ClearNav Company

EZHud - Smart HUD For Motorcyclists

ENSC 440
Final Presentation
August 5th, 2022

Overview

ClearNav Co.

INTRODUCTION

**ClearNav Company
Background & Product**

ClearNav Co.

The **Problem**

Motorcycles are Dangerous

Vehicles in Canada

- 3%
- 35M
- 97%

Serious Injuries

- 12%
- 141K
- 88%
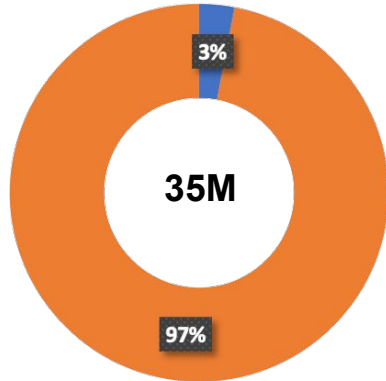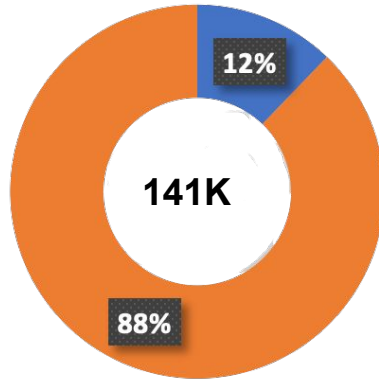
■ Cars
■ Motorcycles

Lack of Infotainment System

- No turn-by-turn navigation

ClearNav Co.

THE SOLUTION

EZHud System

- Turn-by-Turn Navigation
- Digital Speedometer
- Speed Limit Indicator
- Built-in Dashcam

ClearNav Co.

ClearNav Company

William Xue
Chief Executive Officer

Taimoor Ahmed
Chief Design Officer

Spencer Lall
Chief Operations Officer

Namsakhi Kumar
Chief Financial Officer

William Huong
Chief Information Officer

Ahmed Ather
Chief Tech. Officer

OUR PURPOSE

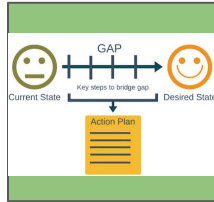Support the local community of motorcyclists by making rider safer

Build technology for motorcyclists that will add value to their riding experience

Bring the HUD technology to the motorcycle market

ClearNav Co.

OUR **MOTIVATION**

Huge gap in the North America Market
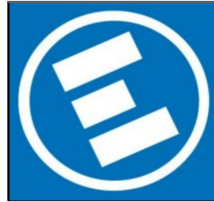
ENSC Curriculum and business

Users of our own product

ClearNav Co.

TECHNICAL CASE

EZHud System Overview

ClearNav Co.

EZHUD **DEVICE**

Attach the EZhud on Helmet
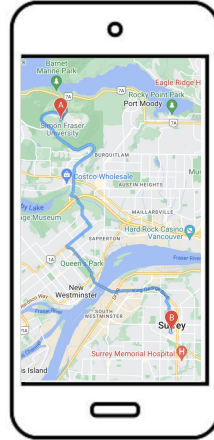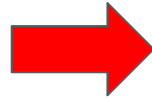
Program Route
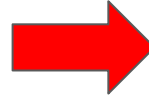
Turn-by-Turn Navigation
Digital Speedometer
Speed Limit Indicator
Built-in Dashcam

ClearNav Co.

SYSTEM OVERVIEW

EZHud Hardware
- External Case
- Heads Up Display

Data Processing
- Android Auto
- GPS processing
- Multimedia
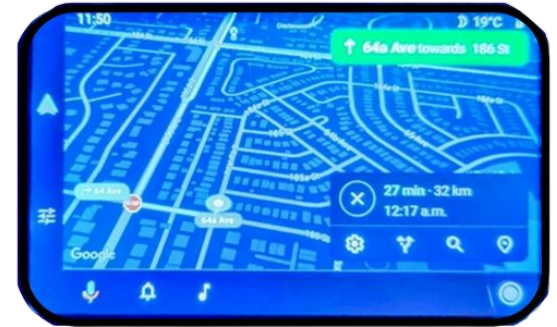
Software and WebUI
- FrontEnd App
- FrontEnd Display
- Video Files

ClearNav Co.

EXTERNAL CASING & ELECTRONICS

Camera

GPS

DC-DC Boost

Battery

Rasp. Pi (CM4)

Camera

GPS (66ch, 10Hz)

DC-DC Boost

3D Printed Attachment

Electronic Components

Button Board

Final Enclosure

ClearNav Co.
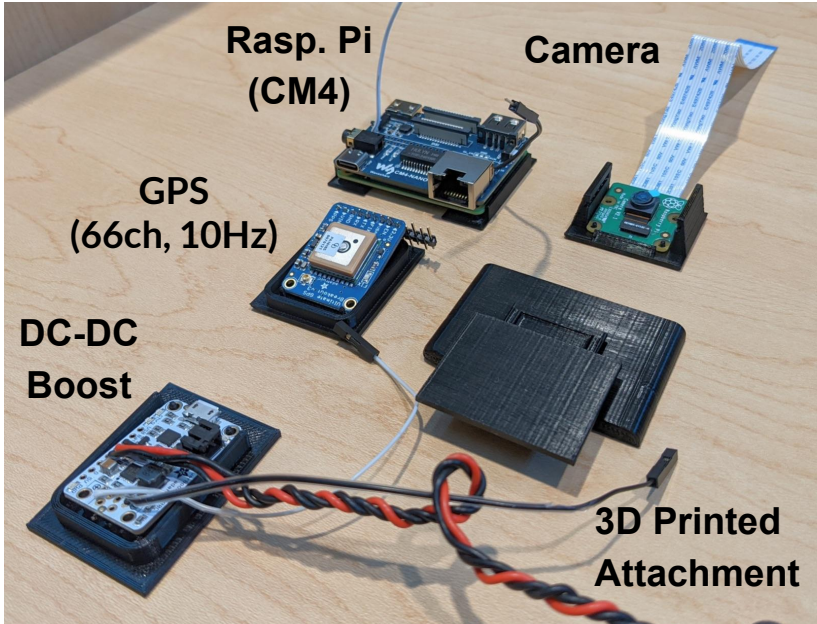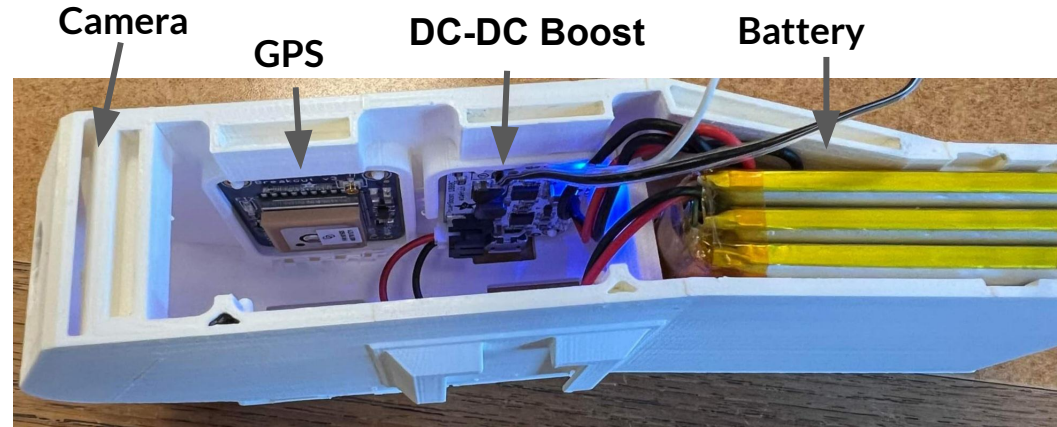
EXTERNAL CASING & ELECTRONICS
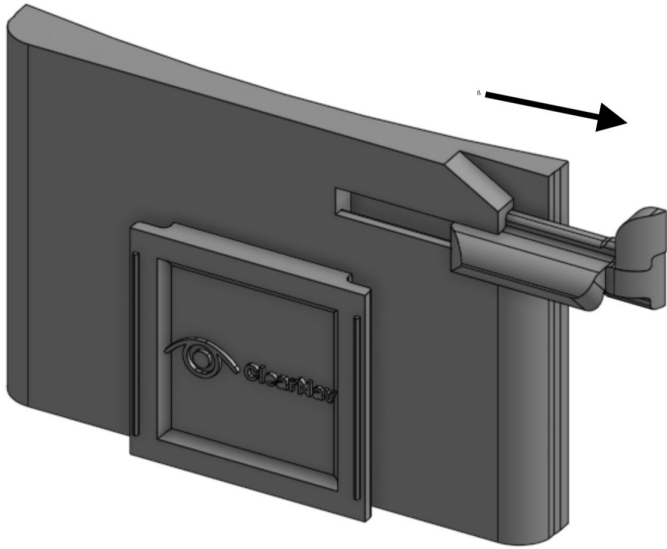
Helmet Mount and Interlock Mechanism

ClearNav Co.
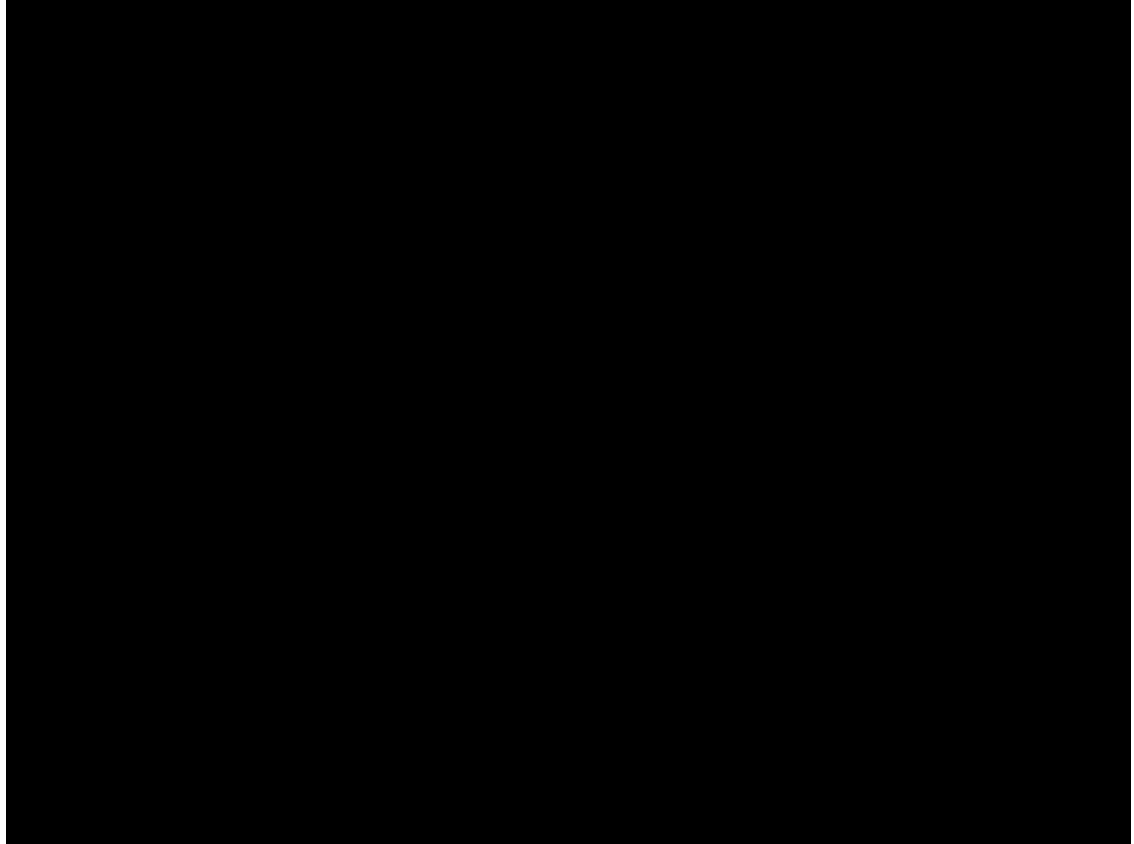
DISPLAY **ATTACHMENT**

Display holder

ClearNav Co.

PRINTED CIRCUIT-BOARD DESIGN

Battery JST Connector

CM 4 Hirose connector

USB

GPIO

CSI Connector

Front View

SD Card

Back View

HDMI

EZhud Carrier Board

© ClearNav
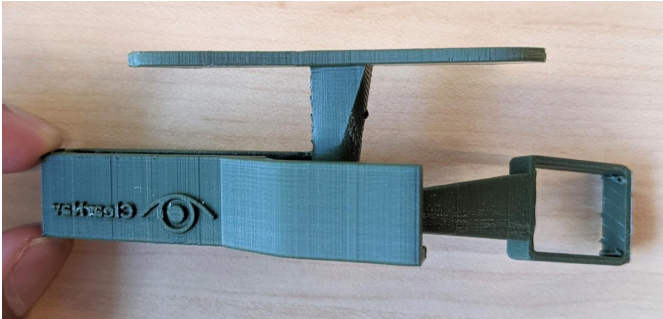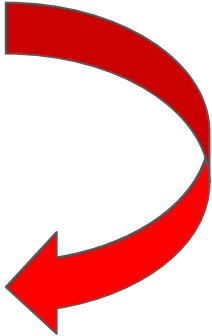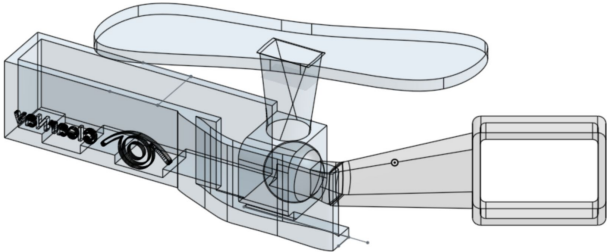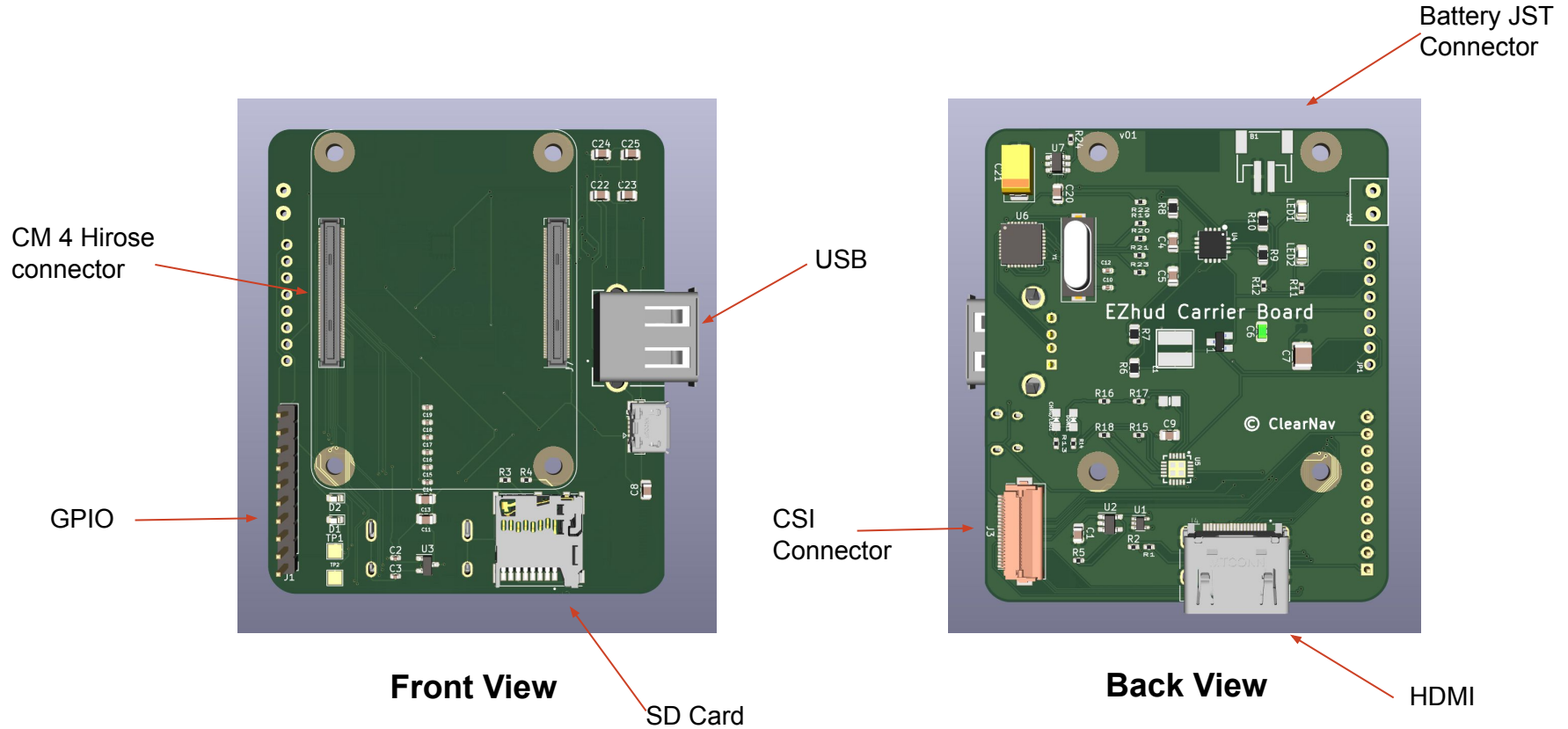
PRINTED CIRCUIT-BOARD DESIGN
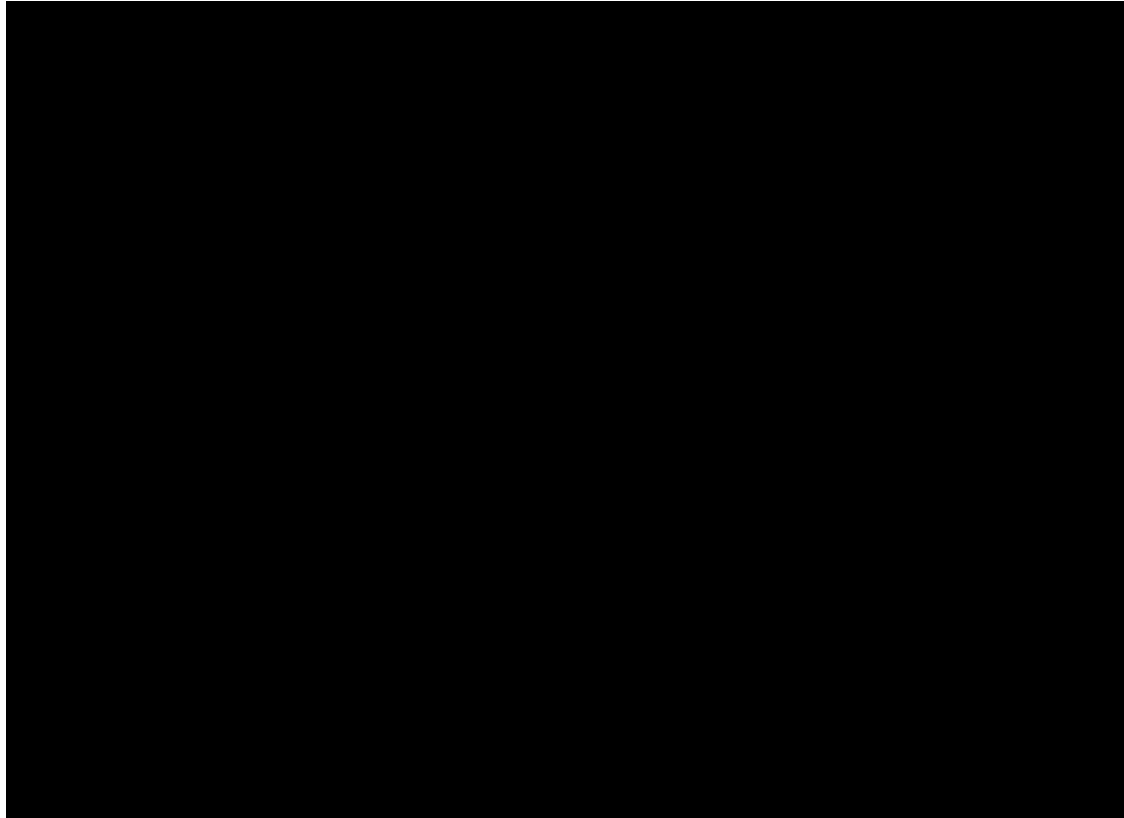
NAVIGATION SOFTWARE

- Google Maps
  - Accurate, up-to-date
- Android Auto
  - Familiar interface
  - Simplify sending turn-by-turn navigation from phone to device

ClearNav Co.
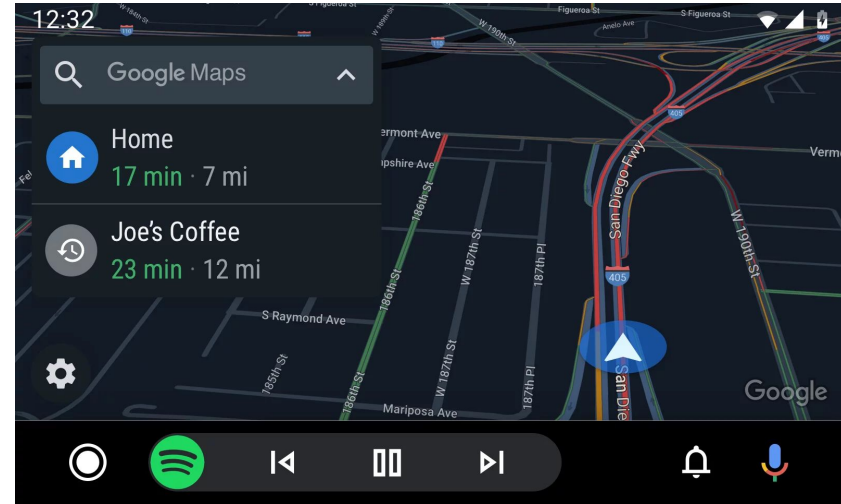
BUILT-IN DASHCAM

- Recording automatically starts on boot
- Dedicated button to start / stop recording
- 720p, 25fps
- Automatic conversion from .h264 to .mp4
- Video file will show on our website after conversion

Recording Button Mode Button Power Button
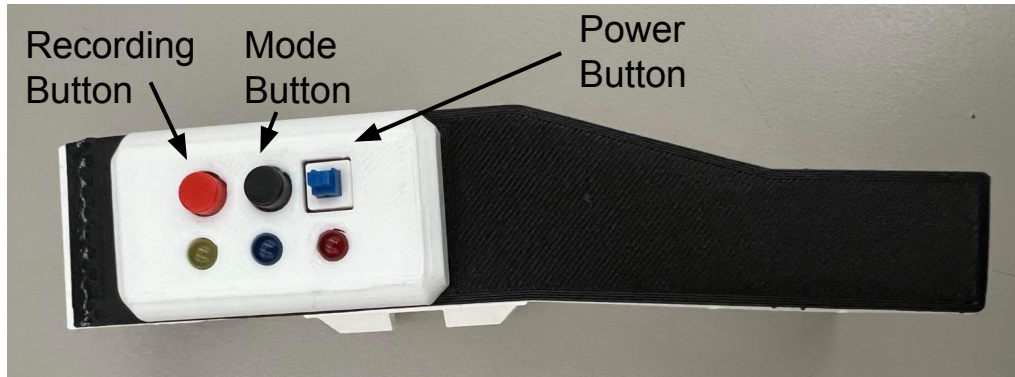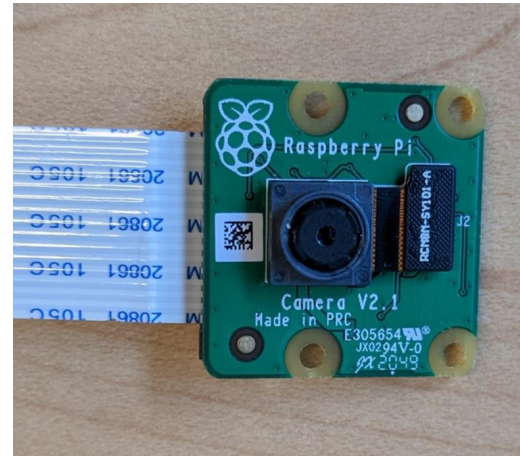
BUILT-IN GPS

- GPS Tracks speed without need for phone connection
- GPS software starts on boot and is available immediately (if fix)
- GUI also shows recording status and signal strength

Signal: 91%, Dashcam: not recording

5 km/h

IP ADDRESS:

ClearNav Co.
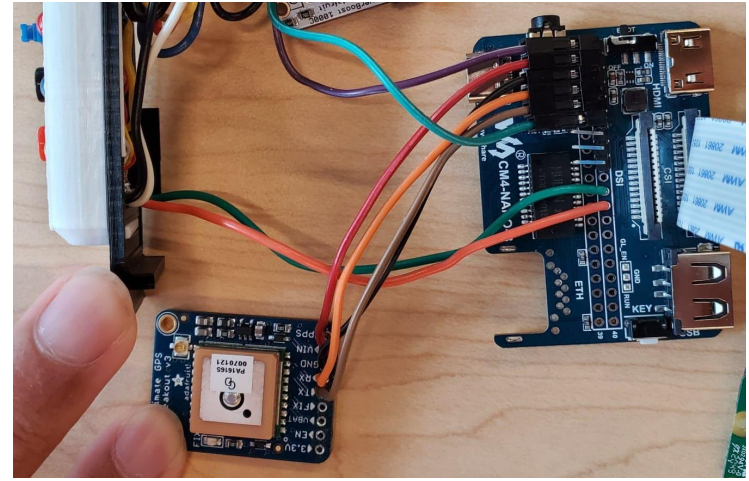
WEB-UI FRONT END

- JavaScript Web App
- Set up route
- View Dashcam footage
- Change Settings

Search page

Videos page

Settings page

ClearNav Co.

CRADLE TO CRADLE & RIGHT TO REPAIR

- Use of PLA (biodegradable bioplastic) for 3D Printing

- Standard, replaceable lithium battery cells
- Replaceable camera and display components

ClearNav Co.

PROJECTED SCHEDULE

ID	Task Name	Duration	Start	Finish
0	**Ezhud - Engineering Prototype (EP)**	**65 days**	**Wed 5/11/22**	**Tue 8/9/22**
1	**1 User Application**	**41 days**	**Wed 5/11/22**	**Wed 7/6/22**
2	1.1 Base Application	14 days	Wed 5/11/22	Mon 5/30/22
3	1.2 Core App Functionality Complete	0 days	Mon 5/30/22	Mon 5/30/22
4	1.3 App-Side Automation of Initial Setup	30 days	Thu 5/26/22	Wed 7/6/22
5	1.4 User Application Complete	0 days	Wed 7/6/22	Wed 7/6/22
6	**2 Microcontroller-Side Software**	**48 days**	**Wed 5/11/22**	**Fri 7/15/22**
7	2.1 Python Scripting to support Camera, GPIO	7 days	Wed 5/11/22	Thu 5/19/22
8	2.2 Software support for camera recording	14 days	Wed 5/18/22	Mon 6/2/22
9	2.3 Support for Bluetooth Connection to Phone App	30 days	Wed 5/25/22	Tue 7/5/22
10	2.4 Refactor Web Server	14 days	Tue 6/28/22	Fri 7/15/22
11	2.5 Microcontroller Software Complete	0 days	Fri 7/15/22	Fri 7/15/22
12	**3 Hardware**	**60 days**	**Wed 5/11/22**	**Tue 8/2/22**
13	3.1 Iterative Device Shell/Housing Refinement	60 days	Wed 5/11/22	Tue 8/2/22
14	3.2 Integrate Camera	7 days	Wed 5/11/22	Thu 5/19/22
15	3.3 Refine Display Mounting Mechanism	21 days	Wed 5/18/22	Wed 6/15/22
16	3.4 Quick Release Mechanism	21 days	Wed 6/15/22	Wed 7/13/22
17	3.5 Device Shell/Housing Complete	0 days	Tue 8/2/22	Tue 8/2/22
18	**4 Maps System**	**46 days**	**Wed 5/11/22**	**Wed 7/13/22**
19	4.1 Wireless Android Auto	21 days	Wed 5/11/22	Wed 6/8/22
20	4.2 Display Speed Limit	25 days	Thu 6/9/22	Wed 7/13/22
21	4.3 Maps Display Complete	0 days	Wed 7/13/22	Wed 7/13/22
22	**5 Integration and Testing**	**65 days**	**Wed 5/11/22**	**Tue 8/9/22**
23	5.1 Rolling Integration and Regression Testing	60 days	Wed 5/11/22	Tue 8/2/22
24	5.2 EP Integration and Testing	11 days	Tue 7/26/22	Tue 8/9/22
25	5.3 Engineering Prototype	0 days	Tue 8/9/22	Tue 8/9/22

ClearNav Co.

22

ACTUAL SCHEDULE

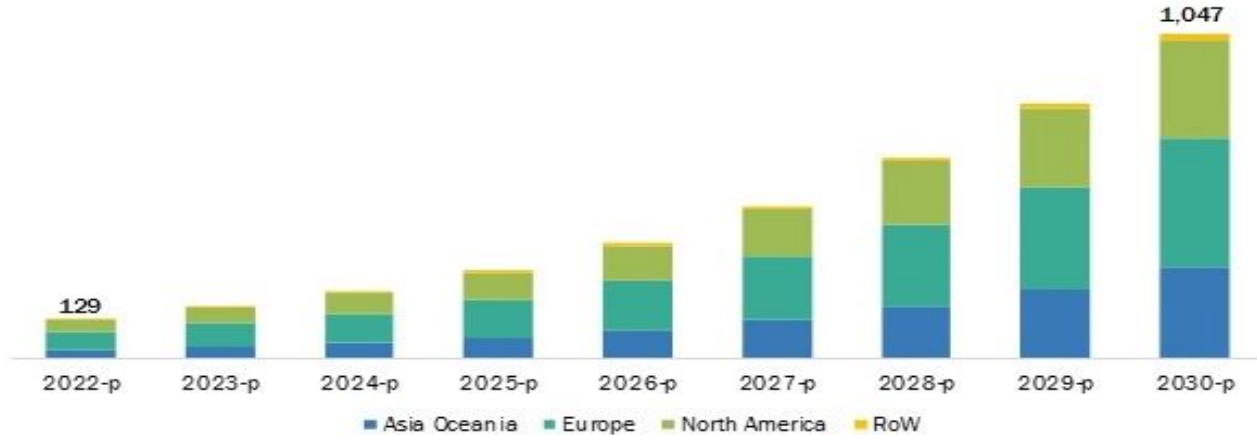| ID	Task Name	Duration	Start	Finish
0	**Ezhud - Gamma Prototype**	**54 days**	**Mon 5/23/22**	**Thu 8/4/22**
1	**1 Software**	**54 days**	**Mon 5/23/22**	**Thu 8/4/22**
2	1.1 Automate Bluetooth Pairing	19 days	Mon 6/6/22	Thu 6/30/22
3	**1.2 Maps System**	**29 days**	**Mon 5/23/22**	**Thu 6/30/22**
4	1.2.1 Wireless Android Auto	29 days	Mon 5/23/22	Thu 6/30/22
5	1.2.2 Maps Display Complete	0 days	Thu 6/30/22	Thu 6/30/22
6	1.3 Dashcam code	16 days	Thu 6/23/22	Thu 7/14/22
7	**1.4 GPS**	**46 days**	**Thu 6/2/22**	**Thu 8/4/22**
8	1.4.1 GPS Speed Limit Capture	5 days	Thu 6/2/22	Wed 6/8/22
9	1.4.2 GPS UI	41 days	Thu 6/9/22	Thu 8/4/22
10	1.4.3 GPS System Complete	0 days	Thu 8/4/22	Thu 8/4/22
11	1.5 Refactor Web Server	10 days	Sun 7/24/22	Thu 8/4/22
12	1.6 Software Complete	0 days	Thu 8/4/22	Thu 8/4/22
13	**2 Hardware**	**52 days**	**Wed 5/25/22**	**Thu 8/4/22**
14	**2.1 Housing**	**52 days**	**Wed 5/25/22**	**Thu 8/4/22**
15	2.1.1 Iterative Device Shell/Housing Refinement	52 days	Wed 5/25/22	Thu 8/4/22
16	2.1.2 Camera Mount	22 days	Wed 6/15/22	Thu 7/14/22
17	2.1.3 Refine Display Mounting Mechanism	10 days	Sun 7/24/22	Thu 8/4/22
18	2.1.4 Quick Release Mechanism	4 days	Wed 7/27/22	Sat 7/30/22
19	2.1.5 Device Shell/Housing Complete	0 days	Thu 8/4/22	Thu 8/4/22
20	**2.2 Electronics**	**51 days**	**Thu 5/26/22**	**Thu 8/4/22**
21	2.2.1 Custom PCB	47 days	Thu 5/26/22	Fri 7/29/22
22	2.2.2 Integrate Components with CM4	21 days	Thu 7/7/22	Thu 8/4/22
23	**3 Integration and Testing**	**10 days**	**Fri 7/22/22**	**Thu 8/4/22**
24	3.1 Gamma Integration and Testing	10 days	Fri 7/22/22	Thu 8/4/22
25	3.2 Gamma Prototype	0 days	Thu 8/4/22	Thu 8/4/22

ClearNav Co.

23

BUSINESS CASE

Market Opportunity & Finances

ClearNav Co.

HEADS UP DISPLAY MARKET

- Globally the market for HUD projected to reach $1047 million by 2030
- Most market share in Europe and Asia-Pacific
- We are here for North America
  - Offering competitive prices
  - Simultaneously competing with companies in Europe

Stacked bar chart showing HUD market projections from 2022-p to 2030-p by region (Asia Oceania, Europe, North America, RoW). 2022-p value: 129; 2030-p value: 1,047.

OUR COMPETITORS

NUVIZ HUD ($852 USD)

EyeRide HUD ($700 CAD)

Competitors

- GPS, dash cam, phone calls, music
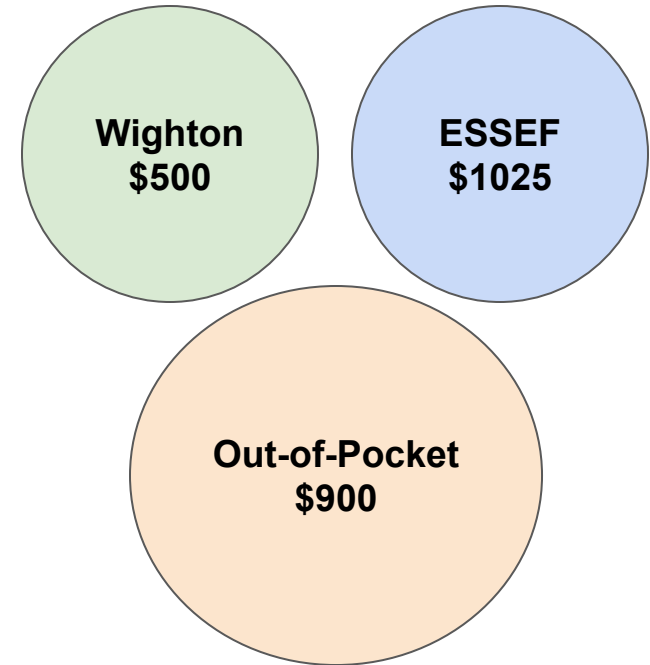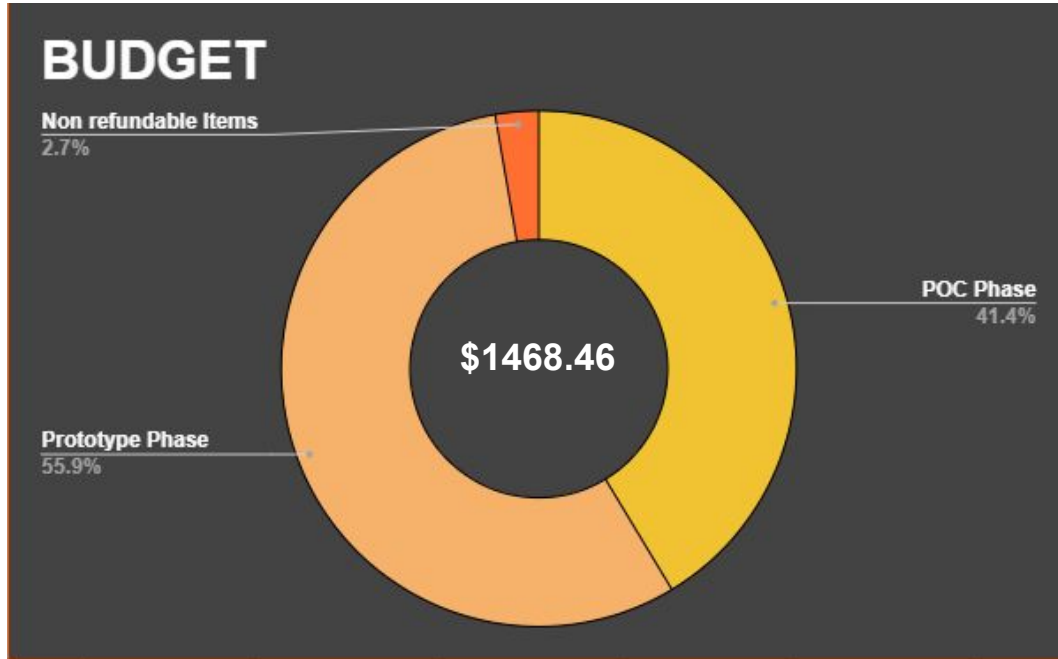- Company halted operation

- GPS, music, voice calls
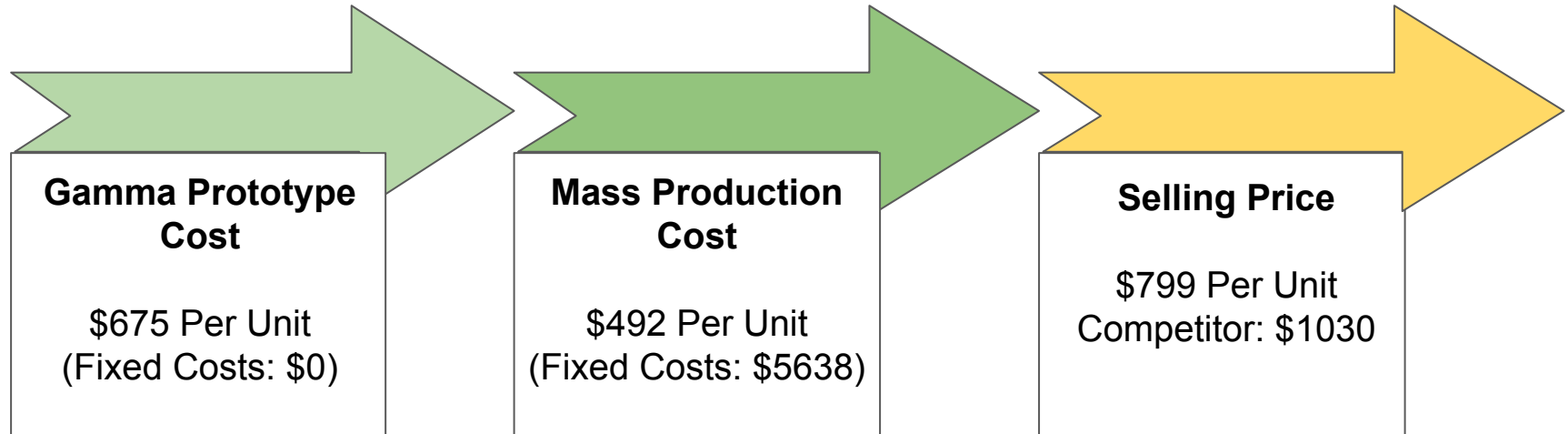- More popular in Europe

ClearNav Co.

OUR IDEAL CUSTOMER

- Adventurous Riders
- Motorcycles without infotainment systems
    - Older motorcycles

ClearNav Co.

BUDGET AND FINANCING

BUDGET

Non refundable Items
2.7%

POC Phase
41.4%

Prototype Phase
55.9%

$1468.46

Wighton
$500

ESSEF
$1025

Out-of-Pocket
$900

ClearNav Co.

COSTS AND SELLING POINT

Gamma Prototype Cost

$675 Per Unit
(Fixed Costs: $0)

Mass Production Cost

$492 Per Unit
(Fixed Costs: $5638)

Selling Price

$799 Per Unit
Competitor: $1030

ClearNav Co.

RISK ANALYSIS

Product Safety & Business Risks

ClearNav Co.

EZHUD RISKS AND **HAZARDS**

- Wearable Electronic Device with Lithium battery can be hazardous.
- EZhud display can be distracting if not adjusted properly covering the field of view of the rider.
- The display of EZhud can vibrate at high speeds, If not mounted according to the directions provided.
- Vibrations at high speed can result in damaging the internal components of EZhud

ClearNav Co.

RISK MITIGATION VIA **DESIGN**

- Components held in place inside the housing to prevent electrical shorts
- Implementation of custom PCB
- The adjustable ball joint in the display mount will allow the user to adjust the display before driving
- Components mounted securely inside the housing
- Interlock mechanism to ensure EZhud remains securely attached

ClearNav Co.

PLAN B FOR COMMERCIALIZATION

- Repurpose the design and use of EZhud to sell to police force
  - Built in GPS to track location and speed
  - Record Law enforcement officers interactions with public through dashcam
  - Enhanced dash cam to record license plates
- Might need some detailed certifications to enter the market

ClearNav Co.

ENGINEERING STANDARDS

ClearNav Co.

RELEVANT STANDARDS

Engineering Standard	How we complied
(CSA C22.2 No. 94.2-07 R2012) Enclosures for Electrical Equipment	- Components inside housing are mounted securely to avoid damage. - Components inside housing are isolated from each other to prevent electrical shorts
(ISO 31022:2020) Management of Legal Risk	ICBC regulations taken into consideration - Route is programmable before operation of vehicle (warning is displayed) - Device is securely attached to helmet - Device must not obstruct riders view - Device must not interfere with operating equipment of motorcycle

ClearNav Co.

RELEVANT STANDARDS

Engineering Standard	How we complied
ECE European Standard	- Helmet accessory standards in Europe is mentioned only in 2020 and not enforced until 2023 - Helmet will be tested with standard ECE tests with and without accessories - No mention of adhesion or aerodynamic standards

ClearNav Co.

CONCLUSION

Project Summary & Self Reflection

ClearNav Co.

PROJECT SUMMARY

What We Achieved	Future Plans
● Designed and integrated prototype for helmet-attachable HUD ● Integrated navigation, speed, and dashcam into a single product ● Developed business plan for commercialization ● Performed breakeven analysis	● Fully wireless system ● Weatherproof design ● Product works completely offline ● More polished user interface ● Integrated Printed Circuit Board into product

ClearNav Co.

SELF REFLECTION

Feedback	What We Learned	What We Would Have Done Differently
● Really think about the customer first and the technology second ● Prioritize minimum viable product first	● Organizing team meetings are difficult ● Looking over documents together is very slow. ● Product integration is hard and time consuming ● Adaptation of design approach from past companies	● Started PCB earlier ● Shorter, more efficient team meetings ● Well defined tasks for each person during work sessions

ClearNav Co.

PROBLEMS AND BLOCKERS

Late scope change ● Computer Vision Dropped ● Dashcam Added	● Semester of planning lost ● Very short time to implement dashcam feature
Wireless navigation	● Couldn't get wireless with app ● 2 Weeks effort
Camera hardware issues	● Wouldn't detect on new rasp. Pi ● 1.5 Weeks
Navigation software	● Had to try several options

ClearNav Co.

PROBLEMS AND BLOCKERS

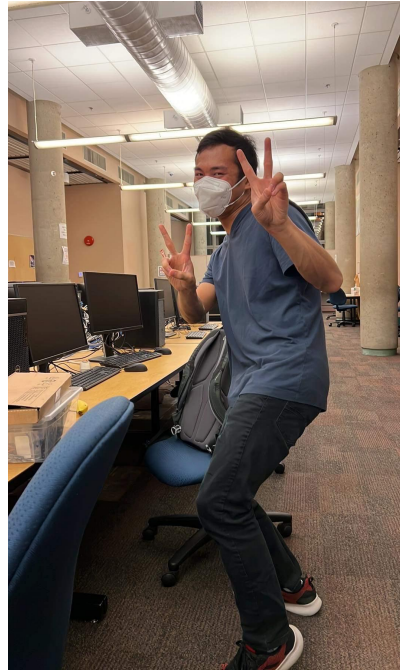|	
● 3D Printing	● Build plate not sticking ● Printer extruder stuck ● Case Tolerances Are Different ● Removing Supports from Inside Cases ● Ball Joints Require Tight Tolerances ● Weak Mesh Like Filament

ClearNav Co.

THANK YOU

April 12th (PoC day), 2:45am

July 8th, 11:12pm

August 4th, 10:30pm

ClearNav Co.

REFERENCES

E. Schaffer, "Motorcycle accident statistics in Vancouver: Warnett Hallen LLP," *Motorcycle Accident Statistics in Vancouver | Warnett Hallen LLP*, 11-Feb-2022. [Online]. Available: https://warnetthallen.com/motorcycle-accident-lawyer/statistics/. [Accessed: 01-Aug-2022].

"Beach handlebar - 55967-08: Harley-Davidson EU," *Harley*. [Online]. Available: https://www.harley-davidson.com/eu/en/shop/Beach-Handlebar/p/55967-08. [Accessed: 01-Aug-2022].

"Clubs and teams," *ESSS*. [Online]. Available: http://www.sfu.ca/esss/engineering-clubs.html. [Accessed: 01-Aug-2022].

"HUD helmet market," *Market Research Firm*. [Online]. Available: https://www.marketsandmarkets.com/Market-Reports/hud-helmet-market-258088609.html#. [Accessed: 10-Jul-2022].

"Product - CSA Group", *CSA Group*, 2022. [Online]. Available: https://www.csagroup.org/store/product/CAN%25100CSA-C22.2%20NO.%2094.2-07/. [Accessed: 20- Jun- 2022]

"International ISO standard 31022 - prime consultores." [Online]. Available: https://primeconsultores.com.pe/wp-content/uploads/2020/09/ISO_31022_2020_EN.pdf. [Accessed: 19-Jun-2022].

"Nuviz - motorcycle head-up display," *Wantboard*. [Online]. Available: https://www.wantboard.ca/products/nuviz-motorcycle-head-up-display. [Accessed: 01-Aug-2022].

"Eyeride head up display + télécommande bluetooth," *EyeLights | Affichage tête haute Moto*. [Online]. Available: https://eye-lights.com/products/eyeride-head-up-display-telecommande-bluetooth-affichage-tete-haute-gps-intercom. [Accessed: 01-Aug-2022].

ClearNav Co.