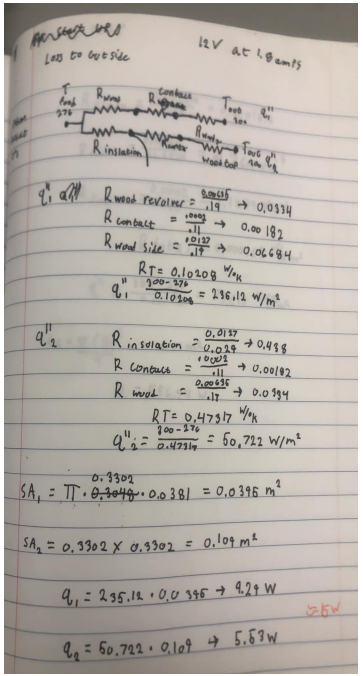


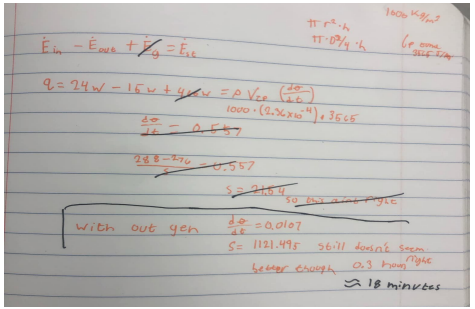
Analysis

Analysis

Calculations:

1. *Heat gained by can from surroundings:*
   - Approximately 15W
2. *Time to cool the can to 37 degrees:*
   - Approximately 20 minutes
3. Motor Sizing
   - Determined that the 23H22-2804S motor, with 169.93 oz.in of holding torque, should be more than sufficient for this application

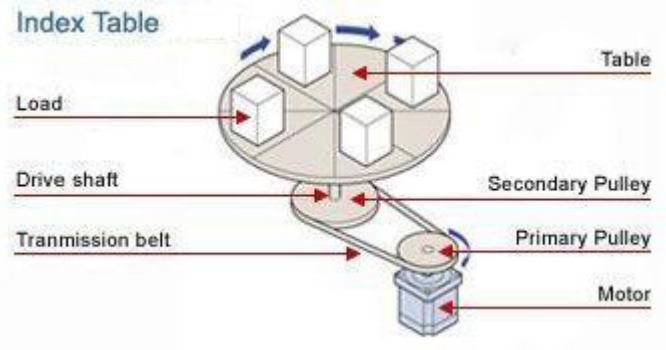


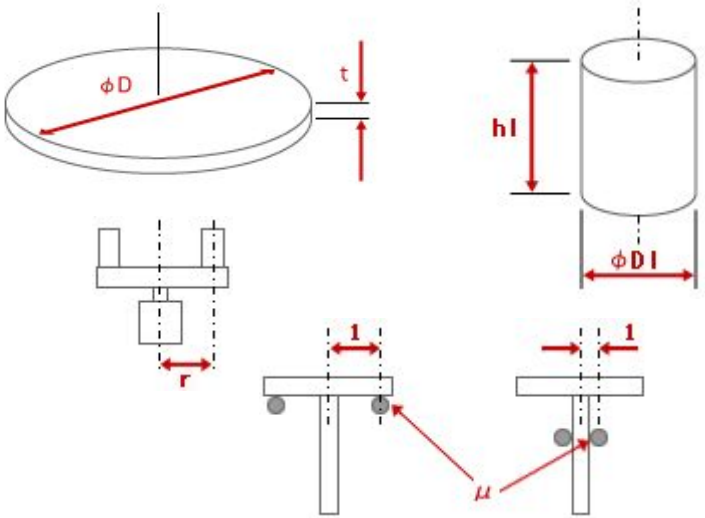


Motor Sizing Calculations

Sizing Results

Load Inertia	J_L	= 413.1	[oz·in^2]			
Required Speed	V_m	= 2.458	[r/min]			
Required Torque	T	= 2.243	[lb·in] =	35.88	[oz·in]	
RMS Torque	T_{rms}	= 2.199	[lb·in] =	35.18	[oz·in]	
Acceleration Torque	T_a	= 8.2643e-3	[lb·in] =	0.1322	[oz·in]	
Load Torque	T_L	= 1.113	[lb·in] =	17.81	[oz·in]	
Required Stopping Accuracy	Δθ	= 3.073	[deg]			





Challenges & Solutions

Power Management: Difficult to find optimal power supply and motor controller to run system.

Complexity & Limitations: Limited number of thermoelectric coolers can be mounted to the assembly to provide adequate cooling power with limited external heating to the housing. Simplicity preferred to reduce failure points.

Material Limits: 3D printed parts should be made with specific filaments in order to improve resistance to warping under sustained heat.

Upcoming Work

- Complete housing assembly
- Mount cooling plate with thermoelectric Peltier coolers and heatsinks
- Wire in Peltier coolers, fans, motor, and relevant controllers
- Test limitations of heatsinks to expunge heat from inner housing, establish temperature control ranges
- Test product on relevant cats

Upcoming Work - Electronics

- **Stepper Motor:** 23HS22-2804S
  - Amps / Phase : 2.8A
  - Recommended Voltage: 12V
- **Motor Driver:** Undecided (needs to match stepper motor specifications)
- **PSU:** PSR-7
  - Output: 13.8V @7A
- **Controller:** Arduino Uno Rev 3

Conclusion

- The cat feeder project is making satisfactory progress moving toward completion.
- Remaining parts to be completed should be ready in Week 10, as initially planned.
- Required functional parts are acquired, full prototype construction and integration are slated to begin week 7, with the completion of the housing.