Smart Snack Dispenser

ECE 445: Senior Design || Team #23

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Introduction

Problem

- 200+ unconscious food decisions daily
- Market lacks solutions
- Weight gain & unhealthy eating patterns
- Plastic waste of individually-packaged snacks

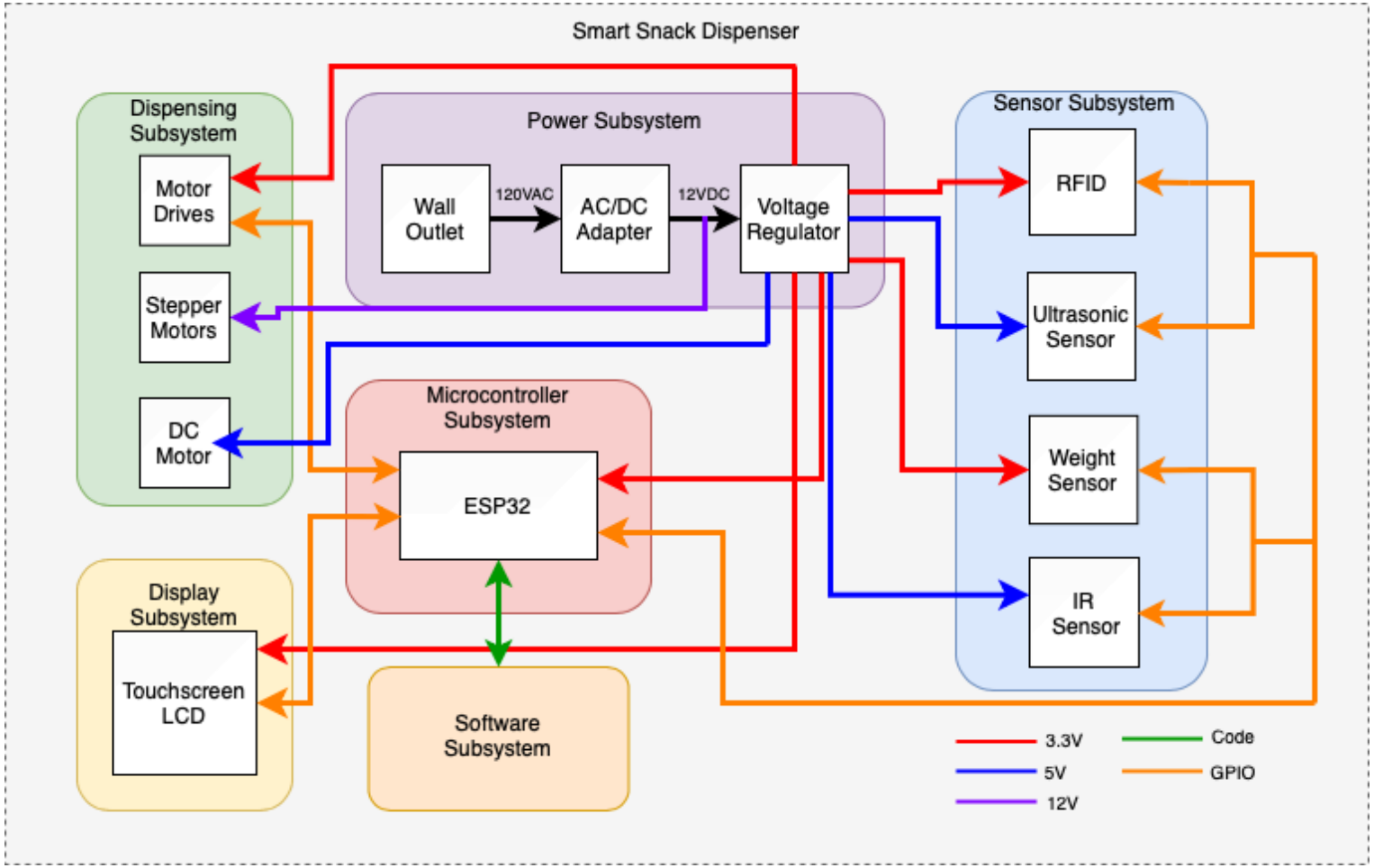
Objective

Our Solution: Smart Snack Dispenser

- User defined portions
- Home appliance
- M&M’s, peanuts, and Skittles
- Calorie tracking
- Diet management

Design

Block Diagram



High Level Requirements

- **Accuracy:**
  - 15% weight tolerance
  - Correct nutrient tracking
- **Speed:**
  - 30 seconds or less
  - Immediate user input response
- **Usability:**
  - UI smooth and organized
  - Intuitive

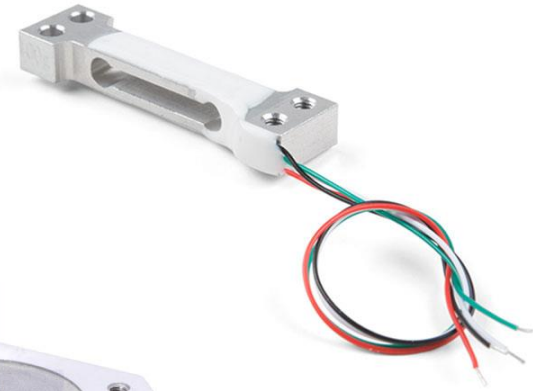
Components

TFT 4” Display

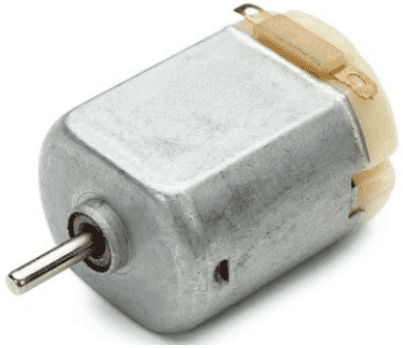
RFID Sensor

Ultrasonic Sensor

Load Cell



IR Sensors x3



DC Motor

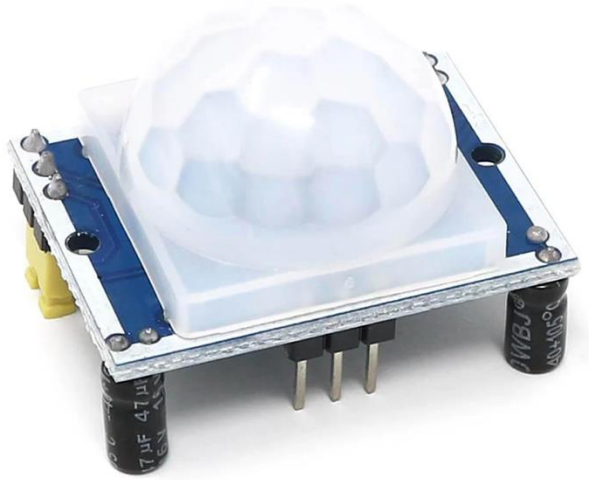
Stepper Motors x3

Design Changes

- PIR sensor → Ultrasonic Sensor
- Photoresistor → IR Break Beam Sensor
- Maximum Dispense: 100g → 70g
- DC Motor

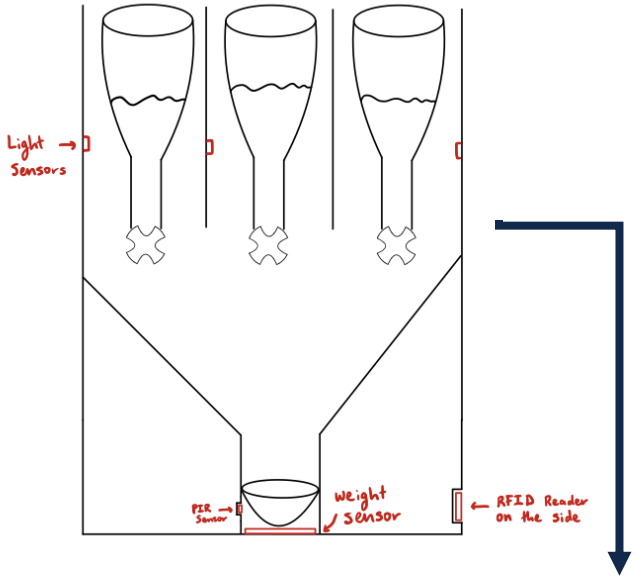
Photoresistor

PIR Sensor



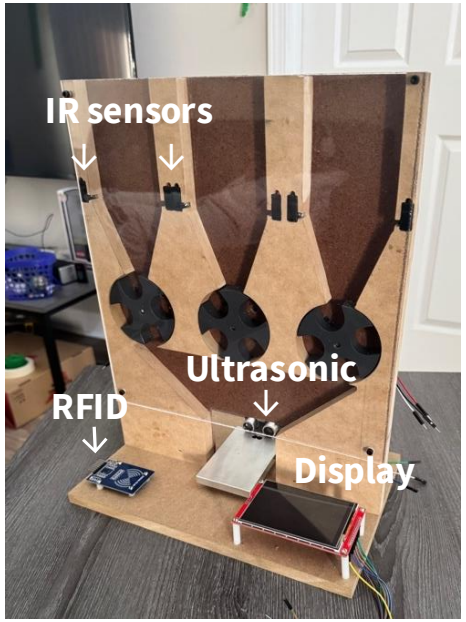
Physical Design

- Collaborated with Machine Shop
  - Alternatives:
    - Linear actuators (too big)
    - Auger screw (not advised)



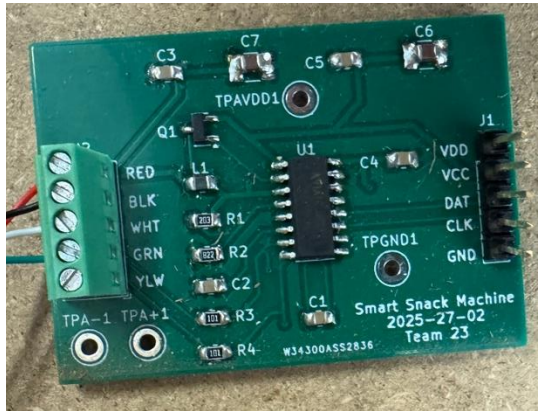
Auger Screw

Linear Actuator

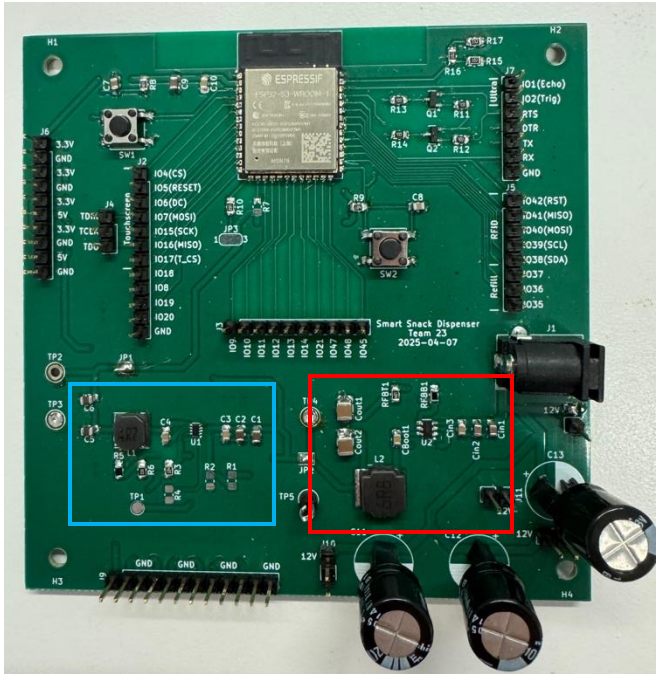


Hardware

- Two custom PCBs
  - Load Cell Amplifier PCB (Analog-to-Digital Converter)
  - Main PCB
    - ESP32-S3-WROOM-1 Chip
    - 12V to 5V Voltage Regulator
    - 5V to 3.3V Voltage Regulator



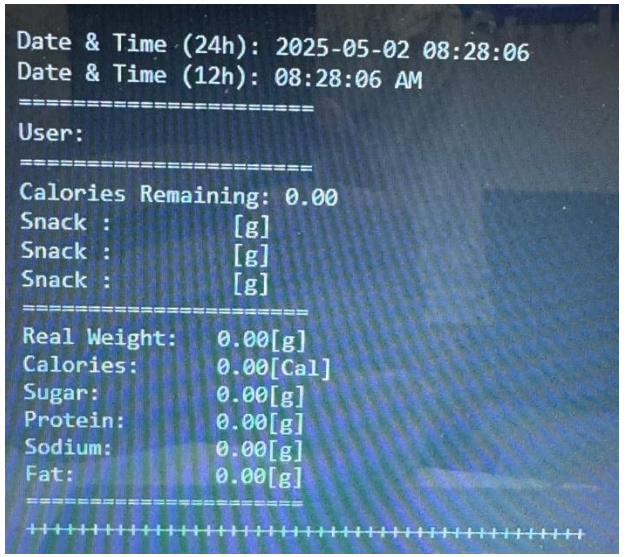
Load Cell Amplifier

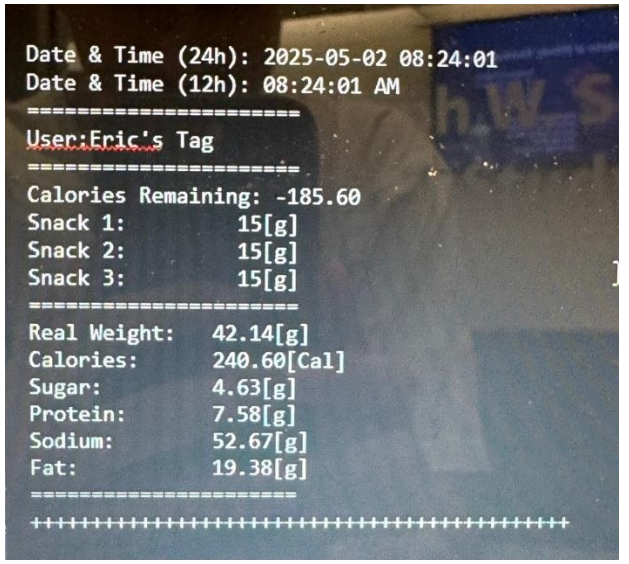


Main PCB

Software

- 15 custom functions
- RFID login → bowl detection → snack selection → precise dispensing & real-time feedback
- Features:
  - authentication
  - multi-snack selection
  - calorie tracking
  - user data logging





Video

Results

Dispensing Subsystem R&V

Requirements
Stepper motors must dispense snacks in 30 seconds or less
Wheels can produce a consistent number of pieces for each snack on average and minimize jamming
DC motor can spin fast enough to provide necessary vibration to avoid snack jamming

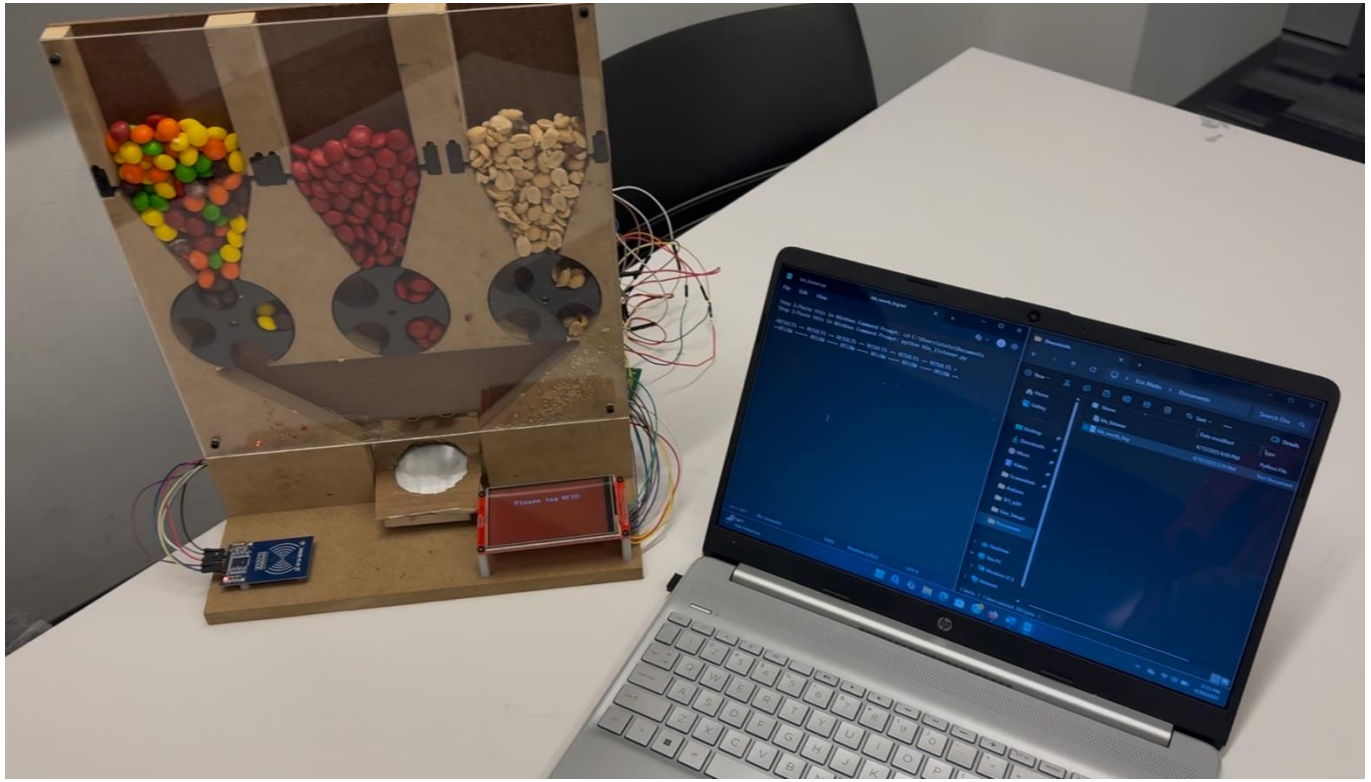
- Time verification: measured with a stopwatch
  - Average (with jams): 32.01 seconds
  - Best (no jams): 23.62 seconds
- Wheel and DC motor verification: qualitatively measured through observation

Dispenses of 70g that had jamming issues
37.35 seconds
30.30 seconds
31.40 seconds
31.37 seconds
30.17 seconds
32.37 seconds
31.12 seconds

DC Motor with small weight attached for vibration

Dispensing wheels and snacks inside machine

Microcontroller Subsystem R&V

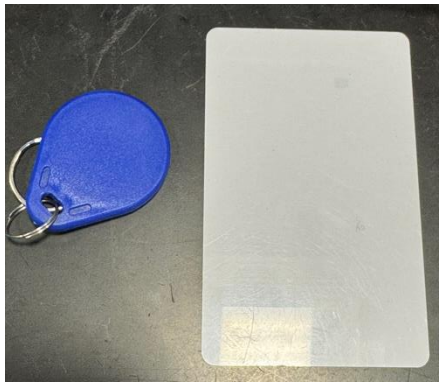


Requirements
All code will be stored within the ESP32 to ensure full independence
ESP32 must relay communication between subsystems when signals are sent through the GPIOs

Sensor Subsystem R&V: RFID

- Included two distinct RFID tags
  - White tag: Eric's Tag
  - Blue tag: New user

Requirements
RFID must read tag and display the correct information associated with that tag



RFID Tags

Eric's Tag Display

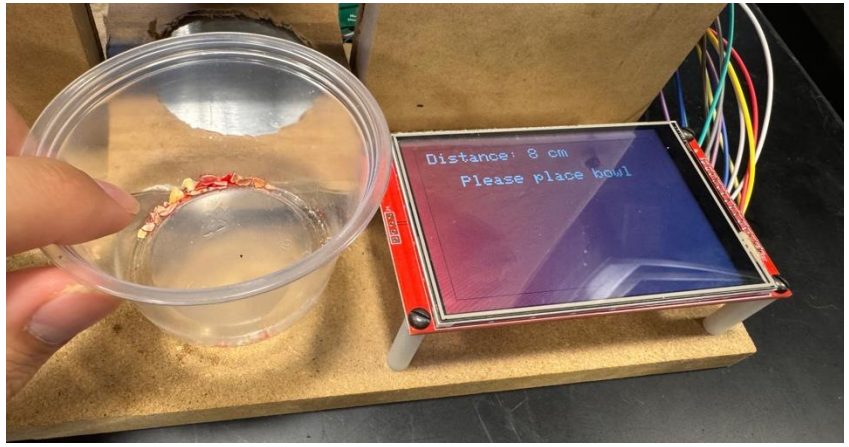
New user Tag Display

Sensor Subsystem R&V: Ultrasonic Sensor

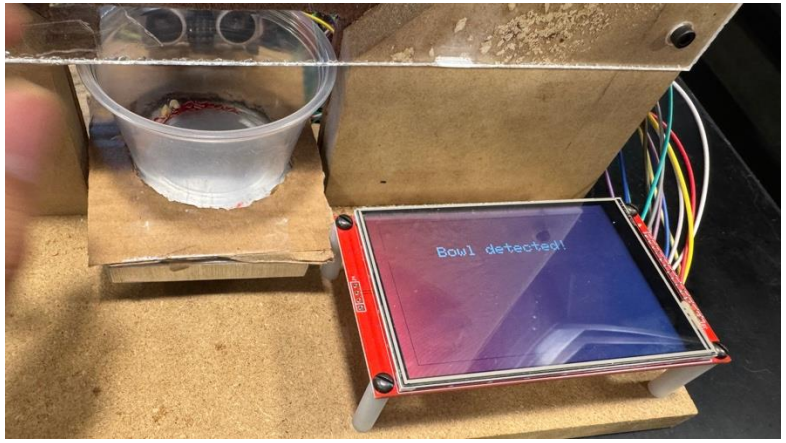
- Ultrasonic facing forward
- Bowl detected at 5cm

Requirements
Ultrasonic sensor must recognize when the distance is shortened due to the placement of a bowl

No Bowl



Bowl is put closer



Bowl in place

Sensor Subsystem R&V: Weight Sensor

- Compared entered portion on machine to the amount weighed
  - Equation: $\% \, error = \left| \frac{desired - measured}{desired} \right| * 100$
- Compared amount weighed to commercial food scale weight

Requirements
Weight sensor must measure the correct amount of weight within 15%
Weight sensor must tare the weight of the bowl

Bowl Tare

Sensor Subsystem R&V: Weight Sensor (Data)

M&M's

Entered Portion	Weighed Portion	% Error	Commercial Scale
15g	13.67g	8.87%	12g
22g	20.61g	6.32%	21g
70g	63.26g	9.63%	60g

Skittles

Entered Portion	Weighed Portion	% Error	Commercial Scale
15g	16.92g	12.8%	17g
22g	21.81g	0.864%	19g
70g	61.34g	12.37%	57g

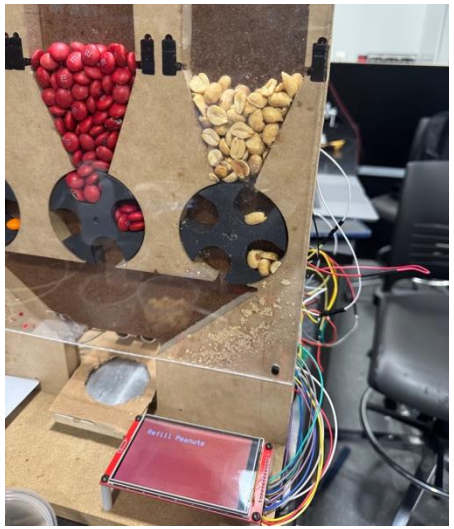
Peanuts

Entered Portion	Weighed Portion	% Error
15g	15.04g	0.267%
22g	21.5g	2.27%

Sensor Subsystem R&V: IR Sensors

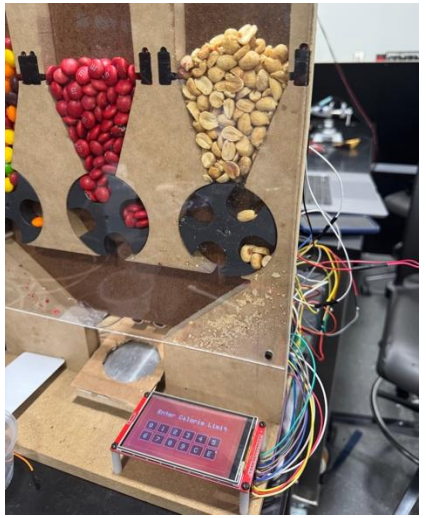
- Code checks IR sensors before each dispense
- User cannot bypass and must refill before dispensing more snacks

Requirements
Receiver must be able to sense the IR beam from across the length of the container
Receiver must not sense IR beam when snacks are present, so that a false notification is not sent



Snacks below IR sensors

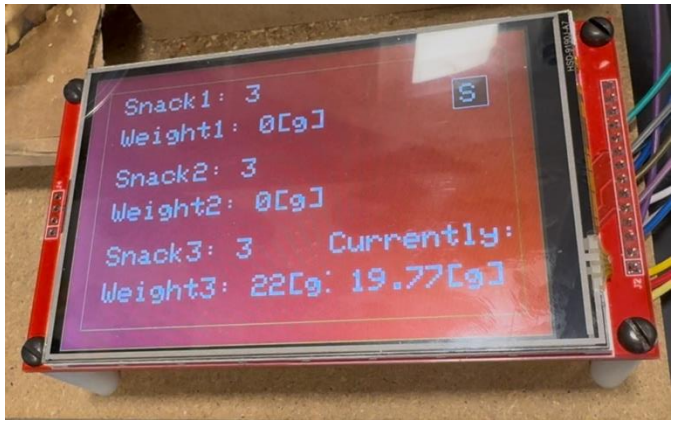
Refill Notification



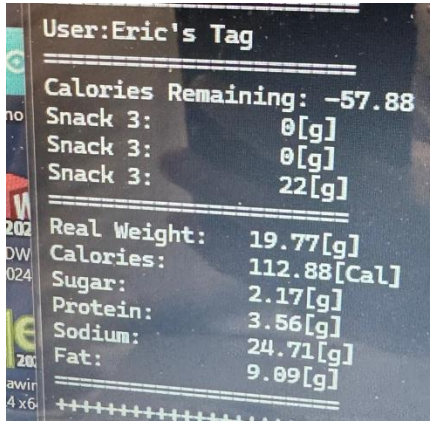
Snacks above IR sensors

Touchscreen LCD Subsystem R&V

Requirements
The LCD correctly shows values collected from various sensors
The display should be capable of user touch to be able to select a variety of options
The LCD should display the correct notifications when necessary



Touchscreen Display Information



Database Information

Software Subsystem R&V

Requirements
The machine should only display the features that the user has chosen
The machine must keep track of and display the correct nutrition values

- Features:
  - Snack info
  - Current nutritional values
  - Chosen snacks

Software Subsystem R&V

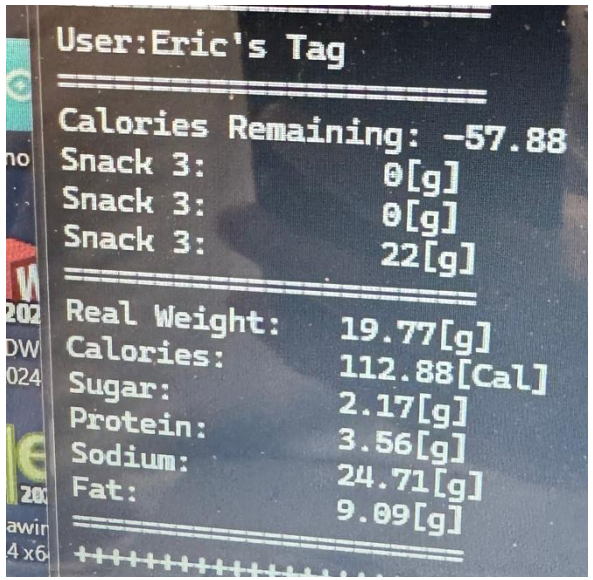
- Example Calculations: 19.77 g of peanuts
  - Calories: 5.71 * 19.77 = 112.88 Cal
  - Sugar: 0.11 * 19.77 = 2.17 g

```
Baseline values per gram ---
Snack Skittles
calPerG1 = 3.93;
sugarPerG1 = 0.75;
proteinPerG1 = 0.00;
sodiumPerG1 = 0.15;
fatPerG1 = 0.08;

Snack M&Ms
calPerG2 = 5.12;
sugarPerG2 = 0.64;
proteinPerG2 = 0.07;
sodiumPerG2 = 0.71;
fatPerG2 = 0.21;

Snack peanuts
calPerG3 = 5.71;
sugarPerG3 = 0.11;
proteinPerG3 = 0.18;
sodiumPerG3 = 1.25;
fatPerG3 = 0.46;
```

Nutrition per gram



Nutrition per portion

Power Subsystem R&V

- 12V Wall Adapter:
  - Average output: 12.03536V
  - 12 + 12(5%) = 12.6V
- 12V to 5V Regulator
  - Average output: 4.958612V
  - 5 - 5(3%) = 4.85V
- 5V to 3.3V Regulator
  - Average output: 3.340948V
  - 3.3 + 3.3(5%) = 3.465V

12V Wall Adapter	12V to 5V Regulator	5V to 3.3V Regulator
12.0355V	4.95875V	3.34102V
12.0354V	4.95842V	3.34086V
12.0353V	4.95853V	3.34098V
12.0353V	4.95856V	3.34092V
12.0353V	4.95880V	3.34096V

Requirements
Wall adapter must be able to provide 12V±5% and a maximum output current of 3A
12V to 5V regulator must be able to provide 5V±3% and a maximum output current of 3A
5V to 3.3V regulator must be able to provide 3.3V±5% and a maximum output current of 3A

Conclusion

Summary of Results

Success

- All sensors work effectively
- High level requirements were achieved
- Machine functions as an independent appliance

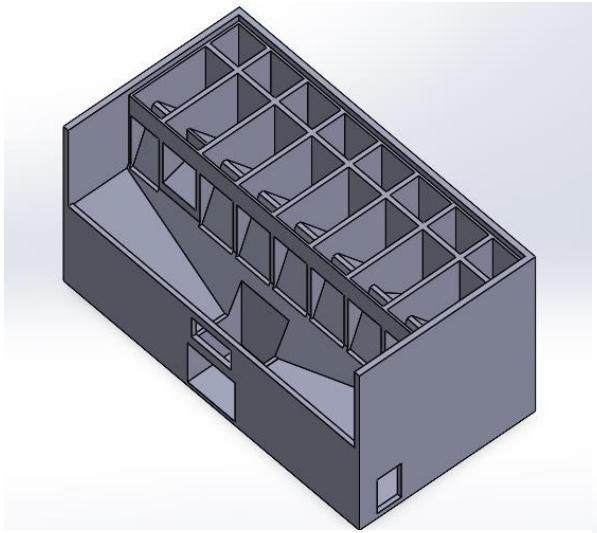
Challenges

- Snacks sometimes jam causing a longer dispensing time
- Wheel design limitations
- Limited snack shape

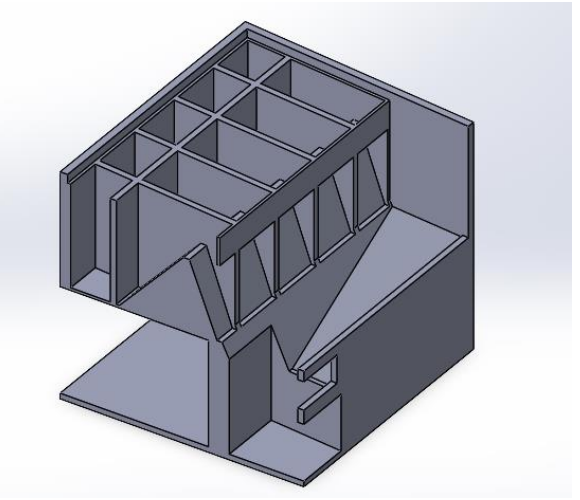
Future Work

Future Direction

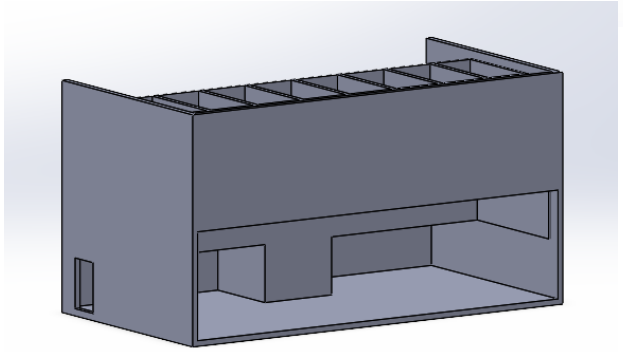
- 2D→3D
- More stock
- Improve dispensing to prevent jams
- Integrate mobile app



Front View



Cross Section View



Back View

Thank You