FoodSavr Proof-of-Concept Demonstration

By Savr Robotics

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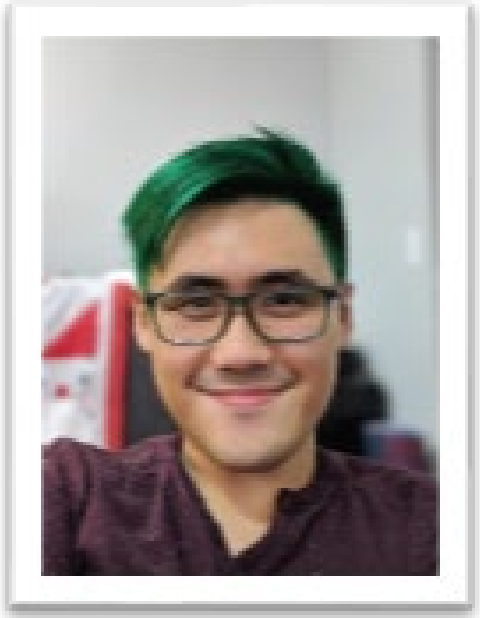

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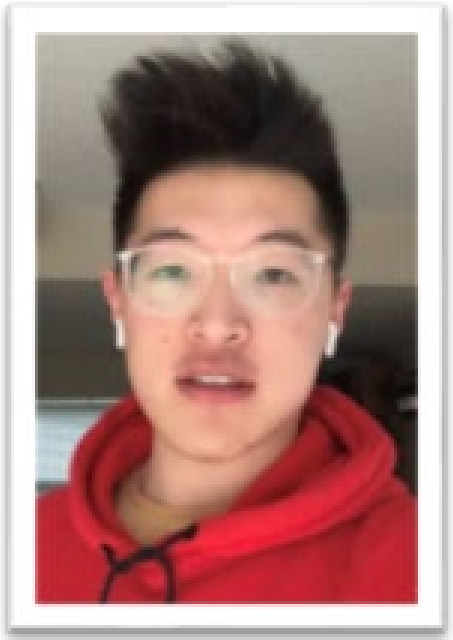

Jay Zhao
Chief Operating Officer

THE TEAM

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Motivation

- Consumers have access to a wide variety of food products in today's society
- Retailers encourage large quantities by offering discounted prices
- FAOUN estimates 1/3 of all food products are wasted [1]
- In North America about 40% of food waste is due to the consumer and 60% due to production and life cycle
- Landfills with food waste decompose and release methane gas
  - One of the largest contributors to greenhouse gasses [2]

FAOUN - Food and Agriculture Organization of the United Nations

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Introduction

- The FoodSavr is designed to combat food waste on the consumer front
- Allow a user to easily track what food items they have in their home
  - Autonomously scan for the barcode to identify the product to prevent multiple purchases
  - Autonomously scan for the expiration date to track possible spoilage
  - Mobile friendly pantry list
- User can plan meals better and waste less food!

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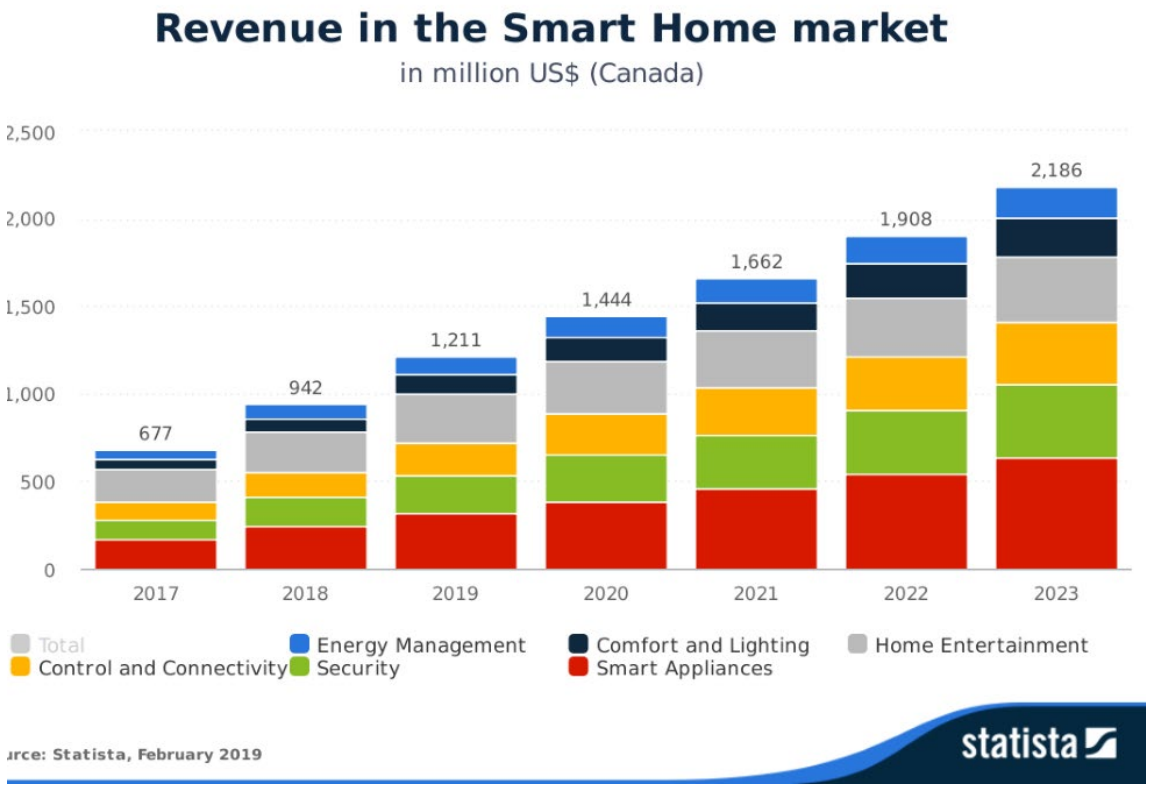
Market



- Targeting Smart Home Market
- The revenue for smart home appliances in 2018 was 241.1 million US dollars [3]
- Projected growth to 634 million US dollars in 2023 [3]

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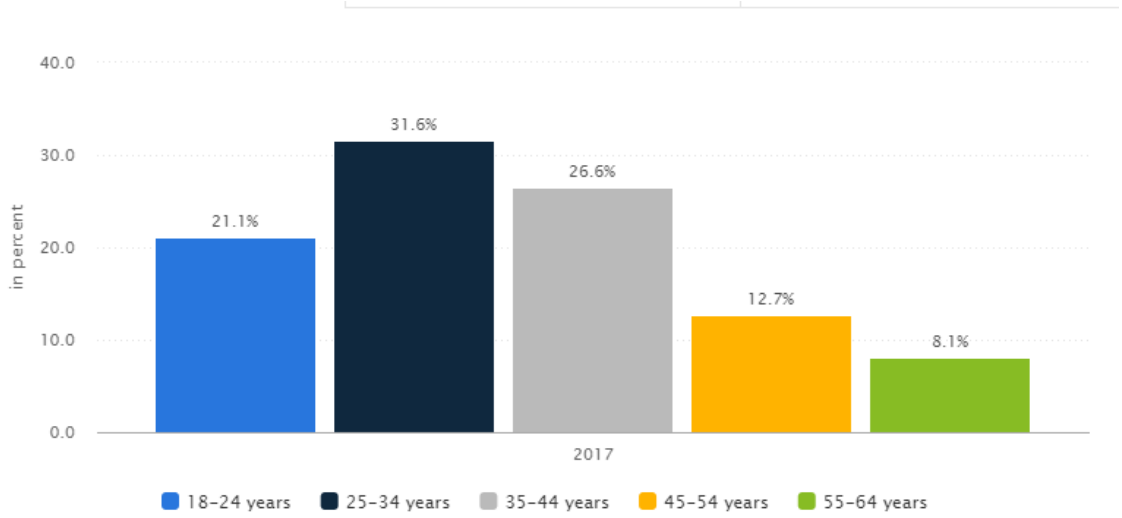
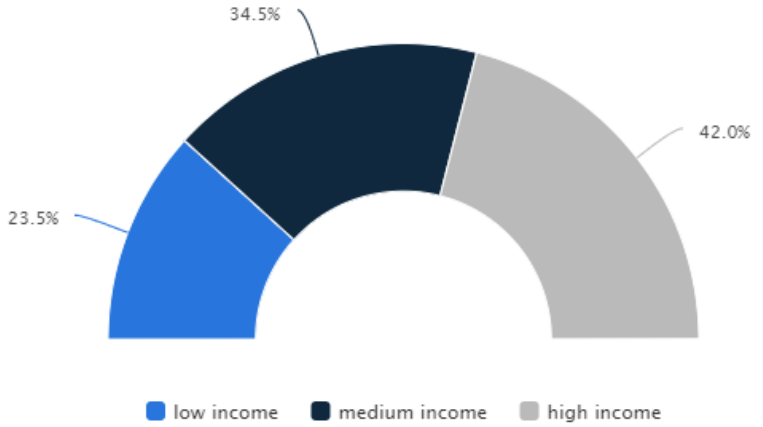
Target Market

- Based on the data from the Statista's Global Consumer Survey the majority of our target users (79.3%) are between the age of 18-44 years old [3]
- 76.5% of our target users in the medium and high income class [3]





Ideal User

- From the demographic research of our customers over 75% will be between ***age 18-44*** and in the medium to high income class
- Our ideal user will be tech orientated and will want a device to help keep track of their groceries through their busy life
- Our product aims to be fully autonomous system where the user will only need to place the item down and all item information will be send to a online user-interface
- They can access this online grocery inventory on their smart phones and on their computers

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Competition

- There’s currently no product on the market which offers the exact same service as our product, the closet product to our product is the **GeniCan** ($150 US) []
  - Product attaches to any garbage can or recycling bin for scanning when disposal
  - Contains voice recognition for products which doesn’t contain bar code
  - Sends all scanned item to an online list

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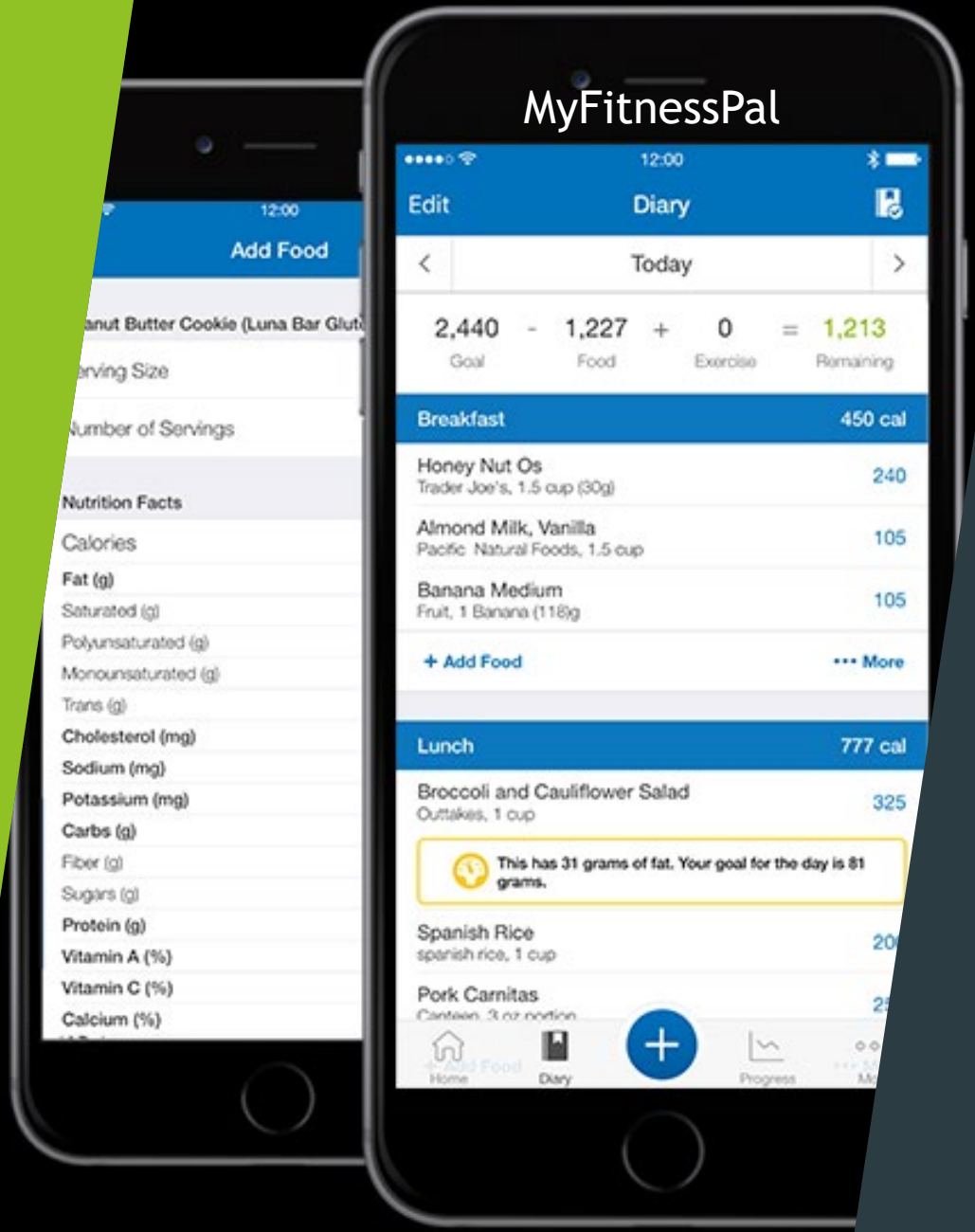

Competition

- Indirect competitions include
  - **MyFitnessPal:** smart phone app for food tracking and providing nutritional facts (free)
  - **Out-of-milk:** smart phone app to used for scanning items to add to shopping list (free)
- Both of these apps require user to scan or enter food items manually, our product aims to provide this process autonomously

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Finance and Pricing

- We plan to price our unit at $250 CA
- For our proof of concept for one unit was $372
- We can bring this price down when mass producing
  - Instead of 3D printing the mechanical arm components we will have mould for each arm component
  - The two Processing units used for prototyping can be changed to a single chip

	Component	Total Cost
Processing Units	Raspberry Pi	$35
	Arduino Leonardo	$25
	Raspberry Pi WIFI Shield	$50
Sensors	Ultrasonic Sensor x2	$15
	Raspberry Pi Camera	$30
Actuators	Hitec HS-645MG Servo Motor	$40
	Hitec HS-422 Servo Motor x3	$45
Electronics	LEDs	$5
	Prototype Board	$5
	Power Outlet	$10
Mechanical	Custom Design 3D Printing	$100
	Ball bearing	$12
	Total	$372

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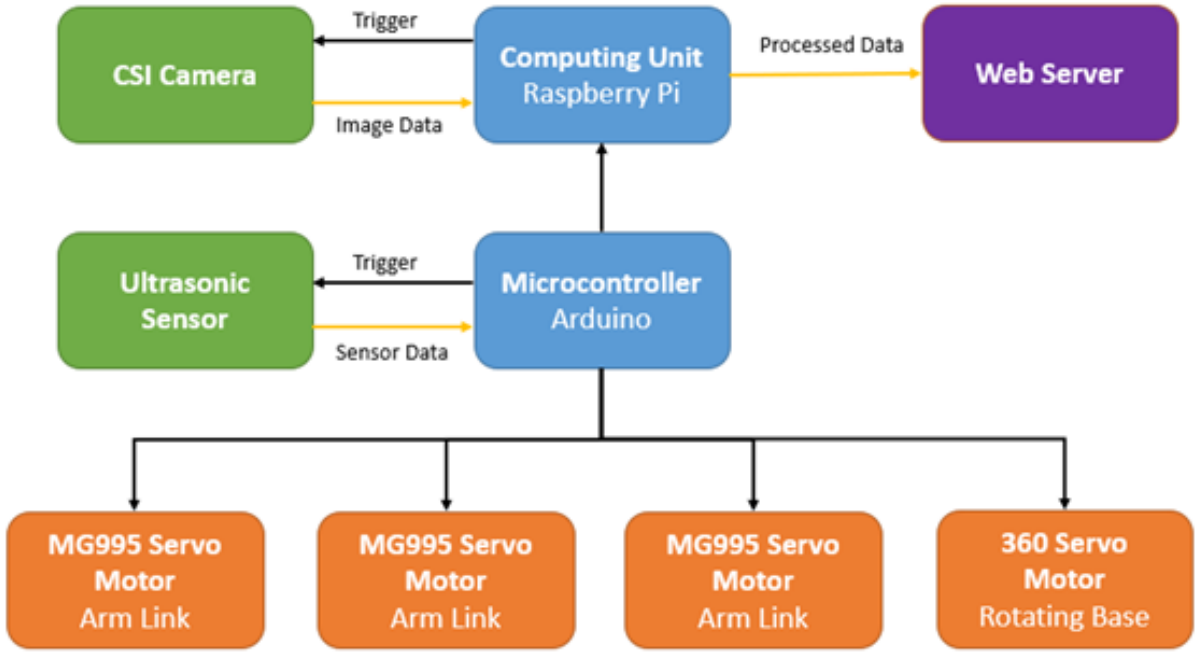
System Overview



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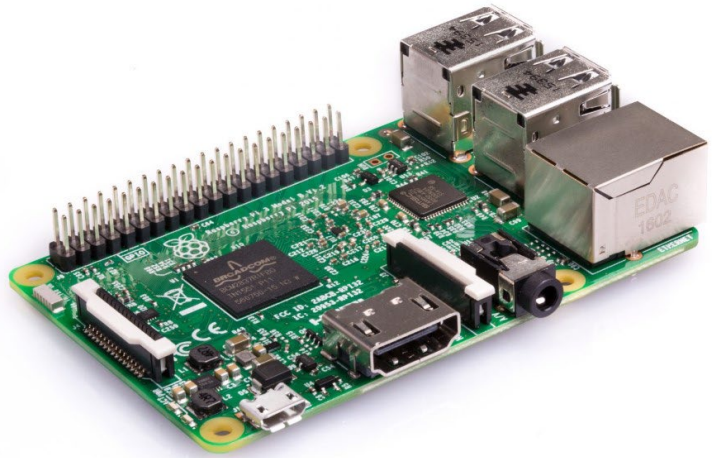
Main Computer



- Raspberry Pi 3 Model B
- Used for capturing and processing images of food item
- Processing of images for barcode and expiry date extraction
- Uploads processed data to web server for user inventory
- Connected to home network through WiFi

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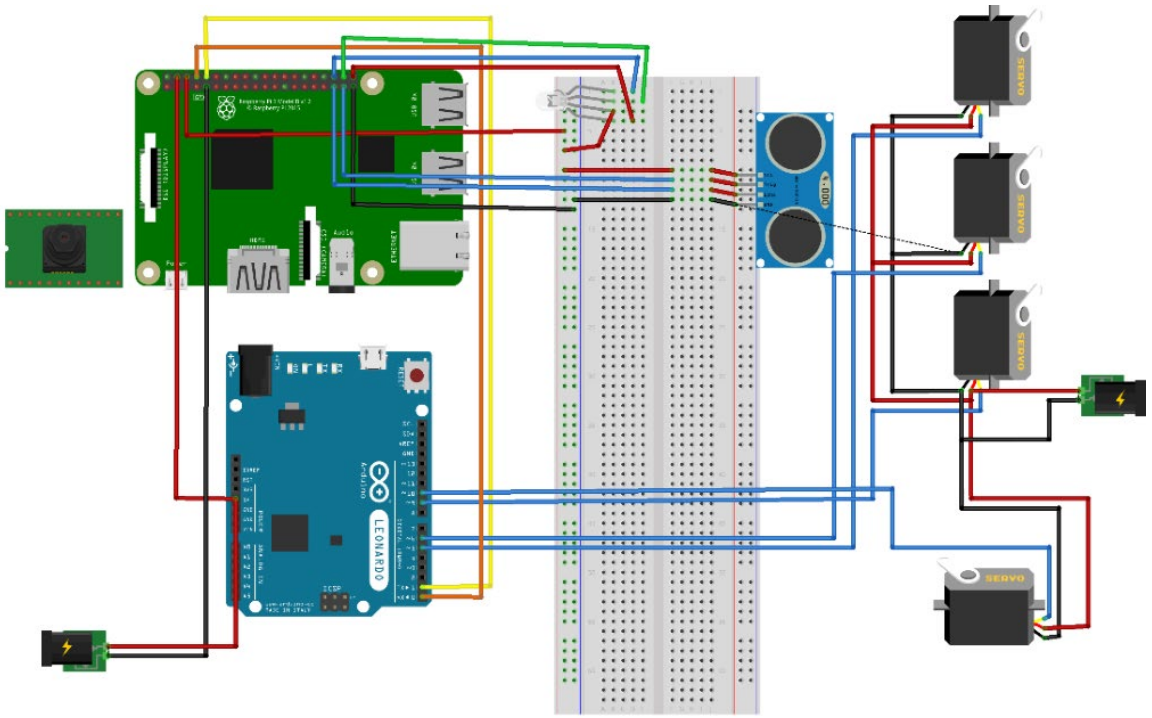
Microcontroller



- Arduino Leonardo used for controlling sensors and motors
- Listens for signal from ultrasonic sensor
- Determine when to start scanning procedure
- Responsible for driving arm motors and the rotating base
- Interfaces with Raspberry Pi through USB
  - When to capture image

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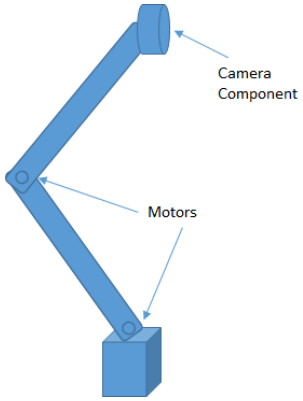
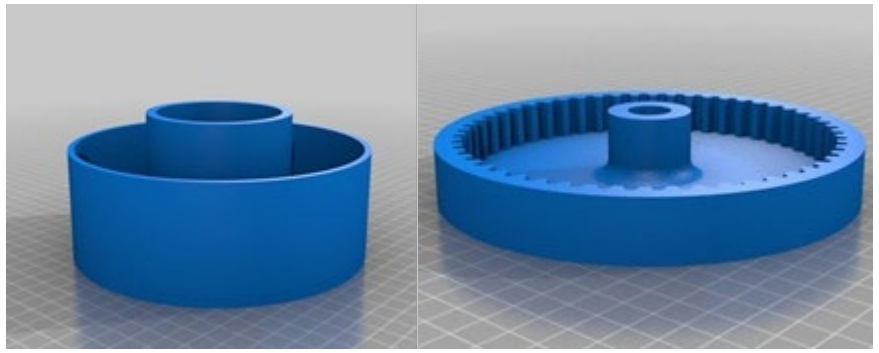
Mechanical Design





- Two main components
  - Rotating Base
  - Robotic Arm
- Rotating base driven by a 360 Servo Motor
- Robotic arm contains two links and 3 motors
  - 2 motors controlling arm
  - 1 motor to control camera orientation
- Model is 3D printed in PLA
  - Sustainable, food safe material to follow cradle to cradle philosophy [4]

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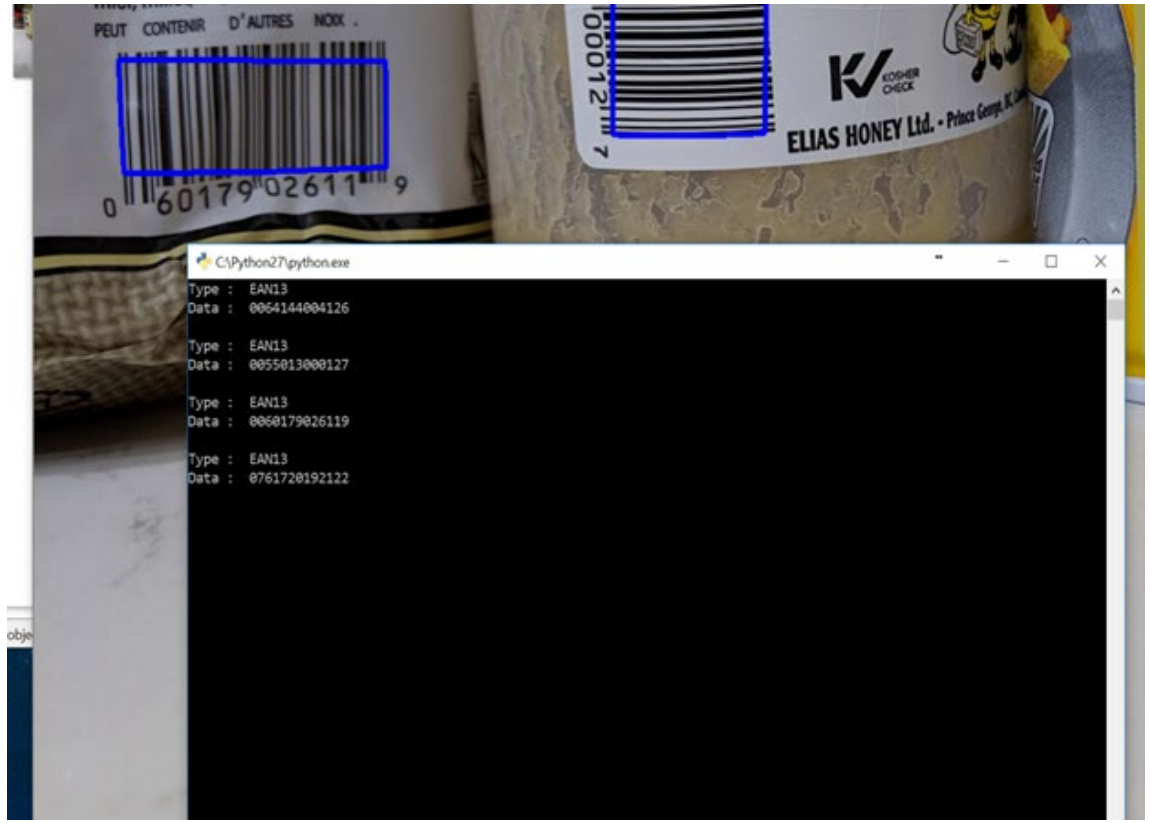
Barcode Extraction



- Once image has been captured, process the image to extract the Barcode
  - Zbar Python Library
  - Processing done locally
  - Returns a UPC for the item
- Query Semantics3 database using UPC
  - Returns JSON object containing detailed product information
  - A comprehensive database is needed, maybe ,multiple databases

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Expiry Date Extraction


```
Start Time: %s  1552504824.5818286
End Time: %s  1552504829.0516992
Total Time Elapsed: %s 4.469870567321777
P18 2019
1251329
MR 17

{'vertices': [{'x': 593, 'y': 2357}, {'x': 2145, 'y': 2357}, {'x': 2145, 'y': 2777}, {'x': 593, 'y': 2777}]}
```

- Once image captured, process image to extract the expiry date
- Pass image through smoothing filter
  - Pillow Python Library
- Send request to Google Vision (API) containing the image
  - Returns JSON object containing all text found in image
- Process text for expiry date using regular expression

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Standards

- Since our product is in the proof of concept phase we followed the standards listed:
  - **WIFI: IEEE 802.15.1:** IEEE standard for implementing wireless local area networks between computers in the 2.4 Ghz and 5 Ghz range
  - **ROBOTIC COMPONENTS: UL 1740** Standard for Robots and Robotic Equipment [5]
  - **DATA PROCESSING: ISO/IEC JTC 1/SC 24** Computer graphics, image processing and environmental data representation [6]

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Major Changes in Scope/Design

Original Design	Actual Design
Arm rotating around item	Item rotating on base
Hall effect sensors for angle measurements	Not needed
Raspberry Pi controlling motors/sensors	Microcontroller for controlling motors/sensors

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Product Risk/Hazard Analysis

Risk/Hazard	Mitigation
Damaging of food products by robotics components	Keep motor speed minimal so that any unexpected resistance halts the motor's movements
User injury due to robotic components	Keep motor speed minimal so that any unexpected resistance halts the motor's movements. Keep rotating components enclosed and away from user.
Food Contamination	Usage of foodsafe materials when building product.
Motor Failure due to improper or heavy use	Use higher rated motors than intended use to compensate.
Overheating	Have a temperature sensor in place to automatically shut off device. Keep most components Idle when not in use.

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Business Risk Analysis

Risk/Hazard	Mitigation
Introduction of competing products	Expected in the future, deal with now(mitigate by strategically pricing a well-developed product)
Inability of supplier to provide needed parts	Modular design of product allows for easy replacement of part with other variations
Smart Home Security Concerns	Usage of secure databases to hold user information and well as transmitting data

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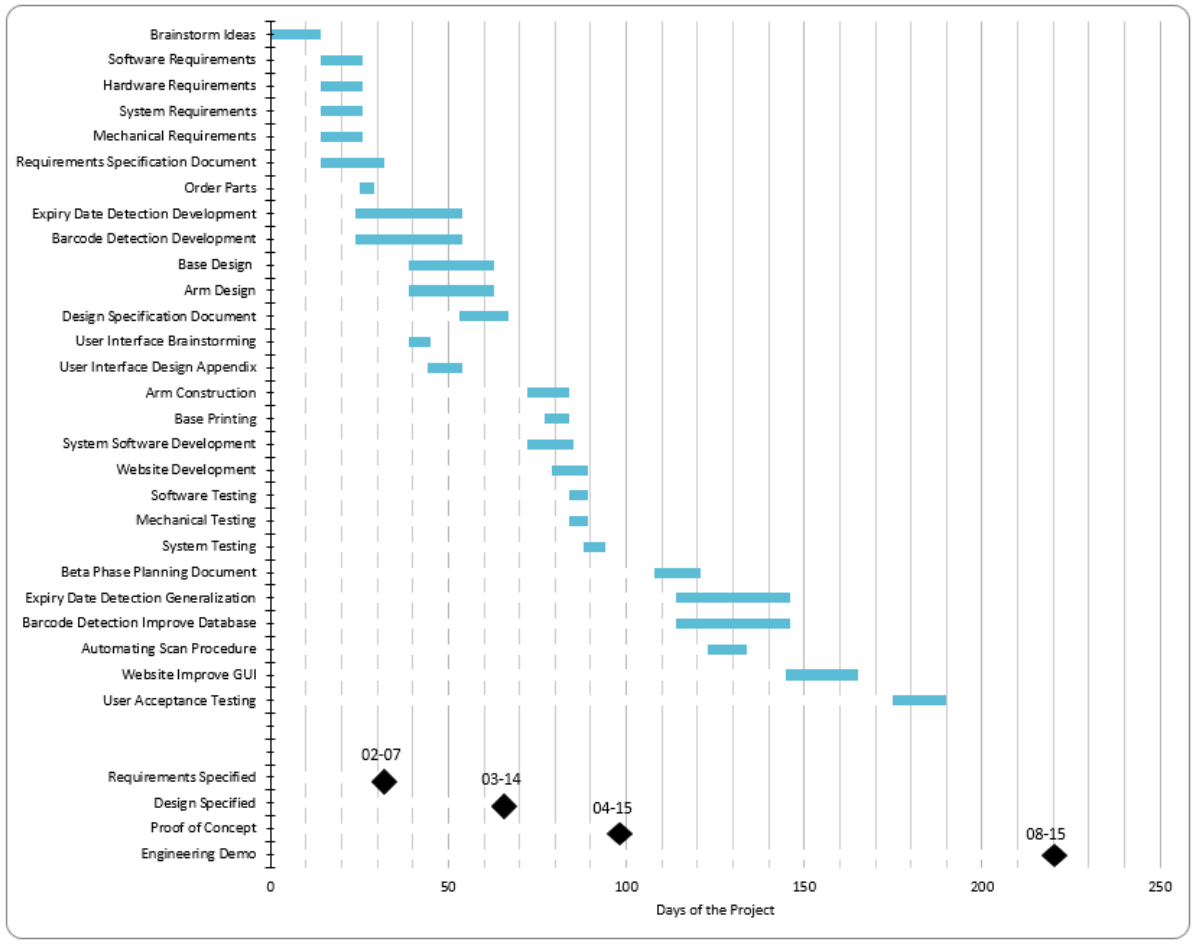
Project Schedule



- Timeline Concerns
  - Parts arriving
  - Incompatible Motor
  - Rotating Base Motor Iteration
  - Full System Integration

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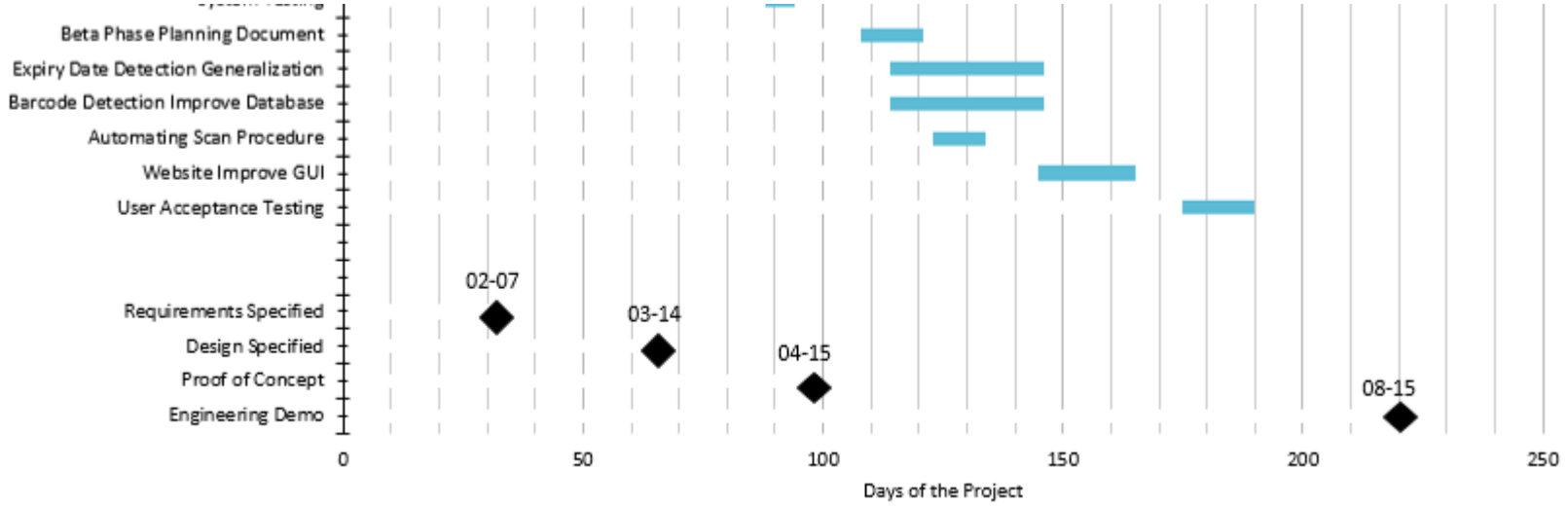
Plan for 440



- Cohesive Physical Design
  - Independent Power Supply
  - Weight sensor to trigger scanning process
  - LED indicators (Idle/Ready, Scanning, Finished)
- Web UI for item inventory
- Exploration of better UPC database

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Reflection

- Need to manage time wisely
- There are mistakes that happen that are out of our control, but must still be taken into account.
- Mistake that are in our control can be minimized by thorough vetting of design decisions.
- Rely on each other, everyone has something to offer.

Conclusion

- FoodSavr aims to reduce the amount of food waste produced by consumers, as well as help consumers save, by providing an automated storage tracking solution

- Three components to the design:
  - Controllers: Raspberry Pi, Arduino
  - Mechanical Components: Rotating base, Robotic arm
  - Image processing: Barcode, Expiration Date

- Next Step
  - Refinement of individual parts
  - Integrating all components to have an end to end automated scanning process with a cohesive physical product to put forward
  - Web Interface and Database
  - Feasibility of using less costly computing unit and micro-controller to reduce cost and bulk

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References

- [1] M. Rezaei and B. Liu, "Food loss and waste in the food supply chain", Nutfruit, no. 71, pp. 26-27, 2017.
- [2] B. Adhikari, S. Barrington and J. Martinez, "Predicted growth of world urban food waste and methane production", Waste Management & Research, vol. 24, no. 5, pp. 421-433, 2006. Available: 10.1177/0734242x06067767.
- [3] “Smart Home - Canada | Statista Market Forecast,” *Statista*. [Online]. Available: https://www.statista.com/outlook/279/108/smart-home/canada. [Accessed: 28-Mar-2019].
- [4] R. Conn et al., "Safety assessment of polylactide (PLA) for use as a food-contact polymer", Food and Chemical Toxicology, vol. 33, no. 4, pp. 273-283, 1995. Available: 10.1016/0278-6915(94)00145-e.
- [5] UL 1740 Standard for Robots and Robotic Equipment https://standardscatalog.ul.com/standards/en/standard_1740_4 [Accessed 05 February 2019]
- [6] ISO/IEC JTC 1/SC 24 Computer graphics, image processing and environmental data representation catalogue https://www.iso.org/committee/45252/x/catalogue/ [Accessed 05 February 2019]

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Any Questions?

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