4-28-2021

The Best Snowboarding Buddy: Snowpes System

Peiwen He
ph7509@rit.edu

RIT

The Best Snowboarding Buddy: Snowpes System

BY

Peiwen He

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Visual Communication Design

School of Design
College of Art and Design
Rochester Institute of Technology
Rochester, NY
April 28, 2021

Committee Approval

Adam Smith Date

Chief Advisor

Associate Professor

Director of Visual Communication Design program

School of Design, College of Art and Design

Mike Strobert Date

Associate Advisor

Senior Lecturer

School of Design, College of Art and Design

Abstract

The mountain ski resorts are huge places, while the maps are difficult to read and remember. Due to the difference of languages and map signs across countries, it's difficult for people to locate themselves on a map. In addition, it can be difficult for a snowboarder to keep contact with their crew. It also makes asking for rescue take longer. For the snowboarders whose ears are occupied, it's dangerous when there's someone behind them closely. For novice snowboarders who snowboard alone, it is not easy for them to learn new tricks so that they may give up. The Snowpes system includes XR (Mixed Reality) snowboarding goggles and a camera drone. With Augmented Reality Head-Up Display (AR HUD) Technology, the Snowpes goggles can help snowboarders navigate through the big resorts safely and connect with their crew easily. The Snowpes goggles' VR (Virtual Reality) mode can help users feel more engaged in the snowboarding community. The Snowpes camera drone can follow the users automatically and it can be controlled by goggles with computer vision and spatial computing technology. Project Implementation includes developing digital 3D model design, Camera Drone HUD Design, Goggles HUD Design, HUD prototype, and a Promotion Video.

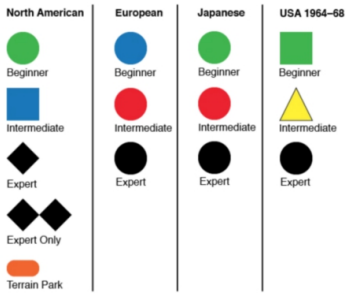
Keywords Augmented Reality, Virtual Reality, Head-Up Display, Drone, Snowboard Goggles

Problem and Solution Statement

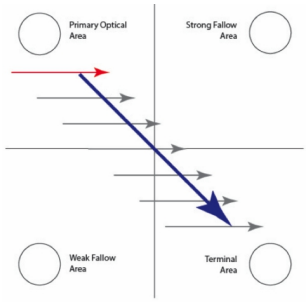
Mountain ski resorts are a huge place. Paper trail maps snowboarders carry around are difficult to read and remember. And the important information, such as navigation, heartbeat, speed, and vertical drop, is not easy to access on the move. When snowboards are doing the sports in a new place, especially overseas, it's hard for them to understand their surroundings intuitively through just a paper trail map. The different languages might also makes asking for rescue late. And they can't know where their snowboarding crew members are, so that they are more likely to lose contact with each others. When snowboarders are on the run, it is important to be aware of other skiers and snowboarders. But it's not possible for snowboarders to hear or focus on everyone. How might we design a system to help snowboards understand themselves and their surroundings and create a safe and pleasant snowboarding experience for them?
The Snowpes system includes snowboarding goggles, and a camera drone. Users can create a custom route easily by tapping the start and endpoint on a 3D trail map showed on the HUD. Moreover, users can choose a buddy to follow along with. They can also track their buddies and vehicles. The video gallery of Snowpes system collects the videos captured by the goggles camera and the camera drone, and there are also the VR tutorial videos and live snowboarding videos. Therefore, users can use the goggles' VR (Virtual Reality) mode to enjoy snowboarding anywhere. With Augmented Reality Head-Up Display (AR HUD) Technology, snowboarders will see the stats on their goggles' HUD and navigate themselves intuitively by switching to the goggles' AR mode. For safety reasons, there will be a visual warning when someone is trying to cut them off. Plus, there's also an emergency call button on the goggles. Project Implementation includes developing digital 3D model design, Camera Drone HUD Design, Goggles HUD Design, App prototype, and a Promotion Video.

Main Body

It is important to be aware of other skiers and snowboarders, especially if they are behind you. But it's not possible for snowboarders to hear or focus on everyone. Over 5% – or 430 million people – of the world's population have disabling hearing loss (World Health Organization, 2020). In addition, most of the snowboarders who I interviewed says that they prefer to listen to music while doing the sports. It's dangerous for them if there's someone close behind them when snowboarding. To address this safety issue, Snowpes goggles apply a special orange AR visual warning to the HUD to tell them which side they need to watch out for. The reason that I choose safety orange to be the accent color for the goggles HUD because the ski resorts use safety orange color on their warning flags. The vivid reddish-orange is used to set objects apart from their surroundings, and there is a very strong complementary contrast between the vivid reddish and the color of the sky (Color Matters, 2021).
North America uses about five symbols to grade the trails, while Europe or Japan uses slightly different symbols to mark theirs (Fig.1), which might cause misunderstanding when snowboarders do the sports overseas. Moreover, Europe and Japan only use colors to mark the difficulty of a trail, which is not user-friendly to the color-blind snowboarders.



[Figure 1. The trail signs rate. Image downloaded track from https://signsofthemountains.com/ in April 2021.]



[Figure 2. How our eyes down a page according to the Gutenberg diagram. Image downloaded from https://www.tales.co.nz/ in April 2021.]

Worldwide, approximately "8% of men and 0.5% of women suffer from color blindness" (color vision deficiency, or CVD), which means that there are about 300 million color-blind people all over the world, almost the same as the entire population of America (Color Blind Awareness, 2020). By using bigger and animated shapes and colors, Snowpes HUD can not only inform users which levels the trails they are heading to but also help the color-blind users understand the European and Japanese trail signs.
Our eyes follow a certain pattern when browsing a page. According to Figure 2. the Gutenberg Diagram divides the page into four quadrants. When it comes to design a HUD, it would be better if the secondary information is not placed on the primary optical area. Snowpes HUD puts the primary data on the primary optical area as well as the strong follow area, and tries to decrease distractions on the snow slopes. To test the balance, authentic and legibility of the HUD, I sketched the HUD designs on the Mylar sheets, and saw the ski resorts through the sheets. In this case, Snowpes can provide a more well-organized and efficient HUD for users with minimized distractions.

Conclusion

Given the fact that ski mountain resorts are huge places, it's easy to get lost and lose contact with other crew members. Besides, there are about 300 million color-blind people and 430 million deaf people all over the world. Goggles with AR HUD technology can help snowboarders navigate through the big resorts with more understanding of their surroundings and also help snowboard crews connect with each others. The 3D trail maps are designed for users to easily plan their route with simply tapping the start and end points. By using the safety orange visual warning, it would be safer for the ear-occupied snowboarders to know there's someone behind them. Snowboarders, especially color-blind snowboarders can be well informed with bigger and animated shapes when snowboarding overseas. The system also provides users a more immersive experience anywhere with the technology of VR, camera drone and streaming. This system is aimed to give users a safe and pleasant snowboarding experience.

Appendix A - Defence Slides

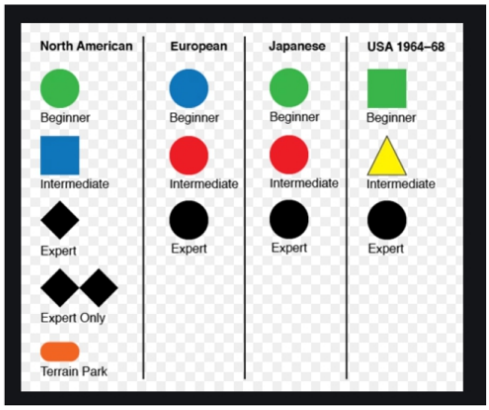
1.

Get Lost or Lose Contact

Mountain ski resorts are **huge places**, while **the maps are difficult to read and remember.** It's difficult for snowboarders to **locate** themselves on a map. It can also be difficult for a snowboarder to **keep contact** with their crew.

2.

North America uses about five symbols to grade the trails, while **Europe or Japan** uses slightly **different symbols** to mark theirs. The signs in Europe and Japan are **not user-friendly** to the **color-blind** snowboarders. While approximately "8% of men and 0.5% of women - **300 million people** - suffer from color blindness".

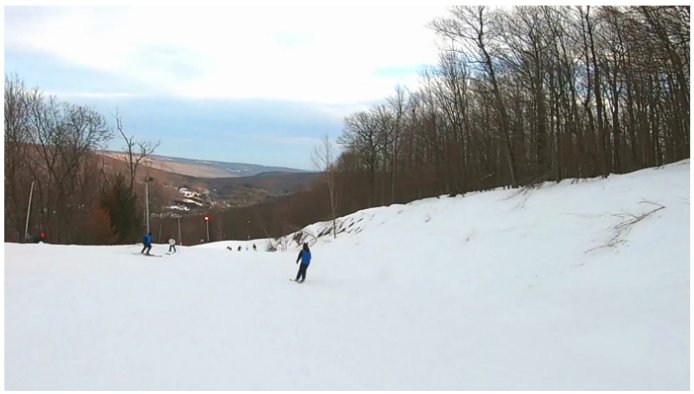


[Figure 1. The trail signs rate. Image downloaded from https://signsofthemountains.com/ in April 2021.]

3.

Hearing Loss

Over 5% – or **430 million people** – of the world's population have **disabling hearing loss**.



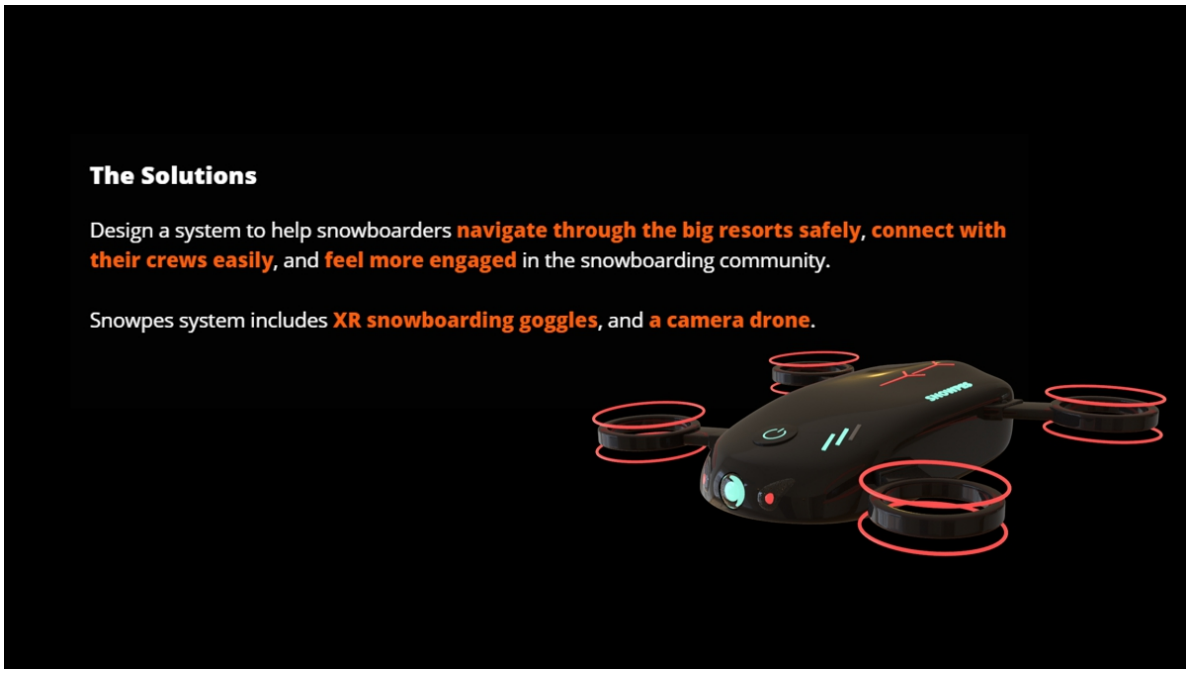
4.

Private lesson can be expensive

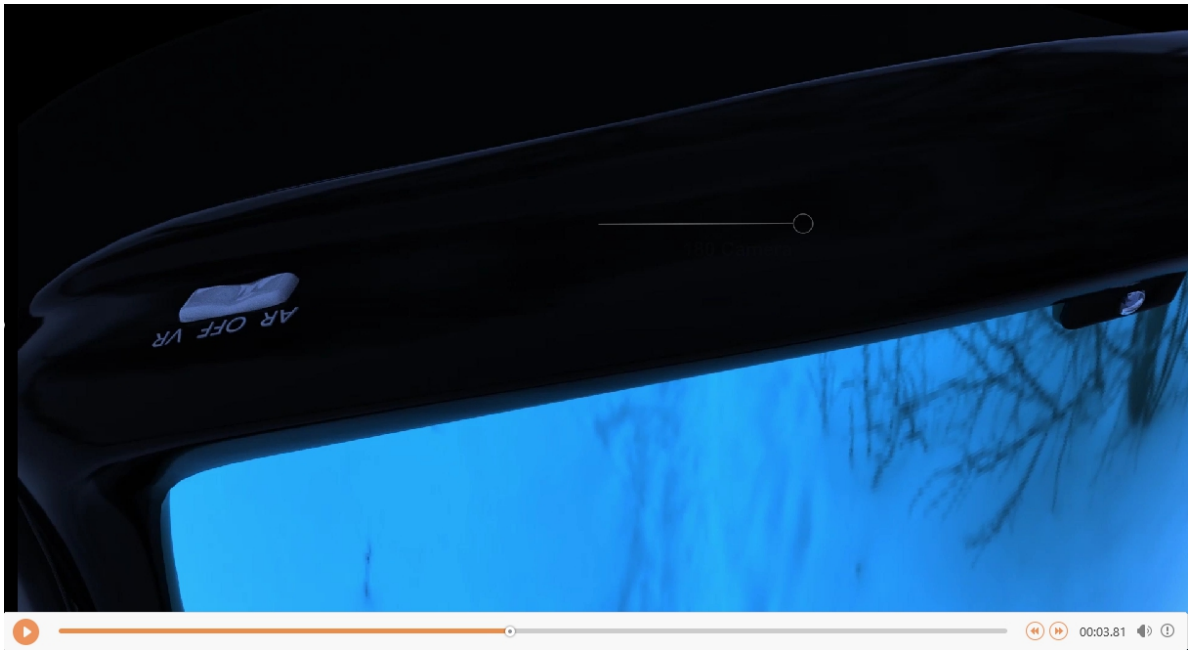
It's **expensive** to learn snowboarding by **hiring a personal coach**. Private lesson can cost more than **$100 a hour.**

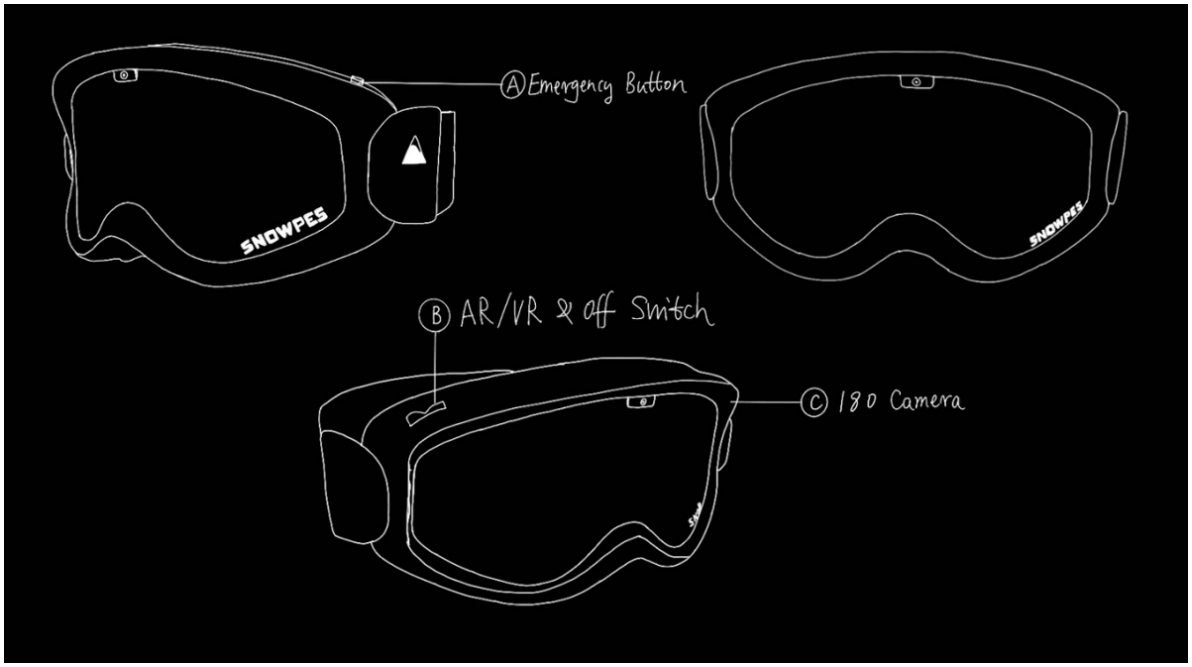
Private Lesson (Ski or Snowboard)*	One Person	Each Additional Person
One Hour	$115	$75
2 Hours	$230	$140
3 Hours	$320	$210
Full Day (6 hours)	$600	$400

[Figure 2. Private Lessons Cost downloaded from https://skibutternut.com/lessons-packages/lessons/private-lessons in May 2021.]




SNOWPES
by PEIWEN
00:01.45

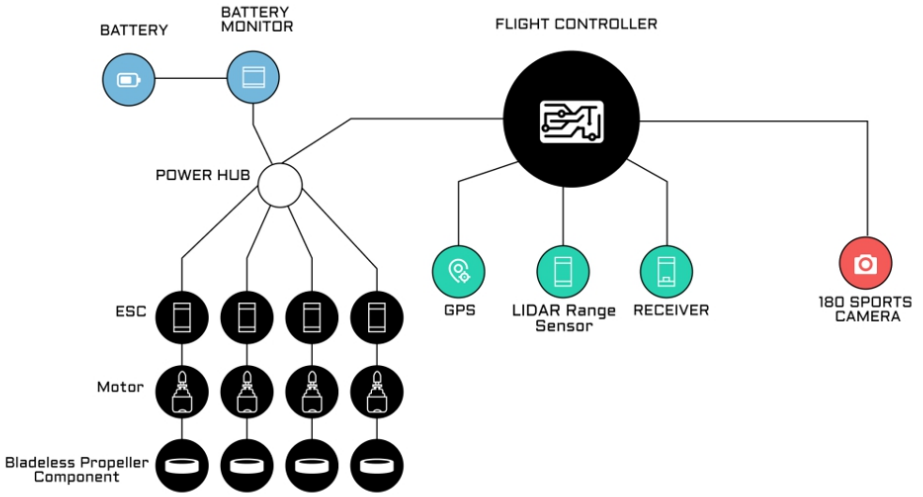

AR OFF VR
00:03.81


Ⓐ Emergency Button
SNOWPES
SNOWPES
Ⓑ AR/VR & off Switch
Ⓒ 180 Camera


SNOWPES
Auto Tracking Target. Superb Computer Vision.
Your Best Snowboarding Buddy.
Weight
1.5 kg
Flight Time
30 min
Camera
4K HDR / 180
Max Speed
100 mph
Range
5 mile
Size
20 x 25 x 5 cm

Diagrams

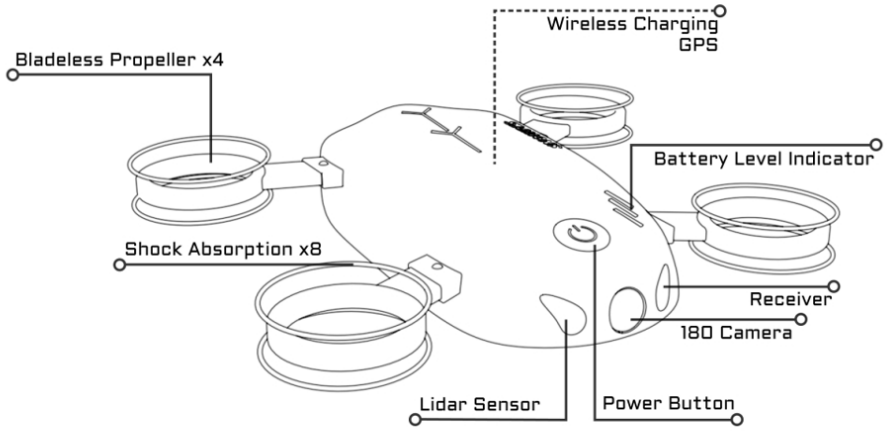
-Hardware Diagram



SNOWPES

Diagrams

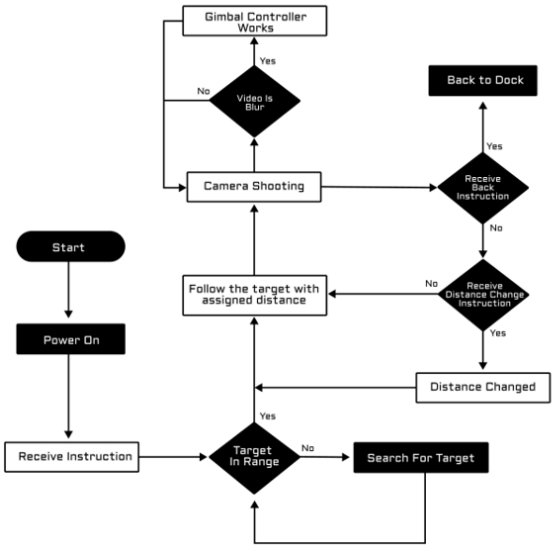
-Callout Diagram



SNOWPES

Diagrams

-Software Diagram



SNOWPES

Users

Snowpes focuses on snowboarders. There are **4 insights** according to the interviews and research from snowboarders of various experience levels and contries.

1. Snowboarding Crew

- Plan their next run with Snowpes goggles **3D trail map**
- Know where their **crew members** are, and choose a member to **follow along**
- **Navigation** on Snowpes goggles **HUD**

2. Overseas Snowboarder

- Navigation with **the trail signs** which users can understand even they snowboard **overseas**
- **Call for help** with one button

3. Beginner Snowboarder

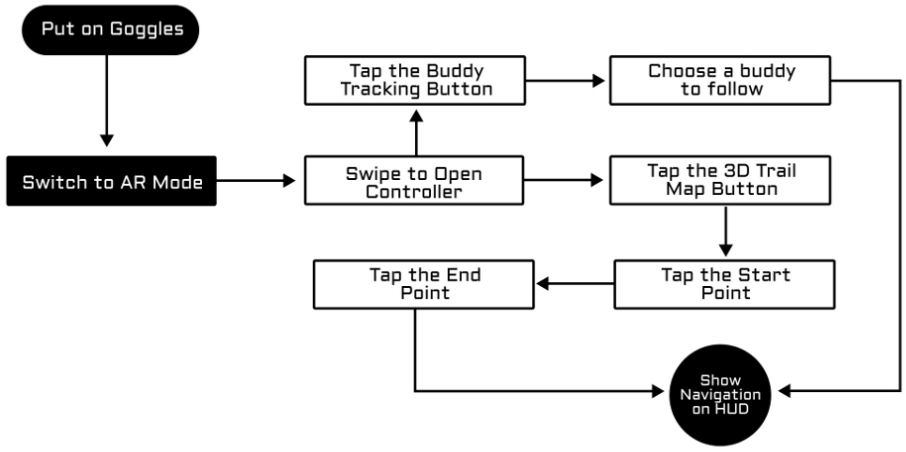
- **Learn new tricks** immersively with Snowpes goggles VR mode
- See other snowboarders **first person POV live video** with their goggles
- **Review their previous run** with videos captured by goggles and camera drone.

4. Ears-occupied Snowboarder

- Give **visual warnings** when there's someone trying to cut off the users.

User Flow 1

Navigation on HUD

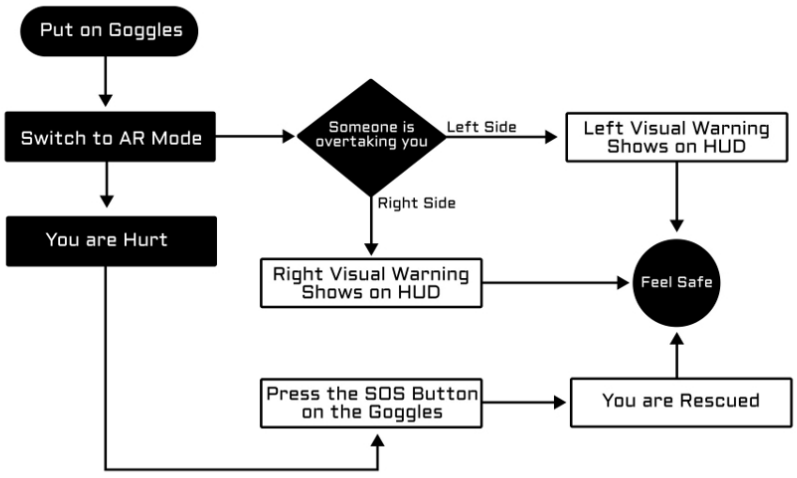


Peiwen He

SNOWPES

User Flow 2

Safety Guard For Users

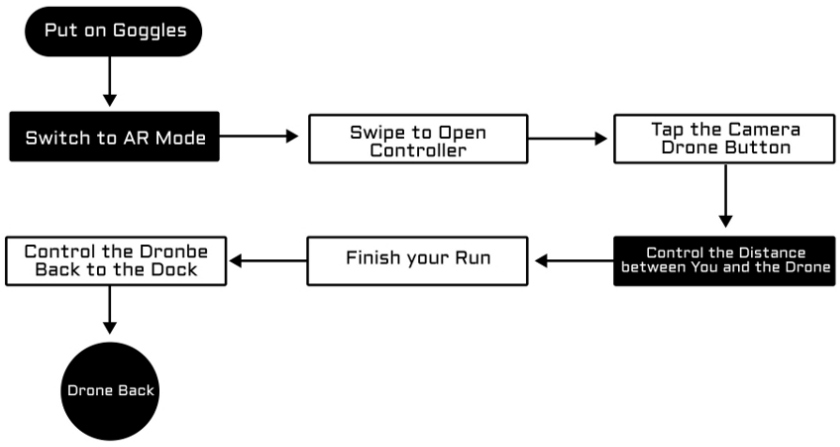


Peiwen He

SNOWPES

User Flow 3

Camera Drone Control

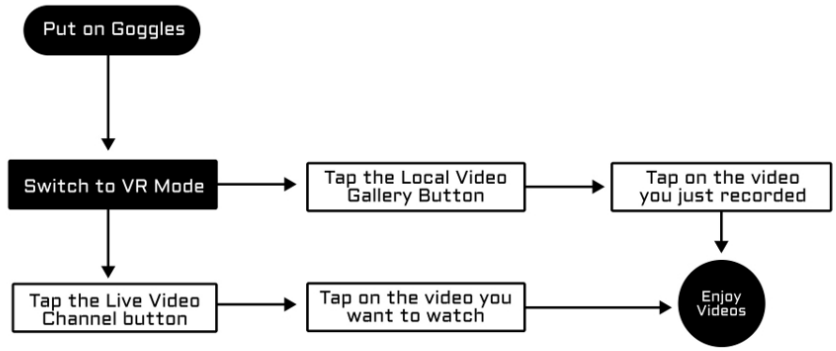


Peiwen He

SNOWPES

User Flow 4

Immersive Experience with Goggles



Peiwen He

SNOWPES

1.

Snowboarding Crew

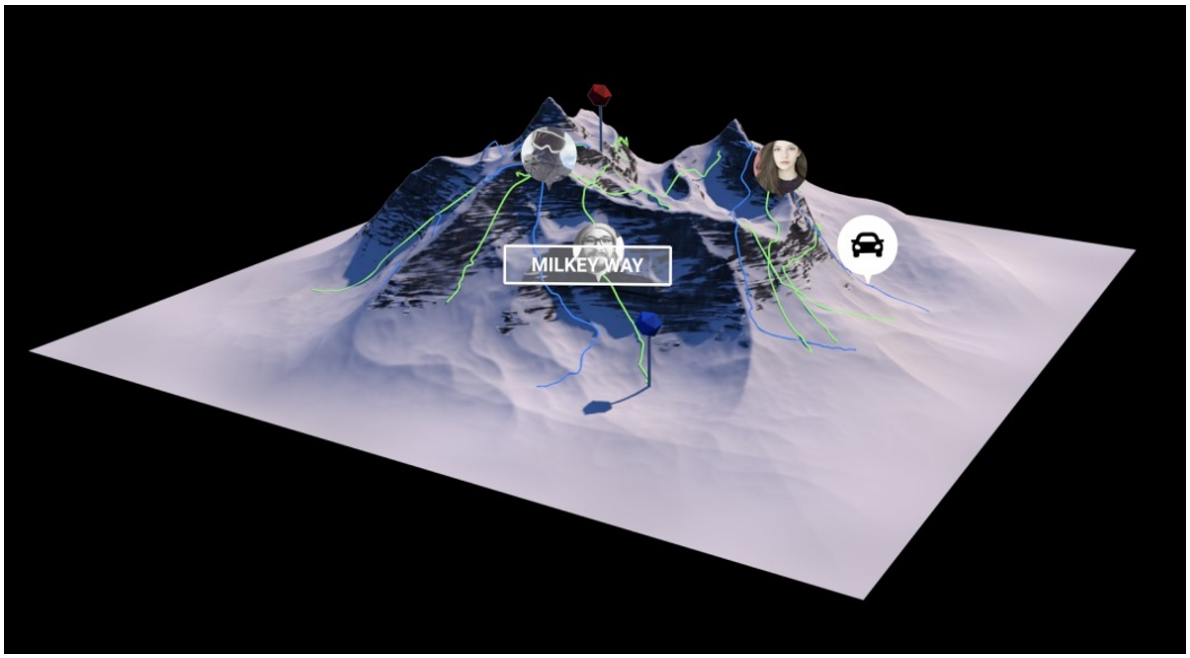
"The trail maps are difficult to read and remember. It's easy to get lost and lose contact with my crew frequently. "

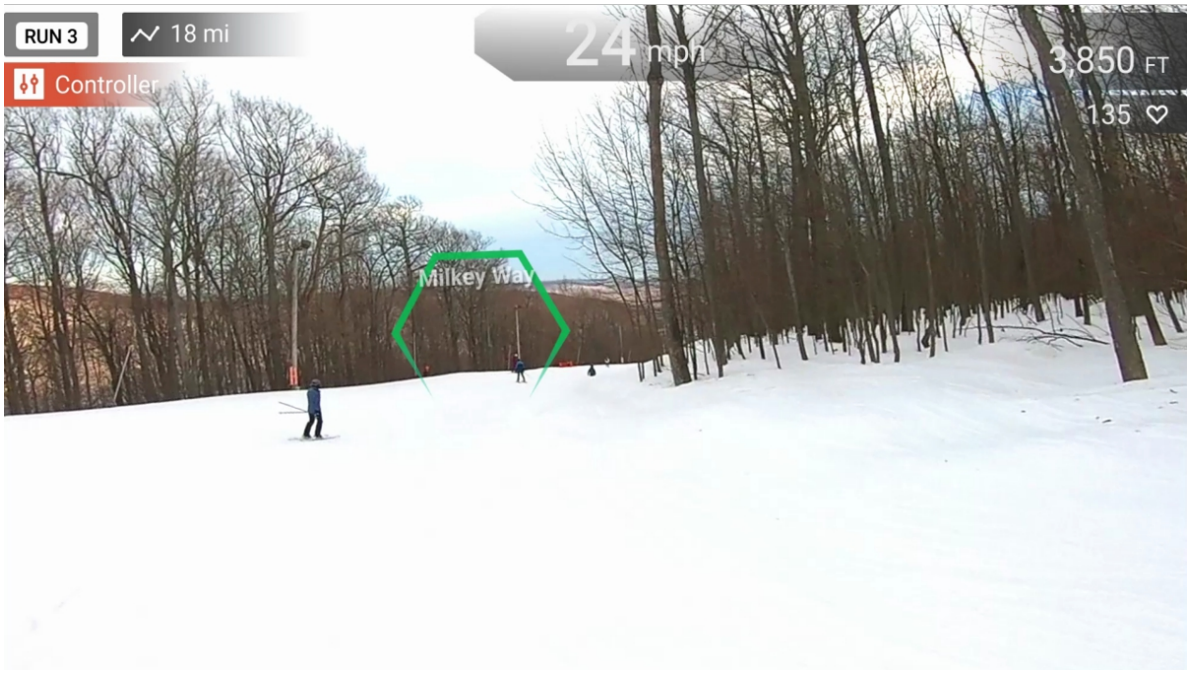
2.

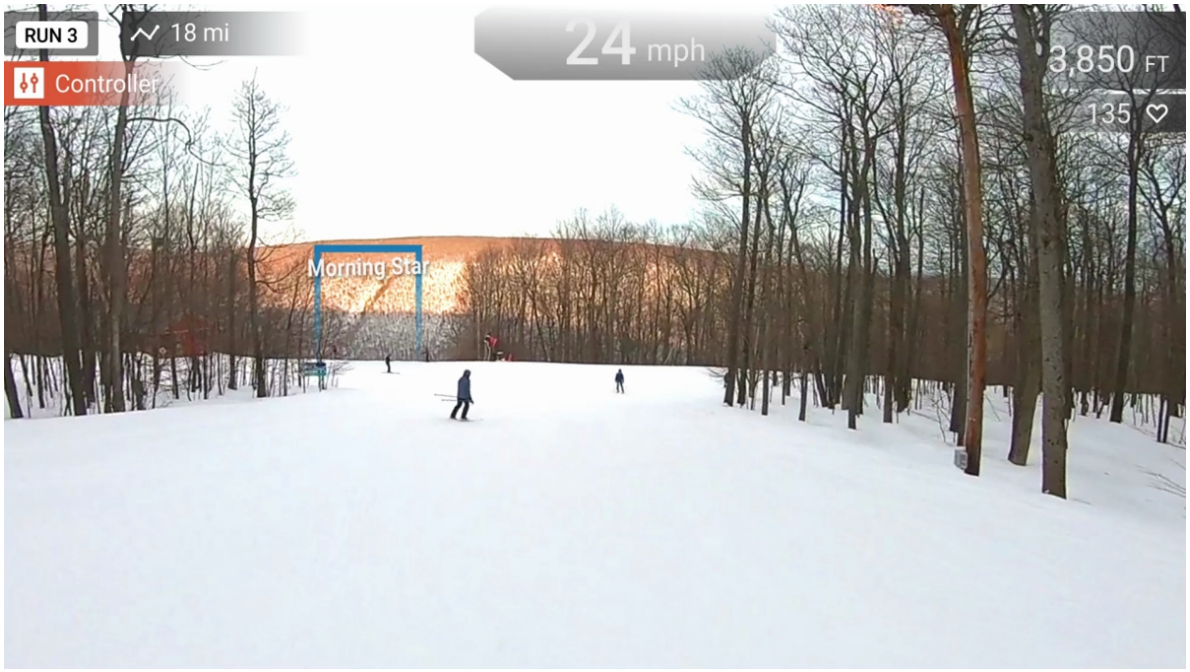
Overseas Snowboarder

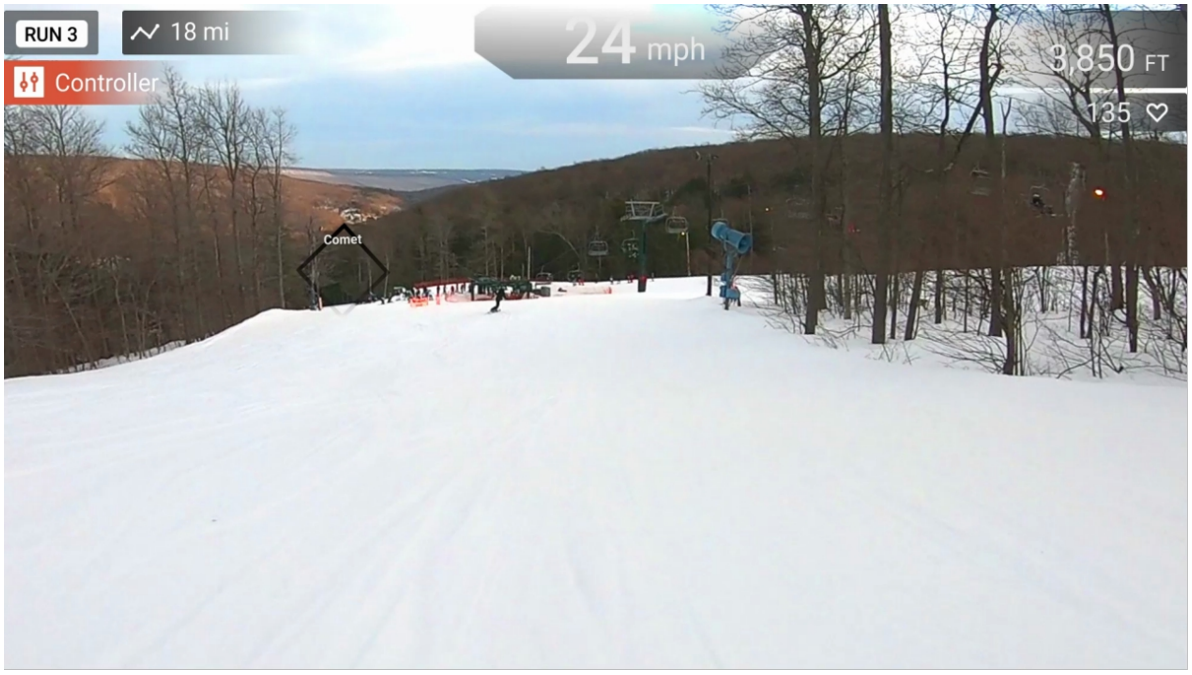
" When I snowboard overseas, the different languages and map signs are a real pain. Especially when I need to call for help."

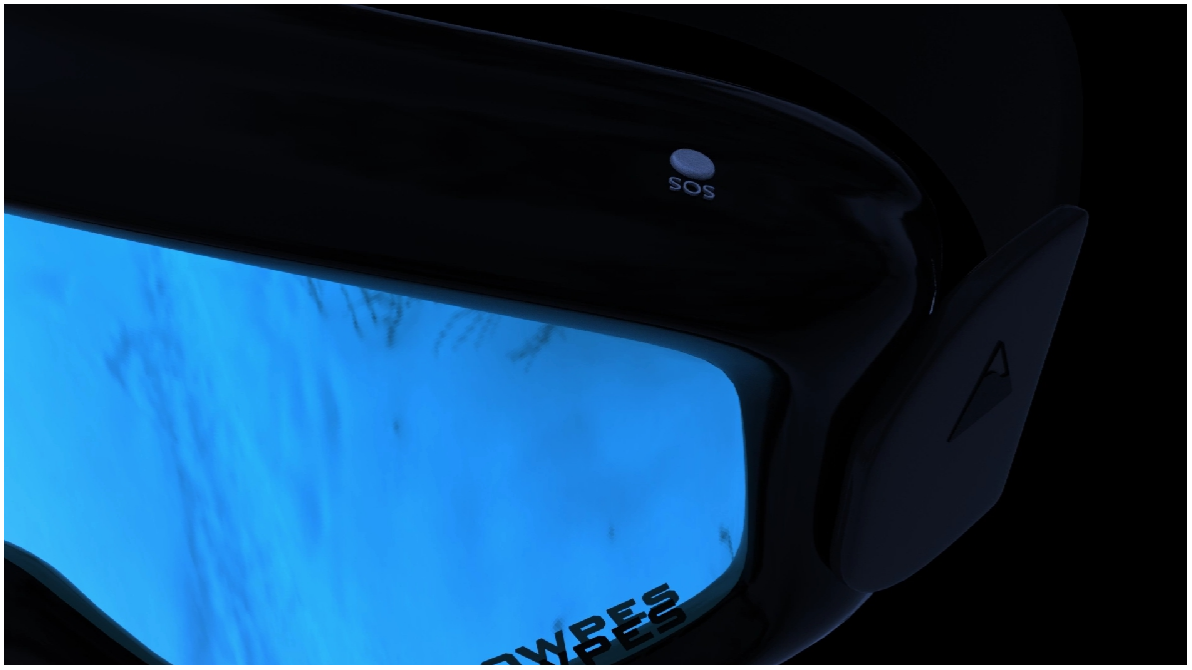

RUN 3
18 mi
Controller
0 mph
3,850 FT
135


MILKEY WAY


RUN 3
18 mi
Controller
24 mph
3,850 FT
135
Milkey Way


RUN 3
18 mi
Controller
24 mph
3,850 FT
135
Morning Star


RUN 3
18 mi
24 mph
3,850 FT
Controller
135
Comet


SOS

3.

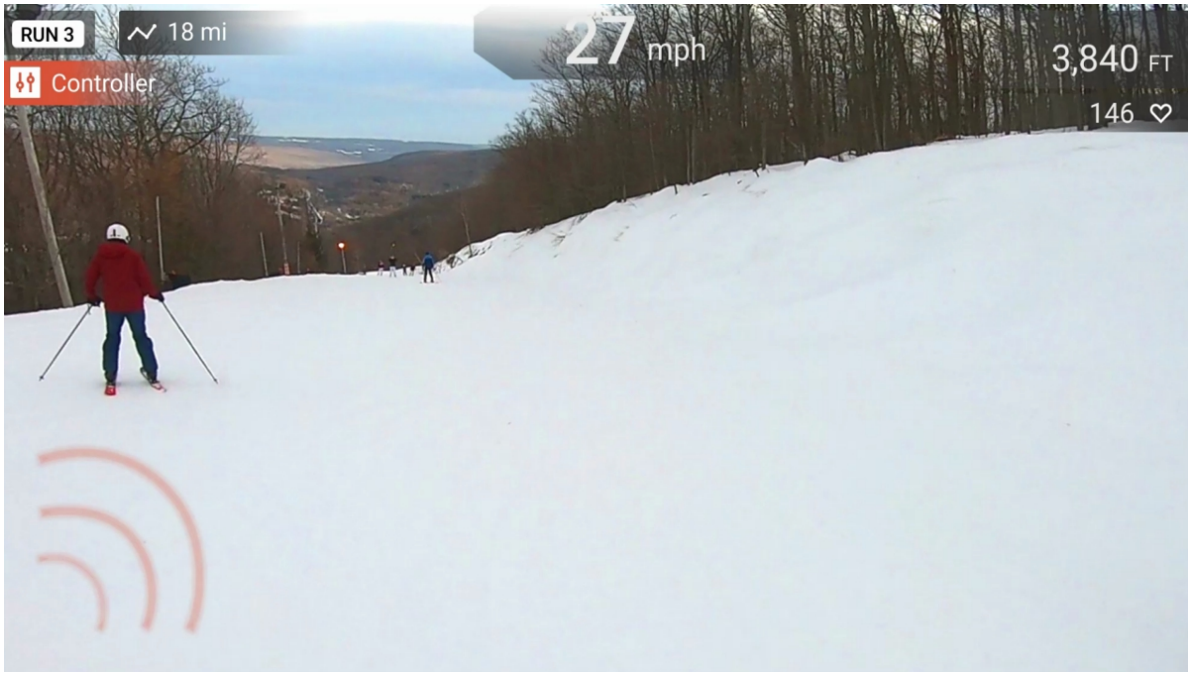
Beginner Snowboarder

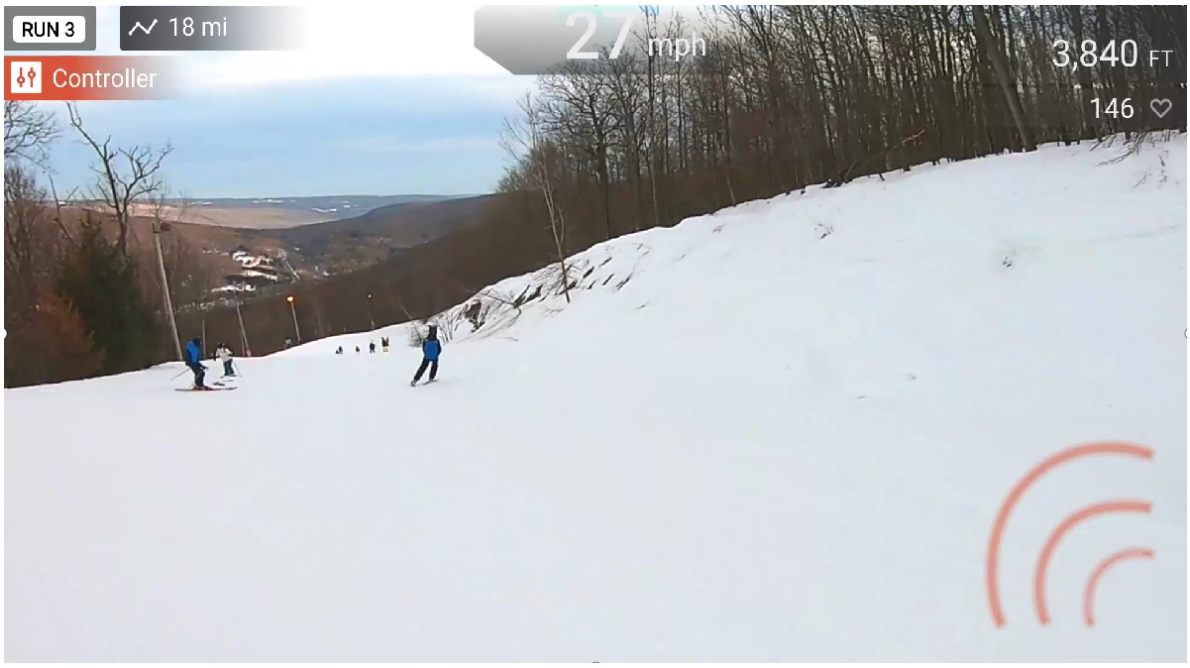
"It's really expensive to take personal snowboarding lessons, and hard to teach myself with online videos. I wish I can be involved into snowboarding community quickly."

4.

Ears-occupied Snowboarder

"Listening to music helps me enjoy the sports more, but sometimes it can be dangerous when there's someone close behind me."


RUN 3
18 mi
27 mph
3,840 FT
Controller
146


RUN 3
18 mi
27 mph
3,840 FT
Controller
146

Research

1.

Color Selection - Safety Orange

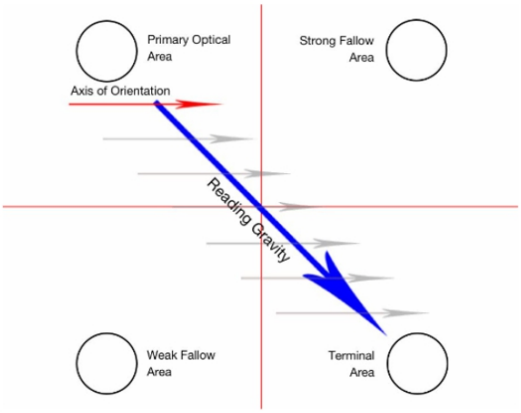
The vivid reddish-orange is used to **set objects apart from their surroundings**, and there is a very **strong complementary contrast** between the vivid reddish and the color of the sky.

Research

2.

Reading Gravity

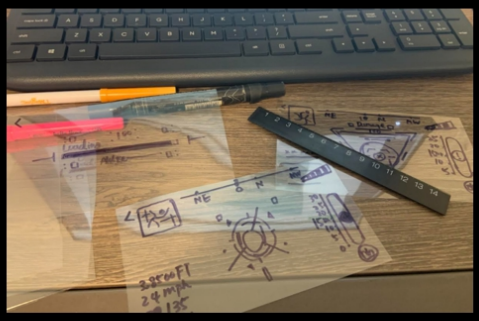
Our eyes follow **a certain pattern** when browsing. The **Gutenberg Diagram** divides the page into four quadrants. When it comes to design a HUD, it would be better if **the secondary information** is **not placed on the primary optical area**.

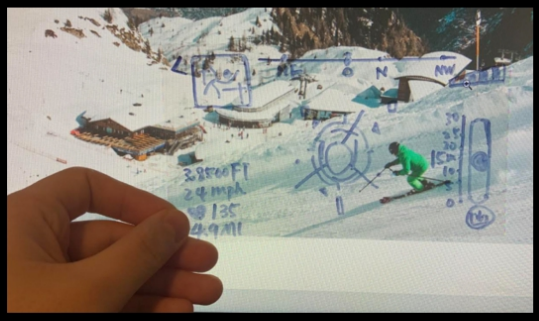


[Figure 3. The trail signs rate How our eyes track down a page according to the Gutenberg diagram. Image downloaded from https://www.tales.co.nz/ in April 2021.]

HUD Testing

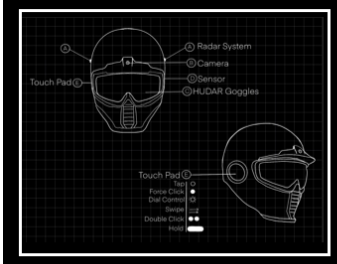
Use **Mylar Sheet** to **test and adjust** the **balance and legibility** of the HUD.



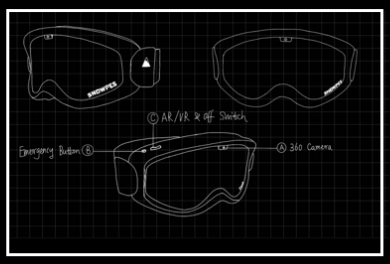


1.

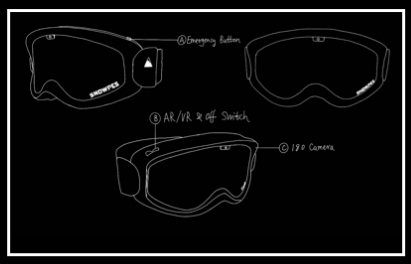
Product Design Iteractions - Snowpes Goggles



- **High Cost** to Buy
- **Long** Learning Curve
- Some Snowboarders **Only wear goggles**



- Might Push the **Wrong Button**
- 360 Camera is **too big**
- Consider **Computer Vision**



- **Final Version**
- Move the **Emergency Button** to the **Left Side**

1.

Product Design Iteractions - Snowpes Camera Drone

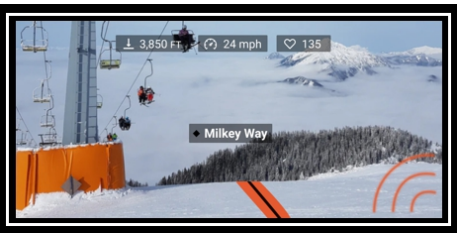
- It might **blend into the snow** too much

- Matte black is reading **too flat as a texture**
- The location of the **LIDAR sensor** is missing

- **Final Version**
- The **receiver** and **lidar sensor** are designed to seem like **the eyes of the drone**

2.

Goggles HUD Iterations



- Try to **decrease the distraction** on the snow slopes

- **Hierachy is not enoght** for the data
- **Avoid** using safety orange everywhere
- Try **exaggerate** the **trail's symbol**

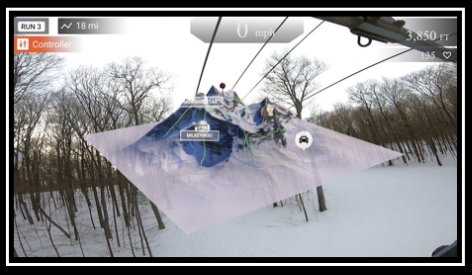
- **Final Version**
- Use **Shapes and Colors** to mark the trails
- Put **Primary Data** to the main area

3.

Map Iterations

- **Tap** on a mobile phone can be **hard** when users on a **lift**

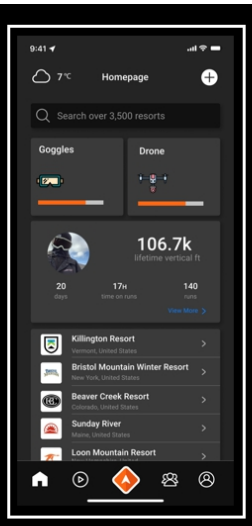
- It's **not convenient** to **explore a map** on mobile **phones**
- **Can't** find out where users **park their car**



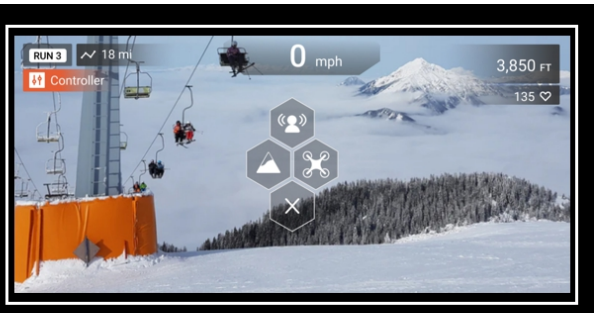
- **Final Version**
- **3D** Trail Map

4.

Controller Iterations



- It's **too cold** to use mobile phones



- **Final Version**
- Use **Gesture** to Open controller

Conclusion.

"In the beginning, I just planned to design a cool HUD for me to not have to worry about the navigation or wait for my firends who are slower than me in mountain resorts. After thinking about **accessbility** and doing the research, I figured out that the people who need this is **more than I expected**. Snowpes system **is user-friendly** to **the deaf** and **the color-blind** users. This system can help users **navigate** through the big resorts **safely**, **connect** with their crews easily, and feel more **engaged** in the snowboarding community. "

Reference

Color Blind Awareness. "Colour Blindness." Colour Blind Awareness. Accessed April 13, 2020. https://www.colourblindawareness.org/colour-blindness/.

Color Matters. "The Meanings of Colors." Color Matters.com. Accessed April 23, 2021. https://www.colormatters.com/color-and-marketing/59-color-symbolism/the-meanings-of-colors.

Signs of the Mountains. "What Do the Symbols On Ski Trail Signs Mean?" Signs of the Mountains. Accessed April 23, 2021. https://signsofthemountains.com/blogs/news/what-do-the-symbols-on-ski-trail-signs-mean.

Ski Butternut. "Private Lessons." Ski Butternut. Accessed May 2, 2021. https://skibutternut.com/lessons-packages/lessons/private-lessons.

Tales. "Part 1: Reading Gravity: Where to Place Important Information." Tales Content and Copywriting. Last modified August 15, 2018. https://www.tales.co.nz/2018/08/15/part-1-reading-gravity-where-to-place-important-information/.

Unsplash. "Snowboard." Beautiful Free Images & Pictures | Unsplash. Accessed March 2, 2021. https://unsplash.com/s/photos/snowboard.

World Health Organization. "Deafness and Hearing Loss." WHO | World Health Organization. Last modified March 1, 2020. https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss.

Appendix B - Bibliography

Color Blind Awareness. "Colour Blindness." *Colour Blind Awareness*. Accessed April 13, 2020. https://www.colourblindawareness.org/colour-blindness/.

Color Matters. "The Meanings of Colors." *Color Matters.com*. Accessed April 23, 2021. https://www.colormatters.com/color-and-marketing/59-color-symbolism/the-meanings-of-colors.

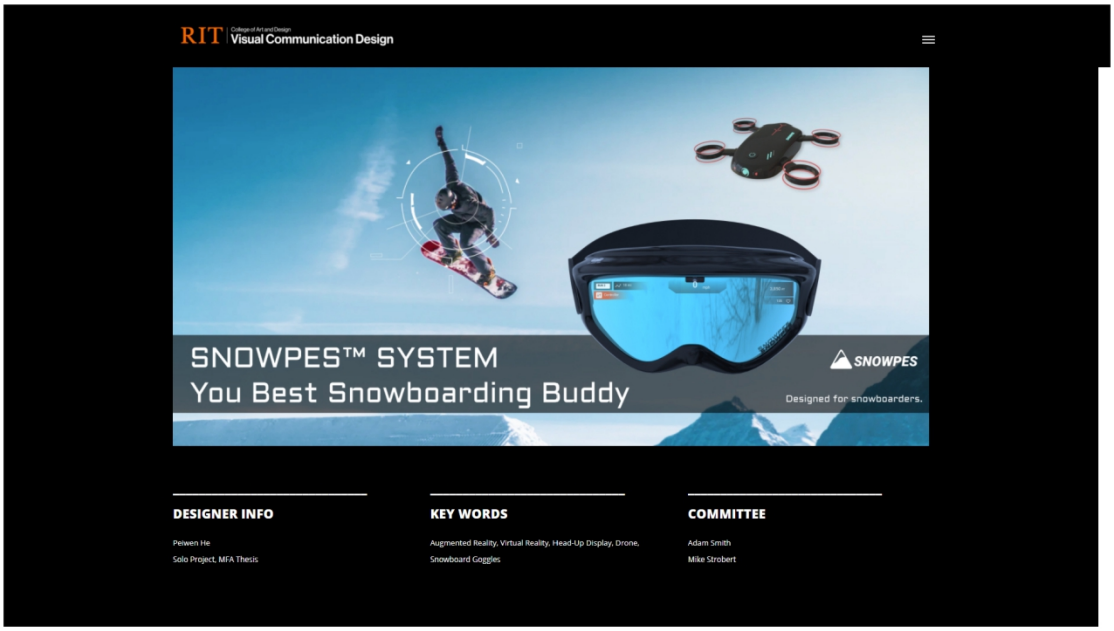
Signs of the Mountains. "What Do the Symbols On Ski Trail Signs Mean?" Signs of the Mountains. Accessed April 23, 2021. https://signsofthemountains.com/blogs/news/what-do-the-symbols-on-ski-trail-signs-mean.

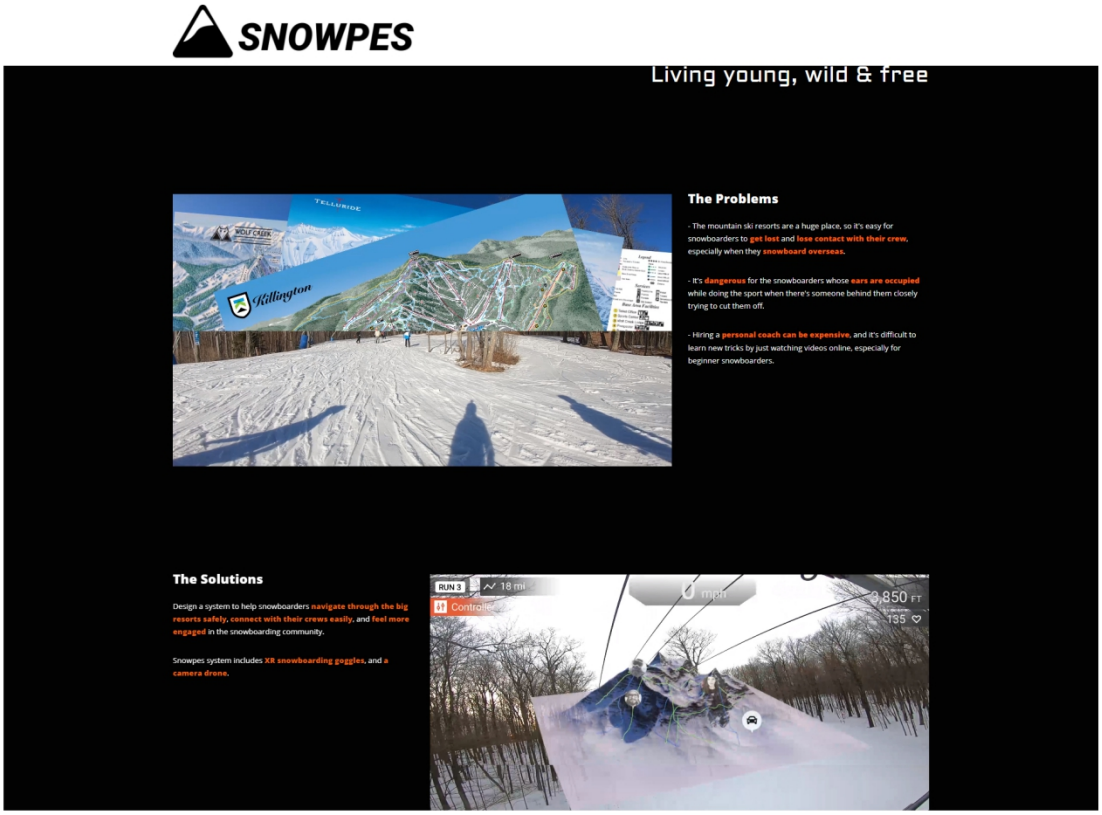
Tales. "Part 1: Reading Gravity: Where to Place Important Information." Tales Content and Copywriting. Last modified August 15, 2018. https://www.tales.co.nz/2018/08/15/part-1-reading-gravity-where-to-place-important-information/.

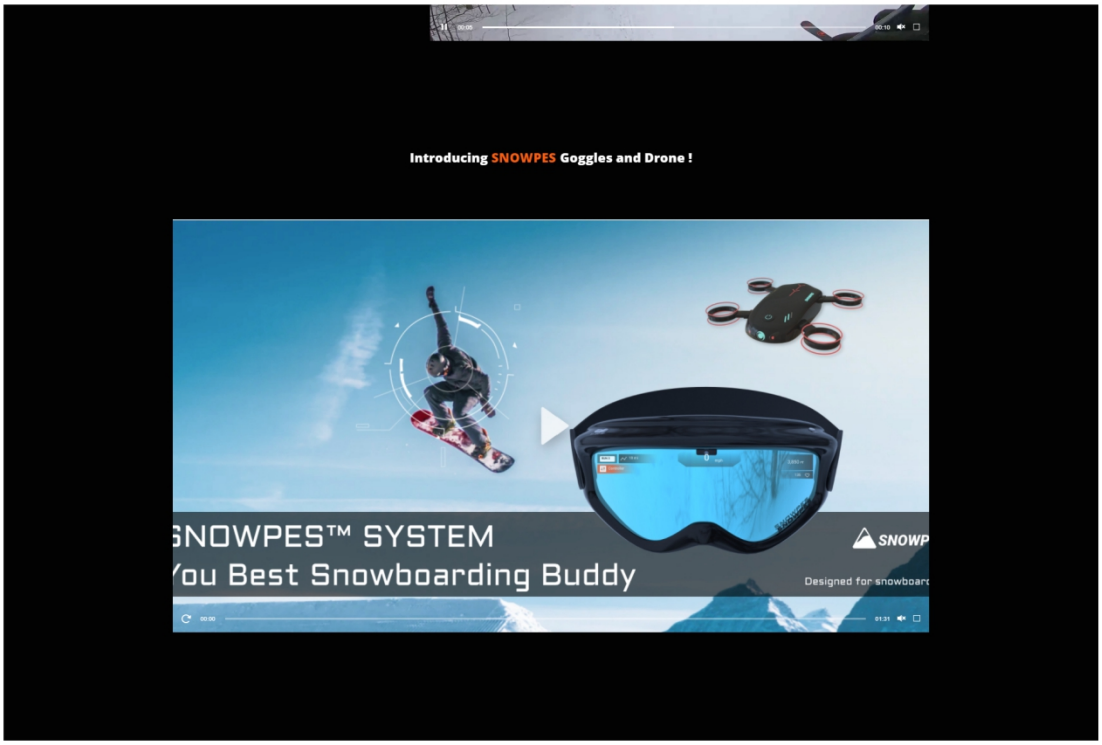
World Health Organization. "Deafness and Hearing Loss." WHO | World Health Organization. Last modified March 1, 2020. https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss.

Appendix C

https://designed.cad.rit.edu/vcdthesis/project/peiwen-he-snowpes







Users

Snowpes focuses on snowboarders. There are **4 insights** according to the interviews and research from snowboarders of various experience levels and contries.

1. Snowboarding Crew

- Plan their next run with Snowpes goggles **3D trail map**
- Know where their **crew members** are, and choose a member to **follow along**
- **Navigation** on Snowpes goggles **HUD**

2. Overseas Snowboarder

- Navigation with **the trail signs** which users can understand even they snowboard **overseas**
- **Call for help** with one button

3. Beginner Snowboarder

- **Learn new tricks** immersively with Snowpes goggles VR mode
- See other snowboarders **first person POV live video** with their goggles
- **Review their previous run** with videos captured by goggles and camera drone.

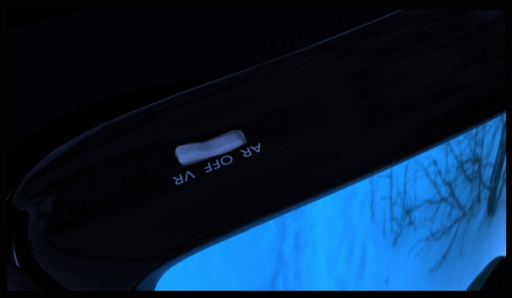
4. Ears-occupied Snowboarder

- Give **visual warnings** when there's someone trying to cut off the users.

goggles **HUD** with the **computer vision** technology.

Switch Goggles Modes

Snowpes goggles have 3 mode - **AR**, **VR** and **Normal Mode**. Users can **change modes** by simply toggling **the switch** on the right side. Users can also switch off the HUD.

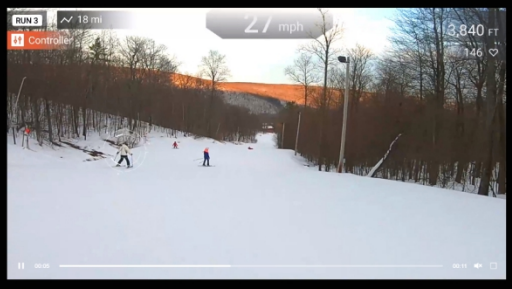


Call out Goggles Controller

In Snowpes goggles AR mode, users can **swipe to open the goggles controller**, which allows users to open **3D trail map**, **control camera drone** and **track their crew members.** The 180 camera on the front side of the goggles allows users to interact with the HUD by using the computer vision technology.

Buddy Tracking

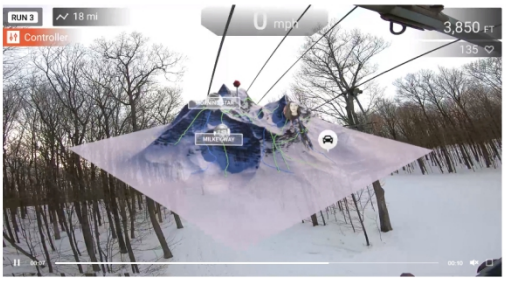
With goggles AR mode, users can **choose a crew member to follow along** without planning their own route.



2.

Overseas Snowboarder

" When I snowboard overseas, the different languages and map signs are a real pain. Especially when I need to call for help."

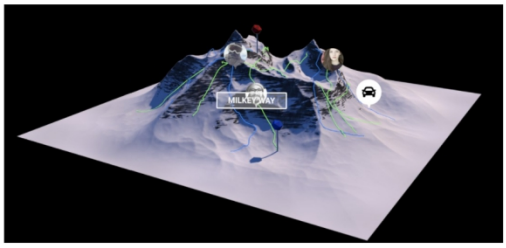


Plan Your Next Run

Swipe to open the controller, and open the **3D Trail Map**. Users can plan their next run by just **tapping the start point** and **end point** with an ease.

3D Trail Map

Besides route planning, users are able to know **where their buddies are** and even **where they parked their cars**.

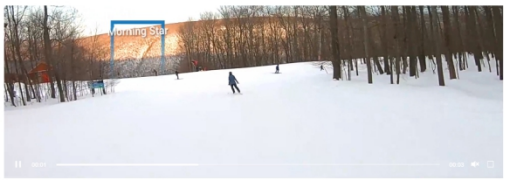


HUD Navigation - Green Path

The Snowpes goggles AR mode can guide users through the mountain resorts intuitively. Even though **the trail signs** may be **different in each countries**, the HUD uses **shapes and colors** to help users understand which **levels** the trails they are heading to, so that **the color-blind** users can understand it too.

HUD Navigation - Blue Path

The Snowpes goggles AR mode can **guide users through the mountain resorts intuitively**. In this example, snowboarders would know they are heading to the **intermediate level path**.



HUD Navigation - Black Path

The Snowpes goggles AR mode can **guide users through the mountain resorts intuitively**. In this example, snowboarders would know they are heading to **the Advanced level path**.

Emergency Call

When users are **snowboarding overseas**, **the language barrier** might cause severe consequences. With the Snowpes goggles, users can be **rescued in time** by simply pressing **the SOS button** on the left side of the goggles.

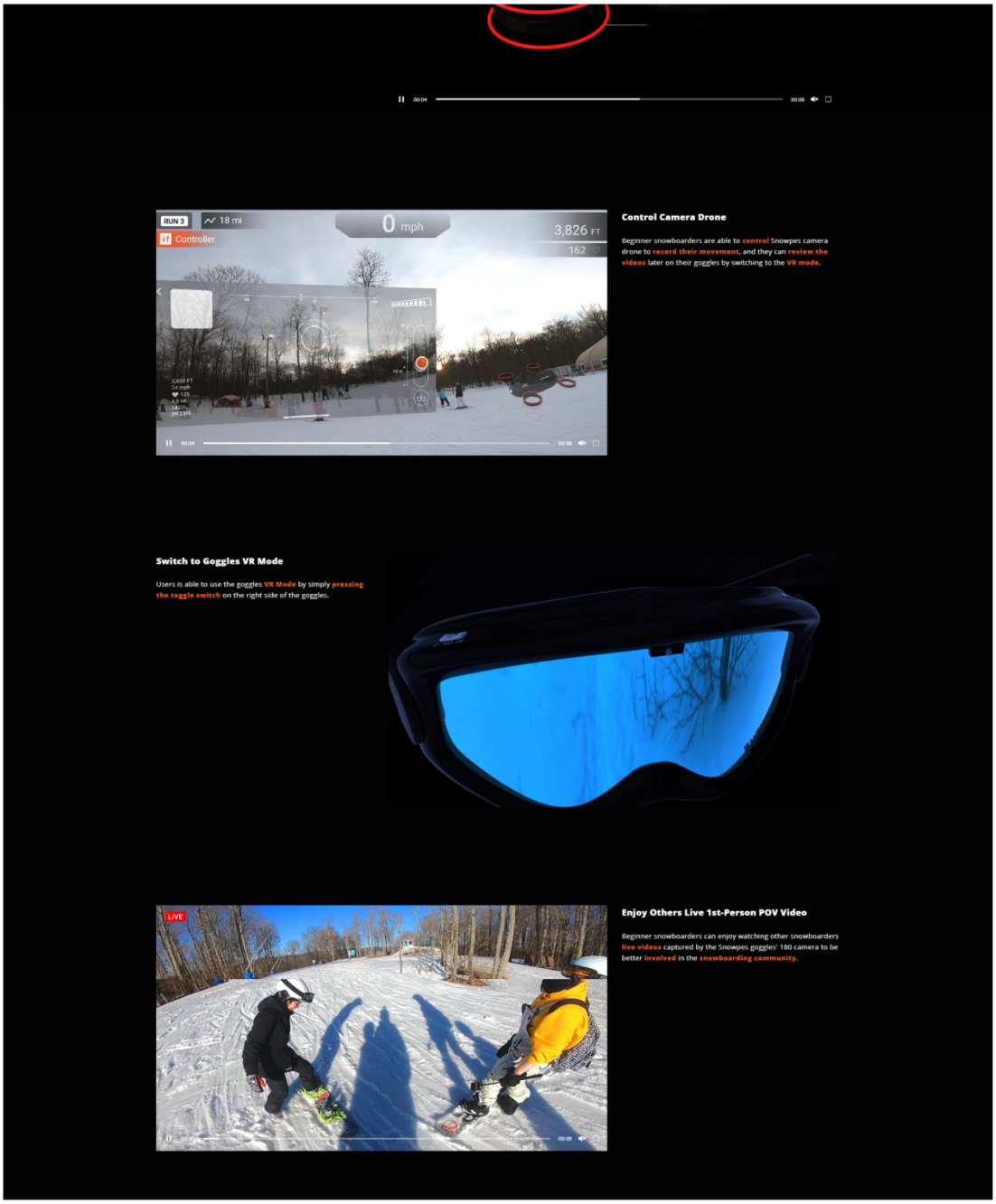
3.

Beginner Snowboarder

"It's really expensive to take personal snowboarding lessons, and hard to teach myself with online videos. I wish I can be involved into snowboarding community quickly."

Snowpes Camera Drone

Snowpes **Camera Drone** can follow the users **automatically** with **assigned distance**. The **bladeless propellers** are **safe** to use in the resorts with the extra help of **orange shock absorbers**.


00:04
00:08
RUN 3
18 mi
Controller
0 mph
3,826 FT
162
Control Camera Drone
Beginner snowboarders are able to control Snowpes camera drone to record their movement, and they can review the videos later on their goggles by switching to the VR mode.
Switch to Goggles VR Mode
Users is able to use the goggles VR Mode by simply pressing the toggle switch on the right side of the goggles.
LIVE
Enjoy Others Live 1st-Person POV Video
Beginner snowboarders can enjoy watching other snowboarders live videos captured by the Snowpes goggles' 180 camera to be better involved in the snowboarding community.

4.

Ears-occupied Snowboarder

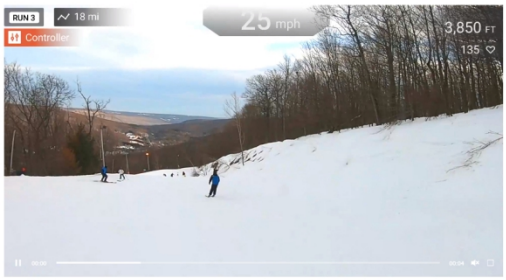
"Listening to music helps me enjoy the sports more, but sometimes it can be dangerous when there's someone close behind me."

Visual Warning - Left Side

Snowboarders whose **ears are occupied** can enjoy their run safely with **visual warning** showing when there's someone trying to cut them off from the **left side.**

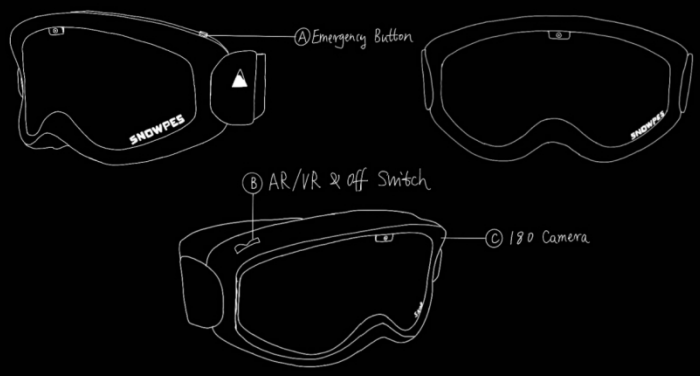
Visual Warning - Right Side

Snowboarders whose **ears are occupied** can enjoy their run safely with **visual warning** showing when there's someone trying to cut them off from the **right side.**



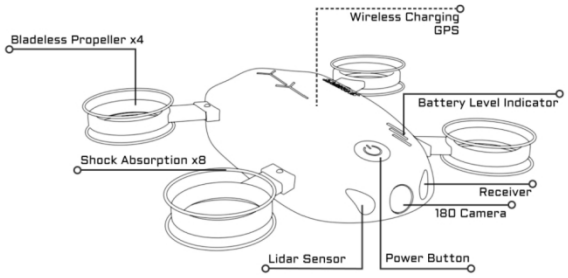
Physical Interface Design

- Goggles



Physical Interface Design

- Camera Drone



Physical Interface Design

- 3D Model

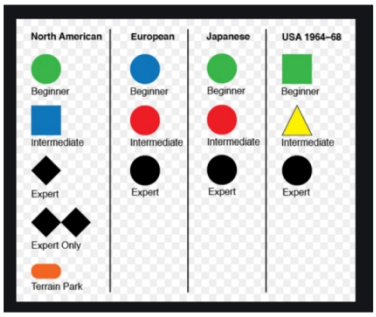
Research

1.

Color Selection - Safety Orange

The vivid reddish-orange is used to **set objects apart from their surroundings**, and there is a very **strong complementary contrast** between the vivid reddish and the color of the sky.

2.



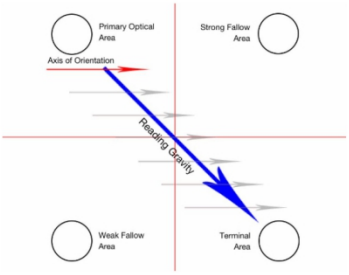
North America uses about five symbols to grade the trails, while **Europe or Japan** uses slightly **different symbols** to mark theirs. The signs in Europe and Japan are **not user-friendly** to the **color-blind** snowboarders. While approximately "8% of men and 0.5% of women - **300 million people** - suffer from color blindness".

3.

Hearing Loss

Over 5% – or **430 million people** – of the world's population have **disabling hearing loss.**

4.



Reading Gravity

Our eyes follow **a certain pattern** when browsing. The **Gutenberg Diagram** divides the page into four quadrants. When it comes to design a HUD, it would be better if **the secondary information** is **not placed on the primary optical area**.

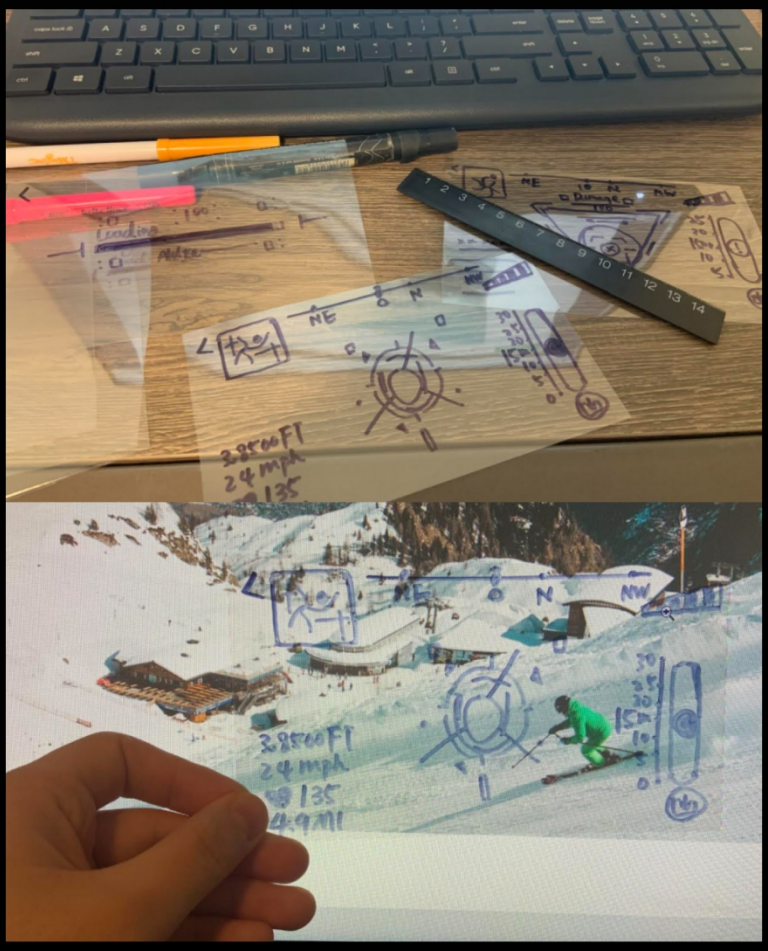
5.

Priveate lesson can be expensive

It's **expensive** to learn snowboarding by **hiring a personal coach**. Priveate lesson can cost more than **$200** per hour.

HUD Testing

Use **Mylar Sheet** to **test and adjust** the **balance and legibility** of the HUD.



Userflows

User Flow 1

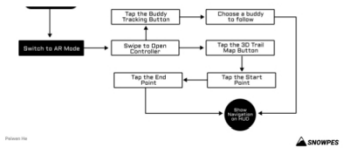
Navigation on HUD

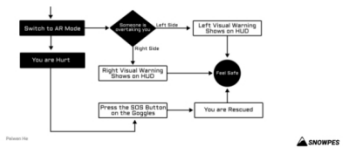
Put on Goggles

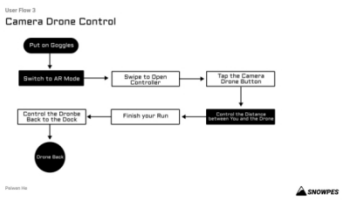
User Flow 2

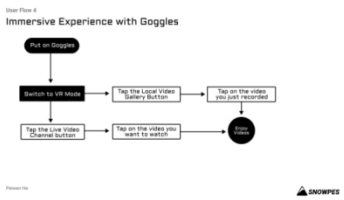
Safety Guard For Users

Put on Goggles





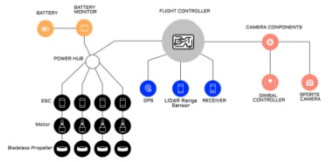


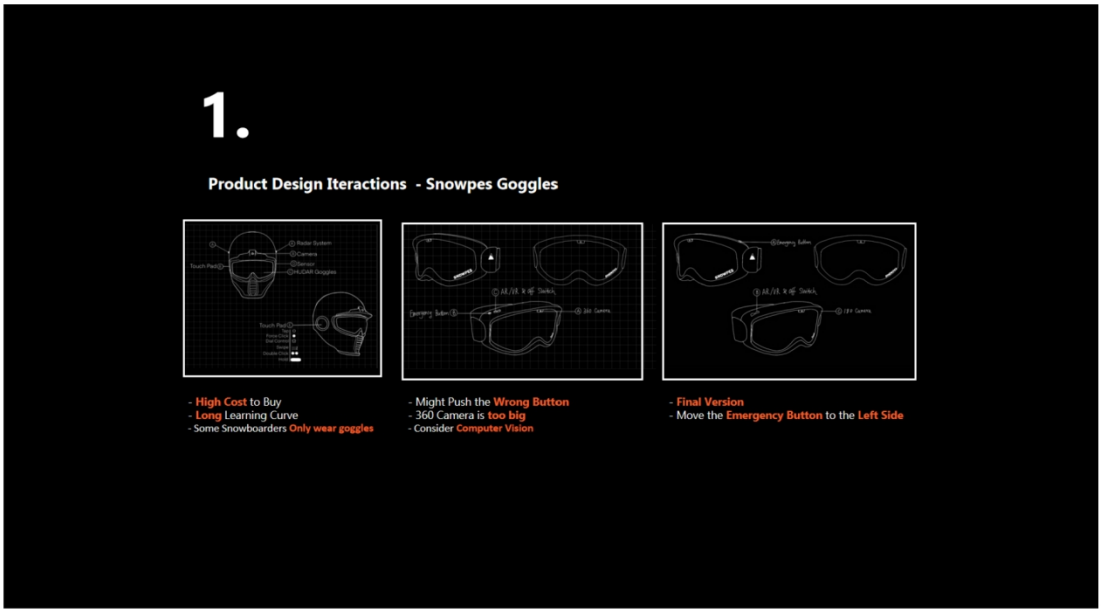


Diagrams - Snowpes Camera Drone

Software Diagram

Hardware Diagram





1.

Product Design Iteractions - Snowpes Camera Drone

- It might **blend into the snow** too much

- Matte black is reading **too flat as a texture**
- The location of the **LIDAR sensor** is missing

- **Final Version**
- The **receiver** and **lidar sensor** are designed to seem like **the eyes of the drone**

2.

Goggles HUD Iterations

- Try to **decrease the distraction** on the snow slopes

- **Hierachy is not enoght** for the data
- **Avoid** using safety orange everywhere
- Try **exaggerate** the **trail's symbol**

- **Final Version**
- Use **Shapes and Colors** to mark the trails
- Put **Primary Data** to the main area

3.

Map Iterations

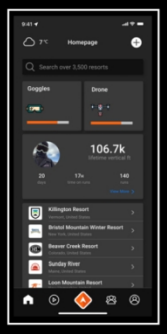
- It's **not convenient** to **explore a map** on mobile **phones**
- **Can't** find out where users **park their car**

- **Tap** on a mobile phone can be **hard** when users on a **lift**

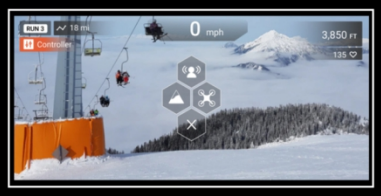
- **Final Version**
- **3D** Trail Map

4.

Controller Iterations



- It's **too cold** to use mobile phones



- **Final Version**
- Use **Gesture** to Open controller

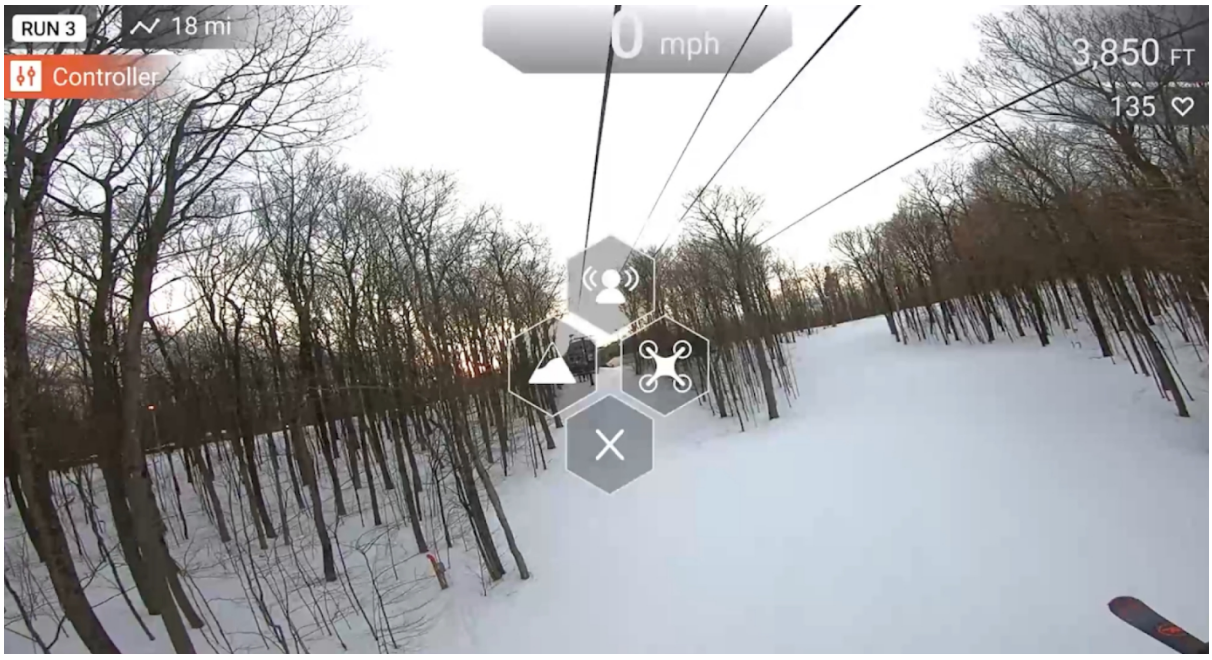
Conclusion.

"In the beginning, I just planned to design a cool HUD for me to not have to worry about the navigation or wait for my firends who are slower than me in mountain resorts. After thinking about **accessbility** and doing the research, I figured out that the people who need this is **more than I expected**. Snowpes system **is user-friendly** to **the deaf** and **the color-blind** users. This system can help users **navigate** through the big resorts **safely**, **connect** with their crews easily, and feel more **engaged** in the snowboarding community. "

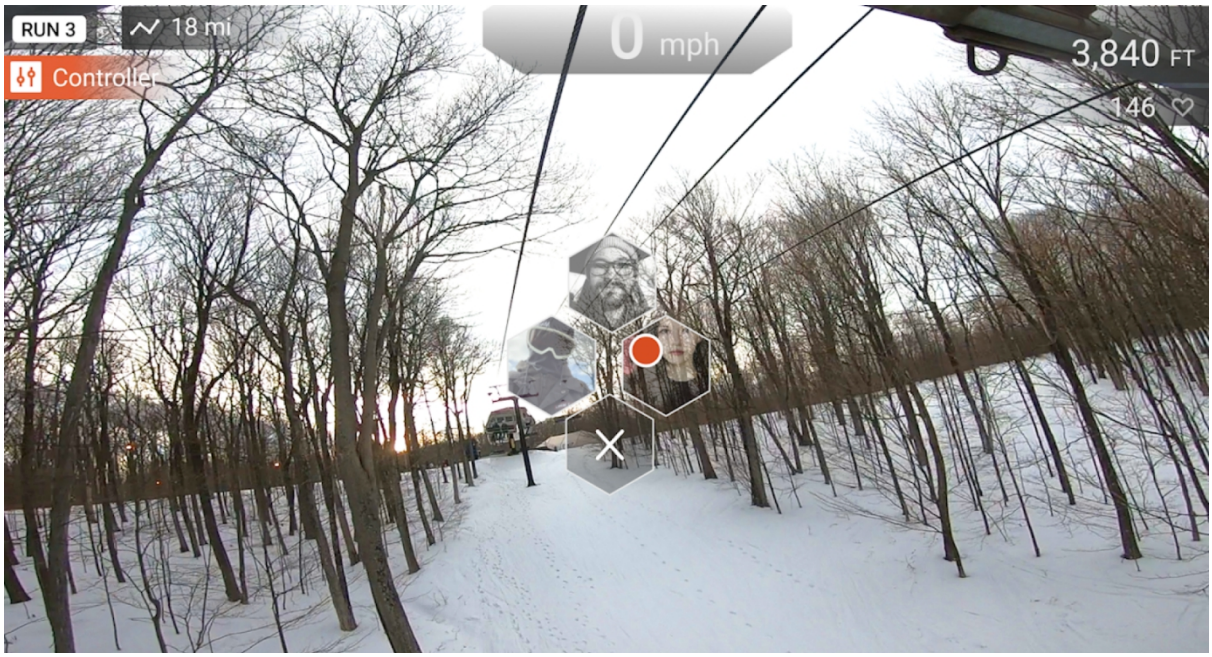
Visit My Portfolio Site

Visual
Communication
Design
MFA

Communication
Interaction
Motion & 3D
Design Studies

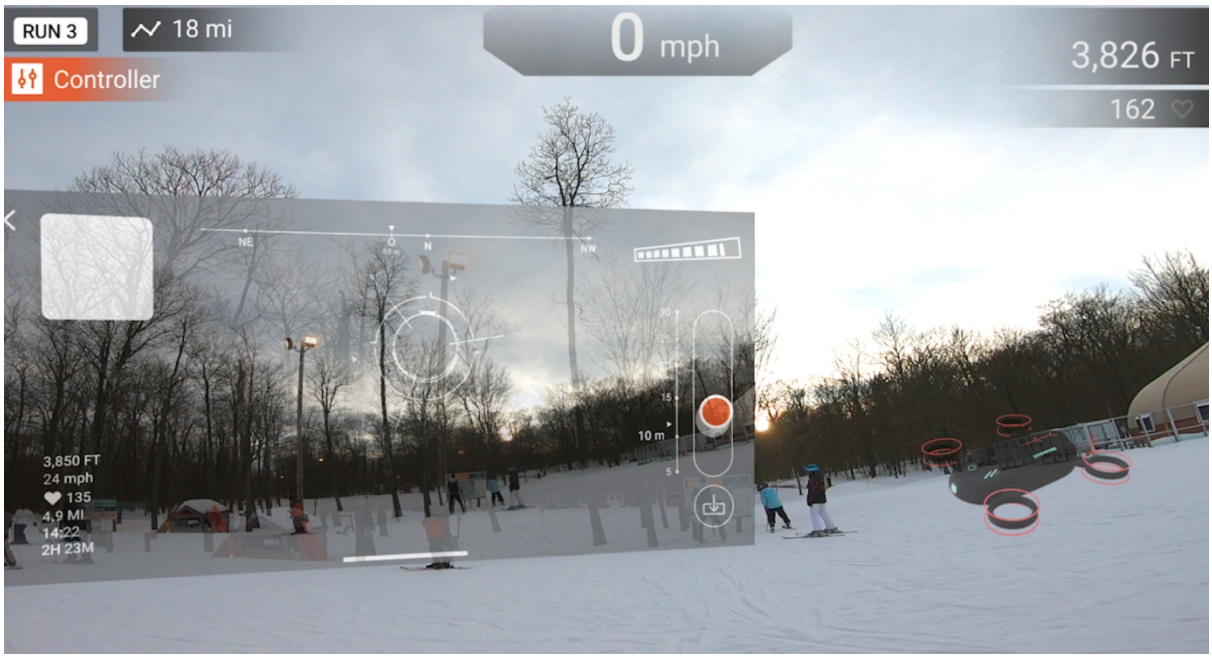

RUN 3
18 mi
Controller
0 mph
3,850 FT
135

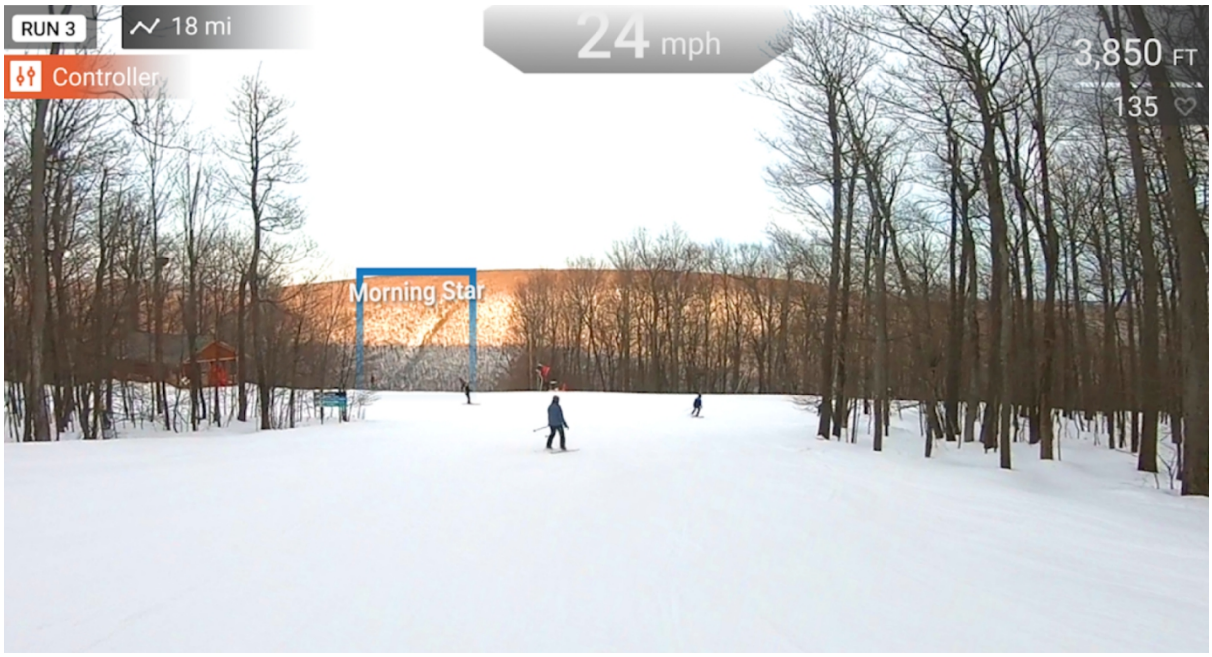

RUN 3
18 mi
Controller
29 mph
3,826 FT
158

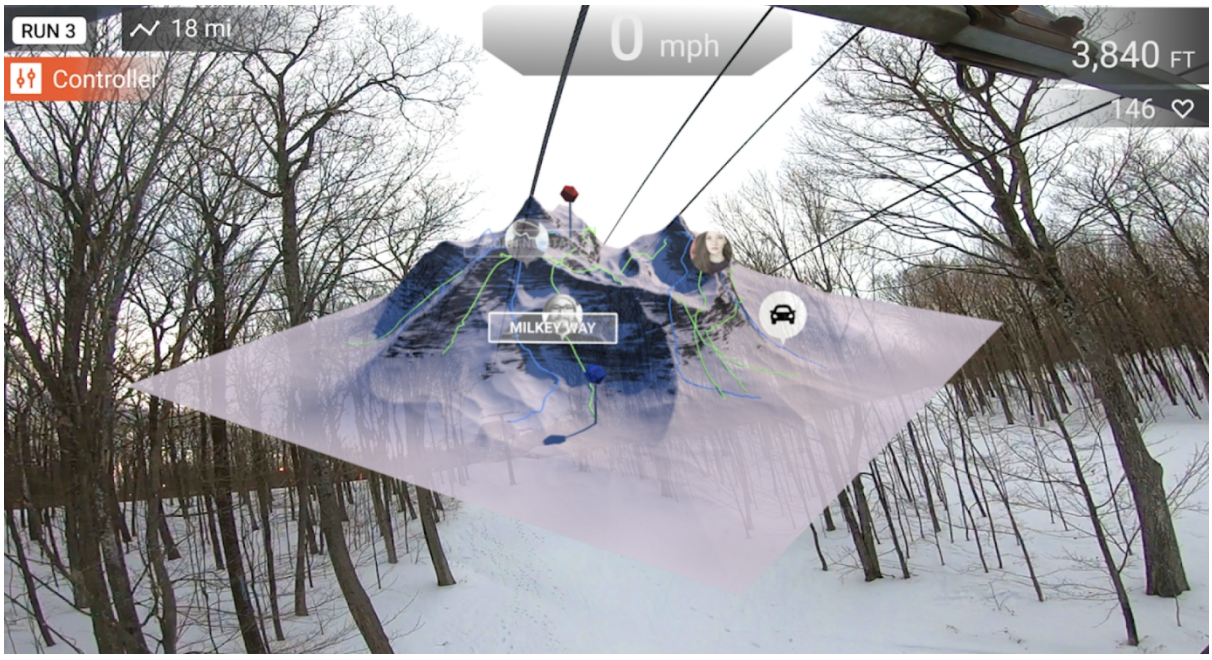

RUN 3
18 mi
Controller
0 mph
3,840 FT
146


RUN 3
18 mi
Controller
30 mph
3,826 FT
162


RUN 3
18 mi
28 mph
3,840 FT
Controller
146
Milkey Way


RUN 3
18 mi
0 mph
3,826 FT
Controller
162
NE
N
NW
10 m
3,850 FT
24 mph
135
4,9 MI
14:22
2H 23M


RUN 3
18 mi
Controller
24 mph
3,850 FT
135
Morning Star


RUN 3
18 mi
Controller
0 mph
3,840 FT
146
MILKEY WAY


RUN 3
18 mi
24 mph
3,850 FT
Controller
135
Comet