Hsuan Han Chen

LUMET

Hsuan Han Chen

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Field : Interaction design

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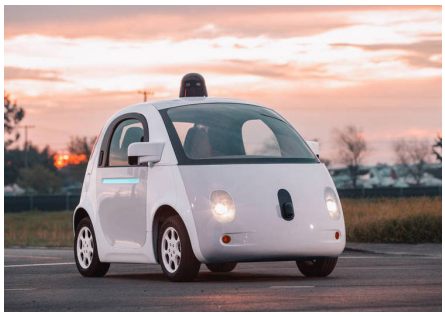
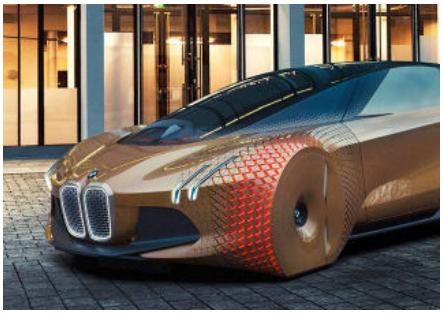
01 INTRODUCTION

Background
Motivation

BACKGROUND

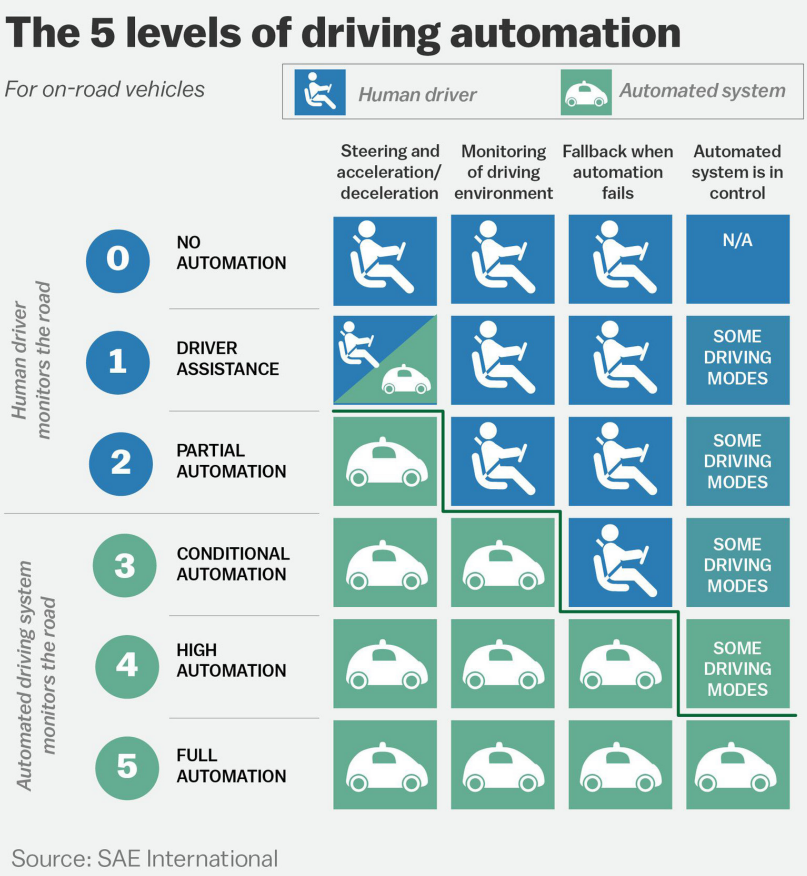






Now a lots of company are working on the autonomous car and public transportation, and they're researching this field hard. In the near future, it would be very different compares to the situation on the street from now.

In this project, my main goals are to work towards providing cyclist autonomous way to use product and better user experience on the street now or in the future. It will be some of self-driving cars on the street, but there are still man-driving cars. So interaction between cyclists and other road users (car drivers and autonomous cars, pedestrians) is really important for road safety, and it needs to be explored deeply.



As you can see from this figure, It divided autonomous cars into different levels. This new trend technology is towards to the full automation right now. But it still has a long distance to go. Now many companies are testing their autonomous vehicles. They're facing different kinds of problems on the road.

It makes started to wonder how autonomy can be put into the cycling, so my project is not about the autonomous vehicles. It's about how autonomous system can implement for the cyclists.

MOTIVATION

My motivation in this project is not only to make a fine and good looking project but to look into how the autonomous design influence the product and how to use interaction design as the core value to develop the process. By asking friends and close relatives I found out that people still have some concerns in the future how to interact with self-driving cars when they're cycling. There are still some issues can be explored and discussed in this area.

I used to ride the bicycle to work before I came to Norway, every time I drove almost one hour for one round, on the bike there are many things on it. Water cage for the water bottle, bike bells to make sound to notice people, bike light to make lights at night. Especially at night you need some light to notice the others on the street to protect you. There are many things on the bike, so there are many possibilities to be explored.

Taipei is a crowed city. There are always a lot vehicles on the street. In my experience people are rush when they're commuting everyday. And daily bicycle commuters are the most dangerous ones on the streets. It's an issue that bicycle commuters should be gotten more attentions on the streets for their safety.

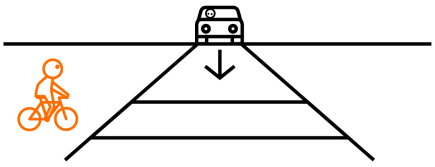
02 *RESEARCH*

Introduction
How bicycle interact with others
Inwards
Outwards
Each other
Beyond
Design brief
How bicycle transmit information

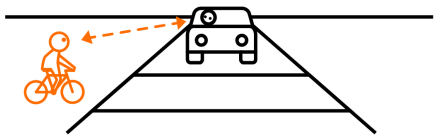
INTRODUCTION

My focus will be on how autonomous system influence the cyclists on the road, but this autonomous system all started from autonomous vehicles. So firstly I looked into how does this future trend influences the cyclist. There are so many questions around how humans will interact with autonomous vehicles – will they provide the other users with conversation, how personable will they be, will they communicate through speech, graphics or gesture?

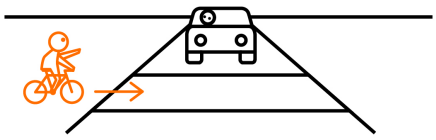
NOWADAYS



01 - The cyclist approaches pedestrian lane



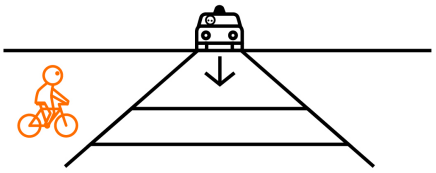
02 - The cyclist checks for traffic - looks to engage. When got the eye contact from drivers, it means cyclist could cross the road



03 - The cyclist gives a sigh to the driver to appreciate

The first case is now how people interact with the drivers. In this case, people rely on the eye contact between people and car drivers. Normally, drivers will stop and look at you or give you hand signal to let you go. Then people could cross the road afterwards. It all depends on the interaction between people.

FUTURE SCENARIO



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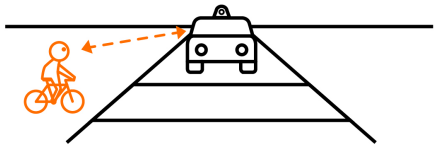
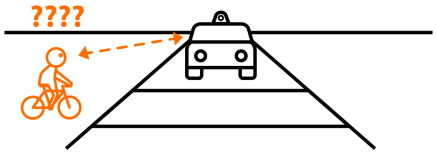


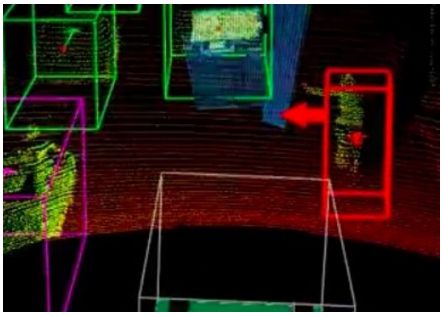
02 - No drivers in the car, and now there's no agreement methods or common sense how to interact with AVs

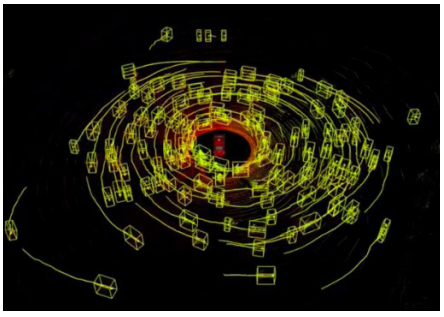


03 - The cyclist gets confused. Does the AVs see me? Should I cross it?

In the future scenario, people will face a situation is that there's no driver in the car. And how could people interact with it because what people rely on before is missing. And now there's no common agreement or sense with it. All of the AVs are still developing, every company still work hard on robot driving cars. It's now already facing a lot of problems like how interact with people on the cars. There are several examples like self driving cars are too cautious on the road, and people are taking advantages on it, in that case, AVs are causing the some traffic jams. And the other issue is how cyclists and AVs co-exist on the road.

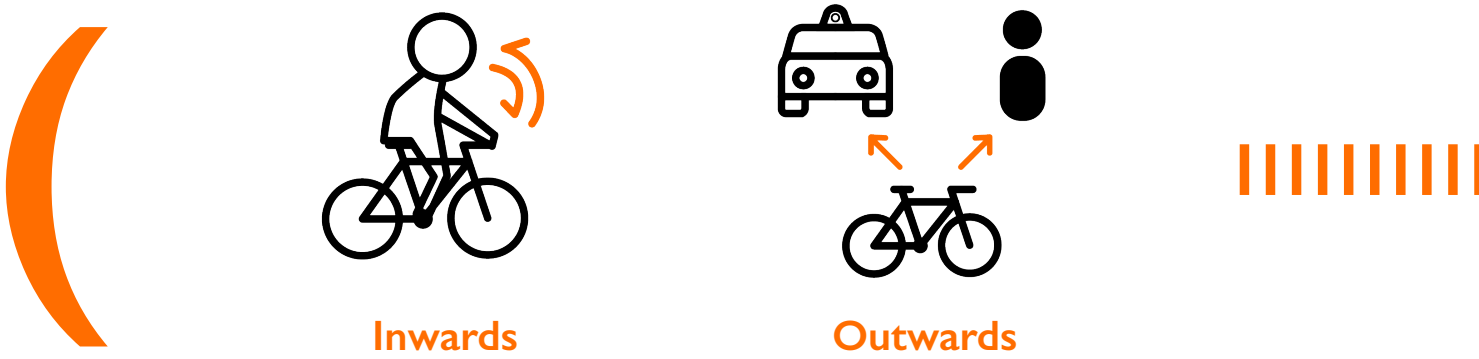
Google are aware of that so they're working on it. They're researching how AVs detecting the hand signal from the cyclists. How to give the way to cyclist becomes their big challenges.





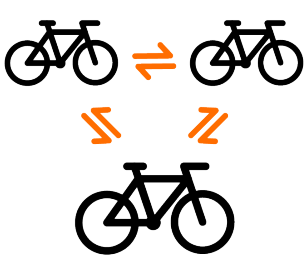
How bicycle interact with others

In the near future scenario, cycling has multiple faces of interaction, not just one towards a situation or factor. I've drawn them out below to explain the differences and similarities in different degree.

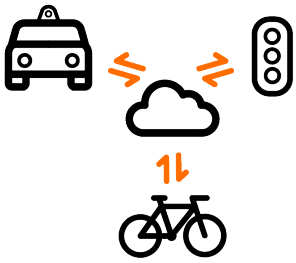


Inwards: Interactions between rider and bike. How rider read the information by bike or how bike give indication to rider.

Outwards: Interactions with external participants, such as pedestrians, other manual drivers, and autonomous vehicles.



Each other



Beyond

Each other: How the bike interacts with other bikes. Does it need to transfer data and learn from one another? What is the level of autonomy should implement in the bike?

Beyond: How the bike interacts with the other road users within its cloud context.

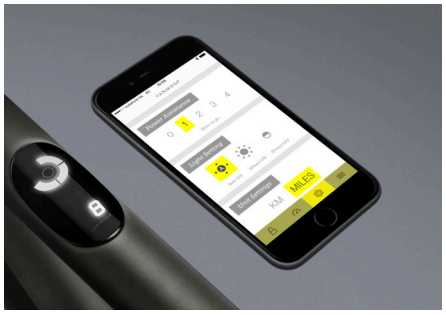
INWARDS

BICYCLE - HUMAN INTERACTION

In this face, it's about how rider get the information from bike or how bikers give orders to bicycle. It could be a form of audio, visual, tangible, haptic or spatial tasks, with different degrees of cognitive understanding. All of which feed into the complex task of riding itself.

Wrong way of information interaction could cause disaster result, for example deaths or accidents due to using cellphones while riding.

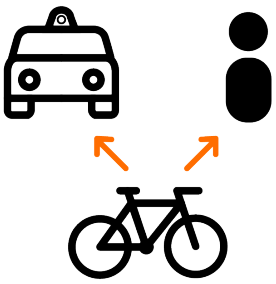
It's common to have this kind of cellphone stand on people's bicycle recently. Help people to navigate to somewhere they would like to go. And people also use it to play POKEMON GO. It would distract people's attention.



Take this Vanmoof bicycle as an example, It's a smart bicycle could use your cellphone to track your bike, like location, battery. Touching unlock technology is also an special point they have.

OUTWARDS

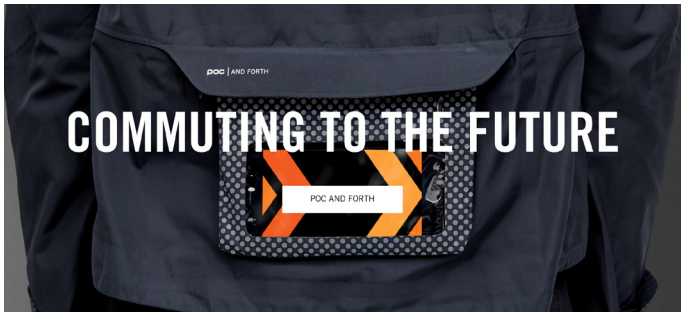
BICYCLE - OTHER ROAD USERS INTERACTION



Interactions with external participants, such as pedestrians, other manual drivers, and autonomous vehicles. It would be an direction how bicycle's condition express to the others. How the other road users read the information form the bicycle. It concerns the safety of the all road users. Like cyclist would turn or stop suddenly could be an incident to the others, then cause some surprises.

Normally, bicycle would have front and rear lights to let the others knows they're here during nights.

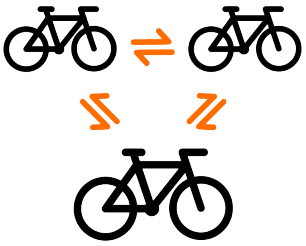
Bike bell makes sounds to notice people that you're coming.



It's a POC project which is called POC AND FORTH. It's an jacket got a pocket at the back which users can put their cellphone in it, and use voice to give the indication signal to the others.

EACH OTHER

BICYCLE - BICYCLE INTERACTION



How the bike interacts with other bikes. Does it need to transfer data or learn from one another? What is the level of autonomy should implement in the bike?

Especially on the cross road or in the heavy bicycle traffic city, in this face should bicycle has their own autonomy to send or receive data from each other to avoid accident and bump to the other. Like autonomous cars can communicate with each other in the future, should bicycle has their own computer core to do that?

There's a project in Taiwan. They use visual Lights communication with LEDS, it's a technology camera could detect the blinking LEDS pattern to know certain state of information. For example, in the video the camera is detecting stop state of scouter. They indicated the advantage is that the actual pixels are transmitting information to you when using a camera as a receiver.

Conventional way to brake

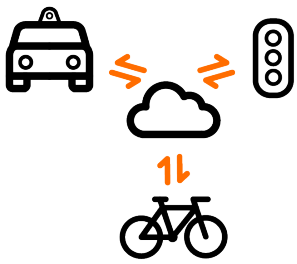
Bicycles communicate

Consider three bicycles riding behind each other, maintaining gap between them. The first bicycle detects an obstacle, causing a sudden-braking scenario. In the case, with a line of conventional bicycles, the speed at which the third bicycle notes the brake lights of the second and reacts to the first bicycle will be slow. This will cause a closing distance between them or a direct collision.

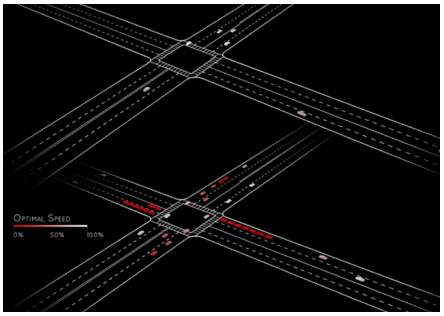
With connected bicycles communicating with each other, as soon as the obstacle is noticed, the transfer of the knowledge of braking between the first and third bicycle can be much quicker.

BEYOND

CLOUD - BICYCLE, AVs, TRAFFIC INTERACTION



Beyond interactions are about the bigger picture. It's not just singular machine, it's a whole system or community of machines learning from each other and growing over time. In turn, these systems give advantages to services. Enabling people and societies to be more efficient and creative with their time.



This is an example by MIT's Senseable City Lab in their Light Traffic project, where cars drive seamlessly through an intersection.

Autonomous vehicles pass through the intersection by communicating and remaining at a safe distance from each other, rather than have a halt at traffic lights, thereby significantly reducing queues and delays.

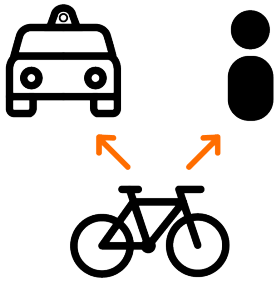
AVs regards bicycle as object

Bicycle extension eyes

In the normal scenario, Autonomous vehicle would regard things around it as objects. Then decide which movement should move or decide next. But if the other object has their own sensors and could also send and receive data from each other. Or there's a bigger system every object could upload their own data to cloud and cloud could give instruction and advisement to everyone.

DESIGN BRIEF

CHOSEN DIRECTION



INWARDS

OUTWARDS

EACH OTHER

BEYOND

After dividing different kinds of interaction in bicycle, it's important to decide which is the way should keep looking into it. Then I chose the first two area to dig in because in the last two area it's more like how a whole system works. And it all depends on the computer processing and how algorithm calculate the results. There are lots of unclear area to consider, like self-driving cars area still developing. There are too many factors I'm not familiar, like artificial intelligence, machine learning or how algorithm works in some systems.

Therefore, the first two area is the direct interaction I can dig into it, and it also fits my background to work on conceptual developing and making prototype to do some direct test and get feedback.

LEVEL OF CYCLING AUTOMATION


Cyclist


Automatic system

	Monitoring of cyclist environment (Signals)	Steering and accelerating / decelerating	Full System Control (Cloud / Internet)
No Automation			
Partial Automation			
Conditional Automation			
Full Automation			

I've drawn out this figure to level out different degree of autonomy in cycling. The direction I'd worked on is the partial automation. It would help cyclist in certain condition.

How bicycle transmit information

Firstly, I looked into what kind of form that normally bicycle would transmit information to the others. And started to think what kind of autonomy I could implement to help cyclist, like safety or visibility. As bellow are the some ways bicycle transmit information.

SOUNDS

- Voice
- Bells
- Mechanical low frequency


LIGHTS

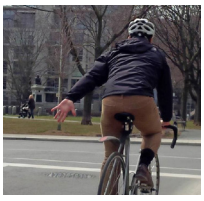
- Front lights
- Rear lights
- Turn signal

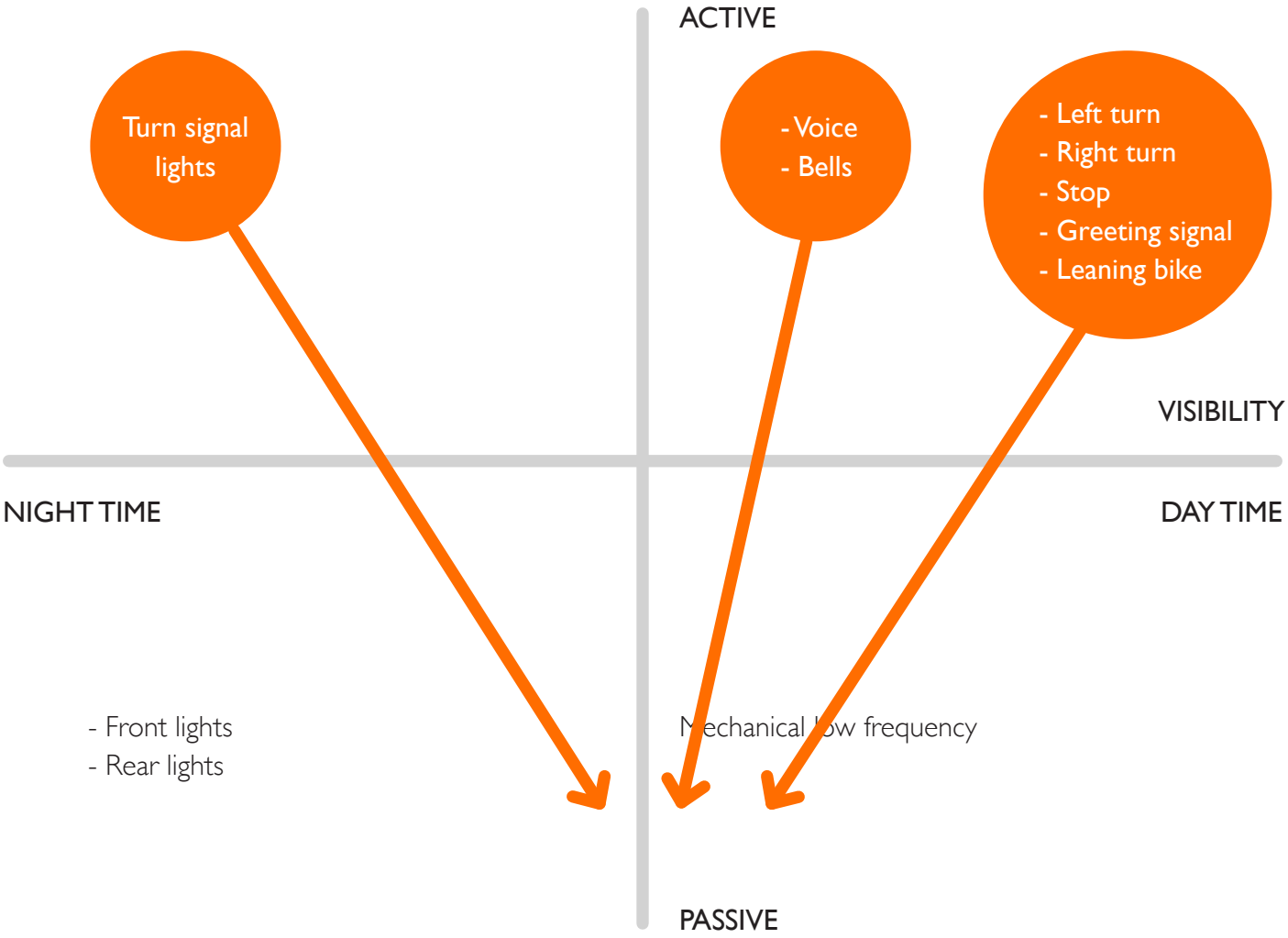


BODY SIGNAL

- Left turn
- Right turn
- Stop
- Greeting signal (hand / head)
- Leaning bike







I've drawn this mapping information to figure out the visibility in day and night time. And it's also about mapping out the passive and active action with cycling. My direction will be bring the active action to passive. That's how I want to implement autonomy into cycling. Help the cyclist while they're riding.

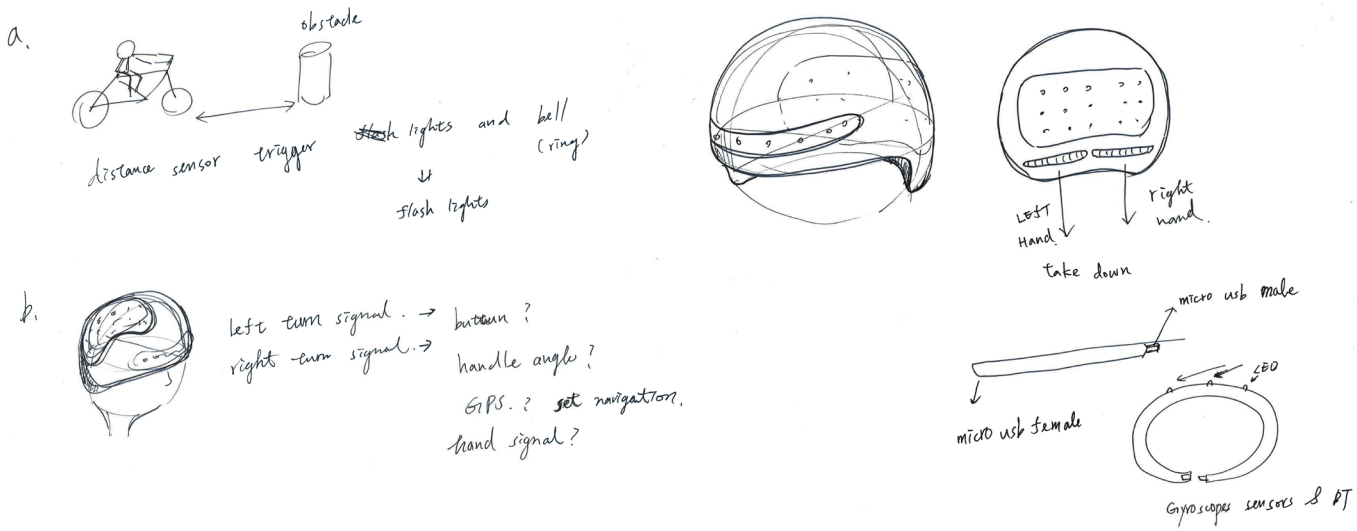
03 CONCEPT PROCESS

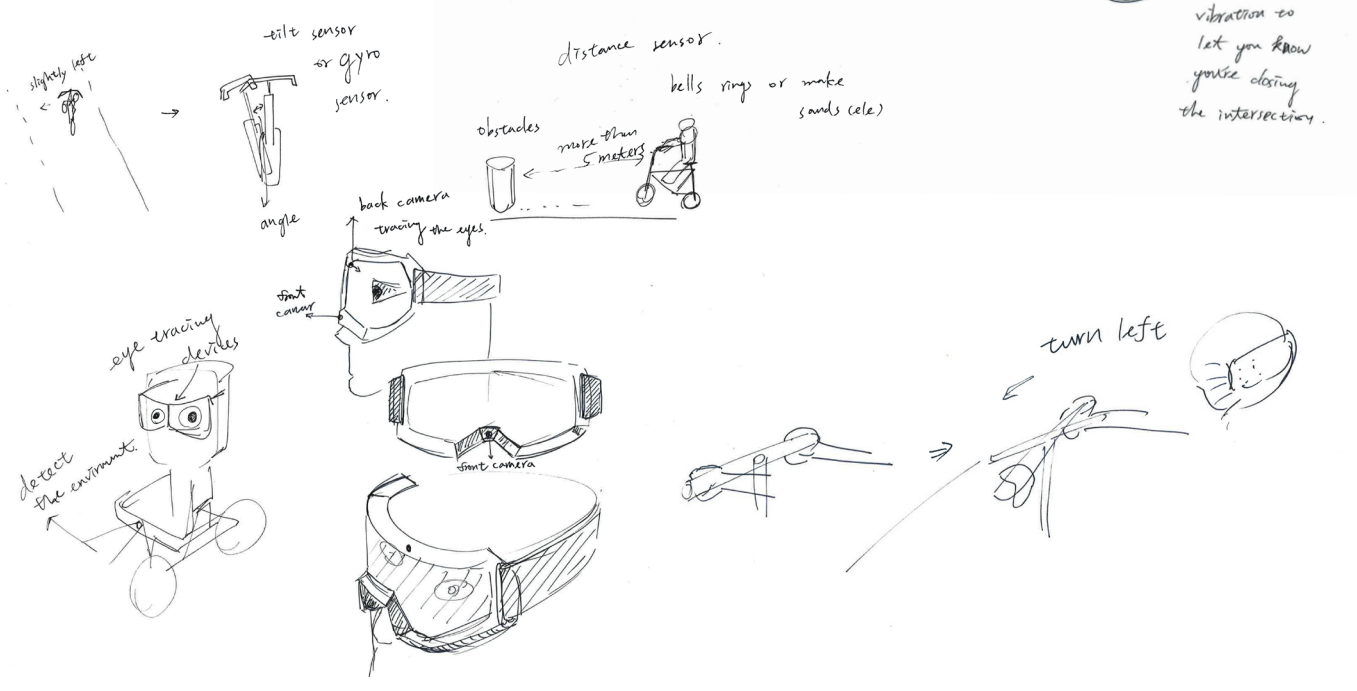
Design concept
- 01 Voice & Bell
- 02 Leaning side
- 03 Hand signal
- 04 Handle steering
- 05 Application navigation

Concept conclusion
Helmet research
Existing case study
Lights position
Lights pattern
Lights pattern user test
Helmet control

DESIGN CONCEPT

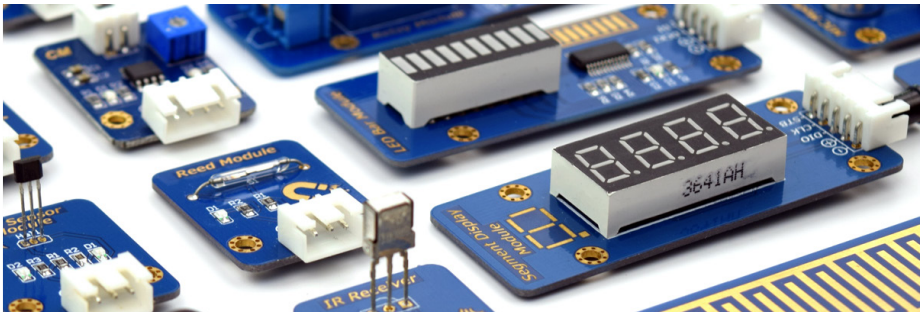
SKETCHES





After the research process, I started to sketch the concept of how to bring bicycle active information into passive. Then I figured out some initial concept, and develop the prototype to test the possibility of the project.

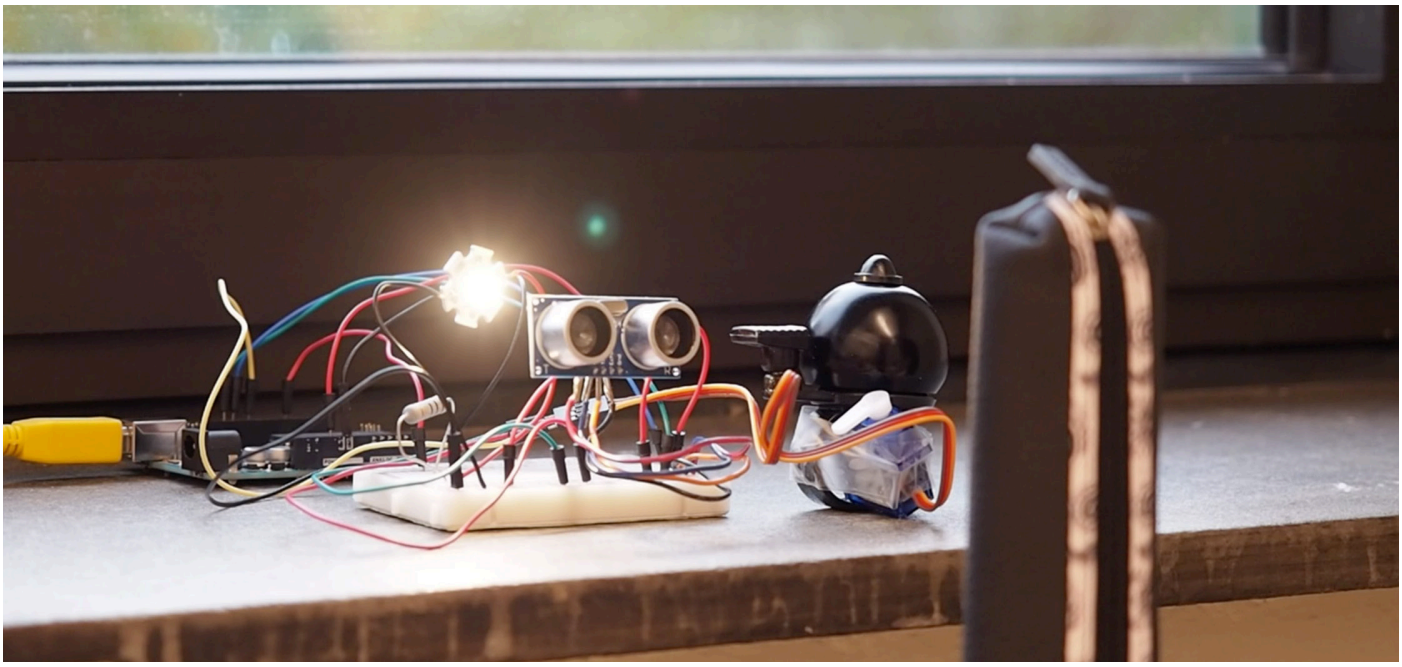
How to build the concept? I used the Arduino to build the prototype. It could use some sensors to detect the situation that the cyclist would face on the street.



In the research period, I listed some main points that I want to bring it into passive condition. So I looked into how could I use the sensors to help the cyclist to deal the issue or situation people would face on the road.

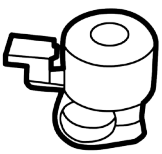
CONCEPT 01

VOICE & BELL

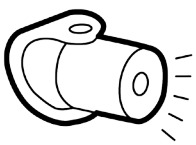


The first concept is about how to bring sounds to passive mode. The main concept is detecting something in front of the bicycle, and it would notify people in front of cyclist. When it detects someone in front of cyclist, it would ring the bell and have flash lights to notify the other road users. It would be like double insurance to let the other road users know that you're coming in two different way, visual and vocal.

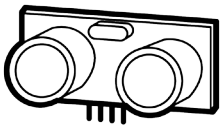
PROTOTYPE MAIN COMPONENTS



Bell



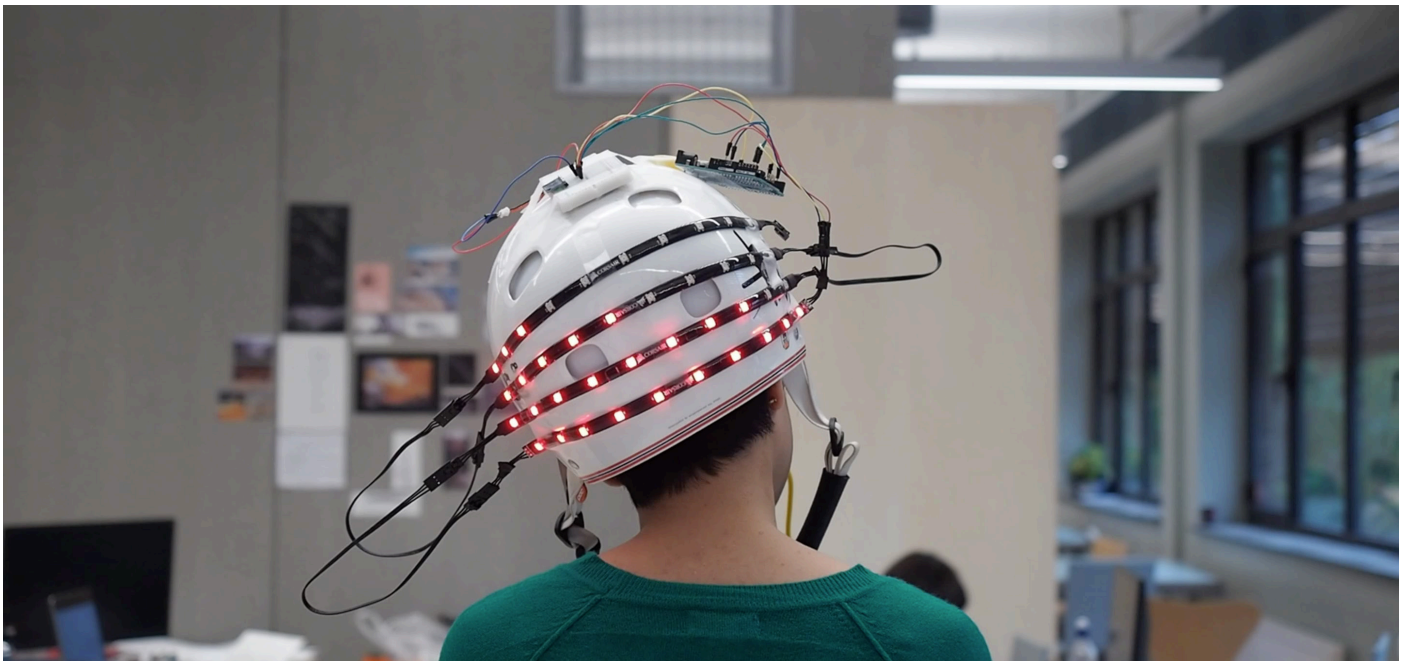
Lights



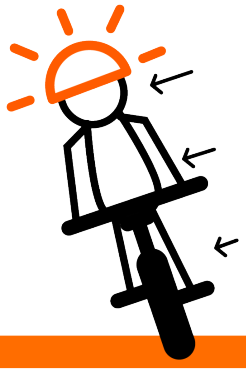
Distance sensor

CONCEPT 02

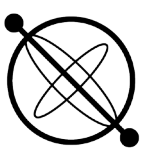
LEANING SIDE



This concept comes from cyclist's leaning their bike when they're riding. When cyclists lean their bike, the lights on helmet would show the inclination by changing the horizontal level. It would change the state automatically, so the other road users would understand the what happens to this cyclist.



PROTOTYPE MAIN COMPONENTS

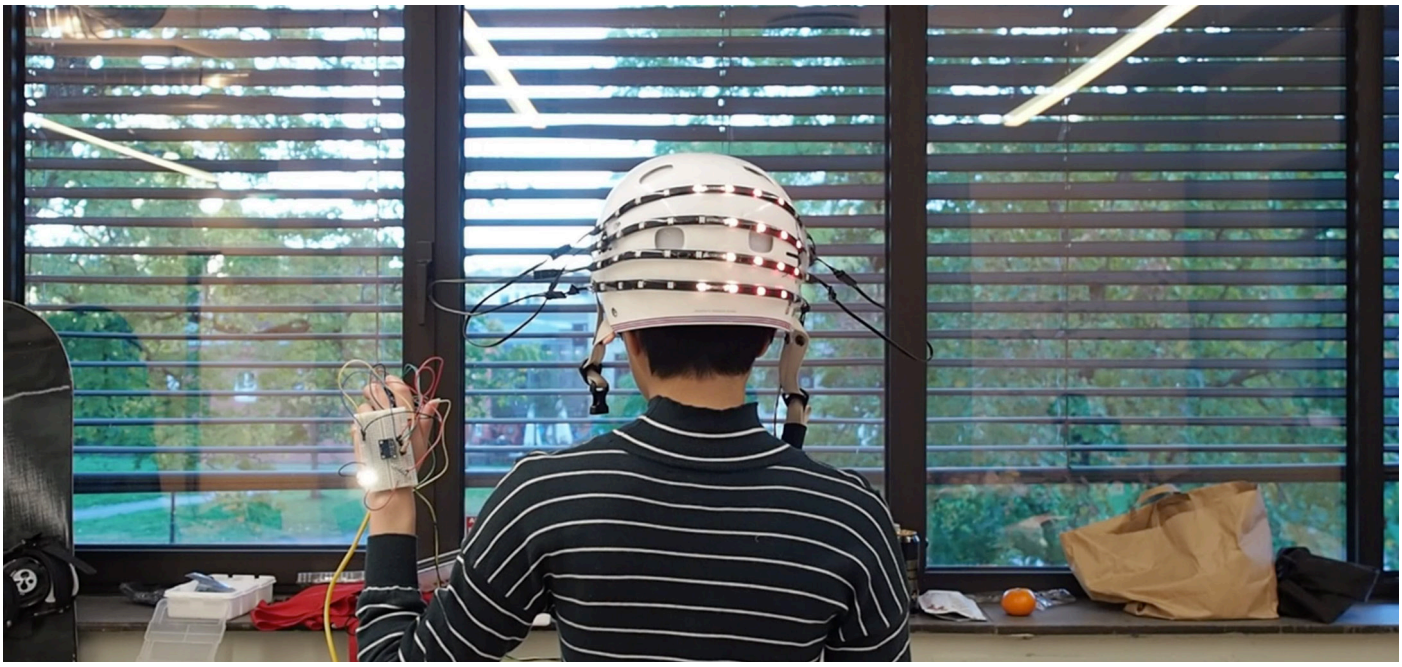


Gyroscope sensor

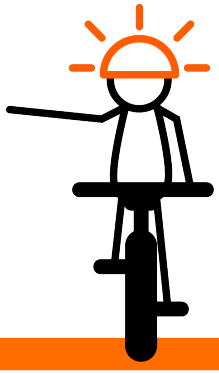
LEDs

CONCEPT 03

HAND SIGNAL



It's really common people use hand signal when they're riding. When cyclist gives hand signal, there will be some signal indicator shows on the helmet. It would be safer for cyclist if they give hand signal at night. There would be gyroscope sensor on cyclist's hand to control the helmet. And LEDs on hands will have more visibility.



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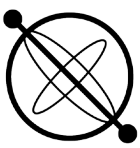
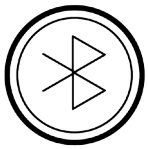


Gyroscope sensor

LEDs

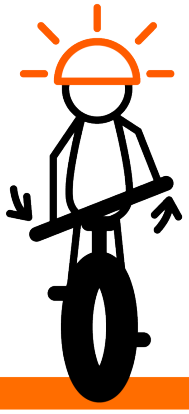


Bluetooth

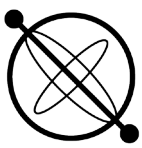
CONCEPT 04

HANDLE STEERING

When cyclist steers the handle to certain direction, then it will show some lights pattern on the helmet automatically. It would let the other road users to know which way you're going to.

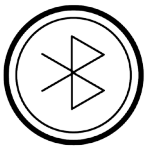


PROTOTYPE MAIN COMPONENTS



Gyroscope sensor

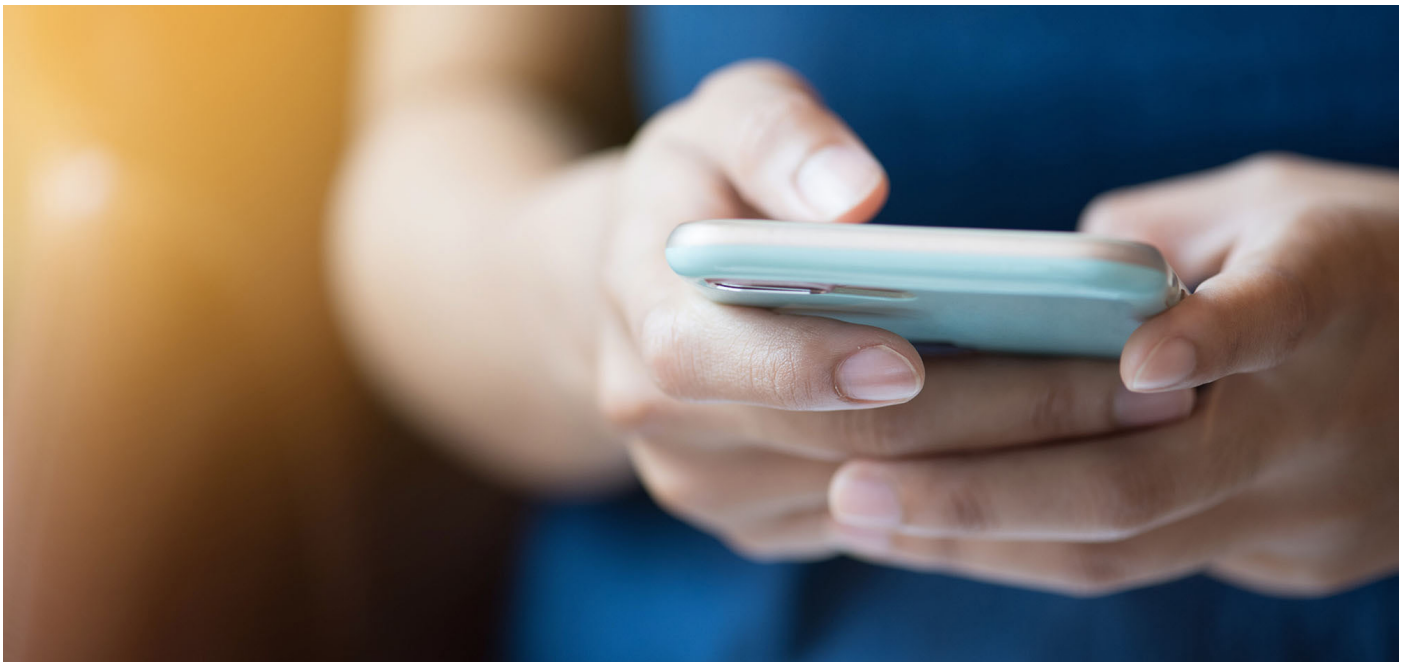
LEDs



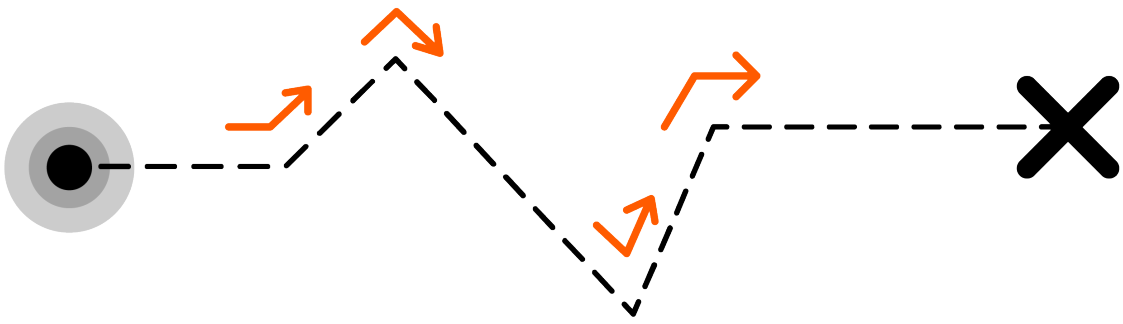
Bluetooth

CONCEPT 05

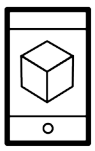
APPLICATION NAVIGATION



This concept is about cyclist set up their destination before they departure. And on their route, LEDs on the helmet will show their turn direction to let the other people recognize it.

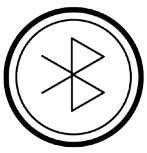


PROTOTYPE MAIN COMPONENTS



Application

LEDs



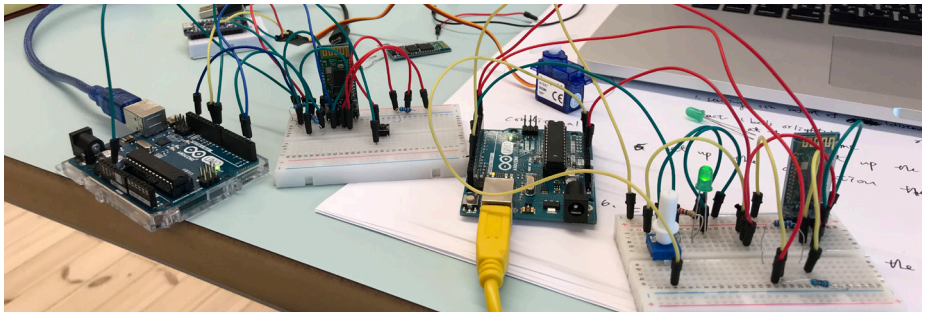
Bluetooth

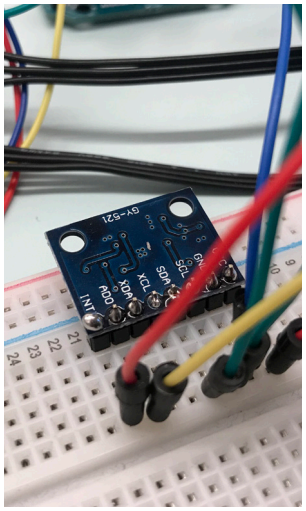
CONCEPT CONCLUSION

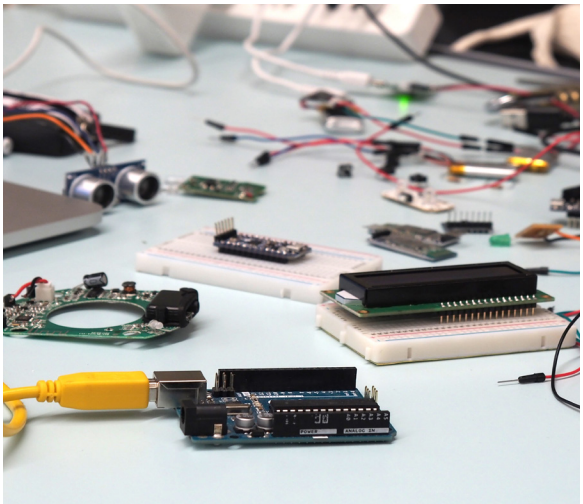
- Hand signal
- Handle steering
- Application navigation

After building prototypes, have some tests. The results shows the helmet concept has better visibilities to help the cyclist at night. So I decided to keep working on this helmet concept. And some of these concepts can implement at the same time. I chose the hand signal, handle steering and also the application navigation concept.

Before Developing the helmet concept, I tested out the Arduino sensors and components. It took me a lot of time to test Gyroscope sensors, bluetooth sender and receiver(HC-05 and HC-06), battery charger, power booster and LED strip ws2812. It would be talked further in chapter 4.



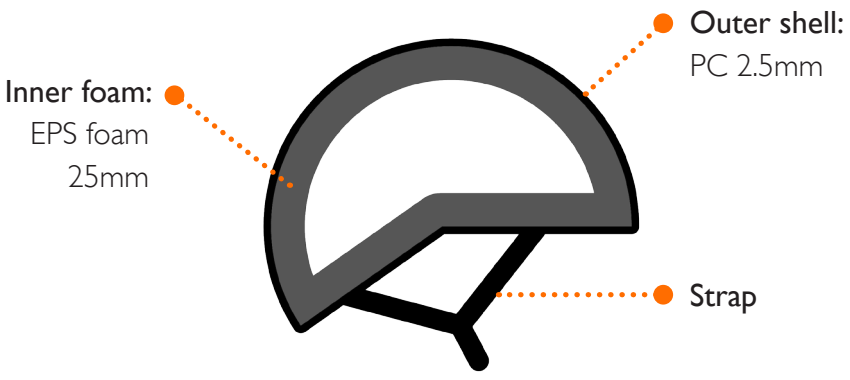




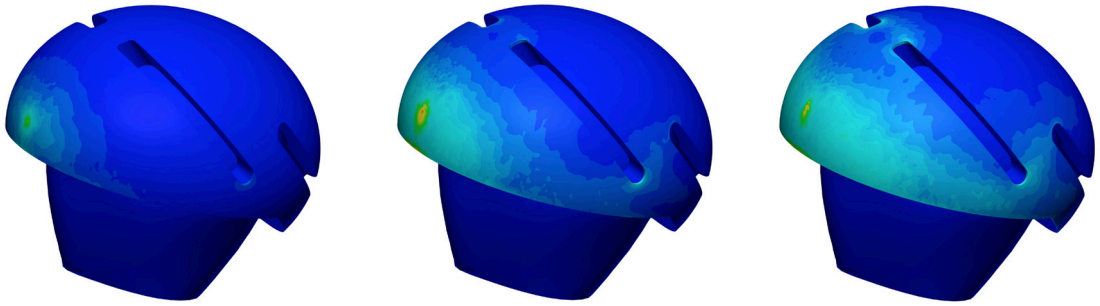
HELMET RESEARCH

After I confirmed my concept, Helmet is my main focus to work on. Then I did some research on it how to achieve the standard of the safety issue. It's like force impact test, airflow test or ergonomics to fit people's head. There are several areas could be look into. But after some researching time, I found out it would be a total different product design project if I want to make a brand new helmet. So I decided to just focus on my original direction which is interaction part, how people use the object and how people read the signal form it. It will a generic helmet project.

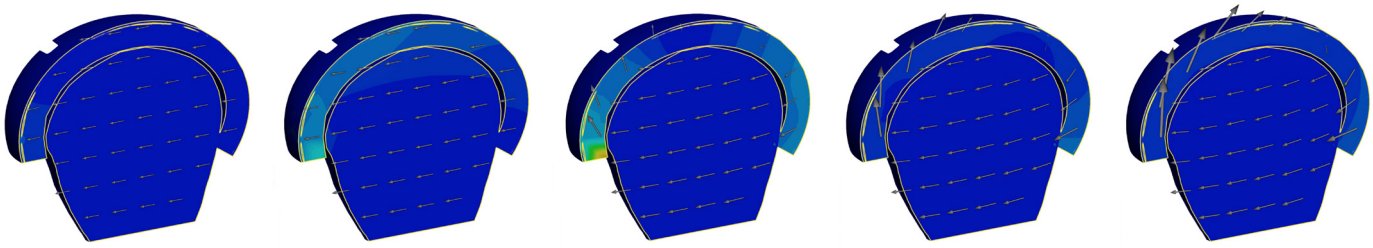
But my project would still achieve some basic helmet standard which is common with the helmet products on the market. The common helmet is composed of three main parts, which are strap, inner foam and outer shell. Inner foam's material is EPS foam which is a rigid and tough, closed-cell foam. Inner thickness usually ranges form 21mm to 28mm. And outer shell is PC material which is 2.5mm.



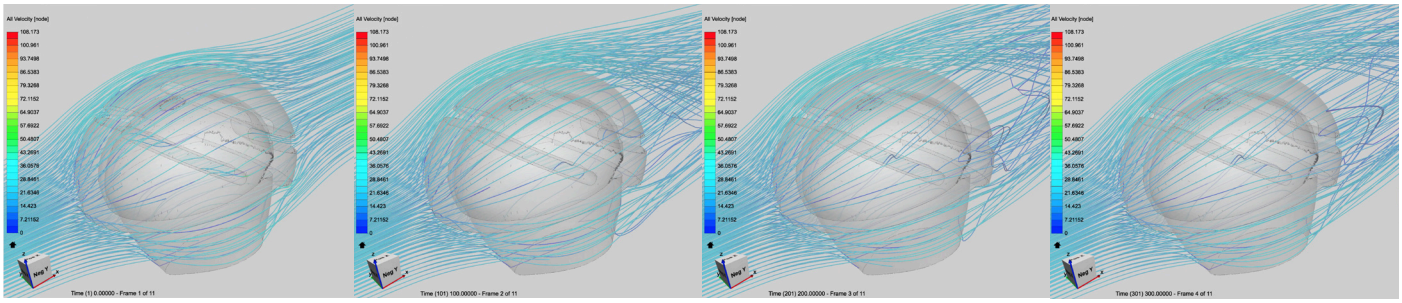
OUTER FORCE TRANSITION SIMULATION



INNER FORCE TRANSITION SIMULATION



AIRFLOW SIMULATION



Although I decided to have generic helmet project. But before that I still tried to do some simulation to see the possible results because my original plan is developing a brand new helmet. So I tested one of helmet sketch model and tried how does the software work before digging more deeper.

SIMULATION TEST SOFTWARE: SIMSCALE

EXISTING CASE STUDY

LIVALL helmet

LIVALL has microphone and speaker that users can connect to their own cellphone. It could use voice control to give helmet instructions. And hand-free function to pick the calls.

ADVANTAGES:
Hand-free

DISADVANTAGES:
Noise environment

TORCH helmet

Torch helmet is a product put LEDs on the helmet, but it doesn't have any further smart device or function.

ADVANTAGES:
Front and rear lights

DISADVANTAGES:
No further functions

POC and forth jacket

POC and forth jacket a jacket could put your cellphone on your back. Then users could use voice control to give the screen instruction.

ADVANTAGES:
Hand-free

DISADVANTAGES:
Noise environment
Wearing earphone while riding

LUMOS Helmet

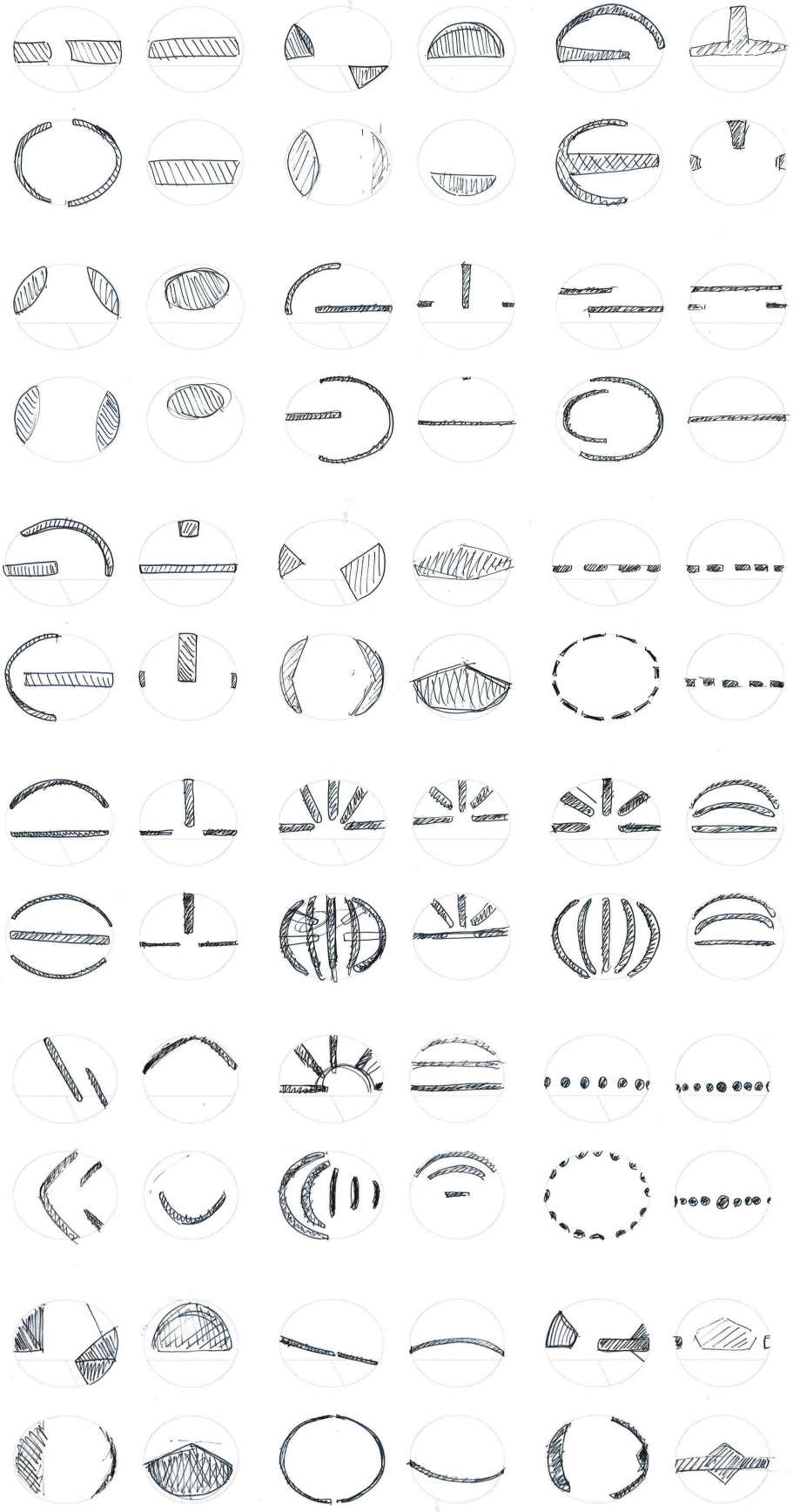
LUMOS has left and right turn signals that users can activate via a wireless remote on the handle. Enhance hand signals during those wide turns with turn signals!

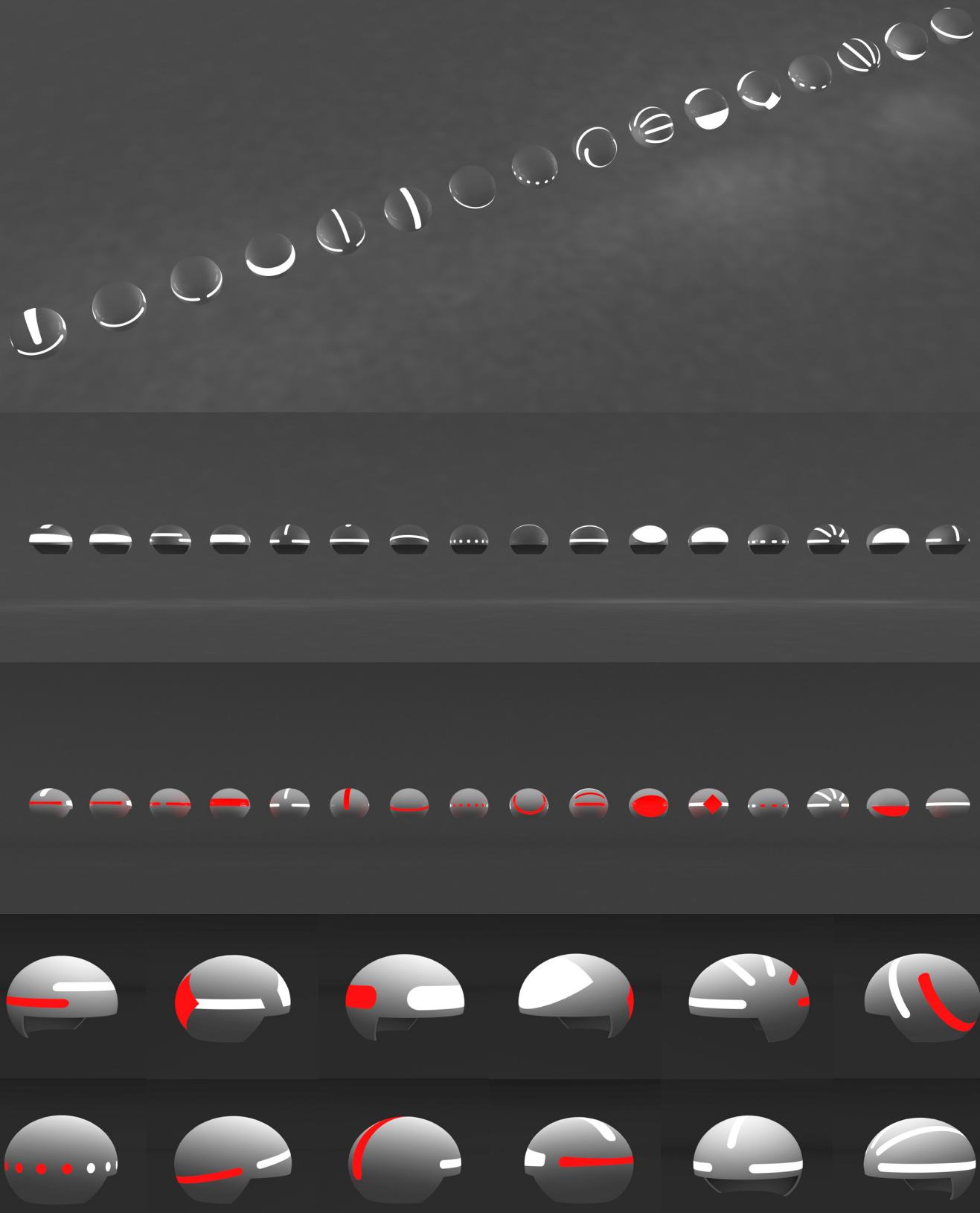
ADVANTAGES:
Clear remote system
Push the button and have signal

DISADVANTAGES:
Two device needs to be charged

LIGHTS POSITION

SKETCH



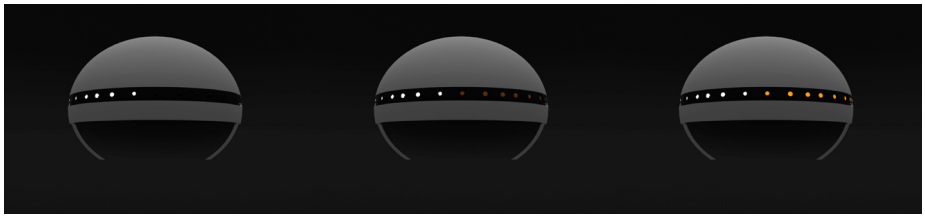


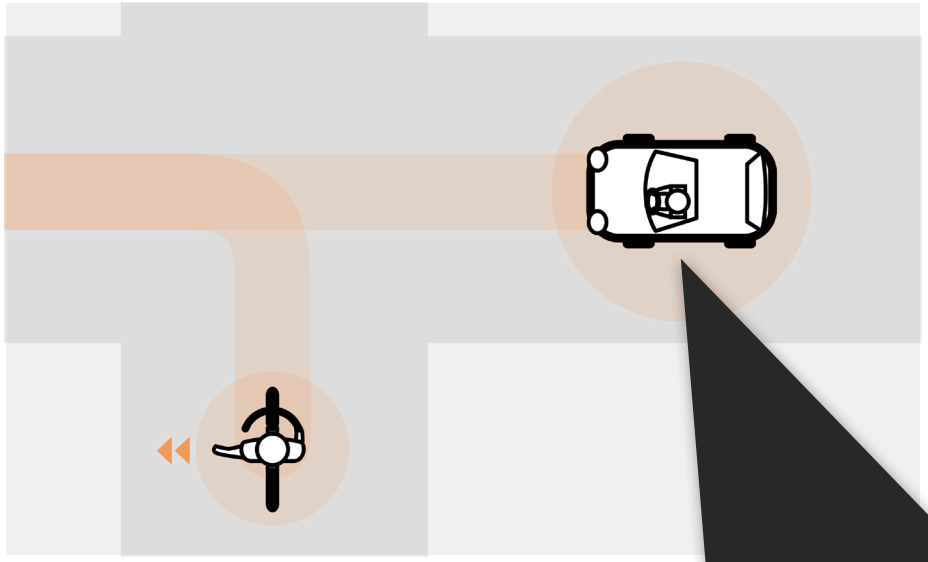
After drawing some initial ideas that what kind of lights position should show on the helmet, I found out there's no reason to have lights on the top of the helmet because lights are directional. The most important thing in this project is the visibility of 360 degree that people around you could see the lights. In this concept, I chose the dots one to continue developing the project.

LIGHTS PATTERN

Firstly, I recognized the signal indicator is common in cars system which is blinking orange signal, which shows left turn or right turn. People always see this kind of lights system shows on the street. People know the meaning of this signal. But I found out that something would happen if I use this type of lights pattern on the helmet.

HALF BLINKING ORANGE LIGHTS



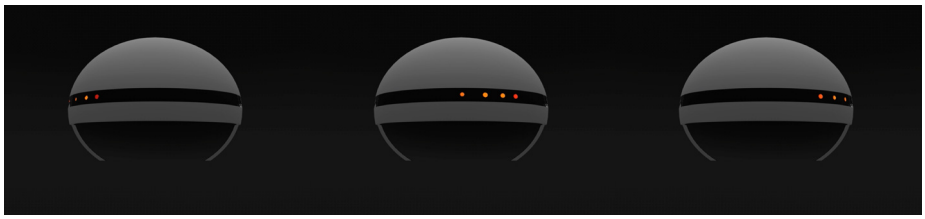


In the above image you can see, it's an intersection where cyclist and car would encounter. The cyclist would like to turn left and there's left turn signal shows on her helmet. But this kind of half blinking orange lights isn't easy to be seen by the driver from the side of the driver.

And all orange blinking lights is not an option because you can't not distinguish the direction.

VIEWPOINT FROM DRIVER

FLUIDIC ORANGE LIGHTS



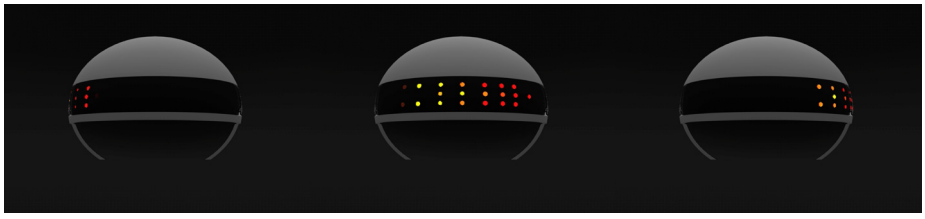
Then I used the fluidic orange lights to show on the helmet. Some of the car industry has already started to use this kind of lights pattern. It could be a trend that people recognize it clearly.

From the side view it become more recognizable for the driver side.

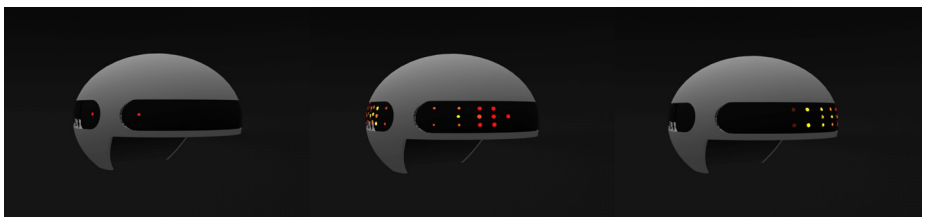
FADING OUT FLUIDIC LIGHTS

How to make the lights more visible? I used the three colors to make the fluidic lights more directional, which is likes fading out color, red, orange and yellow.

THREE LINES ARROW LIGHTS

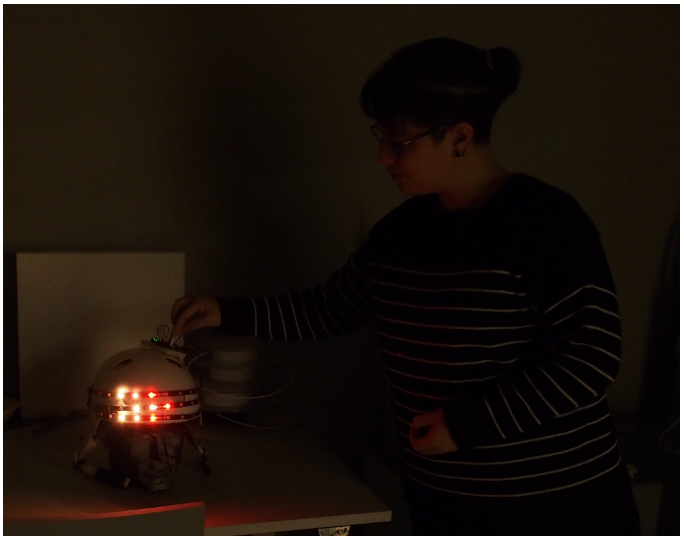


In this three lines LEDs lights, I made this lights shows a arrow direction to let it become more recognizable.

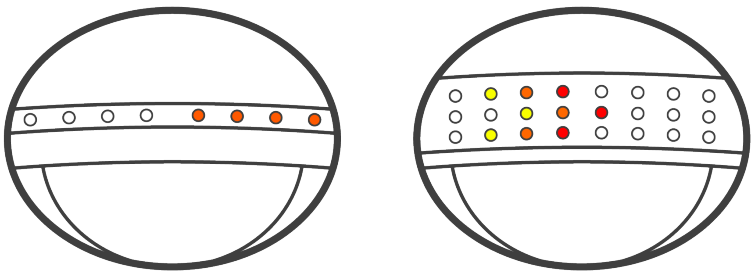


Three lines side view from drivers.

LIGHTS PATTERN USER TEST



After making different type of lights pattern, I need some feedback from the other's view. So I showed some people these lights pattern. And total are 10 people to participate this test. Only one of them thought the half blinking lights is the one he thought which is the best one. He said it's the lights pattern he get used to it because he knows all car's indicator are like this. But the rest of people like the final one with three lines lights. They indicated it's the most visible one. The arrow pattern with different colors helps people more understandable.



1 Person

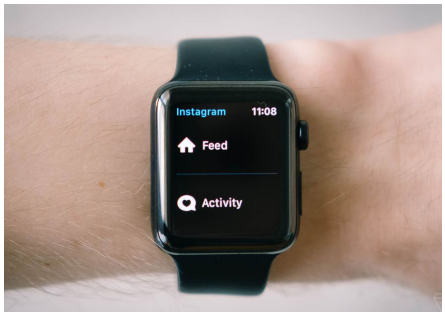
9 People

One of them mentioned that when she wore the helmet she thought it's a little bit too bright if there's three lines of light in the front. And the other person mentioned it's more important to show the condition more obvious at the back because the one behind you are the one have most high opportunity to bump you. After that I decided to use one line in the front and 3 lines at the rear side.

HELMET CONTROL

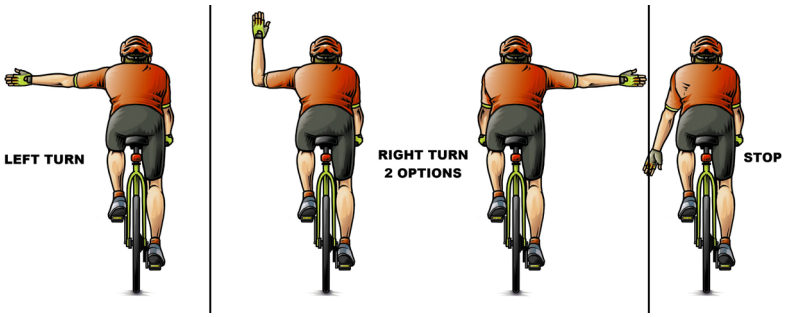
- Hand signal
- Handle steering
- Application navigation

At first, I was wondering to build a steering handle or glove to control the helmet because these are the direct tangible part when cyclist are riding. Put some sensors on the bike handle and bike gloves. It would let me to control the lights on helmet. But I don't know if it's a good solution or not. So I looked if there's the other option to control the helmet. Then smart wristband devices came to my mind, I can make my own concept wristband to control the helmet. People could wear it when they're riding. I could implant the sensors I want to.



But is it a good idea to create other smart device to put on people's wrist? Now some people have already started to wear the smart watch on their wrist to detect their location or health condition. Why don't I utilize their own smart watch to control the helmet? I could create a user interface on their smart device to control the helmet. Many of the smart devices have the gyroscope sensor in it. It could works in the same way.

HAND SIGNAL



As the above picture shown, it's the universal rule for the cyclists' hand signal. But not everyone knows this rule, and people got their own mind to read these hand signal. Take the left hand up hand signal as an example, it's actually a right turn hand signal, but it might to be some other meaning for somebody doesn't know the rules. It could cause some confusing on the road. The reason why cyclist has this kind of left hand right turn signal is that normally cars are always on the cyclist's left or left back side. If cyclist wave their left hand, it's easier to let the car driver see their hand signal.

In my project, I'm going to follow this rule to let the people use hand signal because there's lights pattern on the helmet. I'm not worried it would cause some confusion to the other road users. It would show which way cyclist actually wants to go in certain hand signal.

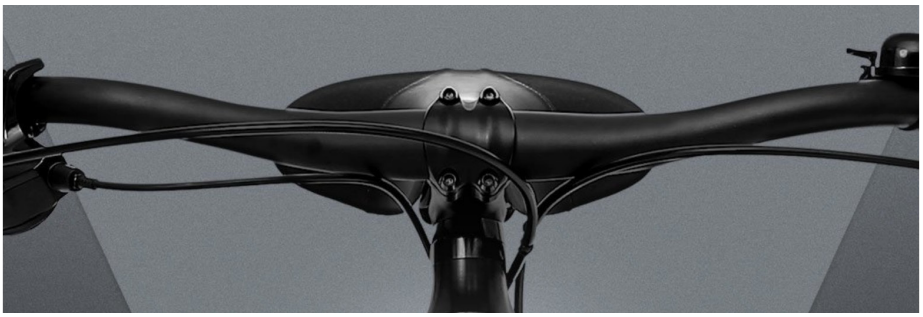
LEFT TURN

RIGHT TURN

SLOW DOWN / STOP

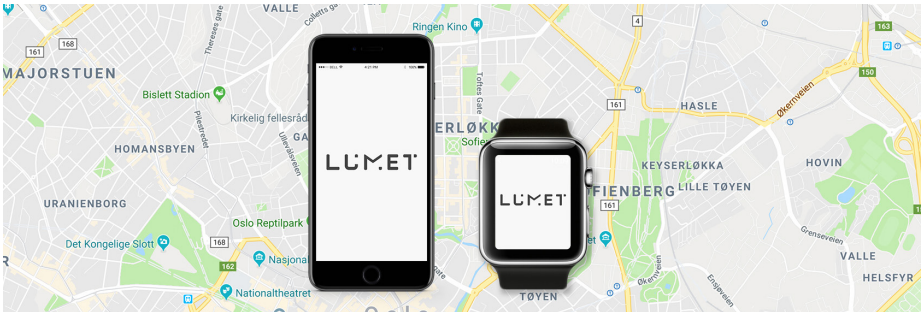
These are the final hand signal I used in my project. Users could use one hand, the hand they wear the smart watch device, to wave their way to go.

HANDLE STEERING



This concept will be implemented by the angle of the handle bar. If the cyclist turn their handle bar over certain degree then your helmet would show the turn signal automatically. It's also controlled by the user's smart watch.

APPLICATION NAVIGATION



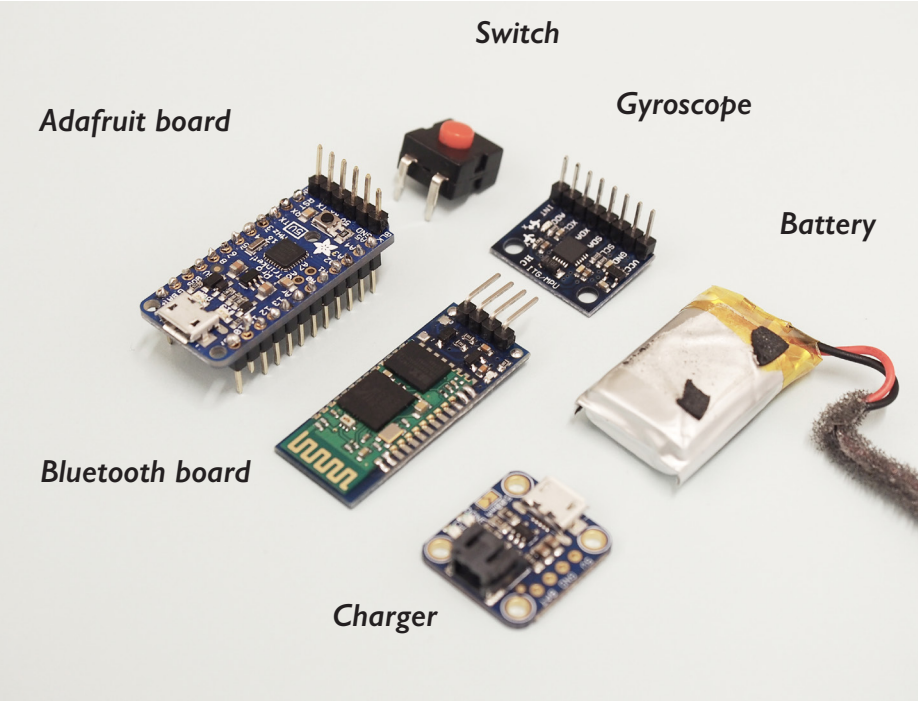
Before departure, users could set up the destination. And on the route helmet would show the turn signal on the all way to destination. And users could see the instruction on their smart watch.

04 *PROTOTYPE BULIDING*

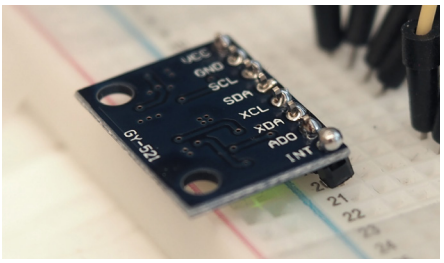
Electronic accessory
Model building

ELECTRONIC ACCESSORY

WRISTBAND PART

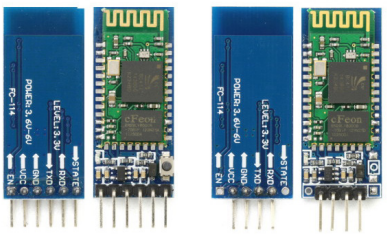


Before built the smart wrist band control, I looked into what kind of electronic accessories I should put into it. As above are the ones I used in wristband device. The most important part are the Bluetooth board and gyroscope sensor.

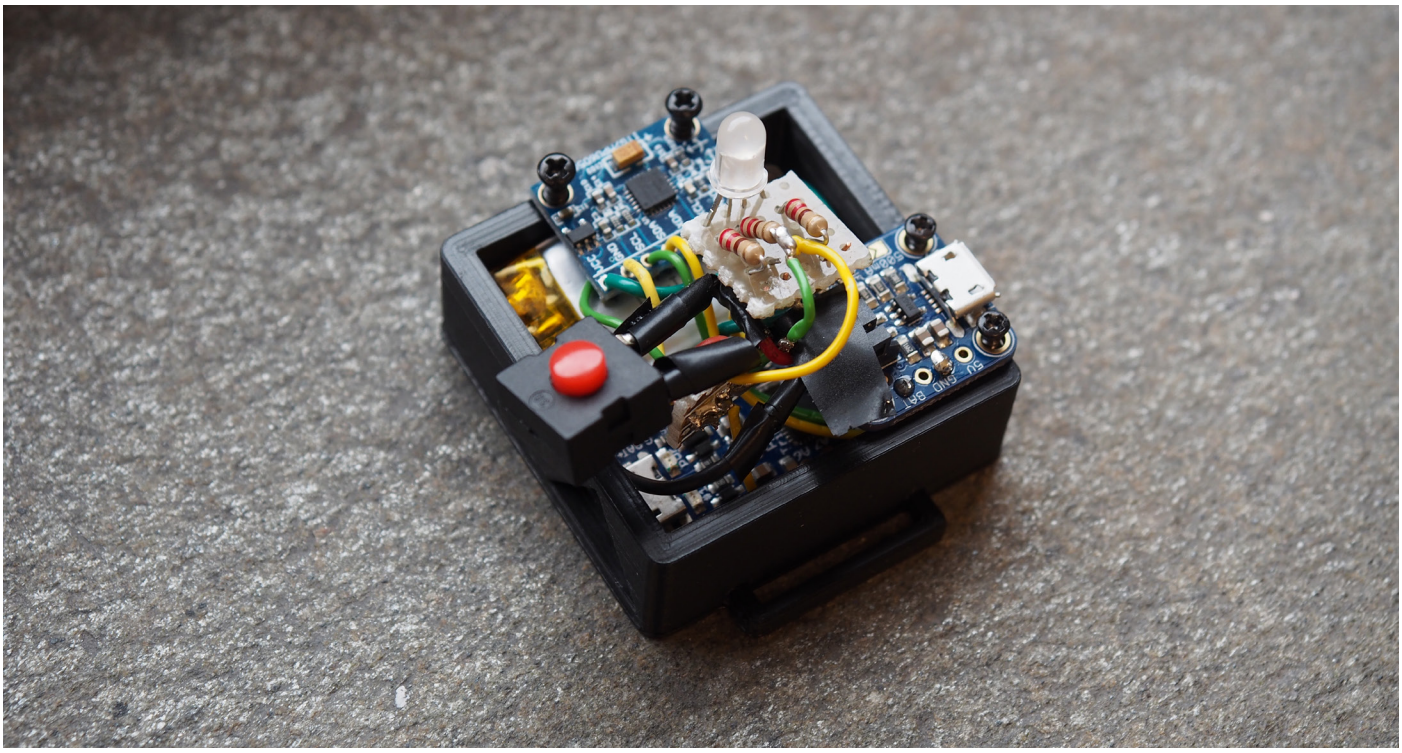


Gyroscope sensor could do the measurement of angular rates in three perpendicular axes, it's the main sensor to detect the hand signal.

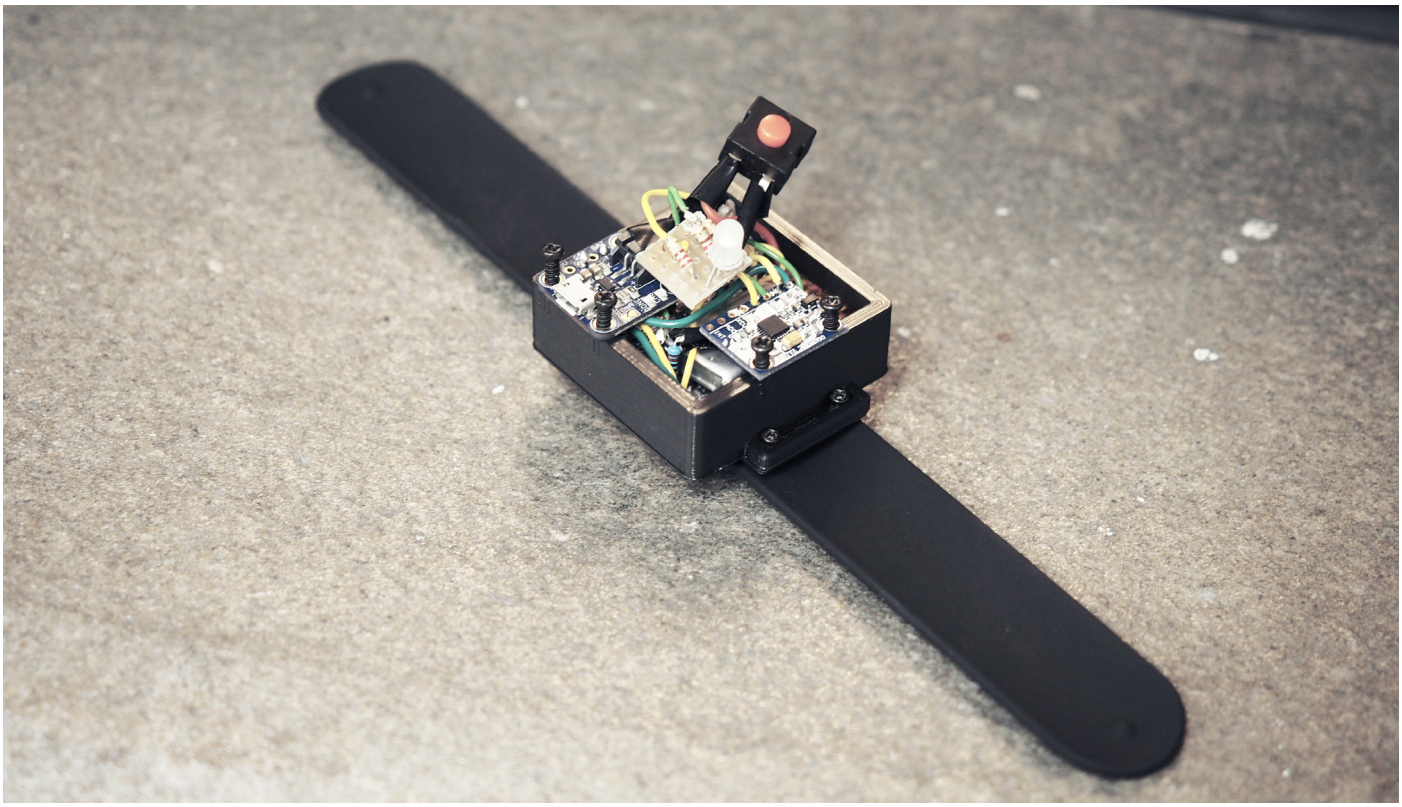
HC-05 ***HC-06***



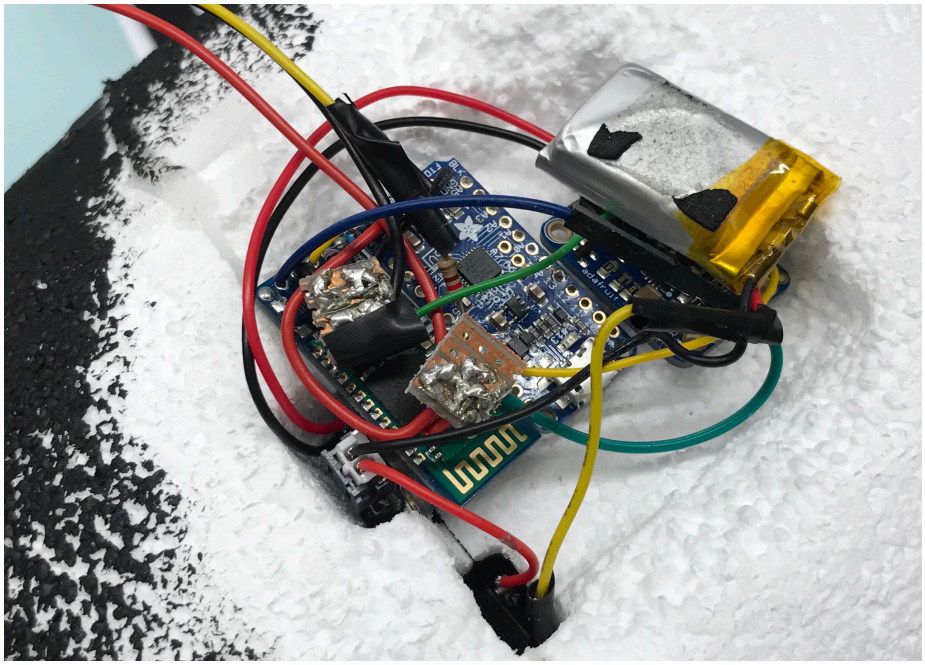
The other is the bluetooth board. There are two different kind of bluetooth board. One is HC-06, the other is HC-05. If I want to connect two board together. HC-05 should be the master and HC-06 should be the slave mode. Then It could communicate with each other.



In order to let the prototype wristband device become more visible, I also put the LED lights on it. And 3d printed a box to put all into it.

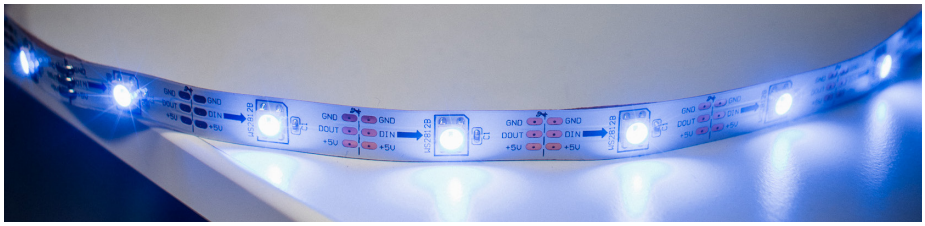


HELMET PART

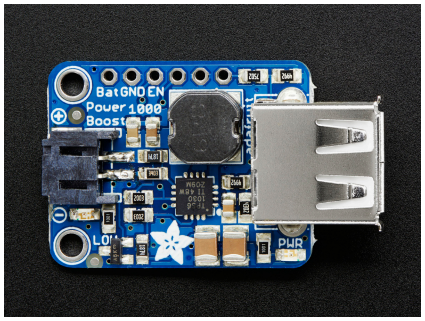


- Adafruit board
- Battery
- LED strip ws2812
- Bluetooth board HC-05
- Charger board
- Power boost
- Switch

LED STRIP WS2812

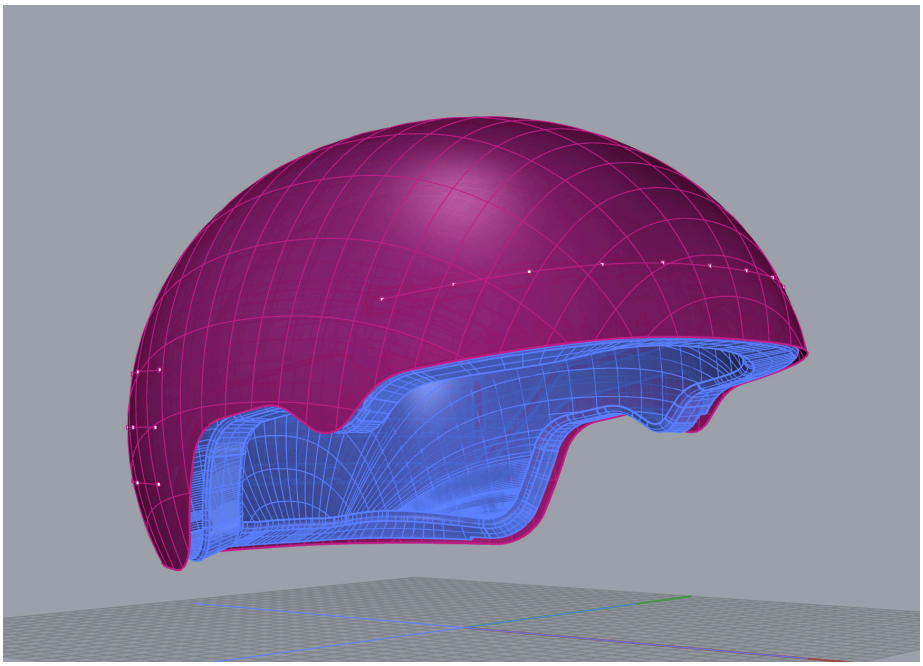


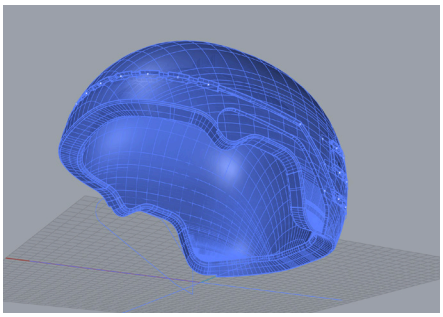
ADAFRUIT POWER BOOST

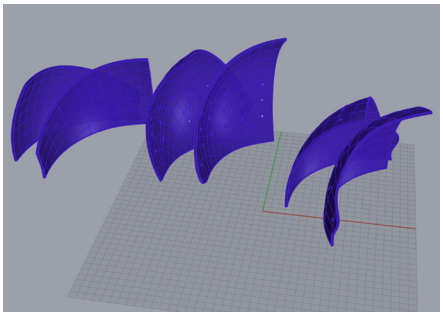


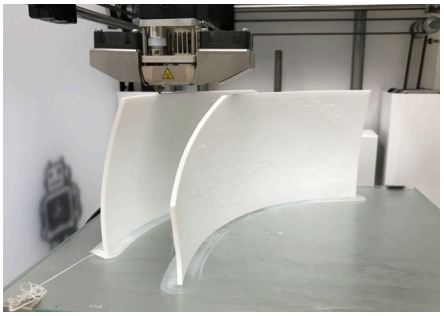
If I only use normal 3.7v Li-battery, the LED would be blinking sometimes because the 3.7v is too low for LED strip. In order to stabilize the LED strip, this project needs to power boost the battery 3.7 volts into 5 volts. So I add the other power boost board to achieve this.

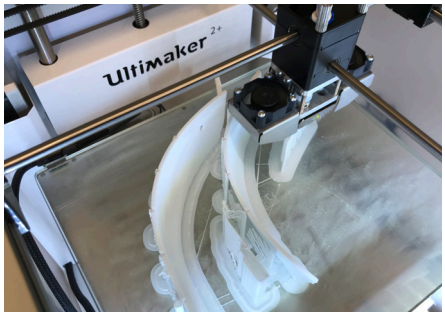
MODEL BUILDING

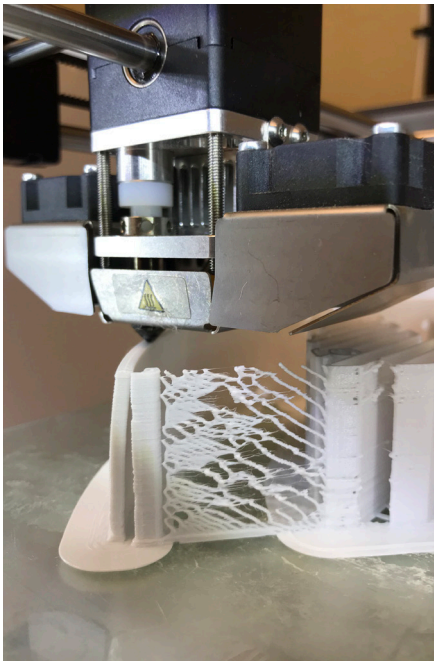


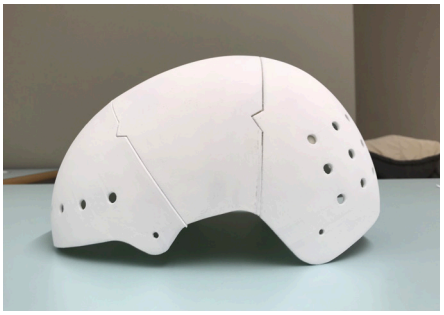


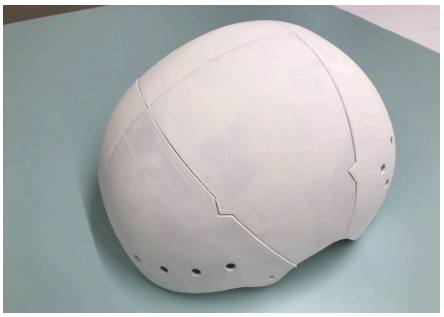


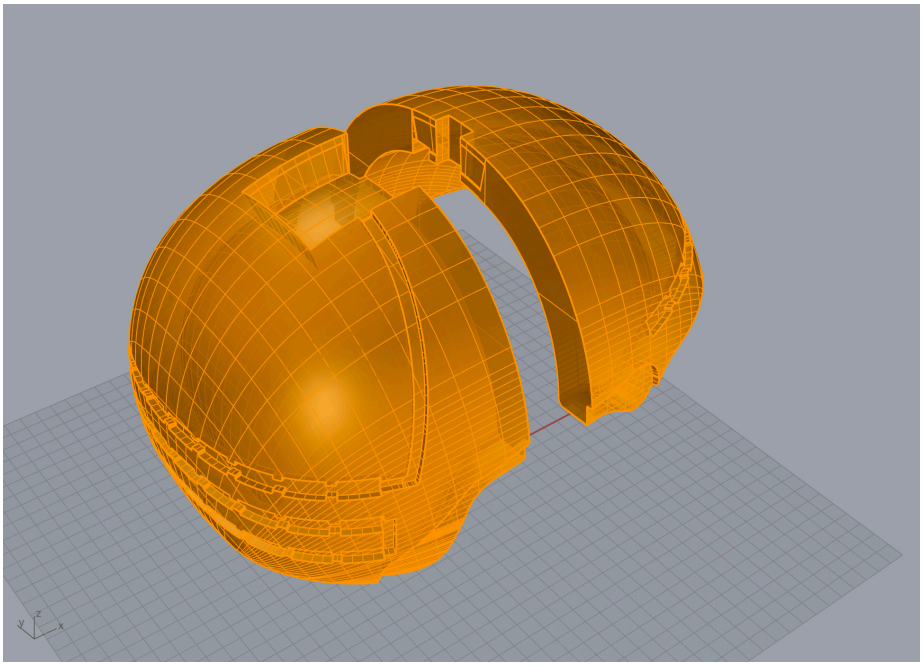


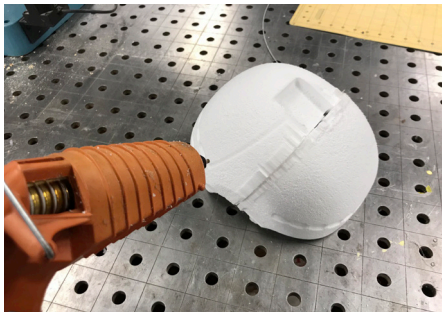


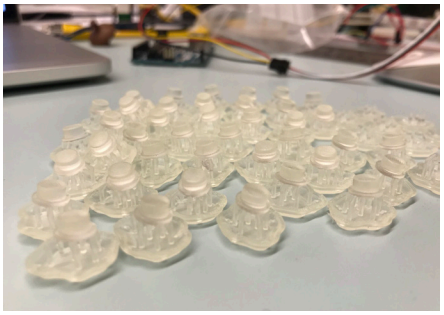


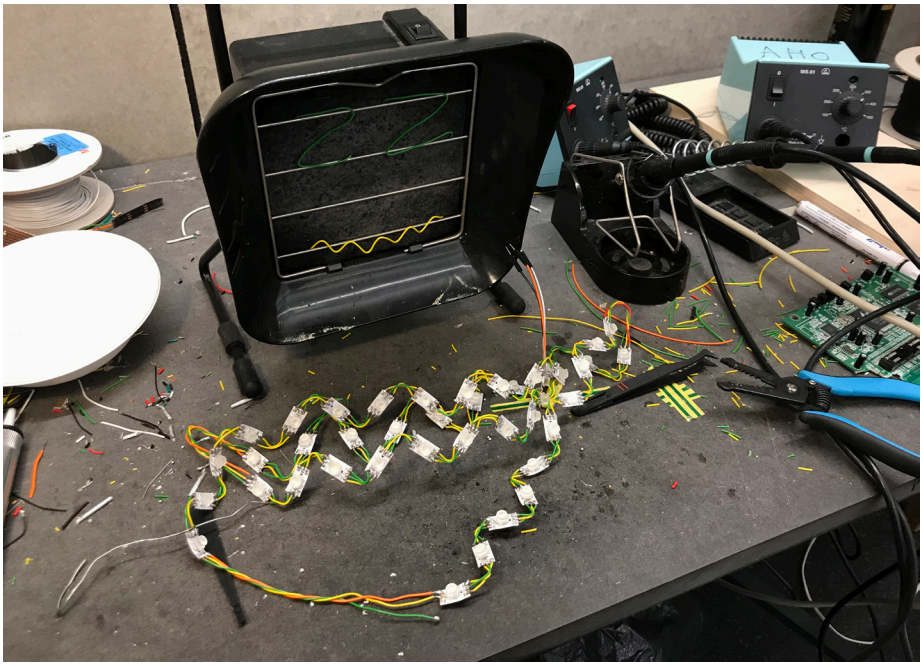


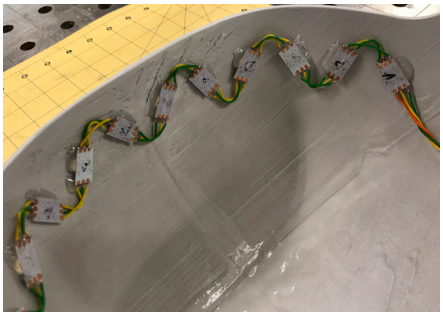


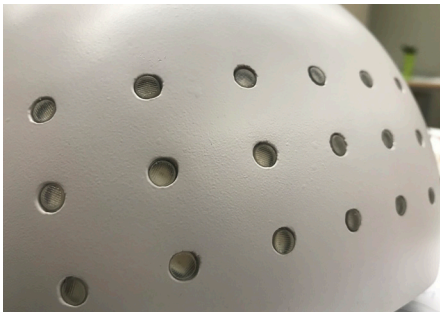


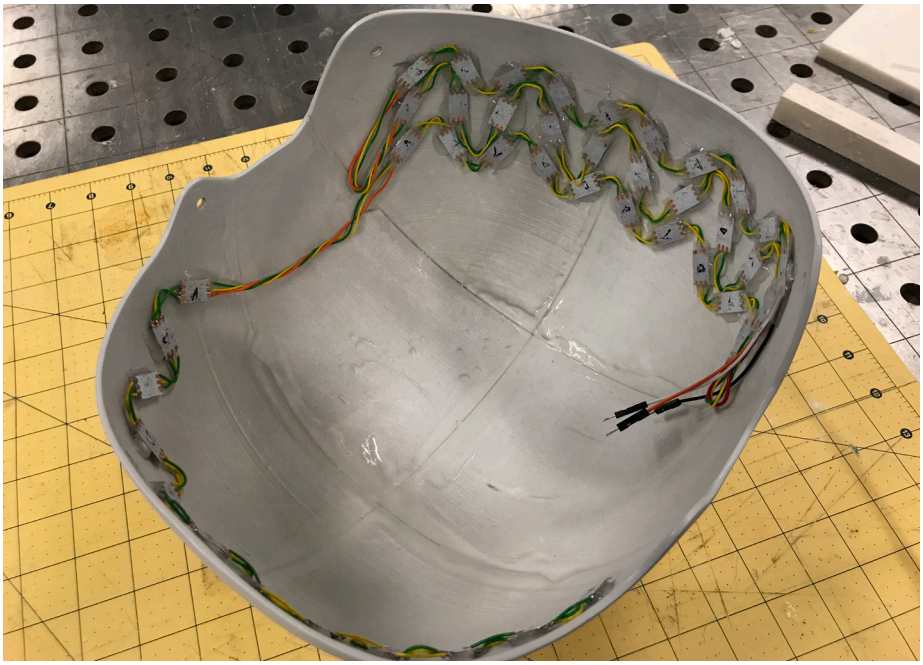


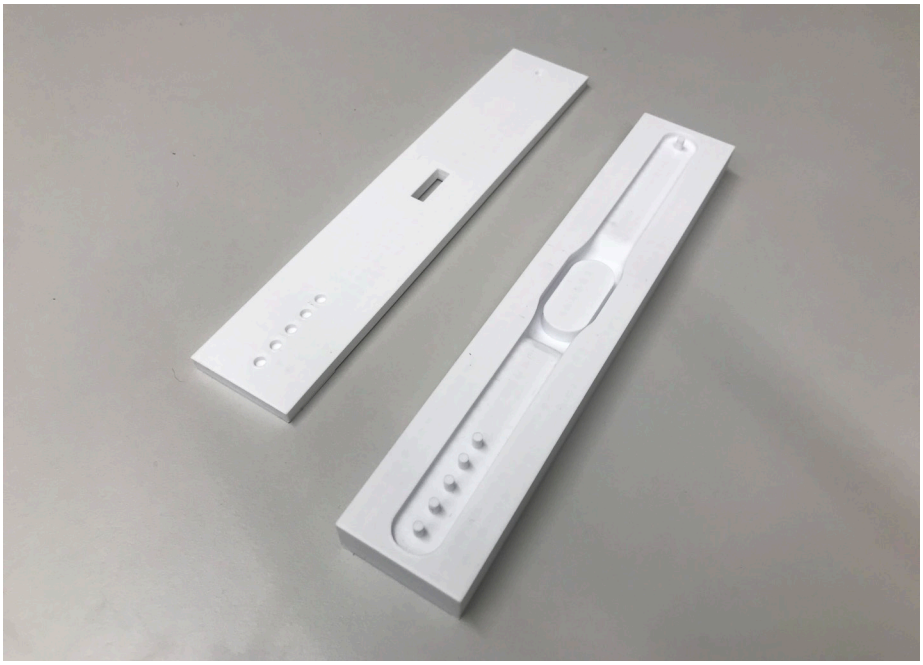












05 *RESULTS*

Final model
Last user test
Next?
Reflection

FINAL MODEL

LAST USER TEST

In order to get some insights, further testing is necessary. I went to street to interview some random cyclist, show them my prototype and how does it work. At also interviewed some students, the one doesn't know anything about my project, at school.

It turned out people would love to wear it on their head to test it out. They said it has fun to test the tangible model to know how does it work.

FEEDBACK

With those test I've gained lots of feedback and insights. Many features are approved but some of them need to be introduced and they would understand how does it work. Some interesting feedbacks are like how sensitive is the hand signal would work. Does users' hand need wave high? How long does the signal on the helmet would persist? Is it heavier than normal bike helmet? These are really good question and feedbacks for my project. Overall they thought it's a practical project could work on the real life .

NEXT?

In this project, there's more things I can do and to do some improvement in the future. If I have further opportunity to continue this project, I would like look into the industrial design and engineering part. How to make a product design helmet? It could be massive production. And about the engineering part, in the process I found out the battery I'm using right now is far way too small than the one I should be. It only could persist around 10 minutes. It's a big issue when I took it outside to test it. I didn't consider about this before I made the prototype. And I made the electronic accessories form Arduino system which are not for the massive production. And like some detail, the application which navigates the helmet on the route. If I continue this project, it definitely needs to be made.

REFLECTIONS

This diploma project was quite challenging, required lots of work but gave me fun and satisfaction in return. I hope this project could really reinforce the safety of the cyclists, but of course now it's still in the concept process.

During this project I have learned a lot from reading the other research to help me clear my mind, think through the main direction or idea. And I almost wrote every code by myself. From looking into how bluetooth board works, connect two boards together and use the Arduino code to control it. And by using 3d printer to help me. Let me thought if I have Arduino board and 3d printer I could almost do any concept I want.

During the research period it's now always smooth. At the start of the semester I believe that I would make a bicycle design in my mind, but during the process I followed the research results then came out a helmet interaction design project. With good planning and time pressure I've managed to finish this project. I put a lot of time on it. In the end, I'm satisfied with the process and the result.

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