Final Presentation

ENSC 440 - Company 5

eye-bex

Eye-bex Inc.

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Presentation Overview

1. Introduction
2. Technical Case
3. Sustainability
4. Business Case
5. Risk Analysis
6. Adherence to Standards
7. Self Reflection
8. Conclusion

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Introduction

Background

- Climbing gym walls have a collection of rocks that form routes. Typically each route is distinguished by a unique colour from its neighbors.
- The challenge of a route is for a member to only use rocks of that colour to traverse from the low starting holds to top finish hold.
- Climbing gyms employ route setters whose responsibility is to design new routes to replace the old routes.

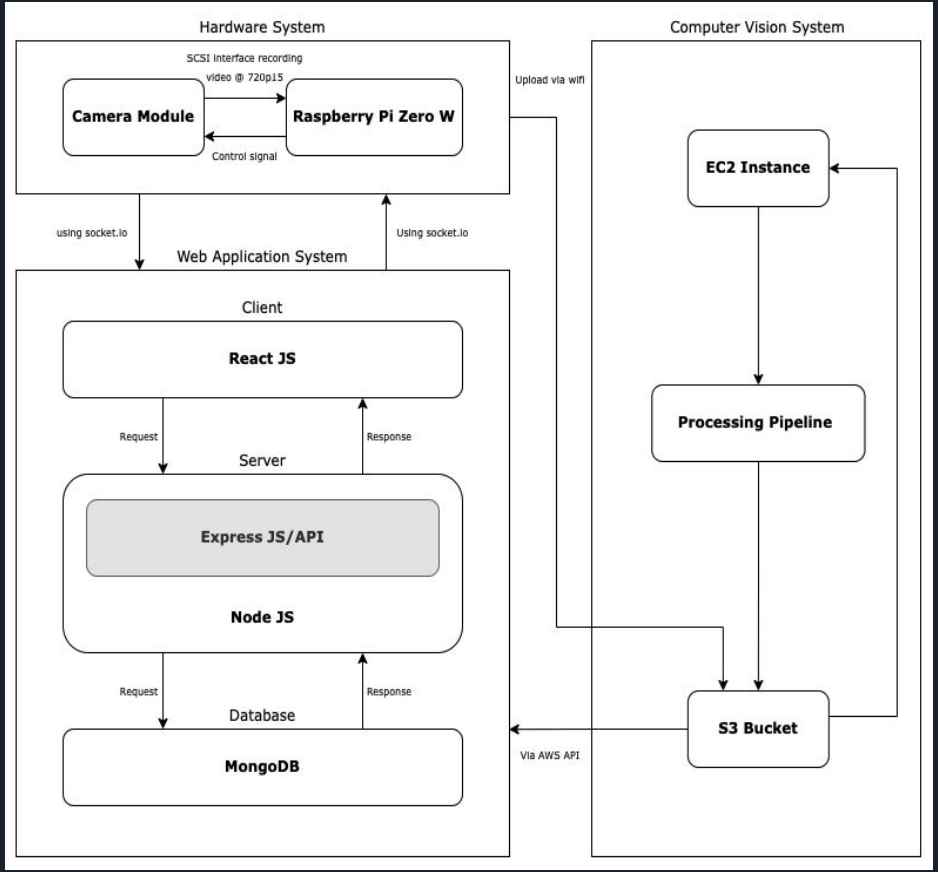
Our Purpose

- Designing routes that are accessible and interesting for all heights is the most difficult job in the climbing gym, and all gyms aspire to it.
- We are using a mounted camera system to record climbers and process data to provide feedback to route setters through a web app.
- Our feedback will help in mentoring new route setters and improve the current setting team by providing quantifiable data.

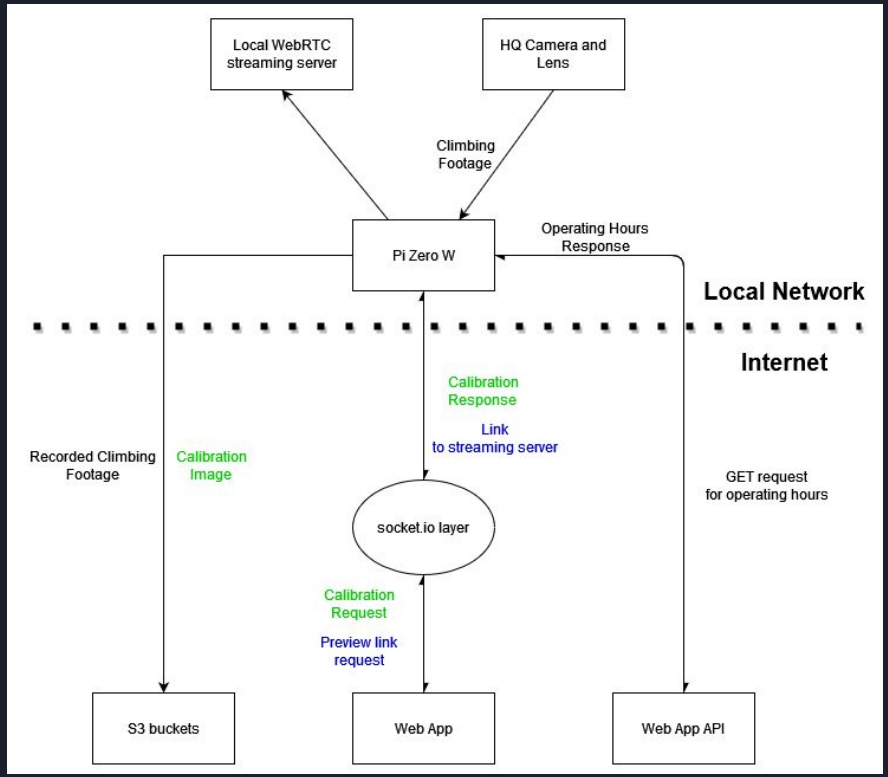
Project Motivation

Technical Case

System Level Design Overview

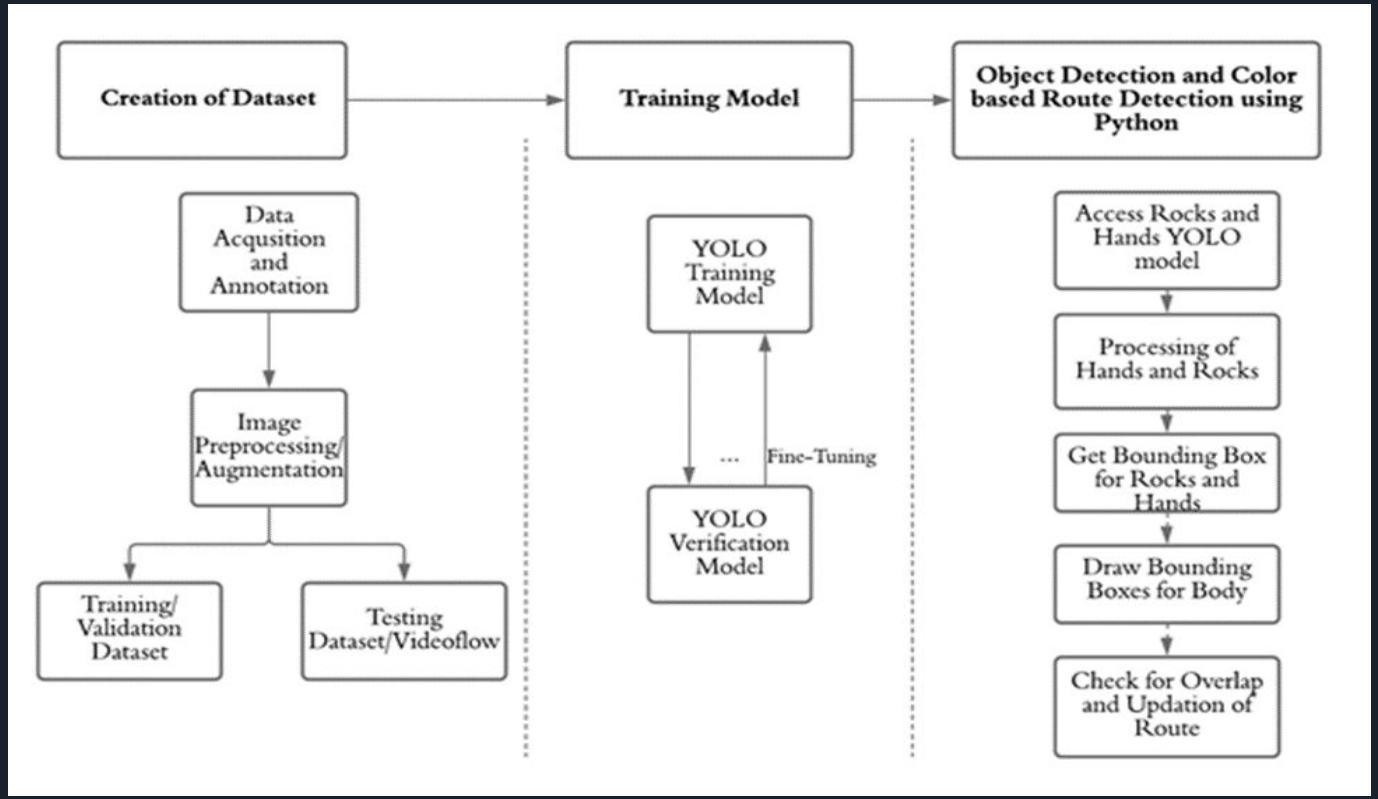


Hardware Outline



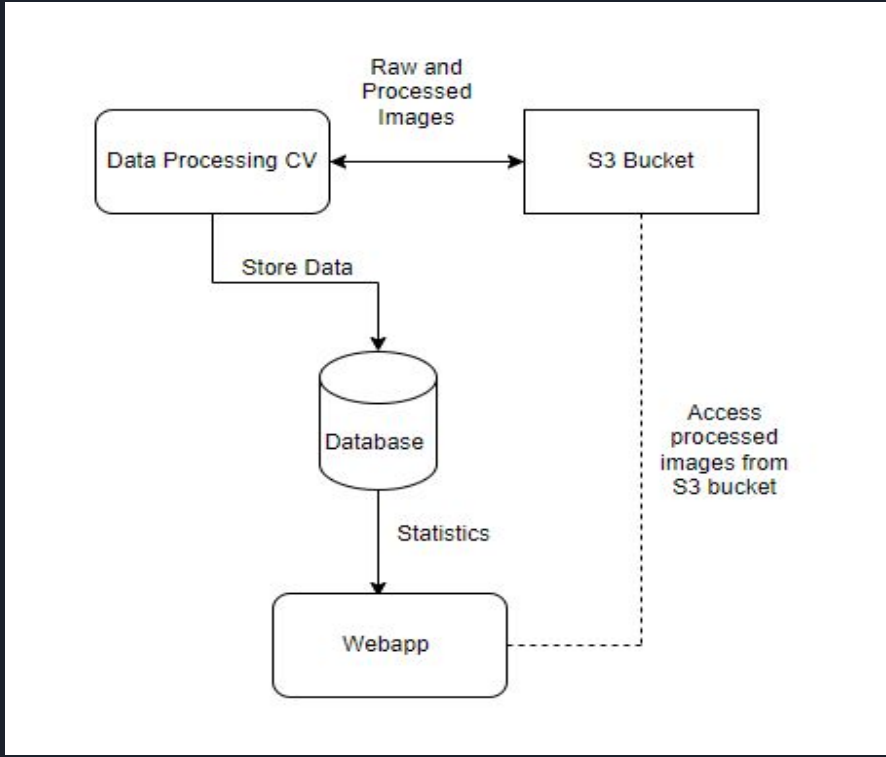
Hardware data flow

Computer Vision Outline - I



Data flow of training and object detection

Computer Vision Outline - II

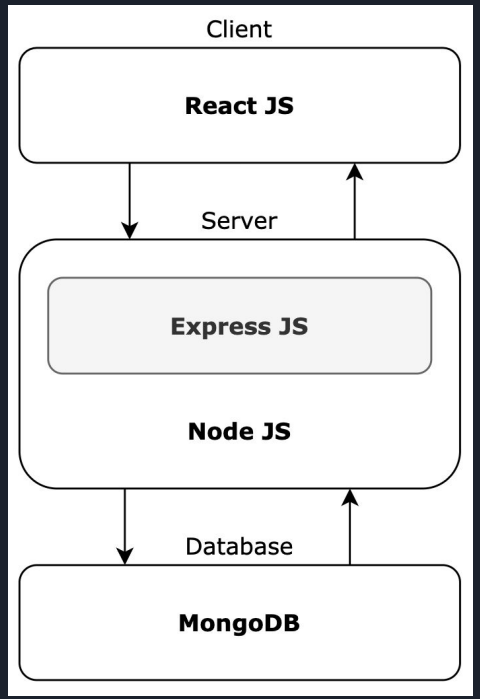


Data Storage and Processing

Computer Vision Outline- III

- Object detection and training using Yolov4
- Labelbox for high quality data training
- Implementation using python
- Aruco markers for identification of start holds and height detection
- Motpy library is used for object tracking
- AWS cloud processing with S3 storage

Web-app Outline - I



Frontend/Client
- Framework: React JS
- Mockups made with Figma

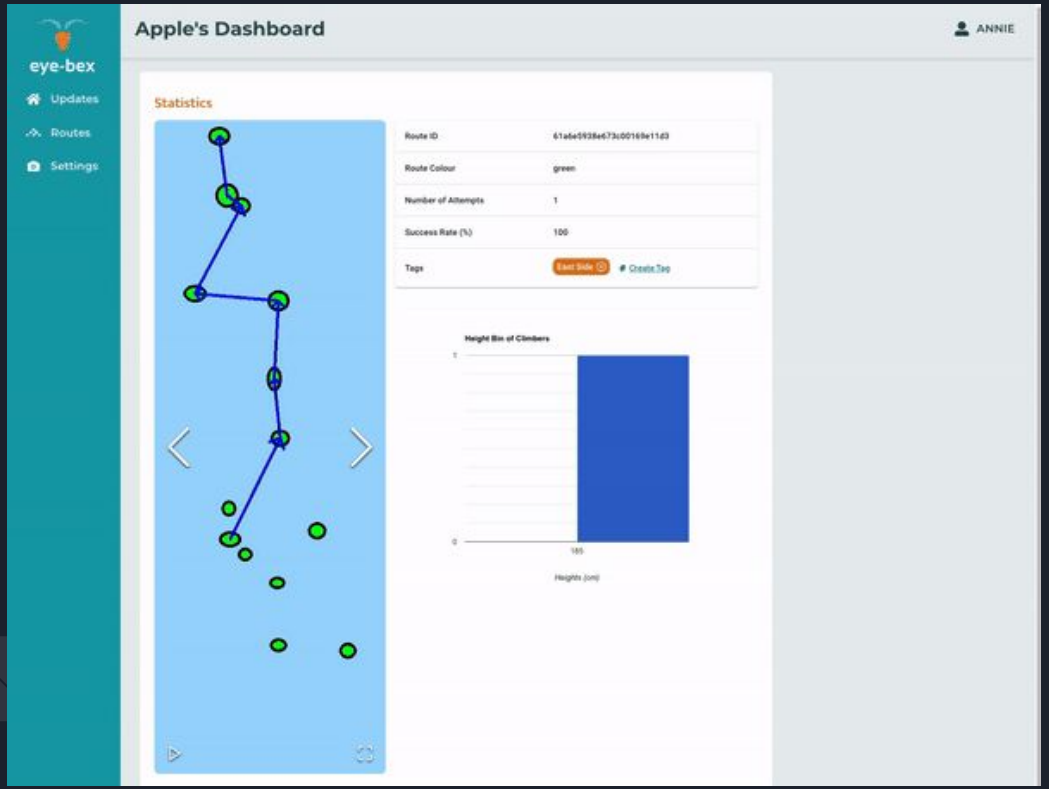
Server Side
- Framework: REST API with NodeJS
- Socket.IO library used to communicate with HW

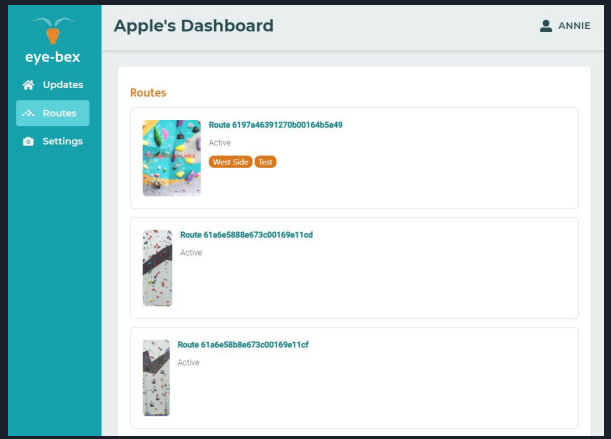
Database
- Framework: Mongodb

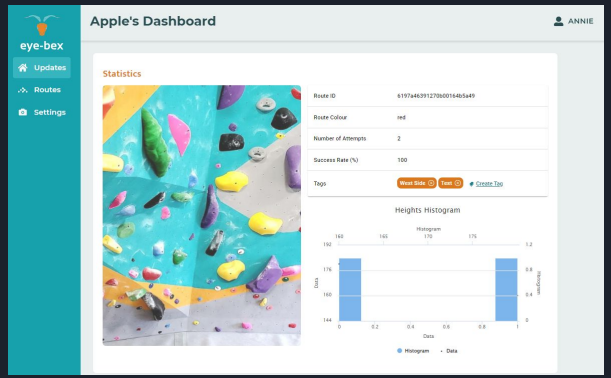
Deployment
- Framework: Heroku

Web-app Outline - II

https://eye-bex.herokuapp.com/

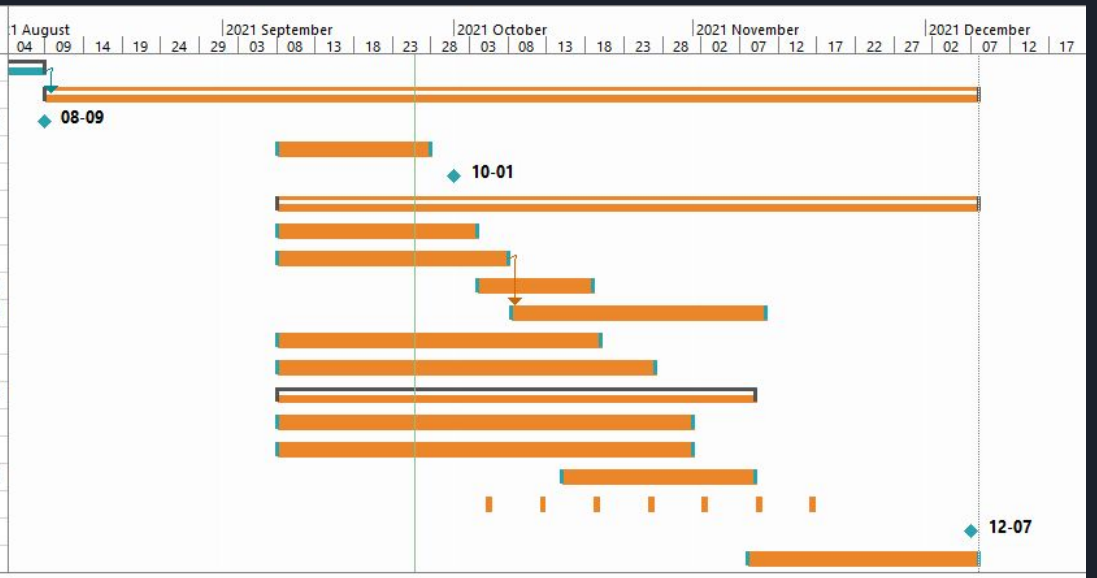






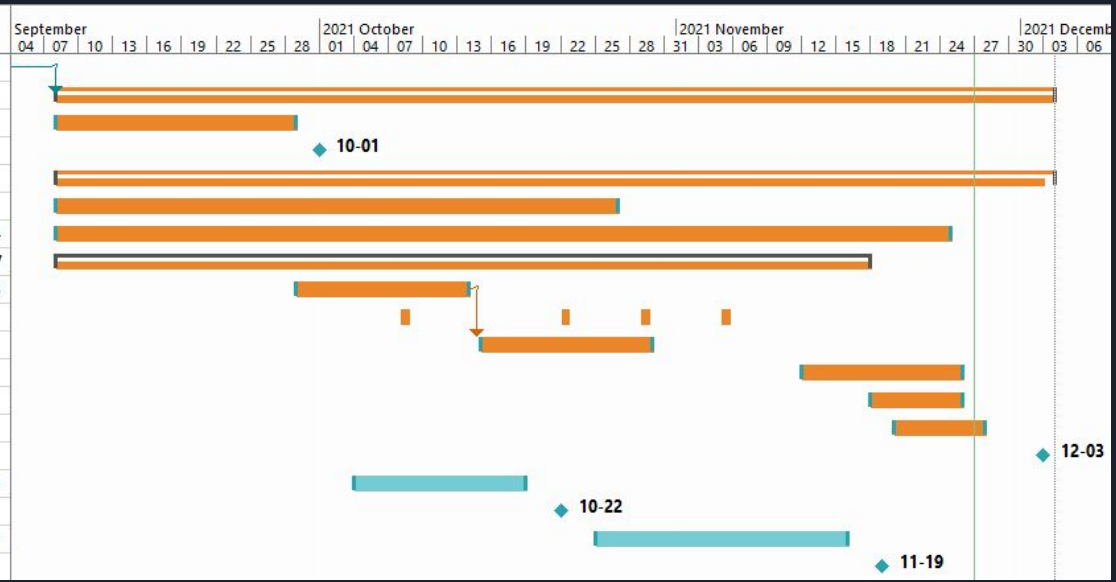
Project Schedule - Estimated

Task Name	Start	Finish
ENSC 405W: Phase I	**Wed 21-05-12**	**Sun 21-08-08**
ENSC 440: Phase II	**Mon 21-08-09**	**Tue 21-12-07**
Online collaboration summary	Mon 21-08-09	Mon 21-08-09
Prototype Refinement Report	Wed 21-09-08	Mon 21-09-27
Prototype Refinement Presentation	Fri 21-10-01	Fri 21-10-01
Functional prototype demo	**Wed 21-09-08**	**Tue 21-12-07**
Setup hardware communication with web app	Wed 21-09-08	Sun 21-10-03
Update case and mount design	Wed 21-09-08	Thu 21-10-07
Saving and tagging custom routes on web app	Mon 21-10-04	Mon 21-10-18
3-D printing and assembling case	Fri 21-10-08	Wed 21-11-10
Processing the sequence of holds	Wed 21-09-08	Tue 21-10-19
Developing web app UI as per specification	Wed 21-09-08	Tue 21-10-26
Fine-tuning computer vision algorithms	**Wed 21-09-08**	**Mon 21-11-08**
Add cheating index	Wed 21-09-08	Sun 21-10-31
Retrain ML model for more accuracy on hold detection	Wed 21-09-08	Sun 21-10-31
Multithreading to detect multiple routes and climbers	Fri 21-10-15	Mon 21-11-08
Weekly test at climbing gym	**Tue 21-10-05**	**Tue 21-11-16**
Functional prototype demo and presentation	Tue 21-12-07	Tue 21-12-07
Full acceptance testing	Mon 21-11-08	Tue 21-12-07



Project Schedule - Actual

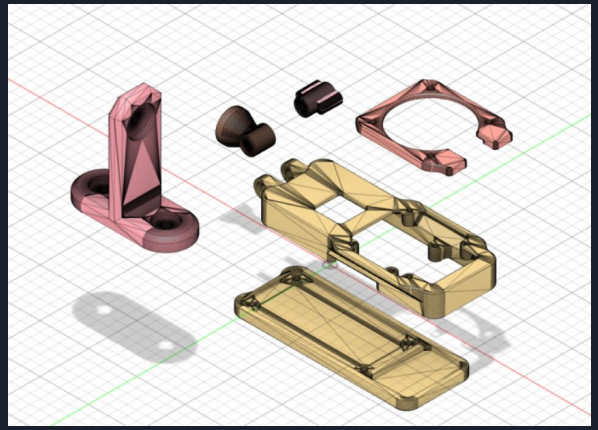
Task Name	Start	Finish
ENSC 405W: Phase I	**Wed 21-05-12**	**Sun 21-08-08**
ENSC 440: Phase II	**Wed 21-09-08**	**Fri 21-12-03**
Prototype Refinement Report	Wed 21-09-08	Tue 21-09-28
Prototype Refinement Presentation	Fri 21-10-01	Fri 21-10-01
Functional prototype demo	**Wed 21-09-08**	**Fri 21-12-03**
Processing the sequence of holds	Wed 21-09-08	Tue 21-10-26
Developing web app UI as per specification	Wed 21-09-08	Wed 21-11-24
Fine-tuning computer vision algorithms	**Wed 21-09-08**	**Wed 21-11-17**
Update case and mount design	Wed 21-09-29	Wed 21-10-13
Weekly test at climbing gym	**Fri 21-10-08**	**Thu 21-11-25**
3-D printing and assembling case	Fri 21-10-15	Fri 21-10-29
Full acceptance testing	Fri 21-11-12	Thu 21-11-25
Saving and tagging custom routes on web app	Thu 21-11-18	Thu 21-11-25
Setup hardware communication with web app	Sat 21-11-20	Sat 21-11-27
Functional prototype demo and presentation	Fri 21-12-03	Fri 21-12-03
Engineering Standards and Future Proofing Report	Mon 21-10-04	Mon 21-10-18
Engineering Standards and Future Proofing Presentation	Fri 21-10-22	Fri 21-10-22
Business Pitch Report	Mon 21-10-25	Mon 21-11-15
Business Pitch Presentation	Fri 21-11-19	Fri 21-11-19



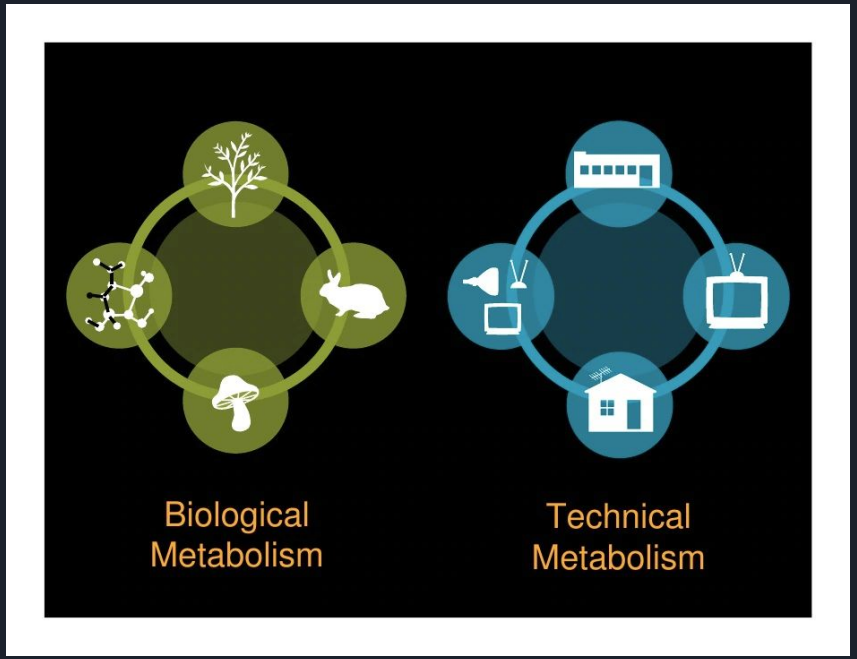
Sustainability

Materials

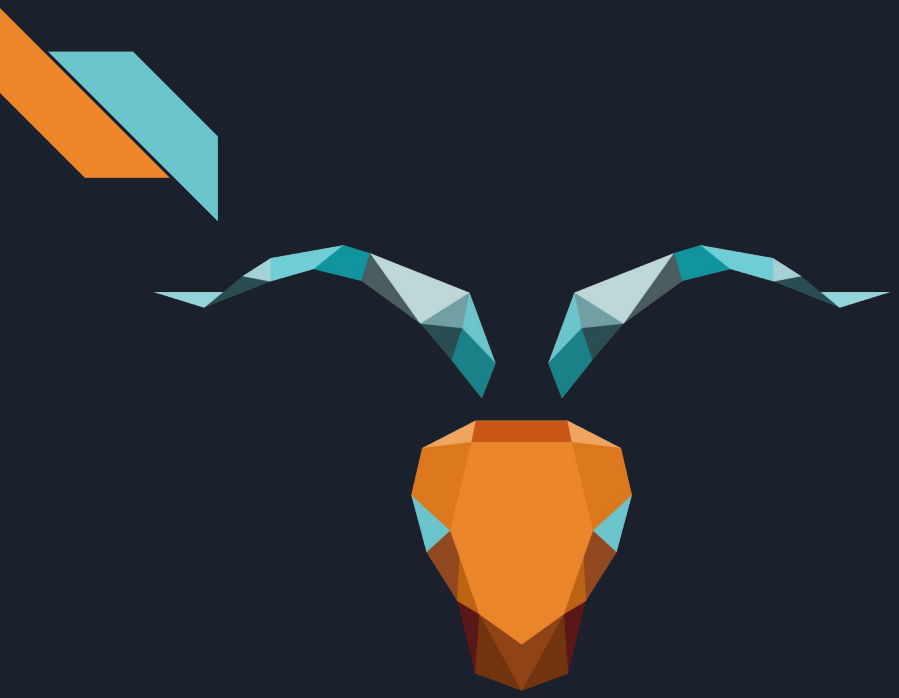
- Using Injection Molding, we can use Nylon (Polyamide) as a material for the casing.
  - Durable against wear and tear
  - Stable under exposure to high temperatures
  - Stiff material will protect internal electronics
  - Biodegradable after 30-40 years



Cradle-to-Cradle Design



- Modular design allows for replacement of any broken component
- Using Nylon (Polyamide) for mount made with injection molding
  - Durable and biodegradable
- Microcontroller and camera module can be repurposed if needed.
- Electronics recycling can be done through Electronic Recycling Association



Business Case

Market for Eyebex

Eyebex is designed for climbing gyms to aide their routesetters

To do this we:

- Discovered key statistics through market research and customer consultations
- Created User Experience for simple and effective reporting of data
- Developed the product alongside our ideal clients to ensure eyebex's usefulness

We hoped aide routesetters by providing summaries and reports of how climber's use their routes without impeding their ability to do their job

Ideal Customer

A testimonial from David Murray, owner of The Hangout Climbing Gym

Market for Eye-bex

<u>Consultation With Clients</u>

- Clients desire least obstructive design
- Aid routesetters not replace them
- Clients open to monthly fee

<u>Market Description</u>

- Eye-bex has no direct competitors which gives us a first mover advantage on the market of ~1000 gyms in North America
- Low barriers of entry include certification, patent and capital costs

<u>Sales Strategy</u>

- Our plan involves the upfront sale of the hardware and retaining the software services through a subscription model

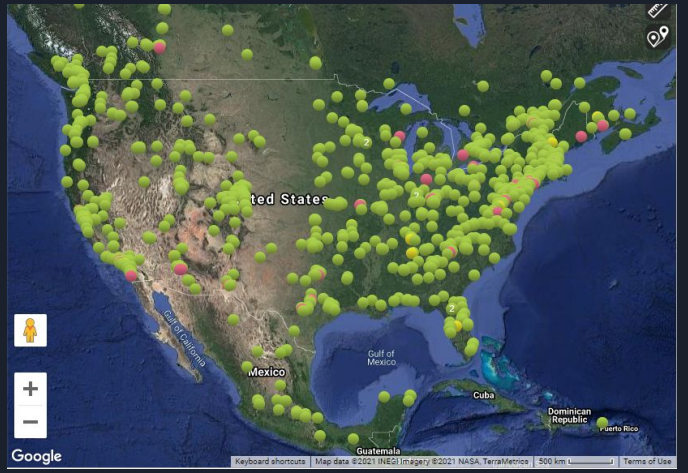


Photo from: https://www.climbingbusinessjournal.com/directory/map/ (2021)

Budget

Considerations:

- Bulk Purchasing of components and materials
- Injection molding for cheaper and more reliable casing
- Fixed monthly costs amazon web services for data storage and computer vision processing
- Cost of patenting product in Canada and the US
- Certifications such as FCC, CSA and Industry Canada certifications
- Salaries for employees
- Working from home as to save on rental costs

Budget

Table 1: Variable Costs

Type	Item	Price (CAD$)
Variable Costs		
Distribution	Package delivery	25.00
Hardware	PLA filament per unit at 30g	0.11
	Assembly screws	1.56
	Raspberry Pi Zero W	14.00
	Raspberry Pi HQ Camera Lens	26.97
	Raspberry Pi Camera Sensor + cable	16.97
	64GB SD card	3.22
	MCM Raspberry Pi Heat Sink Kit	0.76
	Micro USB 3m cable	0.61
Total Variable Costs		**89.20 / unit**

Table 2: Fixed Costs

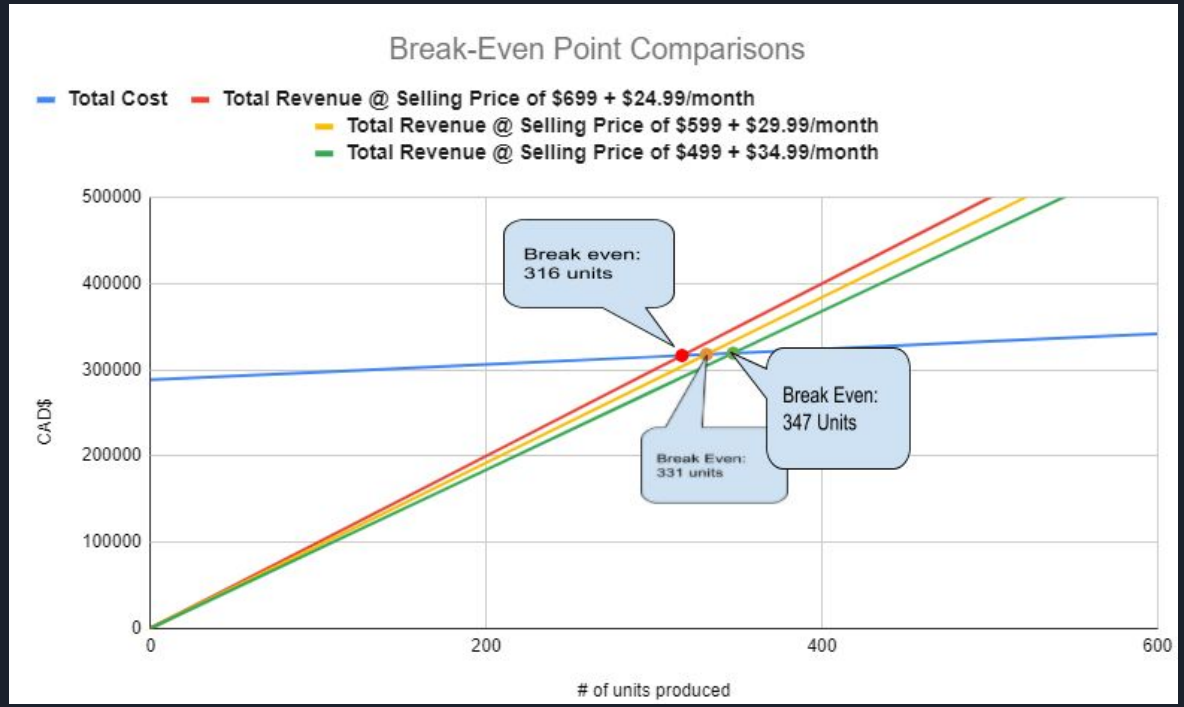
Type	Item	Price (CAD$)
Fixed Costs		
IP Protection	Patents for both Canada and the US	1880.00
Certifications	FCC, CSA and IC certification	5495.00
Production	Injection moulding costs	17886.00
Web App Hosting	Heroku	250.00/month
Cloud Computation	Amazon web services	182.32/month
Payroll	Accumulated monthly salary for the team	21000.00/month
Marketing	Advertisements	500.00/month
Total Fixed Costs		**24037.40/ month**

Break even Analysis and Price

Gamma Prototype:
$237.68 / unit

Mass Production:
$329.57 / unit

Break-Even Point:
331 units with a selling price of
$599 + $29.99 / month



Financing

For mass production potential financing options are:

Venture Capital / Angel Investors:

- Coast Capital Savings Venture Prize[1]
- Queen's Entrepreneurs Competition[2]
- Climbing gym or distributor investment (potentially for early access)

Grants:

- Funding from Canada's National Research Council IRAP for small businesses[3]
- Innovate BC grants (with support from SFU and a climbing gym/ distributor)[4]

Loans:

- Small Business loans from banks or Community Development Finance Institutions
- BDC Technology Financing for technology purchase or upgrade[5]

Risk Analysis

Potential Product Risks and Mitigation - I

- Users could trip over the wiring to the device
  - Ensure that all cabling is fastened to walls/floor and demarcate cable with coloured tape to ensure visibility
- Wall mount failure causes a falling object hazard to those below
  - Wall mount utilizes construction screws rated for 22kgs
- Device may be over-optimized to suite particular types of climbing walls
  - Continue building our list of climbing gym contacts so that we can test our device in differing real-world scenarios

Potential Product Risks and Mitigation - II

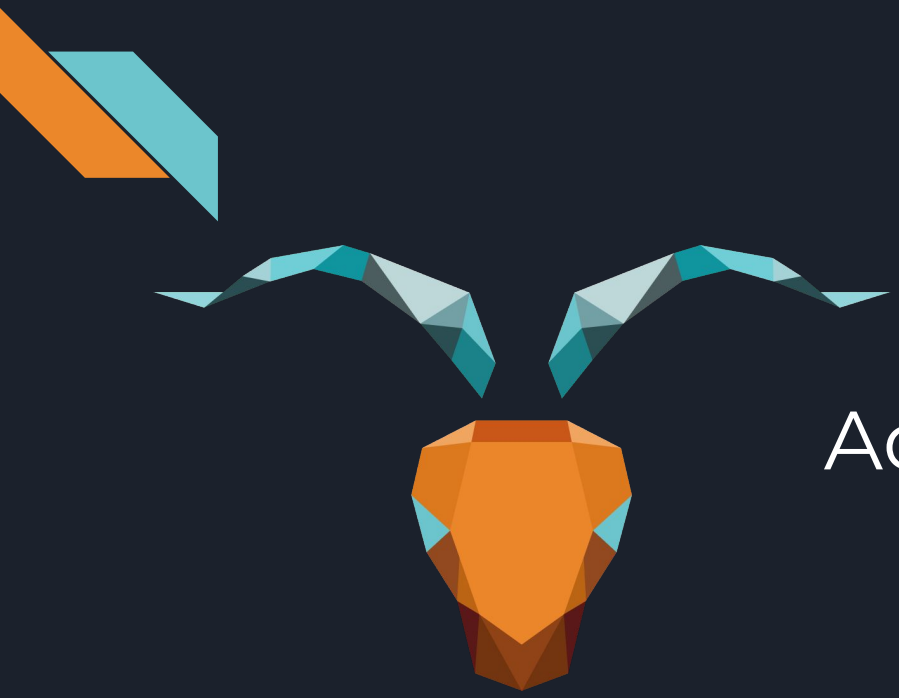
- There may be privacy concerns about video being recorded and stored in servers which are hosted in the United States
  - Having climbers sign a waiver for the storage of of their climbing data in another country, and prevent access of video by any person outside of the admin
- The computing servers may go down during operation of system
  - Potential 48 hours worth of backup space on device and automatically update web server of multiple failed uploads
- Low adoption rates from gyms
  - Constant and thorough client consultations and potentially offering a pilot run to gyms to let them see how the product will work

Risk Analysis - Classification

	Severity →		
Likelihood ↓		**Mount failure - Safety**	
	Object detection accuracy - Design	**Low Adoption - Financial**	**Ceiling mount viability - Design**
	Server cost changes - Design		**Tripping hazard - Safety**

Plan B

- After initial adoption, Eye-bex's services can be expanded to include personal users, which multiplies the potential market.
- Transitioning to the following pivots retains core technologies that Eye-bex has developed:
    - Providing a social platform similar to Strava for recreational enthusiasts
    - Live scorekeeping for competition climbing
    - Integrating Eye-bex's machine learning technology into a mobile app that takes and analyzes self-recorded footage



Adherence to Standards

Engineering Standards I

- During the development of Eye-bex we have incorporated several engineering standards from IEEE, IEC, CSA and ISO.

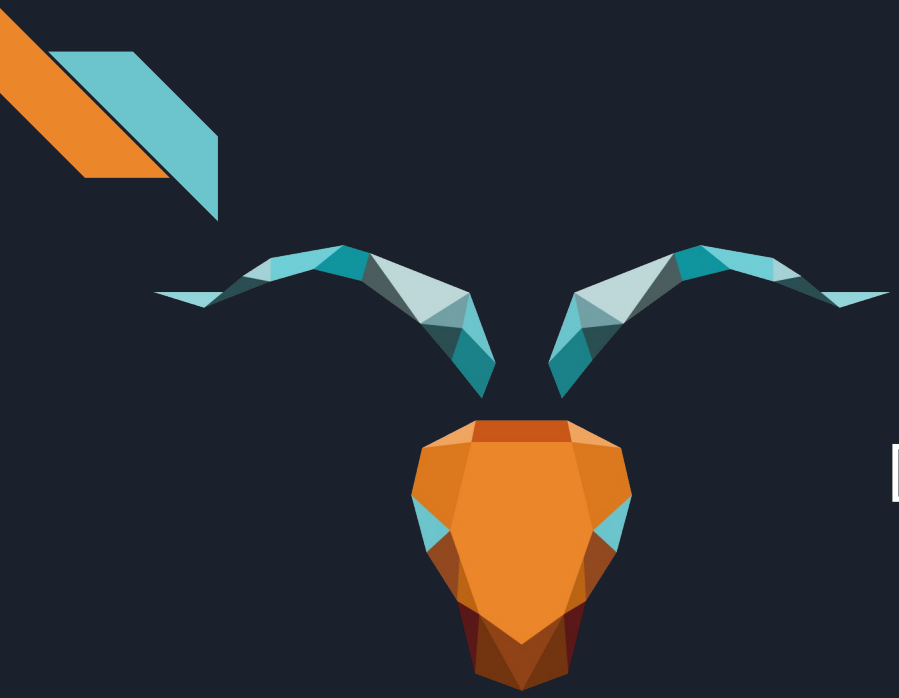
- **CAN/CSA-ISO/IEC/IEEE 12207:18** - Framework for software life cycle processes [6]
  - During the simultaneous operation, and maintenance processes, our company's subscription based model financially justifies active server side software updates and customer service to prolong the life cycle of our product.

Engineering Standards - II

- **CAN/CSA-ISO/IEC 26557:18 -** *Tools and methods of variability mechanisms for software and system [7]*
  - Our computer vision model is trained with a widely varied data set that accommodates a large selection of rock holds that can be used by gyms.
  - We provide variability in where the camera can be set up by including both a swivel mount, as well as a tripod mount for floor placement.
  - The product can also accommodate a variety of wall sizes with scalability through the addition of extra camera systems.
- **UL 2442 -** *UL Standard for safety wall and ceiling mounts and accessories [8]*
  - This standard applies to devices that offer structural support for the mounting of audio/video equipment, in our case a video camera.
  - The Eye-bex weighs 117.5g
  - The wall mounting apparatus weighs 10.4g
  - Our installation screws are rated for 22kg

Engineering Standards - III

- **IEEE/ISO/IEC 23026-2015 -** *Systems and software engineering - Engineering and management of websites for systems, software, and services information [9]*
  - This standard deals with managing the requirements for the life cycle of a website
  - Lays out a general framework for ensuring up to date data, web pages can be viewed from different devices with different screen sizes and can be accessed easily and in a timely manner
- **ISO/IEC TR 12182:2015 -** *Systems and software engineering - Framework of categorization of IT systems and software, and guide for applying it [10]*
  - This standard provides a framework for categorizing software engineering products through a set of axes from different viewpoints, for example architecture, scale and data.
  - In our case, this is a very small embedded system that relies on software as a service (SaaS) model. Eye-bex is classified by 2 axes: in this case 1) very small scale and 2) embedded systems.



Demonstration

HW Demo

Computer Vision Demo

Web-App Demo

https://eye-bex.herokuapp.com/

Self Reflection

Feedback

Client Feedback:

- Directions of features focus on
- User Interface Feedback

TA/Prof Feedback:

- Keep in contact with them, focus on what clients what
- Reconsideration to avoid local server hosting
- Edge cases such as trying only couple rocks
- Use molded/recycled cases instead of 3D printed case

What We Learned

- Technical Skills
- No amount of planning can replace the insights of testing. Test early and test often
- Documentation takes a lot of time and effort
- Good documentation saves time when working in team, and allows for seamless collaboration

What We Would Do Differently

- Get to testing our model earlier
    - Custom training a computer vision model took more time than we thought

eye-bex

Conclusion

Summary

Target Market: Rock Climbing Gyms

Problem:

- Routesetters find it hard to compile statistics on what is a “good” route
- Hard to remove personal bias, especially height and grade creep

Our Solution:

- A computer vision camera system to automatically gather and display route statistics

Future Plans

- Web App Refinements
  - Run Image Overlay
  - Quality of life features such as operating hours
- Recycle Pre-existing camera molds
- Improve Computer Vision Model

Acknowledgements

Thanks to ...

- The Hangout Climbing Gym
- SFU Climbing Gym Staff
- 405 Professor Craig Scratchley
- 405 TAs Srishti Yadav and Timothy Yu
- 440 Professor Andrew Rawicz
- 440 TAs Chris Hynes and Eric Brace

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Q & A