

Automatic generation of architectural renderings based on deep neural network

The research is part of the research project of Somatosensory Big Data Internet of Things Laboratory of Chongqing University.(Lead and directed by prof.Liu Li)

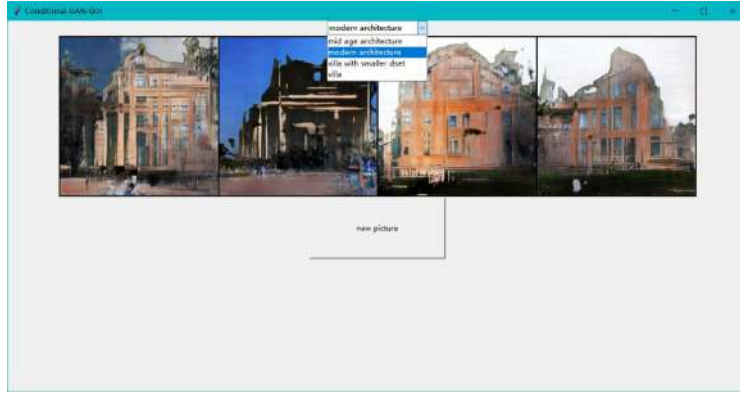
Project report Code <https://drive.google.com/file/d/1cadD1ysQ-vODsTL0QkvAn31B5k8dlu8Z/view?usp=sharing>
<https://github.com/Frankd35/SRTP>

Work involved: Project leader

Responsible for task allocation and schedule control.
 Research direction determination, literature review, and data set collection.
 Responsible for part of the server building work and neural network coding.

Brief Introduction of Project Achievements

Different styles of architectural rendering datasets were fed into different types of neural network frame works(GAN,CGAN,PGGAN,DCGAN), and the results are generated by quantifying the renderings with the inception score.
 Based on DCGAN, we carried out the foundation work of our subsequent software development and GUI.



Background and Research significance

The traditional architectural design process relies on field research, manual sketching, model building and rendering effect drawing, **which takes a long time**. If only according to the design requirements(such as style,number of plies), renderings can be generated to meet the needs roughly, designers can **better communicate with first party** and **get inspiration for further design scheme**.

The automatic generation of architectural renderings is of great value in the field of architectural design without too much unique requirements, such as residential design, which can **greatly improve the efficiency of drawing and communication**.

Research experimental processance

Set up data set

We downloaded a standard data set from Kaggle, supplemented it with crawlers, and ended up with 25 different architectural styles.

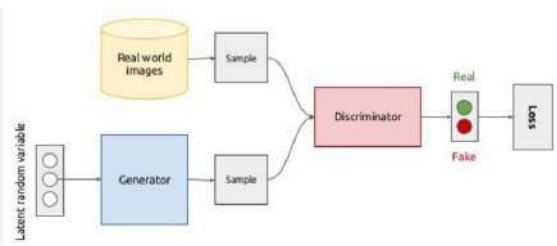


Model training and improvement

We have tried to use four networks (GAN, CGAN, DCGAN and PGGAN) for training, and adding correspondent attribute information.**The loss function is minimized by modifying parameters**. We found that DCGAN worked best in the models we chose for training.

GAN

Firstly, we try to use the basic GAN network model, we refer to the open source GAN network (<https://github.com/eriklindernoren/PyTorch-GAN/tree/master/implementations>), adjust the parameters to train our dataset.After 1000 iterations, the Outlines of the building image were visible, but not very well.



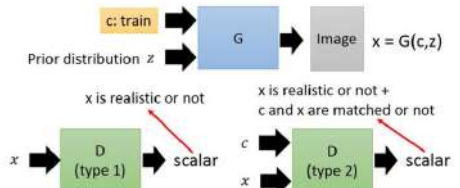
CGAN

CGAN(Conditional GAN) sends the tag together with the generator and discriminator to generate/judge the result based on the tag. In this way, we can control the generation of architectural renderings of different styles. From the visual clarity, the effect of CGAN is better than that of GAN.

$$\max_D \{\mathbb{E}_{x \sim P_{data}} \log D(x|y) + \mathbb{E}_{x \sim P_G} \log(1 - (D(x|y)))\}$$

The probabilities in native GAN are all changed to conditional probabilities

Conditional GAN



PGGAN

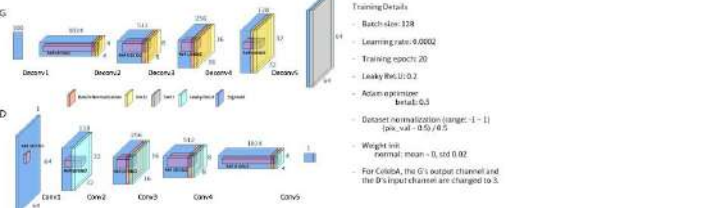
After the above model was built, we tried to use PGGAN model to generate high-resolution images. Incrementally let generators and discriminators grow. Starting with low resolution, gradually adding new layers and complicating the network model to learn better details



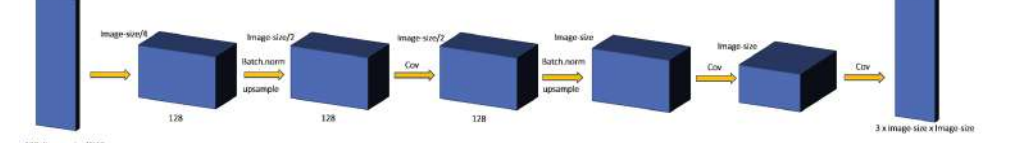
DCGAN

Then we tried DCGAN, which combined CNN and GAN, and used deconvolution operation, which is suitable for unsupervised learning tasks. We adjusted parameters and convolutional layer on the basis of principles, and the adjusted model structure, which is as follows:

Original model

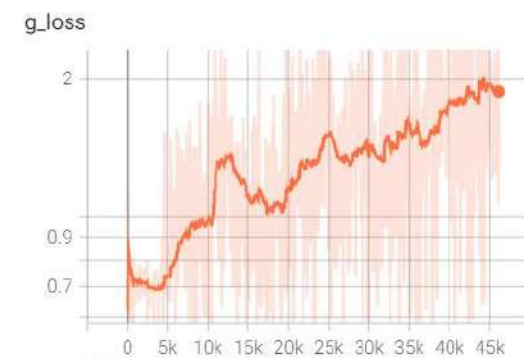


Our changed model

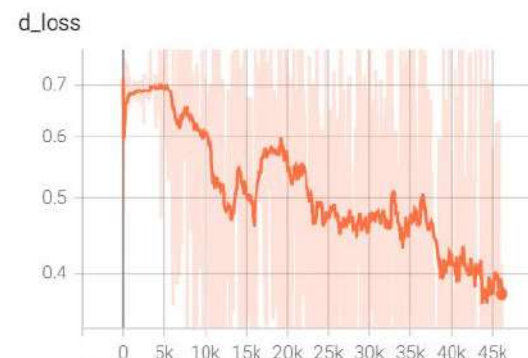


DCGAN rendering generation effect

DCGAN generation iterative process



Loss function of generator



Loss function of Discriminator

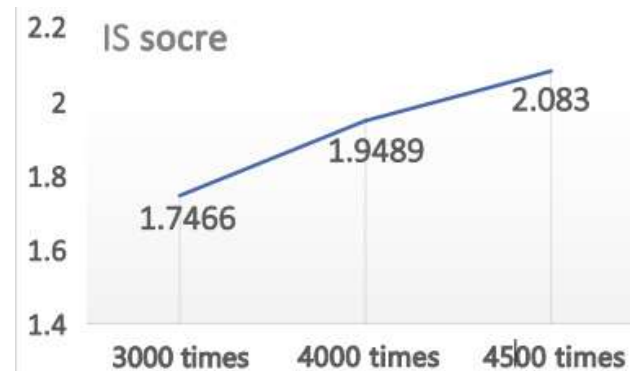
IS score to evaluate renderings

Models are evaluated from the following two perspectives:

1. Whether the generated image is clear and looks like real picture;
2. Models that generate more diverse samples deserve better scores.

Here, we use IS Score to evaluate the quality of the generated images. The higher the IS score is, the better the model is.

IS (Inception Score) indicators of models with different iterations times



With the increase of iteration times, the image effect is getting better, but there is a possibility of over-fitting

IS (Inception Score) indicators of different neural networks



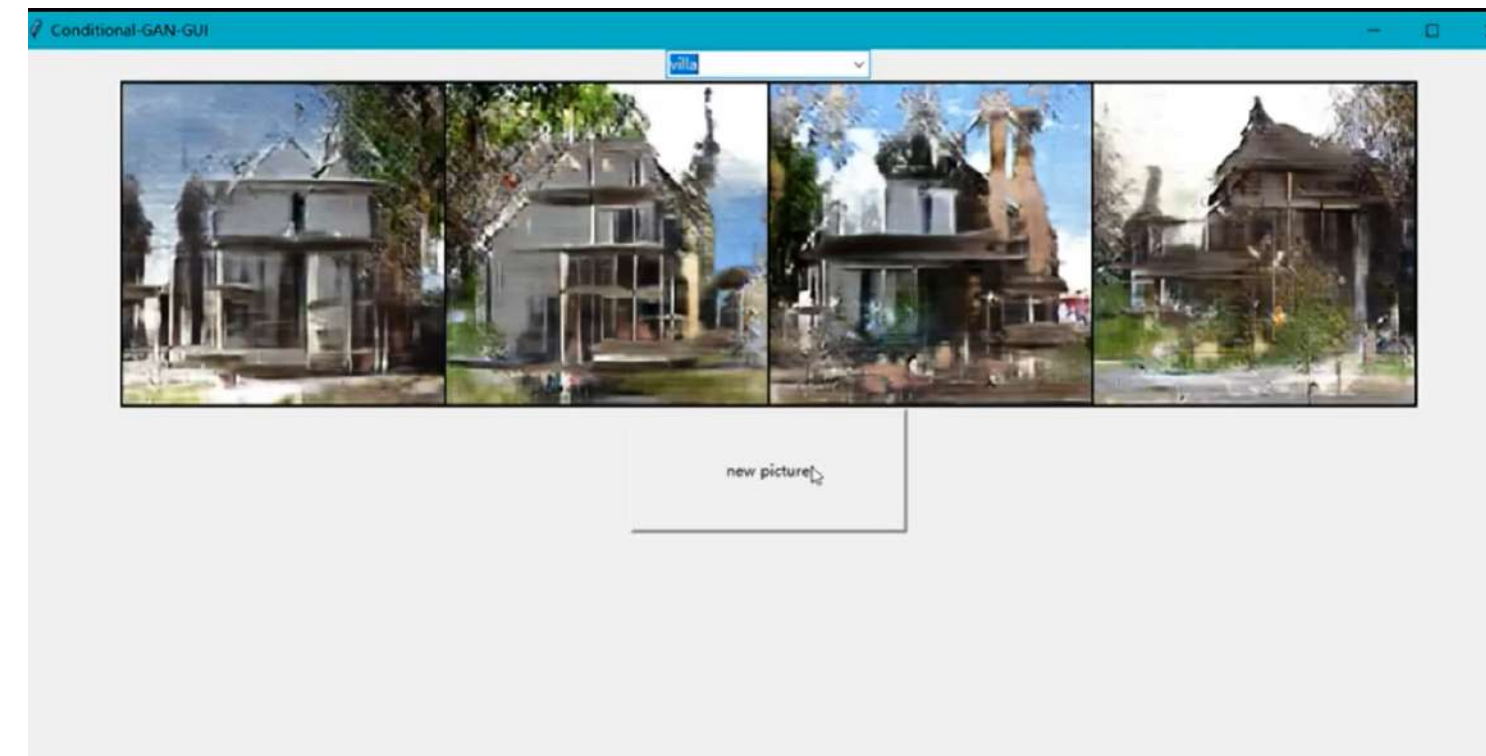
The generation effect of DCGAN is obviously better than that of other GAN, which is also subjective to us.

Operation demonstration of GUI interface:

https://youtu.be/_xt_T3uFyj0

https://www.bilibili.com/video/BV1RY4y147j9?spm_id_from=333.999.0.0

By selecting the style tab, the user can reproduce the architectural image of the style they want. Each selection generation calls the model in the background.



In the above study, we only try to choose the style, and other control conditions, such as storey height, area and facade color, can also be used as selection labels for control generation. The future of our ideal model is to generate satisfactory renderings through label control, which will greatly reduce labor costs.

Building life cycle Carbon footprint

question-answering system
based on knowledge graph

This is a team work for the knowledge Graph course (explaining the concept of knowledge graph and basic programming construction).

We collected information related to carbon footprint in the whole life cycle of building construction, constructed knowledge map based on Neo4J, and completed a question and answer system for users to query information.

Work I involved: Provide solution idea
Write codes for Q&A system

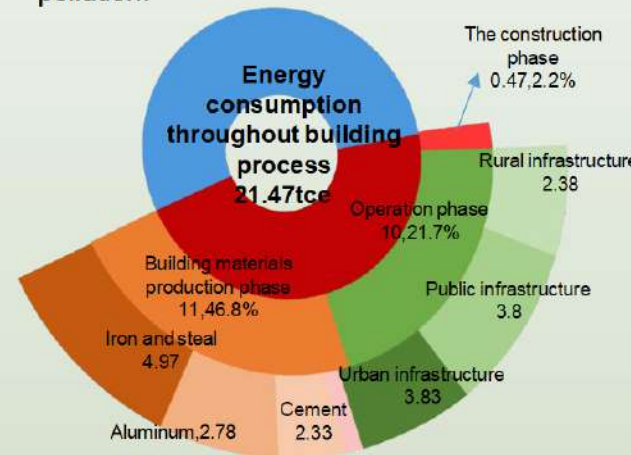
User's manual <https://drive.google.com/file/d/1yVlh2pEQkComd3P31RRhnyqIDalwQxSI/view?usp=sharing>

Codes <https://github.com/fukexuexue/Carbon-footprint-Q-A>

BACKGROUND



The construction industry uses a lot of energy, has large carbon emissions, and emits a wide range of pollution.



Data source: China Building Energy Consumption Research Report (2020)



The damage from excessive carbon emissions is enormous.

Building industry accounts for 46.5% of the country's total energy consumption and 51.3% of national carbon warming.

To achieve carbon peak and carbon neutralization in the construction field is very important to achieve the goal of carbon neutral

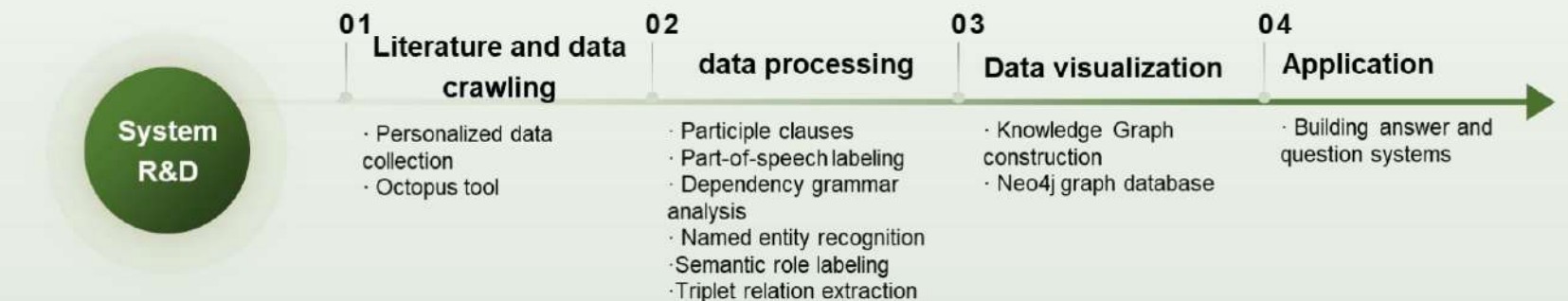
RESEARCH MEANING

- Identify carbon footprint emission factors
- Define the calculation standard of building carbon footprint
- Necessity of building carbon footprint life cycle assessment

Improve the transparency of carbon footprint accounting

Low-carbon control of the whole life cycle of the building

DESIGN PROCESS



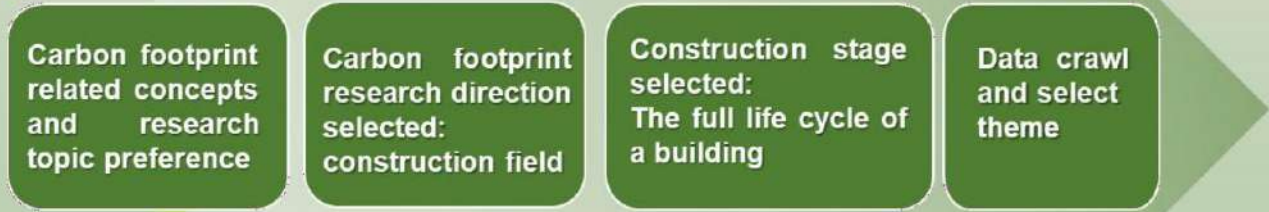
The data processing layer receives original data

High-quality data enter into the knowledge processing layer to form high-quality knowledge map.

Knowledge management layer provides the ability to store index and query knowledge map.

01 Literature and data crawling

Personalized data collection Octopus tool



Subject headings selection : Building life cycle Measurement method Carbon footprint factor Building material Way Enterprise

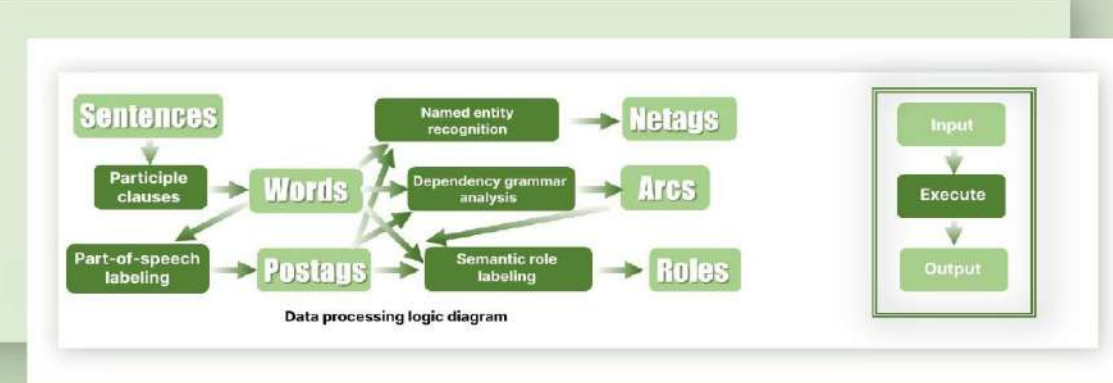
标题	作者	期刊	年份	引用	下载
基于BIM的装配式建筑全生命周期管理问题研究	齐宝南; 李长福	施工技术	2014-08-10	252	7967
建筑生命周期碳排放核算	高嘉懿; 张智慧	工程管理学报	2010-02-15	250	3252
BIM在国内建筑全生命周期的典型应用	过俊	建筑艺术	2011-02-20	247	5649
可变折旧率估计及资本存量测算	陈昌兵	经济研究	2014-12-20	245	5604
中国建筑环境影响的生命周期评价	曹金; 朱敏; 谷立静	清华大学学报(自然科学版)	2006-12-30	242	2755

Sorting by citation ensures high quality of data collection, better for screening data.

The crawl data is highly correlated:

#	标题	摘要	关键词
1	基于生命周期理论的...	摘要: 船舶承担了世界约80%的货物量,实现了近三分之...	关键词: 生命周期 时空网络模型 投入产出分析; 船舶碳足...
2	多层建筑项目全生命...	摘要: 当前全球变暖带来的环境问题越来越严重,在我...	关键词: 低碳建筑; 建筑全生命周期; 碳足迹; 综合碳排放系...
3	建筑全生命周期碳足...	摘要: 近年来,由于碳排放急剧增加而导致的环境恶化或...	关键词: 建筑全生命周期 碳足迹; 设计分析工具; 低碳建筑...
4	基于LCA方法的对虾...	摘要: 温室气体排放不断增多造成的气候变暖问题已经...	关键词: 碳足迹; 生命周期评价; 对虾池塘养殖;
5	海绵城市建设典型措...	摘要: 气候变化导致全球的自然、生态、社会系统发生...	关键词: 低碳; 海绵城市措施; 碳排放;
6	住宅建筑DfE指标体...	摘要: 随着全球生态环境的恶化,人们生态环保意识的...	关键词: 碳足迹; 住宅DfE指标体系; 生命周期评价; AHP层...

02 Data processing



Data screening >> Data cleaning >> Data conversion >> Data fusion

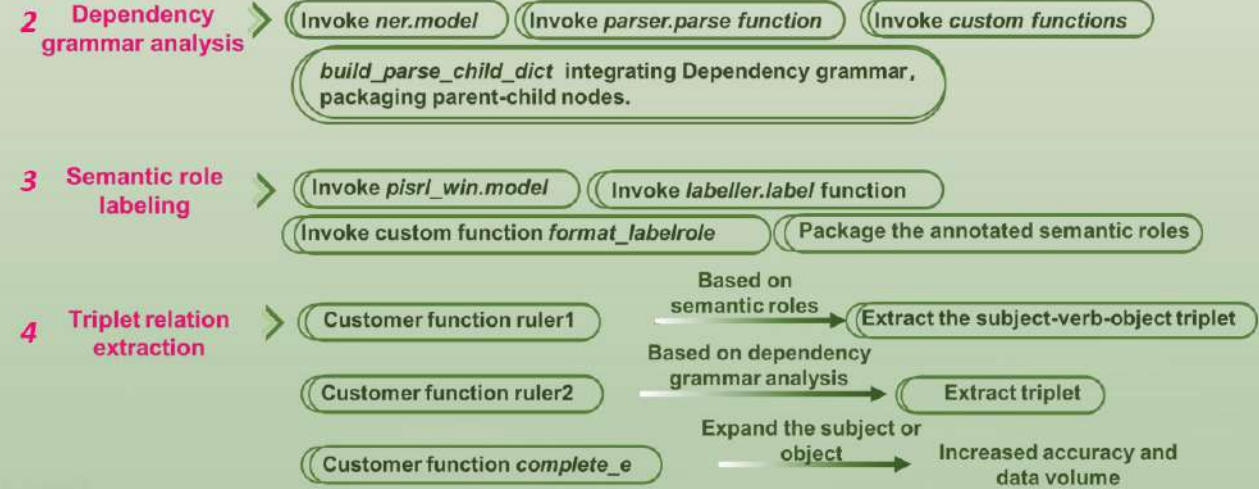
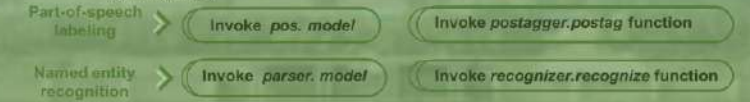
During the data processing process, we do:
 Participle clauses: Invoking the Segementor function, creating external dictionary.
 Semantic role labeling: Adding external part-of-speech lists and defining model accuracy.

1 Participle clauses > Invoking segementor function > Creating external dictionary > Individualized participles

```
INFO: 2021-11-28 05:37:32 R: 0.986938 ( 650 / 689 )
INFO: 2021-11-28 05:37:32 F: 0.979122
INFO: 2021-11-28 05:37:32 Best result (iteratin = 8) P = 0.971429 | R = 0.986938 | F = 0.979122
```

Training set accuracy P≈0.97 R≈0.99 F≈0.98 Good training effect

```
D:\workspace\python_exe\01\PycharmProjects\zstp\zbn093.py
Process finished with exit code 0
```



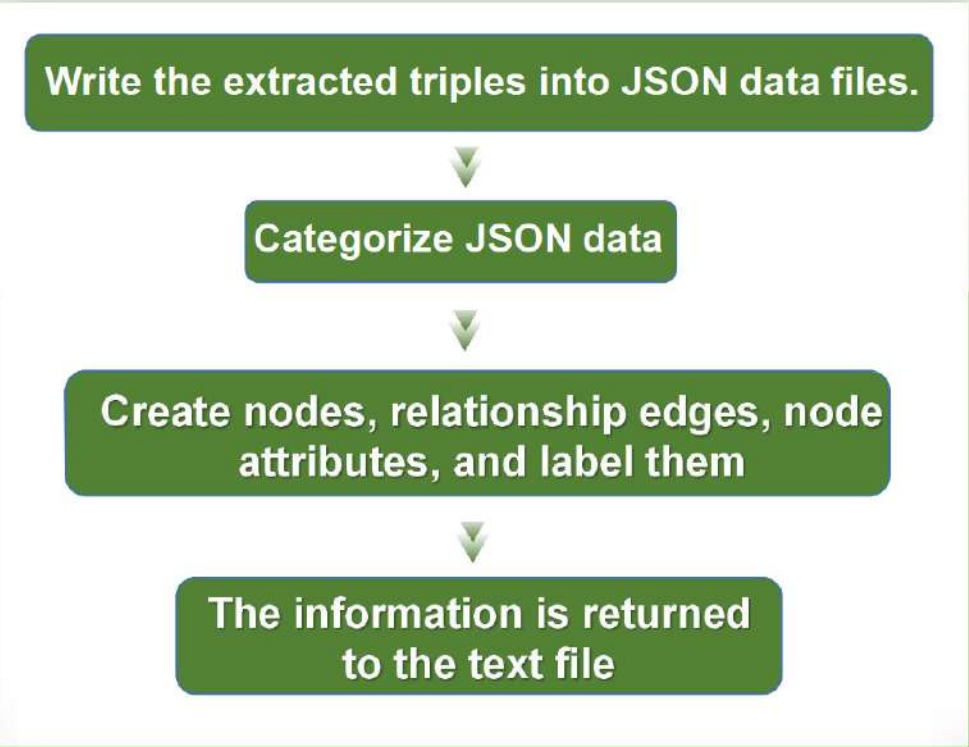
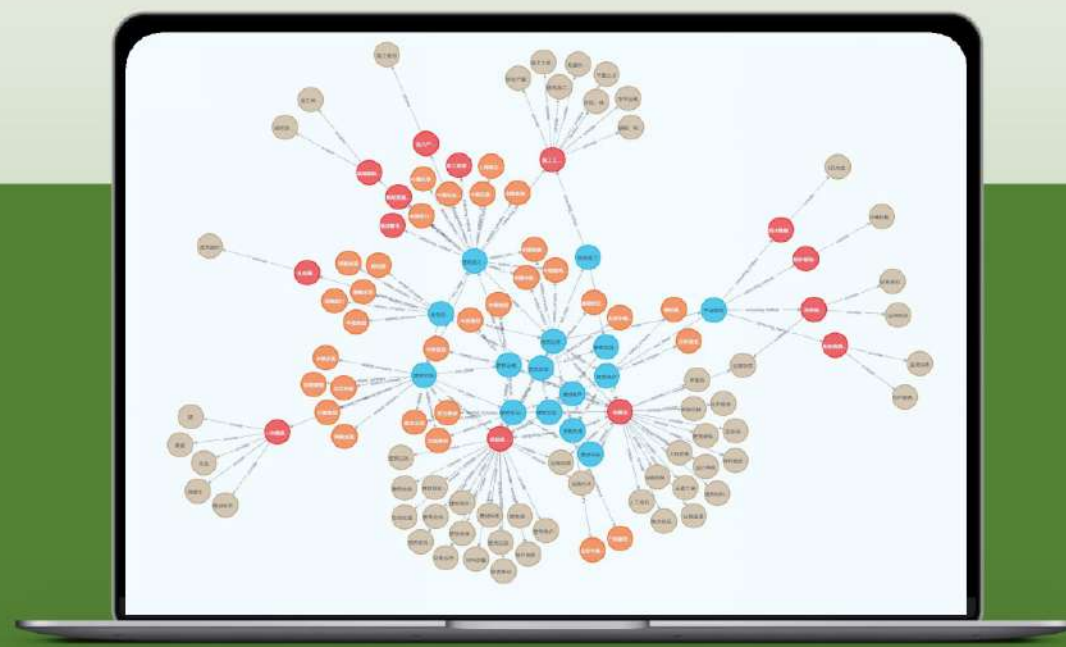
```
def parse_parse(sentence):
    words = list(self.segmentor.segment(sentence))
    postags = list(self.postagger.postag(words))
    arcs = self.parser.parse(words, postags)
    netags = self.recognizer.recognize(words, arcs)
    roles = self.srl_labeler.label(words, arcs, netags)
    return arcs, netags, roles
```

```
def extract_triplet(sentence):
    arcs, netags, roles = parse_parse(sentence)
    for arc in arcs:
        if arc.relation in ['SVO', 'SVOO']:
            subject = words[arc.index1]
            verb = words[arc.index2]
            object = words[arc.index3]
```


03 Data visualization

Building knowledge graph

Based on NEO4j graph database

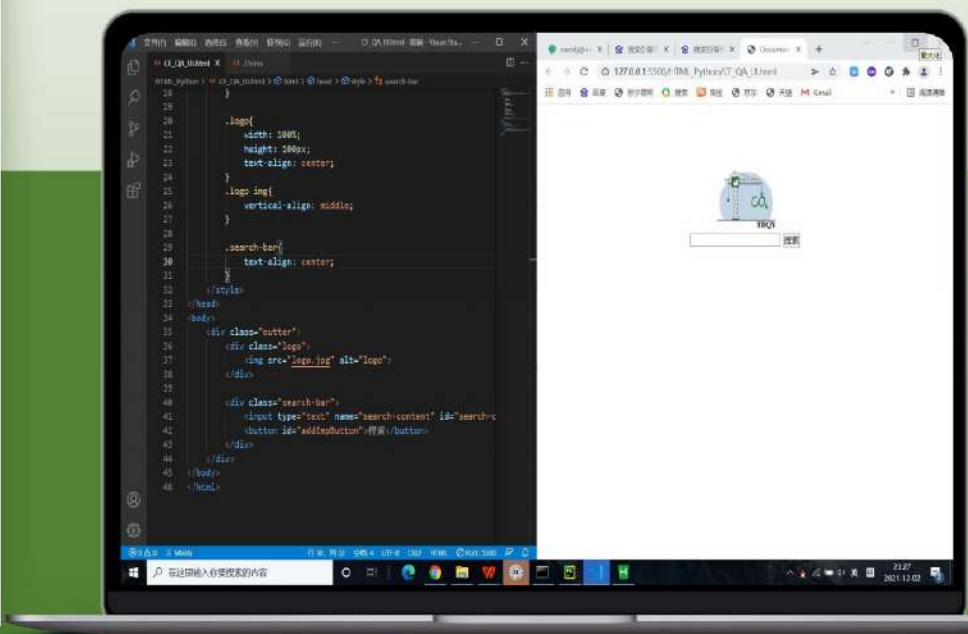


04 Application service

Building of question answering system

Fifteen pieces of data form a JSON data file, which generates 116 entities and 150 relationships.

- Four kinds of entities: Stage, Calculation method, Enterprise, Factor
- Five types of relationship: Sub-stage, Next stage, Related enterprises, Methods used, Factors considered



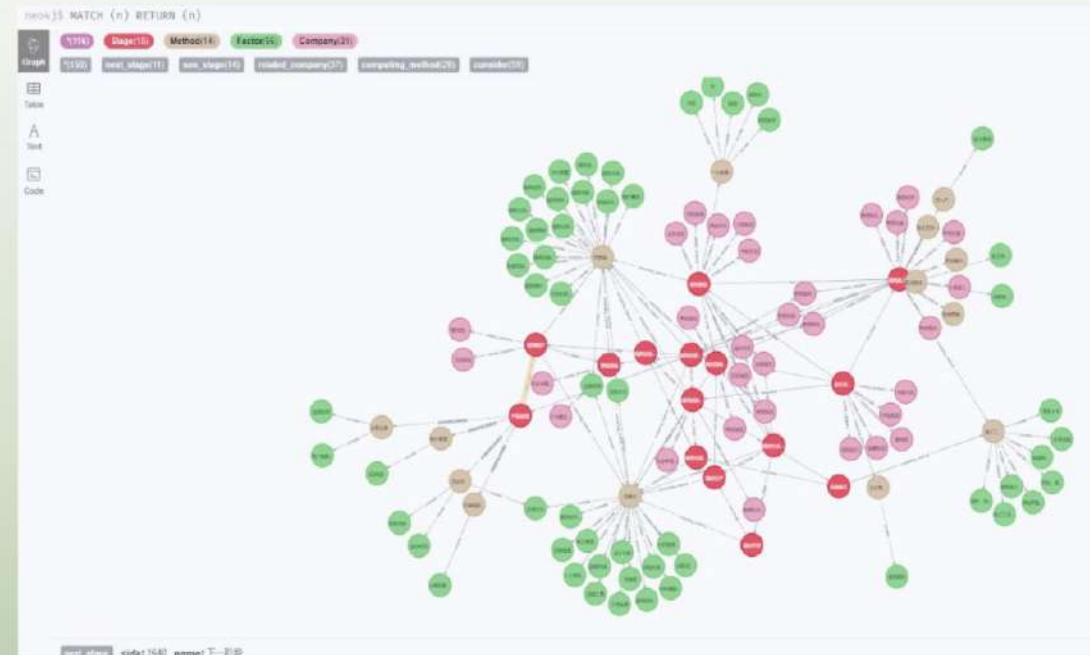
For example

What are the emission reduction methods in building operation and maintenance stage? [Search](#)

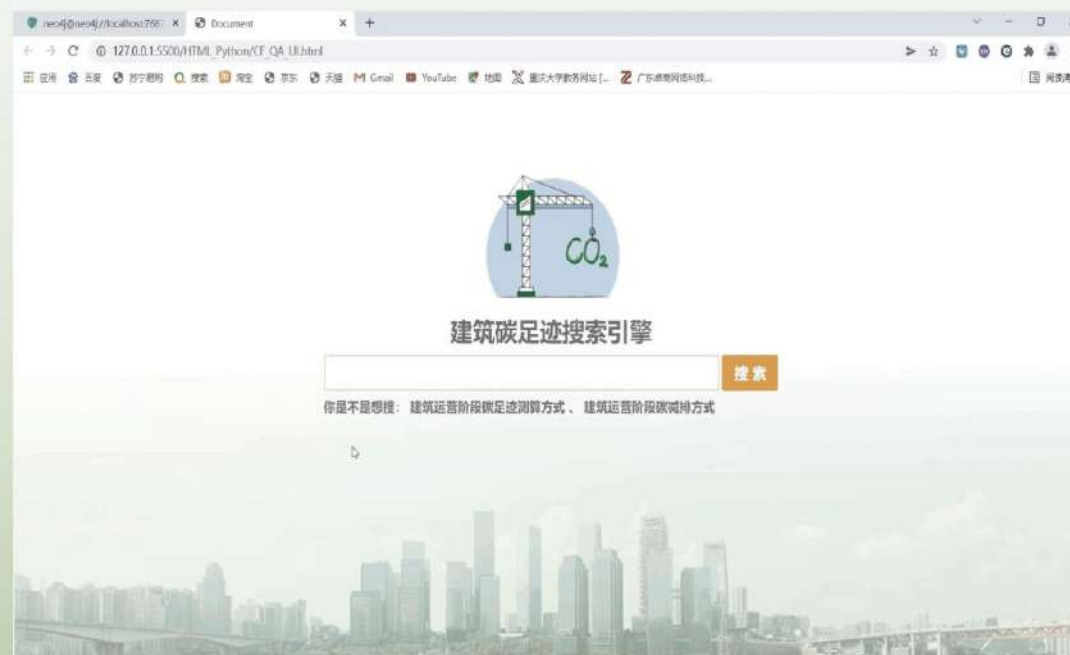
In the construction operation and maintenance stage, there are the following emission reduction methods:
Constructing green space for carbon offset, using real-time statistics of the detector to timely update the old equipment

The types of question which can be answered:
Define description class, phase relation class, calculation method class, influence factor class, improvement measure class, associated company class

05 Demo display



Knowledge graph demo



Question answering system demo

06 Application outlook

More benefits of exploring the sources of carbon emissions

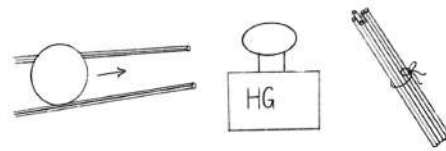
Clarifying the carbon footprint factors of full life cycle of the building

To achieve building carbon emissions reduction from the source

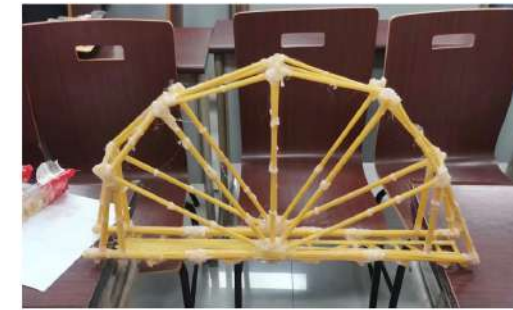
“Carbon footprint + Prefabricated buildings” make “Green + Smart” construction come true

Breakthrough in construction field to achieve a domain-wide carbon footprint traceability

Make Bridges Out of Spaghetti



Analysis based on systems engineering



Project summary

This is a project done by 5 people, which is an course project of systems engineering.

It requires us to use given amount of pasta, hot melt glue to make a spaghetti bridge in an hour and a half, and the bridge could carry the best weight and its deck could pass through ping-pong balls. Before the construction of the spaghetti bridge, it is necessary to design the working scheme with the knowledge of systems engineering and structure. Consideration of the scheme need to include how to design the most load-bearing bridge with artistic style, how to reduce the amount of pasta being used to lower the weight, and in view of the limited time, how to design the best team workflow.

We use **KJ method** to sort out the overall research ideas, use **analytic hierarchy process** to determine the structure, use **linear programming** to plan the pasta materials, and use **ESIA and Gantt chart** to plan the team workflow.

In this project, I take part in the whole process of discussion and finish the analytic hierarchy process and mechanical analysis to determine the structure.

Team project 2021.04-2021.05 | Skill: Systems thinking/Force analysis/Teamwork

Design for novice crowdsourcing carriers

Individual project 2021.12-2022.4

Adviser : Cai shunyao

Design thinking

User research

product and interface design

This is an integrated design of helmet, AR glasses and APP for novice crowdsourcing carriers to make it easier for them to gain delivery experience, find their way and improve safety awareness.



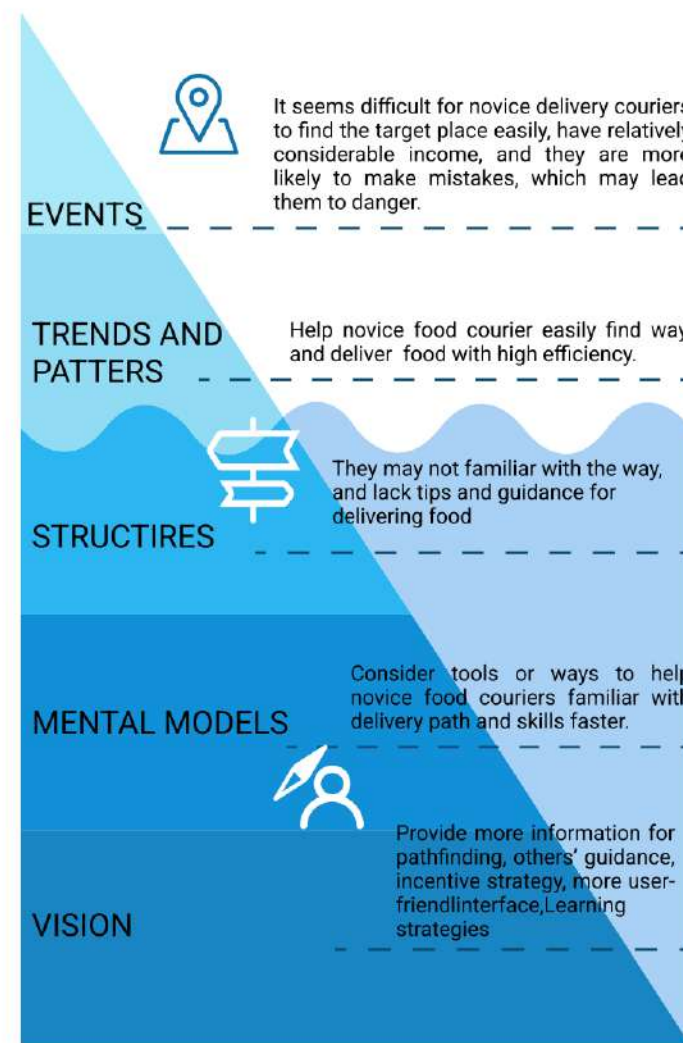
SILENT STORIES



For novice food couriers, there may be many difficulties. They always **can not find the way and destination easily**, like complex malls in cities, places lack of positioning in the suburbs, etc. Thus the delivery can not be on time.

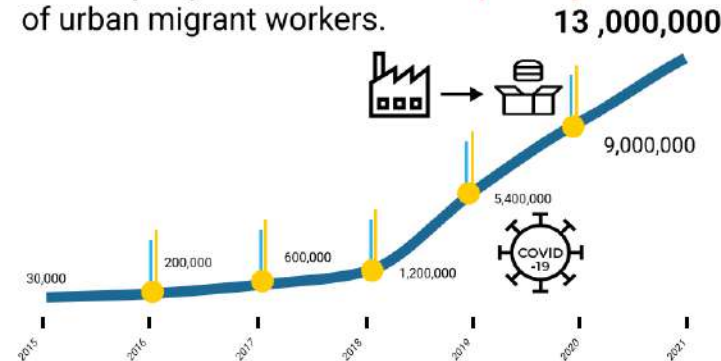
They may also **lack instructions and techniques for delivery work**, like how to use the platform to safeguard their rights and no one to ask for. How can we help novice food couriers better delivery?

ICEBURG MAP



BACKGROUND

At present, there are about **13 million** food delivery workers in China. It is a job with relatively low investment, good returns and relatively high risks. This is the **primary choice** of urban migrant workers.



During covid19, the number of food delivery men increased by **60 million** a year. Factory closures and reduced face-to-face service, making workers poured into delivery industry, resulting in a surge in the number of food delivery workers. Moreover, delivering food is also used by **more people as a part-time job** to increase their income. It is estimated that the demand for delivery men will reach 30 million in the next five years.

Food couriers are a huge group that deserves our attention.

RESEARCH

Distribution of food couriers

Overall, 77% of delievry men come from rural areas, and the riders flow to first-tier cities from all over the country. **Delievry men are mainly in big cities**, with Guangzhou, Shanghai and Beijing accounting for the largest number. However, delievry men on Meituan platform covers 781 out of 832 poverty-stricken counties in China, indicating that delievry work is also a new type of **anti-rural work mode**, distributed in rural towns.



Two types of food couriers

Food couriers are basically divided into two types:

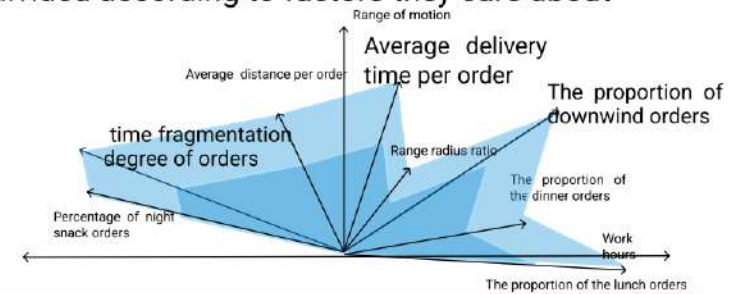
<p>Crowdsourcing courier. With more flexibility and less rules Depend more on their own Longer time to get familiar with delivering work Lower unit price orders, which is harder to deliver Part time</p>	<p>Dedicated courier Takeaway platform employees Station manager to manage the whole group Old master to guide new recruits Higher unit price of orders, which is also easier to deliver Having fixed rules and strict working hours</p>	<p>More than 37% of couriers are crowdsourced couriers who have their own job and choose to deliver food to raise their income.</p> <p>Other income of couriers</p>
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Novice food couriers

Food couriers are a group with **high mobility**. Crowdsourced couriers **are more mobile** than full-time riders because they are less restricted and easier to join. For novice couriers, it usually takes **a half years** to get familiar with the delievry environment and rules. Only after passing through this difficult period can they make profits.

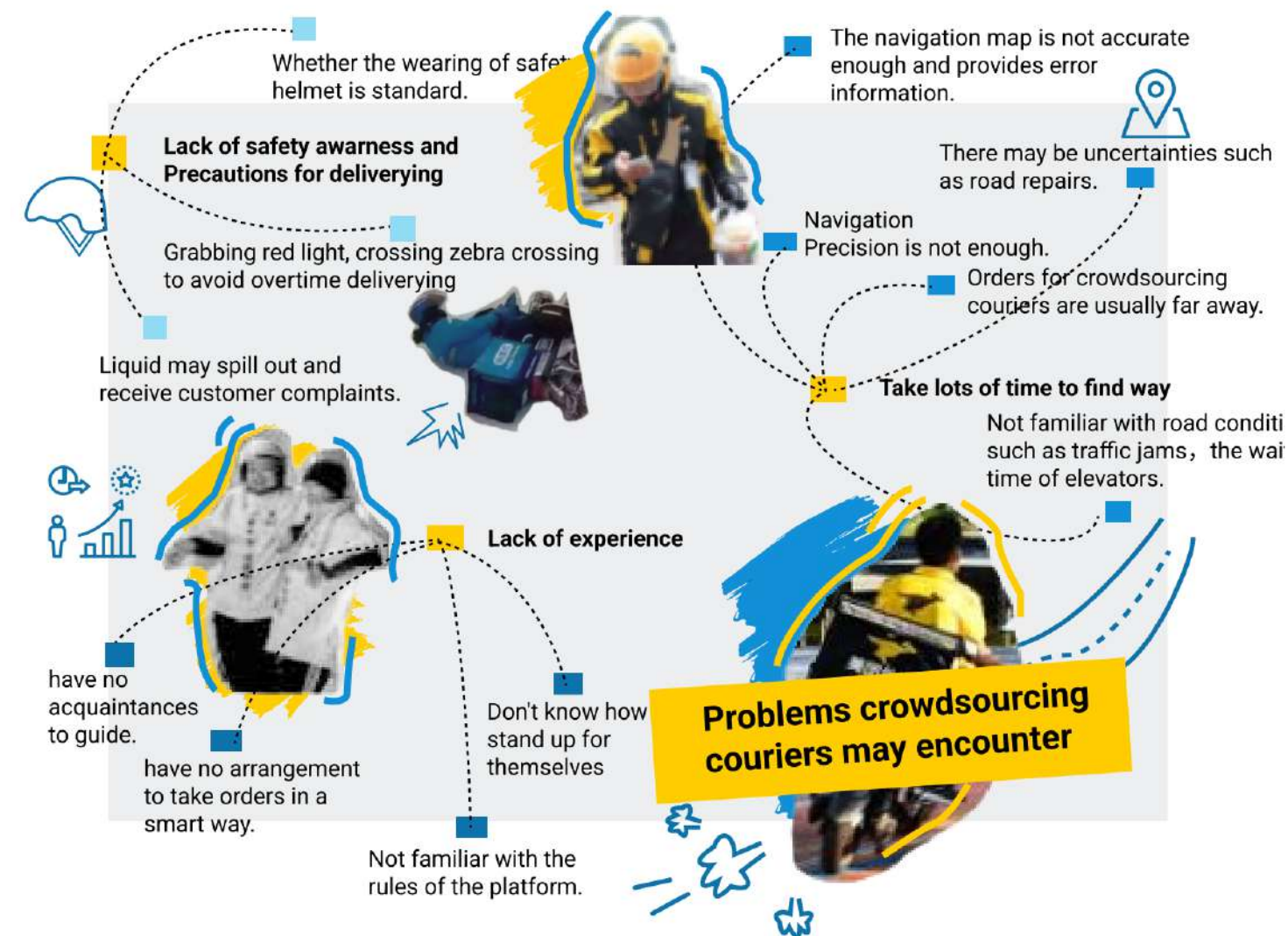
Style of delivering

Couriers' food delivery style has two basic components: time and space. In these two dimensional clocks, there are many factors that they care about. Different types of couriers can be divided according to factors they care about

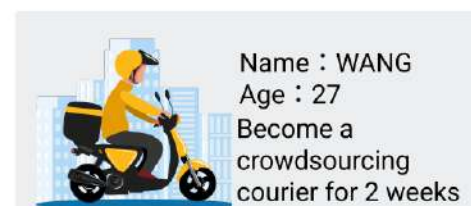


Novice crowdsourcing couriers may encounter more difficulties than novice dedicated couriers, and they are a large group. How can we help them?

MIND MAP



PERSONA



Name : WANG
Age : 27
Become a crowdsourcing courier for 2 weeks

Situations : Crowdsourcing couriers in first-tier cities. Active in areas with **dense population and abundant orders**.

Pain point: The **layout** of densely populated and commercial areas is always very **complicated**, which makes it difficult for novices to find their way. Unfamiliar with shops providing delivery service and some unnoticeable residential areas.



Navigation is not accurate enough in cities, especially in places with tall buildings.

Malls with several districts and has complex layout are difficult to identify the target place.

There are some old residential buildings in the downtown areas, and their house number is not clear, which may bring trouble for delivery.



Name : ZHANG
Age : 26
Become a crowdsourcing courier for 1 week

Situations : Crowdsourcing couriers in small towns, where restaurants and customers are sparsely located

Pain point: As restaurants offering delivery services and customers order food are **scattered**, he can't plan their route properly because they are not familiar with the road conditions



Maps are not accurate enough and may provide incorrect information

Especially in small towns, the location of orders for Crowdsourcing couriers may be remote, and the inaccuracy of maps can lead to the wrong way and even security incidents, especially for beginners who are not familiar with the way

Take orders more intelligently



NAME : XU
AGE : 23
Become a crowdsourcing courier for 3 weeks

Situations: Urban migrant workers, working as factory workers during the day, deliver takeout after work to supplement their household expenses.

Pain point: As **no acquaintances** in the takeout industry, there is **no one to lead**. As a result, understanding the delivery skills and techniques is difficult and slow.

Do not know how to better deal with customers' requests for food, merchants' delay for food preparing, fines imposed by platforms, traffic restrictions and other rules.



Hope to learn different methods for different places, such as hospitals, schools or elevator apartments.

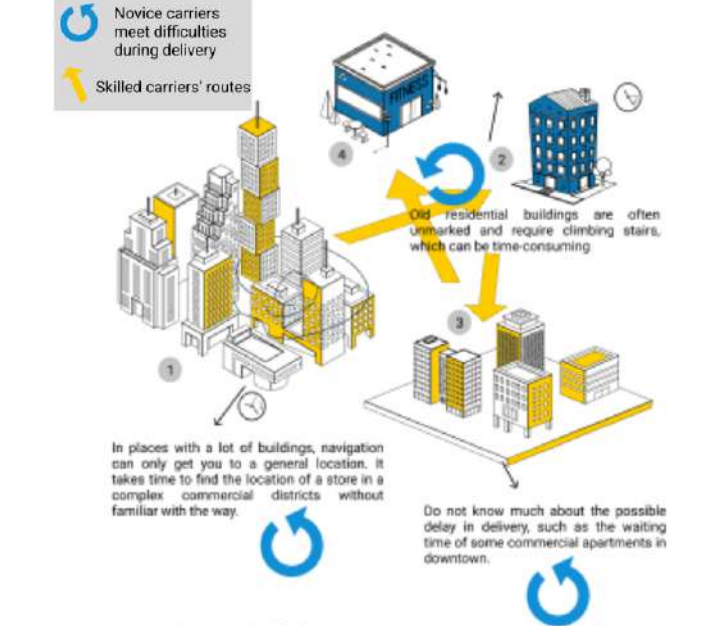


MOVEMENT MAPPING

Crowdsourcing couriers in downtown areas and suburb areas and small towns may have different movement characteristics.

Crowdsourcing couriers' moving map in downtown areas

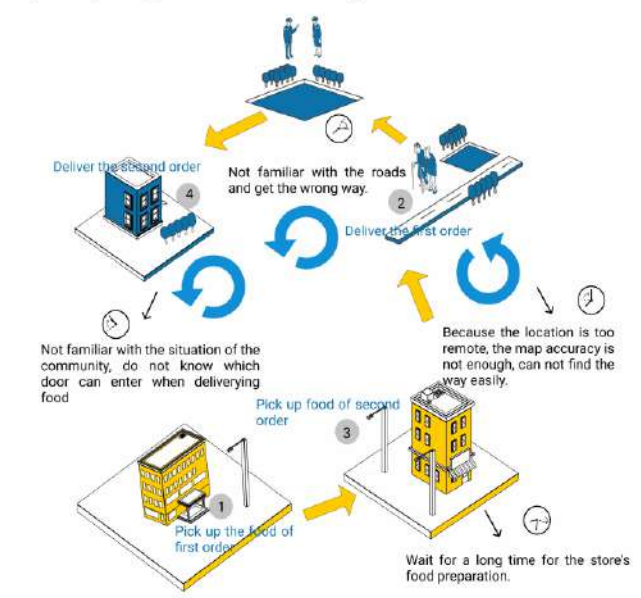
Carriers in downtown areas would frequently ship orders back and forth in a concentrated area



Compared to skilled couriers, novice crowdsourcing couriers in downtown areas are **not familiar with the details of the complex layout** of the distribution area, and are easy to be late. Unable to take advantage of conditions such as long elevator waiting times.

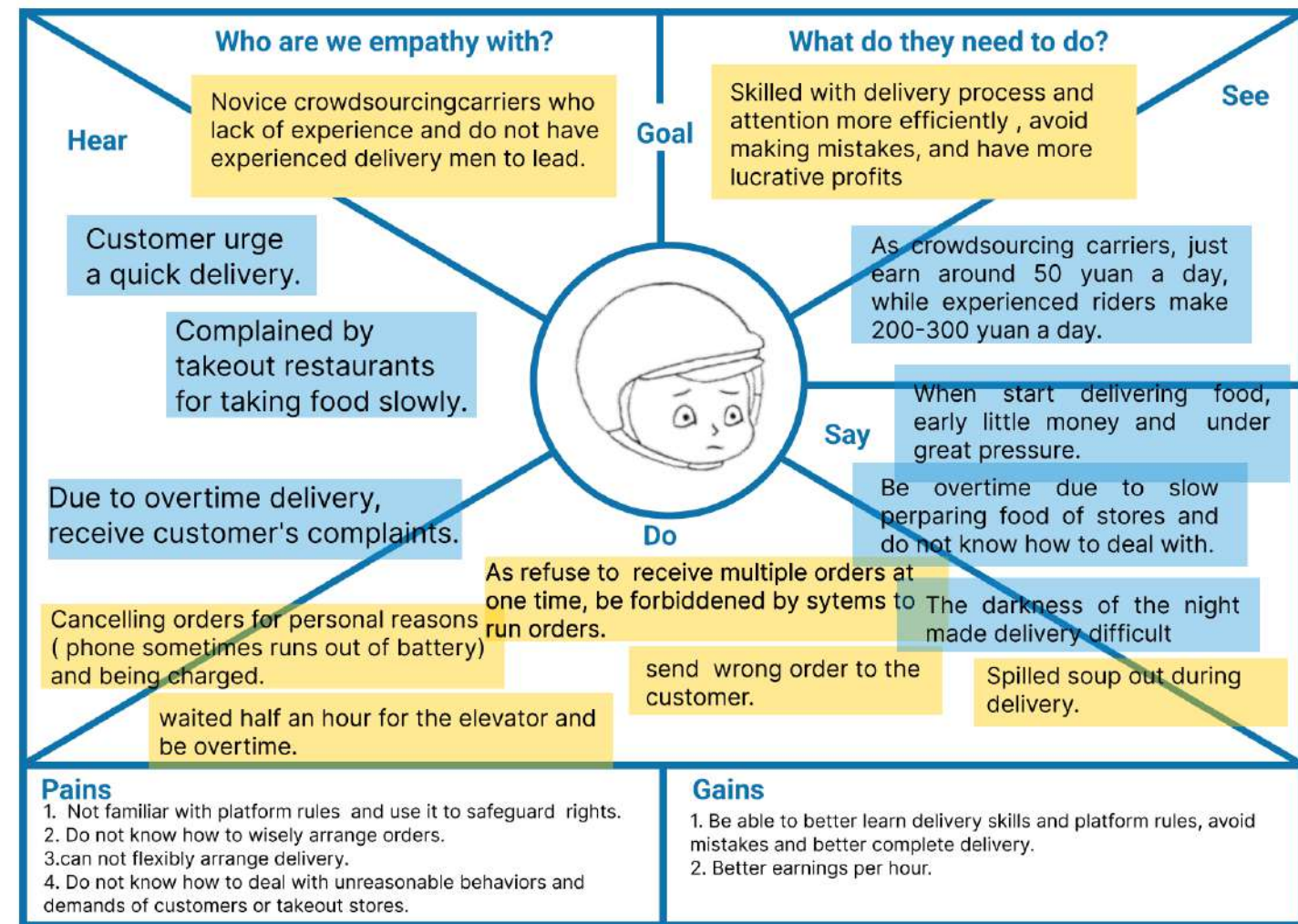
Crowdsourcing couriers' moving map in suburb areas and small towns

The order for carriers in suburb areas are more diffuse, requiring long-distance delivery orders

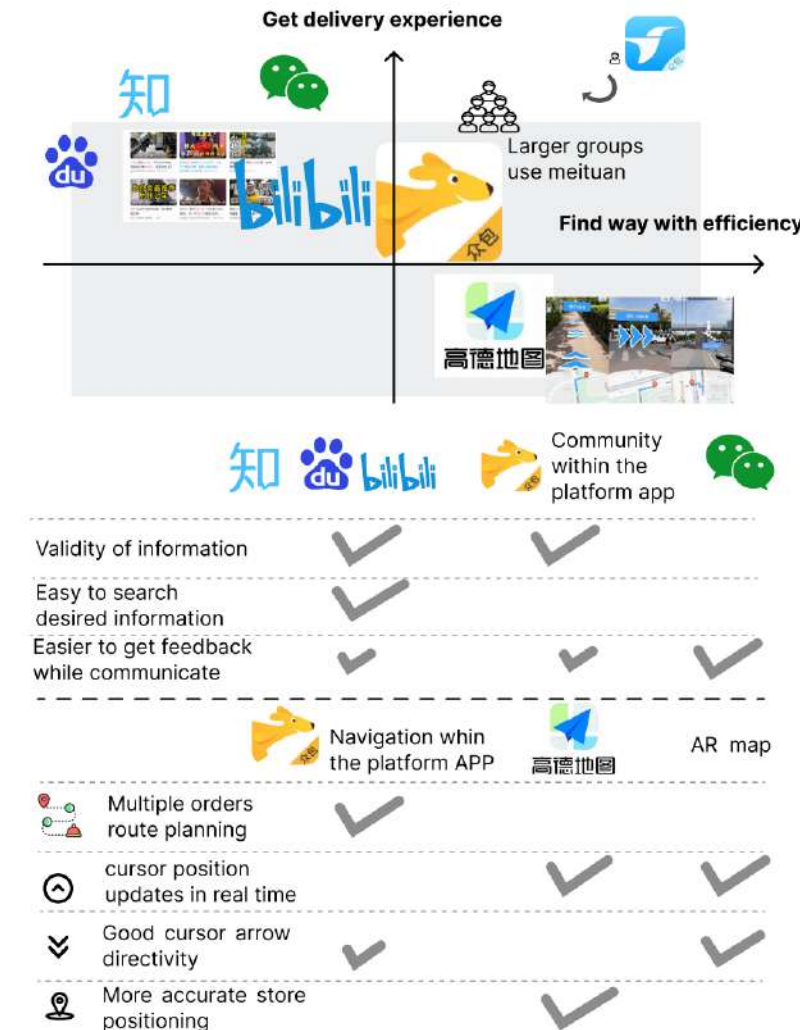


Compared to skilled couriers, novice crowdsourcing couriers are **not familiar with roads and can not take multiple orders at once** and properly **manage their time**, which is the main painpoint of pathfinding for carriers in small towns and suburb areas where customers and food stores are scattered.

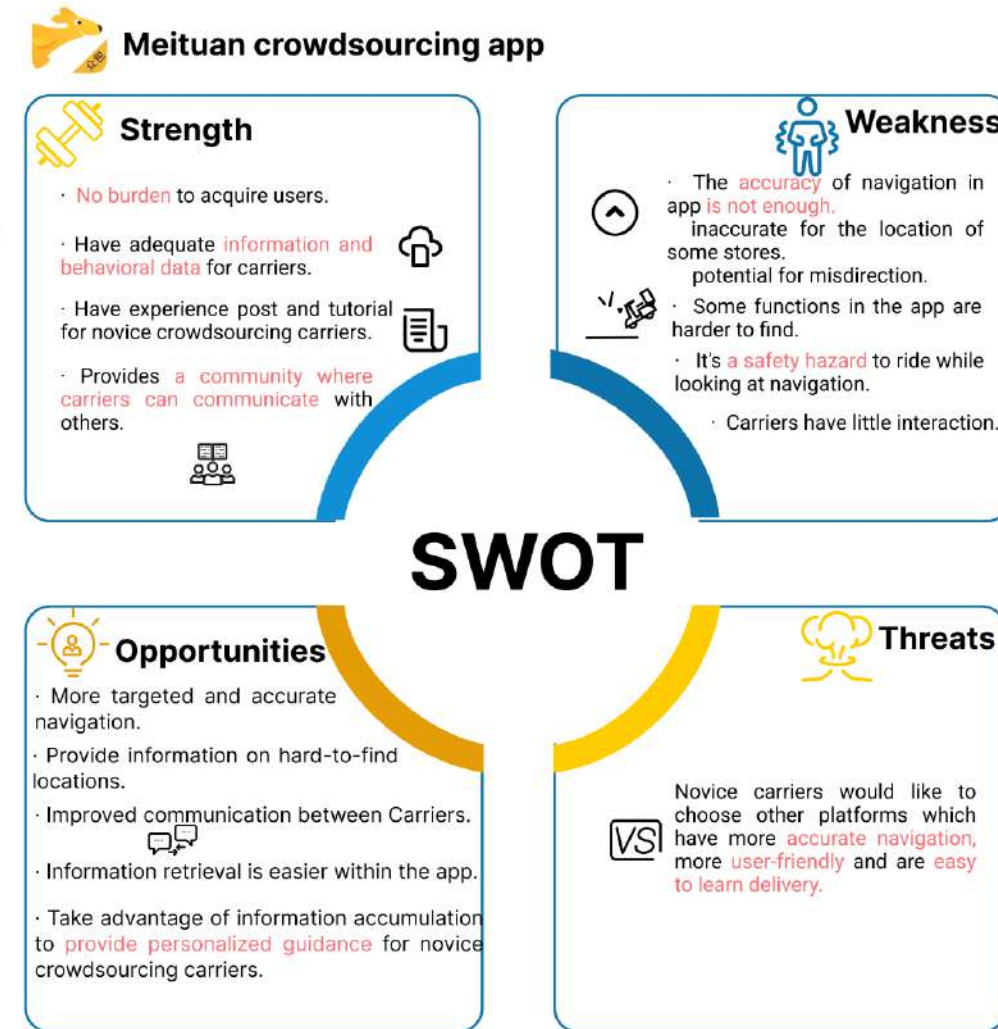
EMPATHY MAP



PERCEPTUAL MAP



SWOT



SUMMARY

Painpoint

Can not find road easily.

Don not know much about the techniques and matters needing attention during delivery.



Novice crowdsourcing carrier



Carriers in downtown area



Carriers in rural area and small town

More easy to find destinations whose map information are not accurate.

More accurate navigation

Better finishing delivering multiple orders at one time

More easy to find destinations with complex layout and lack identification.

Know better about platform rules.

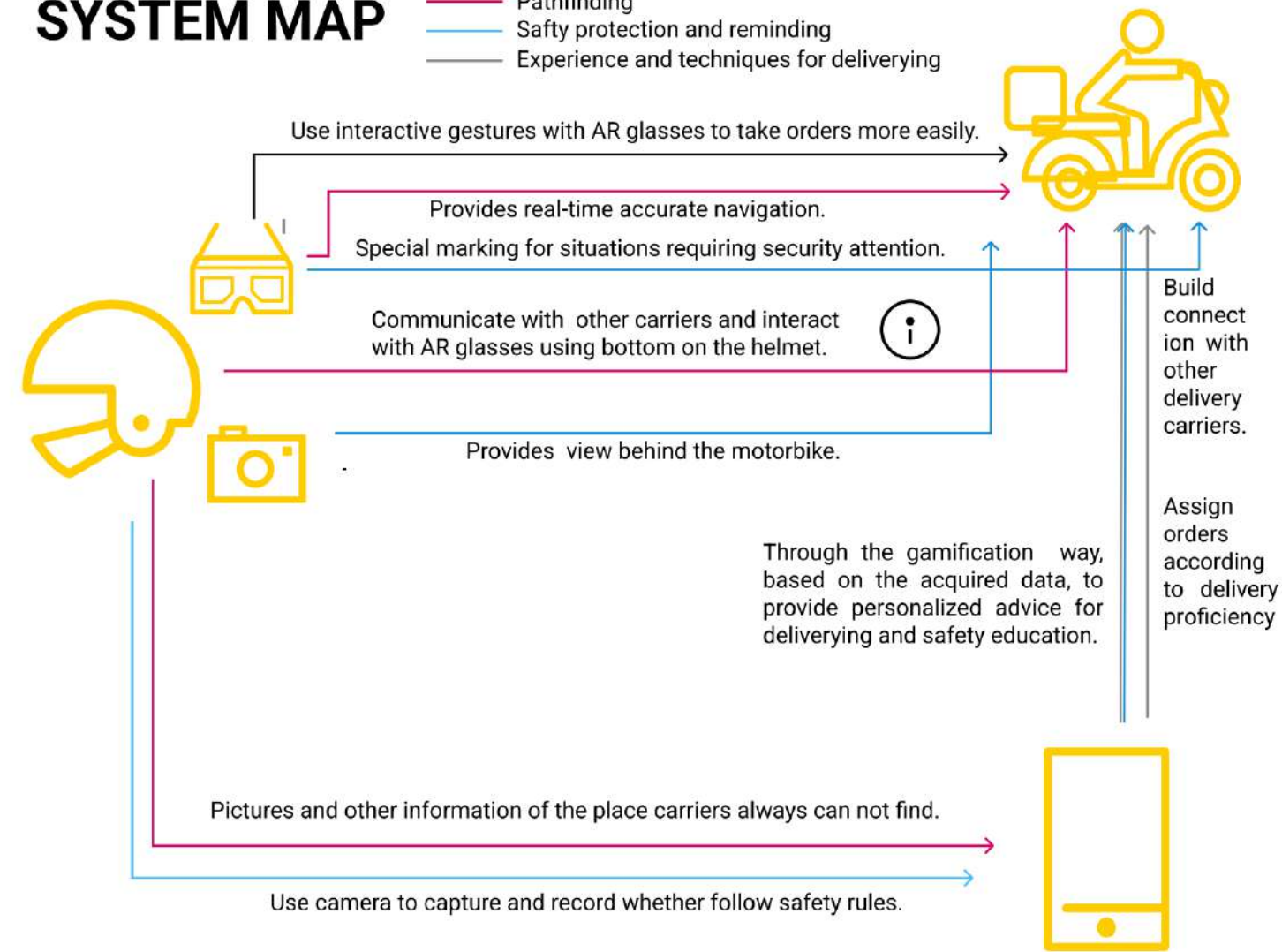
Get delivery experience more smoothly.

Better security protection and reminding.

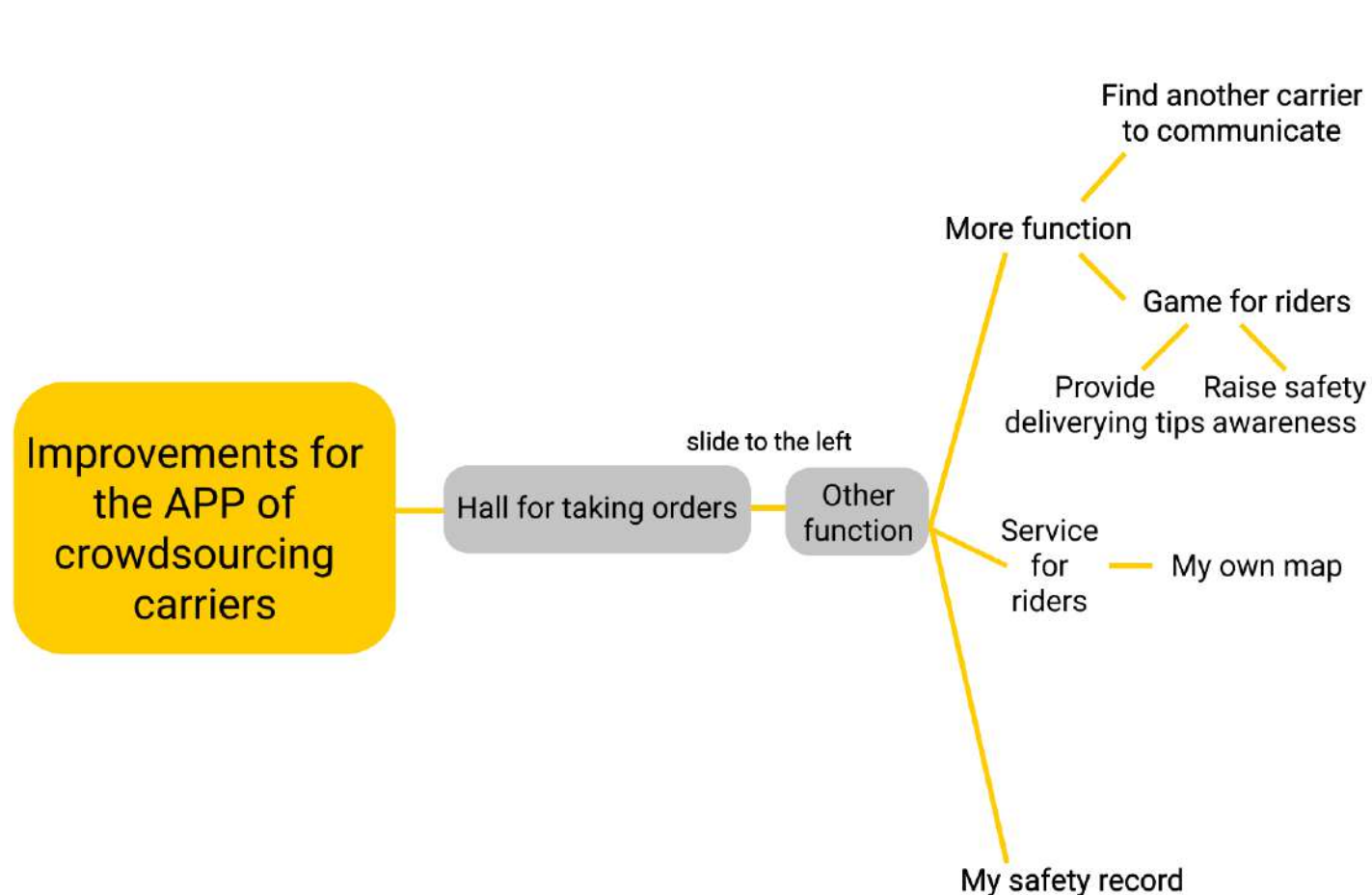
want to get techniques and experience for delivering.

SYSTEM MAP

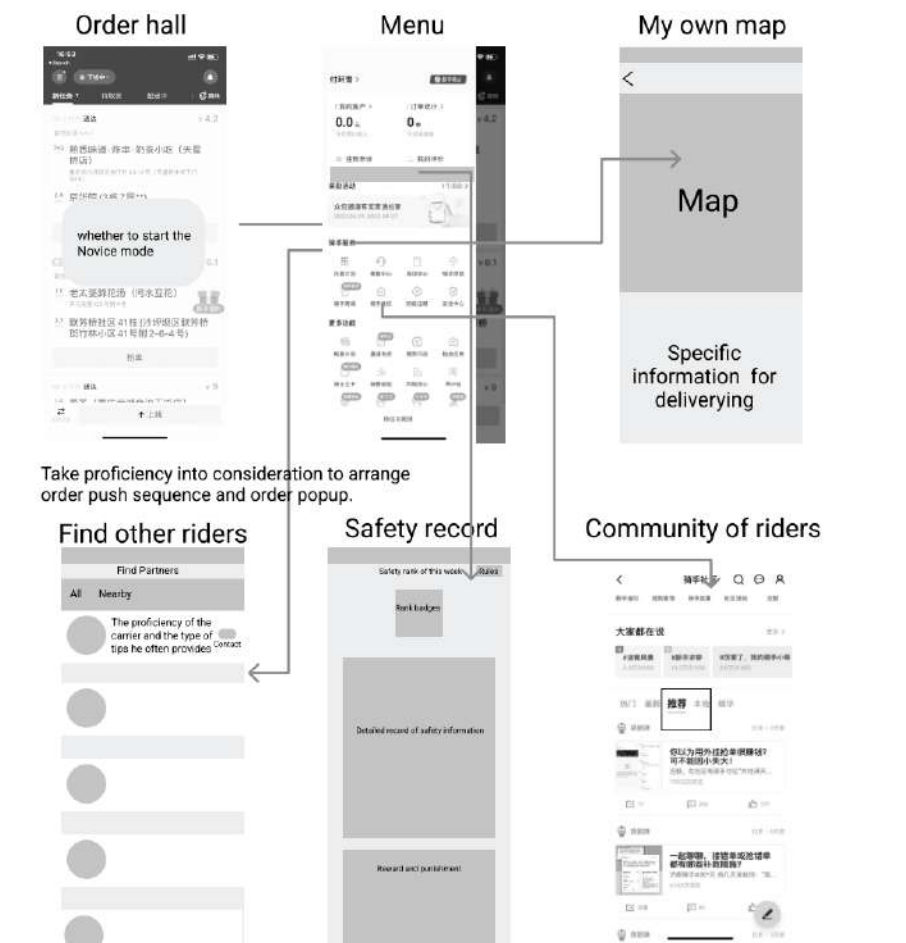
- Pathfinding
- Safety protection and reminding
- Experience and techniques for delivering



INFORMATION STRUCTURE



Low-fi prototype



Moreover, recommendations information are made based on data collected from cameras and behavior tracks.



High-fi prototype



- Carriers can use this function to **connect with skilled carriers, both online and offline to know better about delivery, incentives will be provided** to skilled carriers by platform.
- They are recommended to novice carriers **by skills novice carriers need to improve and the distance between them.**
- The system automatically marks and recommends to carriers' own **frequently visited but easy to go wrong areas.**
- The system also allows carriers to annotate their own perceived considerations by a way of annotation drawing, etc
- Monitor carriers' compliance with safety during delivering by camera and give rewards and punishments are given weekly.

- **A gamified prize answering game.** in the app which crowdsourcing delivery men use is introduced to provide delivery experience and increase safety awareness.
- Carriers get a reward for answering the question correctly and at the same time they get experience and raise safety awareness.
- **By completing daily safety tasks or tasks which can make them more experienced**, the kangaroos can have more tools and add blood to fight against attack from other animals.
- **Carriers could also receive a bonus** if the Kangaroos defeated their enemies

Human factor analysis of helmet design

- 1. Good impact resistance.**
The design combines EPS and EPU's (polyurethane), a new multi-protection foam TauReUp to enable the helmet **have enough strength.**
The shell material should be **as thick and light as possible**, and cushioned.
- 2. Comfort level.**
All dimensions of the helmet design shall be appropriate to the size of the user's head. The main body parameters taken into account are:

- (1) Head circumference: 586mm
- (2) Maximum head length: 195mm
- (3) Maximum head width: 164mm
- (4) Sagittal arc length: 375mm
- (5) Crown arc length: 383mm

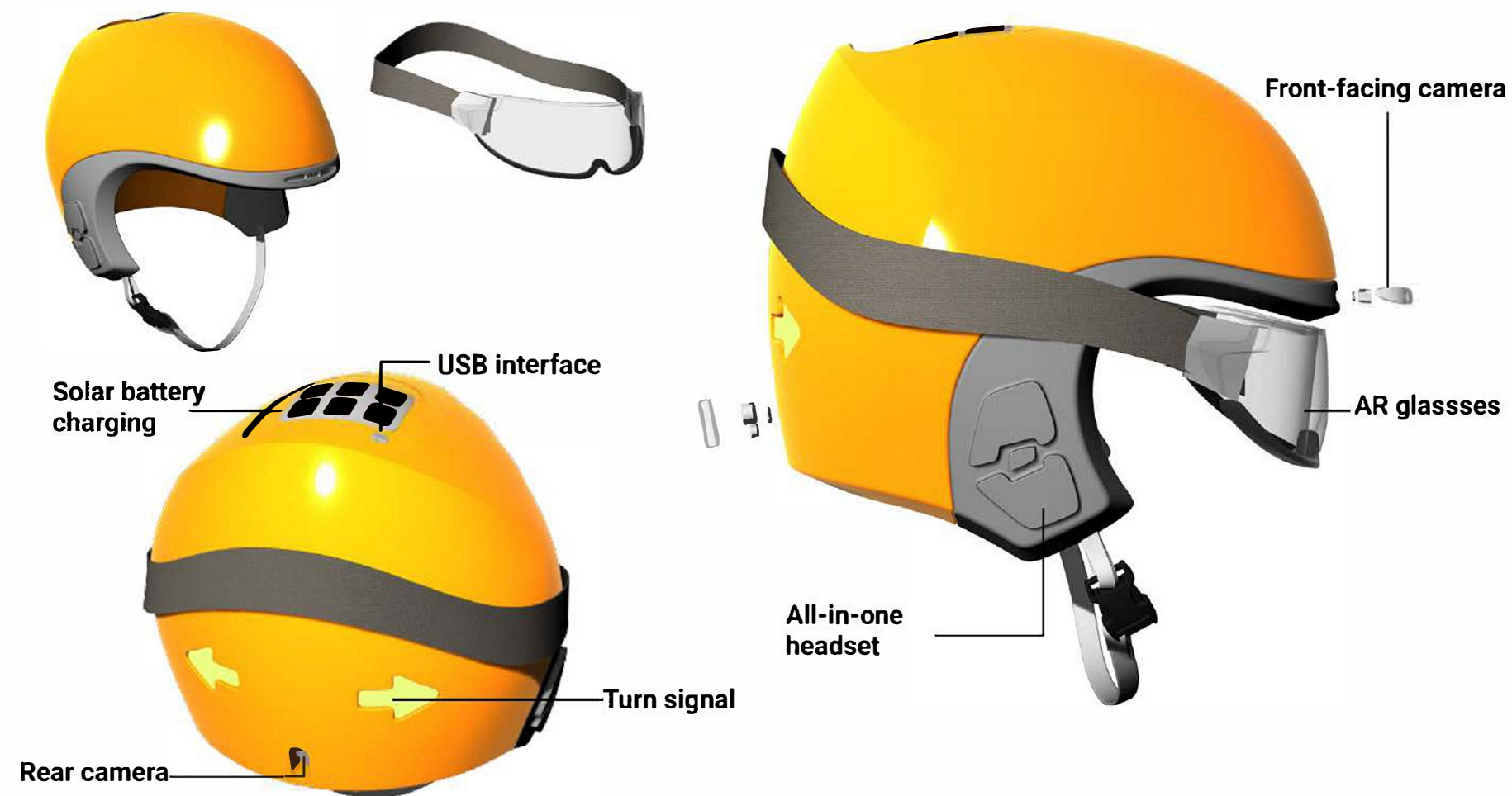
- 3. Wear stability.**
The correct helmet should be worn with the helmet adjusting band crossed about 1.5 cm below the ear. The entire band is secured to the jaw, not the throat, leaving a finger's thickness of about 1.5 cm.

- (1) Head circumference: 586mm
- (2) Crown arc length: 383mm
- (3) Ear base minister: 54mm
- (4) The length of the submaxillary solitary between the tragus points: 321mm

- 4. Broaden your horizons.**
Left and right horizontal field of vision is not less than 105°, the upper field of view is not less than 25°the lower field of view is not less than 45°.

Considerations about human factor size satisfy 95% of male quantile and 90% of female quantile
Data from Head-face dimensions of adults.GB/T 2428-1998

Modeling and rendering

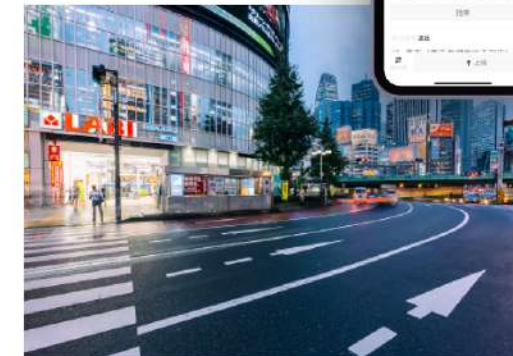


Interaction and scenario

1. Take delivery orders



By pressing the middle button for about 3 seconds to take order quickly.



Order allocation based on carriers' territory and proficiency level.



Novice crowdsourcing carriers in a township may be assigned first to an order whose location is more easily located and then to a more dispersed and isolated order.



Novice crowdsourcing carriers in downtown may be assigned first to a school or a community with a clear layout, then to a complex business district.

Orders that are on their way will be delivered at the same time first, followed by orders that need to be properly routed and timed



More accurate

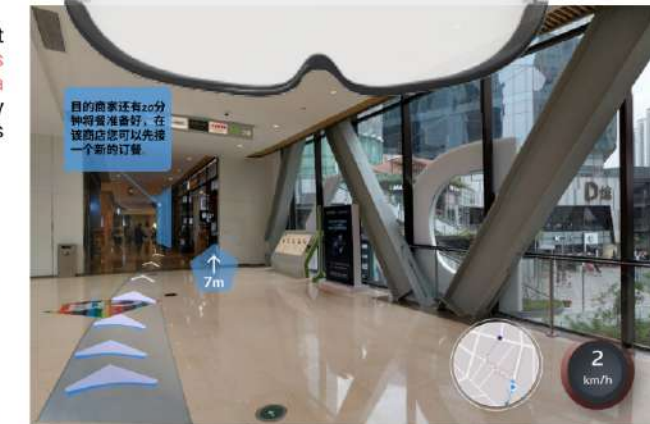
Navigation applications that implement AR use several inputs such as the user's location via GPS, initial camera measurement, and object location. They also track object movement, which makes the navigation of AR more accurate.

More convenient and safe

AR applications can collect detailed data on traffic with live images which saves the carriers' time and allows them to access the best routes and services.

AR applications can highlight and superimpose directions on what your camera sees, along with instruction points for easy readability.

Carriers also won't need to look at their phone during the ride.



2. AR navigation

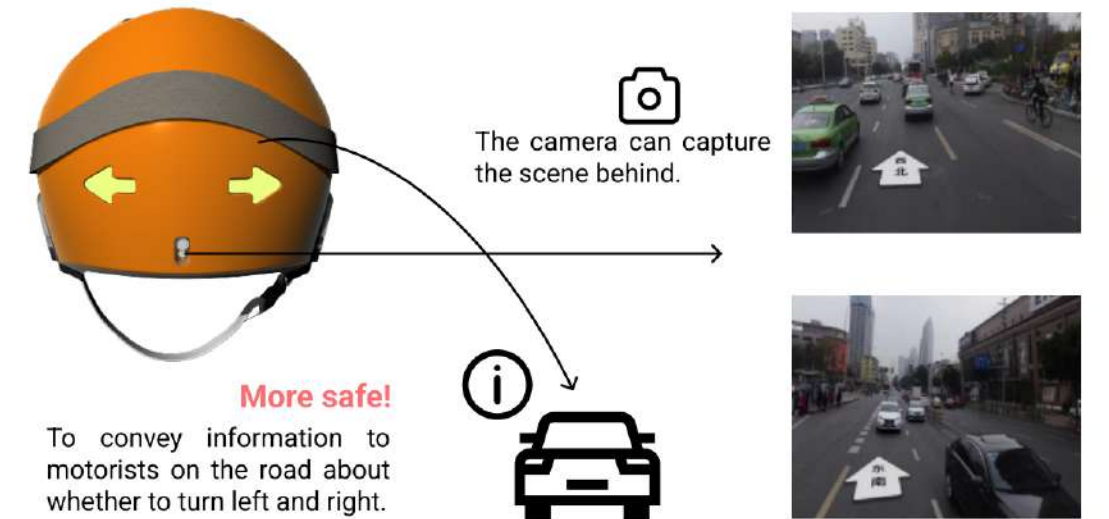
3. Ask for help through headphones



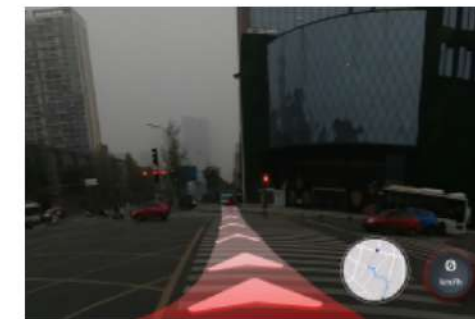
Dial the button to carriers in the hall for emergency directions or delivery inquiries



Dial the user's phone number through the key to notify the finishing of order delivery.



More safe!
To convey information to motorists on the road about whether to turn left and right.



Use color and sound warning for areas need higher safety awareness.



Record violations and Associated with the weekly security ranking in app.

4. Safety warning and recoring

This is a smart city solution concept that connects LV2C, a mobile mobility, to city system to help create low-carbon city and cool city.
 This innovation concept has entered the final of Innovation Competition in Construction Engineering and Management (ICCEM)



A Leaf Vehicle To Cool city, save energy and build self-adaptive city.

2022.3-2022.4 Director: Cai weiguang
 Research System design product design

Team work
 Participated in literature reading, scheme conception and presentation of urban application scenarios

BACKGROUND AND RESEARCH

Cities are leading on climate action and innovation for the world, **but still face significant structural barriers**. In today's transition towards **green and sustainable urban future**, diverse structures within cities co-exist and act in balance to contribute this transition, in which energy infrastructures significantly promote the pursuit for **'cooler cities'**.

1. Mitigate Urban hit island effect(UHI)

What is UHI?

An urban heat island (UHI) is an urban area that is significantly warmer than its surrounding rural areas due to human activities.

What causes UHI?

anthropogenic heat additions, albedo decrease, **storage of heat in infrastructure (buildings, paved areas etc.)**, evapotranspiration, or variations of energy



4 major impacts of UHI

- **Increased Energy Consumption** due to varying heating and cooling costs and emissions associated with generation of energy.
- Elevated Emissions of Air Pollutants and Greenhouse Gases.
- Compromised Human Health and Comfort.
- Impaired Water Quality.

3 main ways to mitigate UHI and cool city

- Design and build buildings with less energy and passive climate control.
- Use white paint to reflect heat (expensive but cools).
- The roof is transformed into an urban garden. Use the tree canopy to cool off.

Current measures to mitigate the heat island effect are costly, less adaptable and less mobile.

UHI effect will consume a lot of energy. Is there any energy-saving way to cool city.

2. Decarbonization-reduce carbon emission and use of low carbon power sources

What is decarbonization?

Decarbonisation refers to the process of reducing carbon dioxide (CO₂) emissions resulting from human activity in the atmosphere. The current (and optimistic) objective of decarbonisation is to, eventually, eliminate our carbon dioxide emissions.

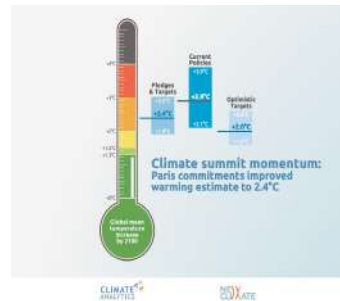
In practice, **getting to zero net emissions** requires **switching to clean energy sources** and **shifting from fossil fuels to electricity**

Why is decarbonization so urgent?

According to the World Economic Forum, **full decarbonisation of our energy systems is the only solution** to climate stabilisation.

Now, we are already **lagging behind targets set in 2015**, and our current policies would, in the best-case scenario, lead to an increase of 2.1 °C and, in the worst-case scenario, to a rise of 3.9 °C

With a 3 °C increase (the current average we're heading towards if we don't change our ways), cities like Miami, Shanghai, Osaka or Rio de Janeiro **would sink underwater**. Additionally, a total of **275 million people** worldwide would need to **relocate and escape the flood**.



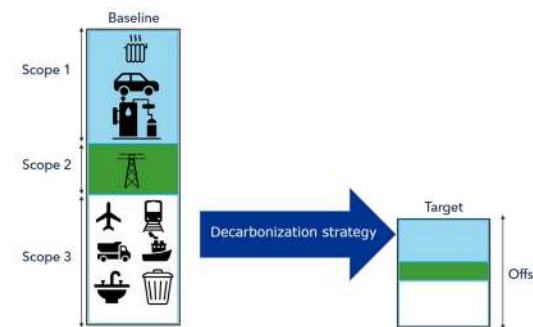
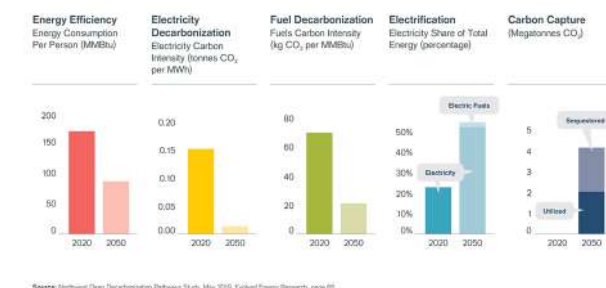
How can we achieve decarbonization?

- Energy efficiency: reducing energy consumed to provide an energy service.
- Electricity decarbonization: reducing electricity generation emissions intensity.
- Fuel decarbonization: reducing the emissions intensity of liquid and gaseous fuels.
- **Electrification: switching end uses from fossil fuel to electricity.**
- Carbon capture: capturing CO₂ from a facility or removing it from the atmosphere.

As for cities:

- Urban energy, transport and building infrastructures are gradually becoming greener.
- There are **more electric vehicles** on city streets.
- Better water treatment and recycling schemes, and more solar panels on rooftops around the globe.

Five decarbonization strategies.



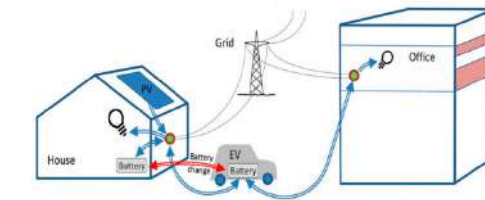
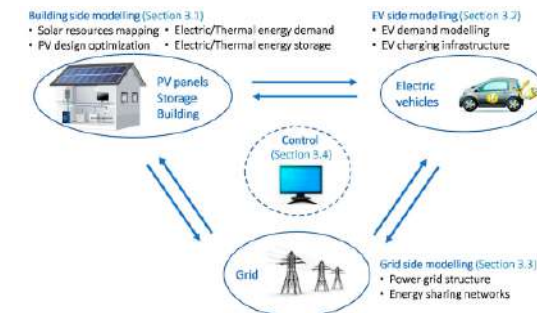
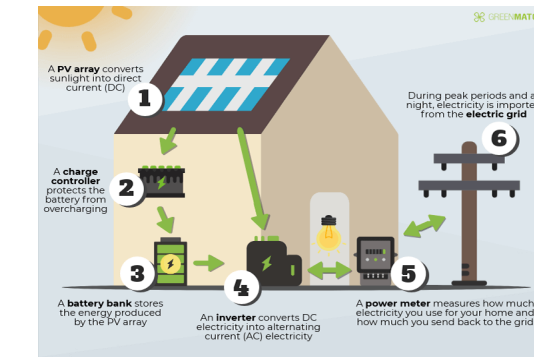
When renewables meet e-mobility

As we increasingly rely on renewables and low-carbon emission energy sources to power our cities, factories and vehicles, a new problem arises: How can wind turbines **produce energy when there's no wind?** How can our solar panels **meet sudden demands of energy during the night?** Part of the answer lies in how we **store energy** and **loop it back to the grid** to ensure a secure and constant flow.

Cities' electricity needs to be more flexible to reach decarbonization.

PSDF—Solar photovoltaic, Energy storage, Direct current and Flexibility

This concept and the establishment of the PSDF system is mainly to think about how the building as a part of the city can **help the building, the city better achieve flexible electricity allocation**, in order to achieve energy conservation and decarbonization of buildings and cities. In addition, this system makes innovation in the exchange system of **solar energy, household appliances and electric vehicles**. It has already landed on some buildings and the system's implementation in a digital park has reduced carbon emissions by **210 million tons**, equivalent to planting **290 million trees**.



New energy vehicles make great contribution to decarbonization, but charging piles are not enough



Road transport, in particular, is the **"chief culprit" of carbon emissions**. Transportation, which accounts for **28%** of U.S. greenhouse gas emissions, is more than electricity production or industry. So the car industry plays a key role in achieving carbon neutrality. The development of **new energy vehicles** will also help achieve carbon peaking and carbon neutrality ahead of schedule. While electric cars are greener, electricity needs to be generated from cleaner sources, with less coal.

However, as the sales of new energy vehicles exploded, the number of charging piles increased disproportionately. Additionally, most charging piles are private ones installed in residential communities, with only **an average of six to seven vehicles per common pile**.

A broader urban scenario should be integrated by optimizing the energy relationship between different urban sectors.

Making cities cool usually means consuming more energy, how can we cool city and mitigate UHI while saving energy and reducing carbon.

*Cool city and mitigate UHI: Can it be more flexible and time-sensitive?
Saving energy and reducing carbon: Electricity consumption in cities and buildings is better regulated, and charging of new energy vehicles is more convenient.*

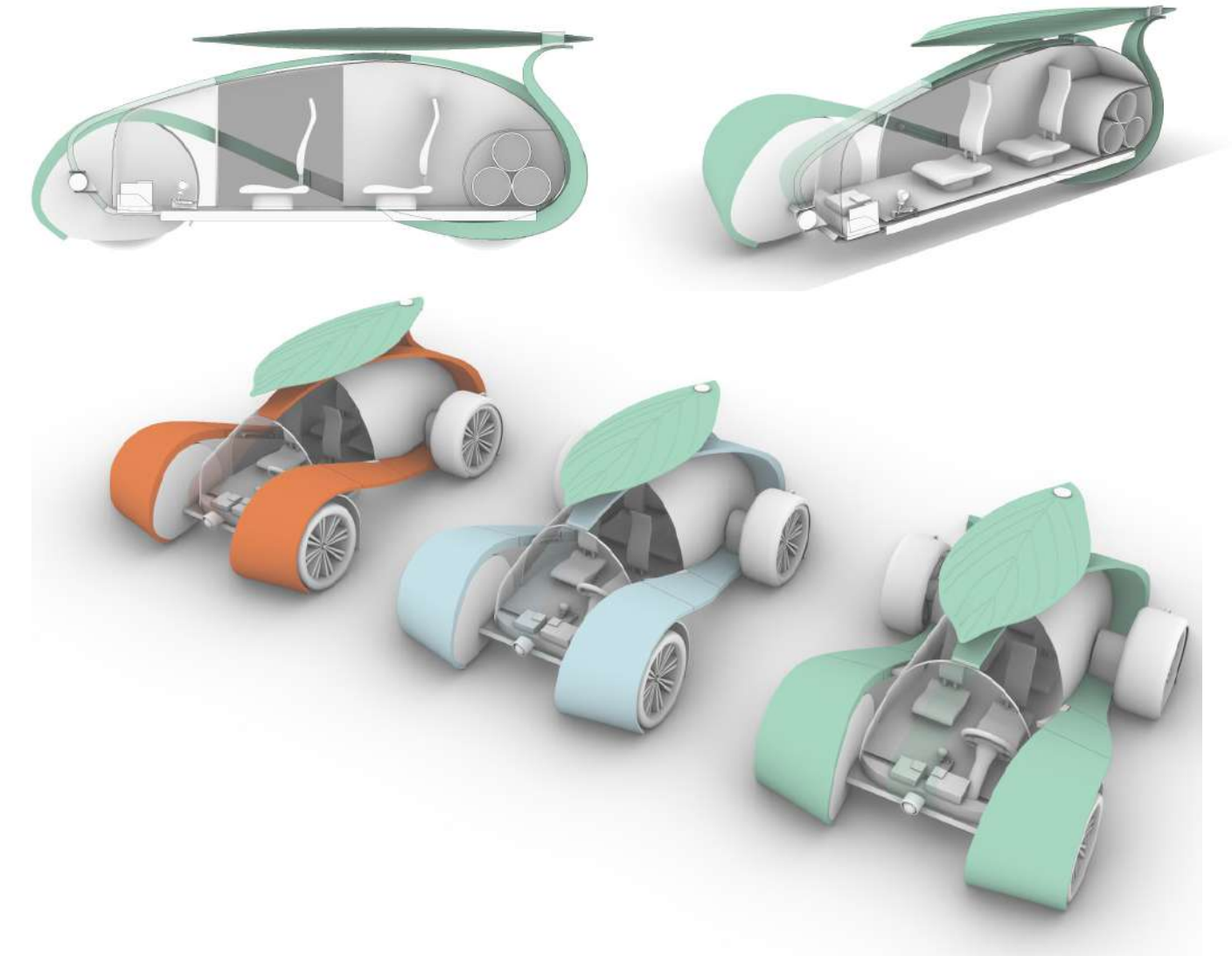
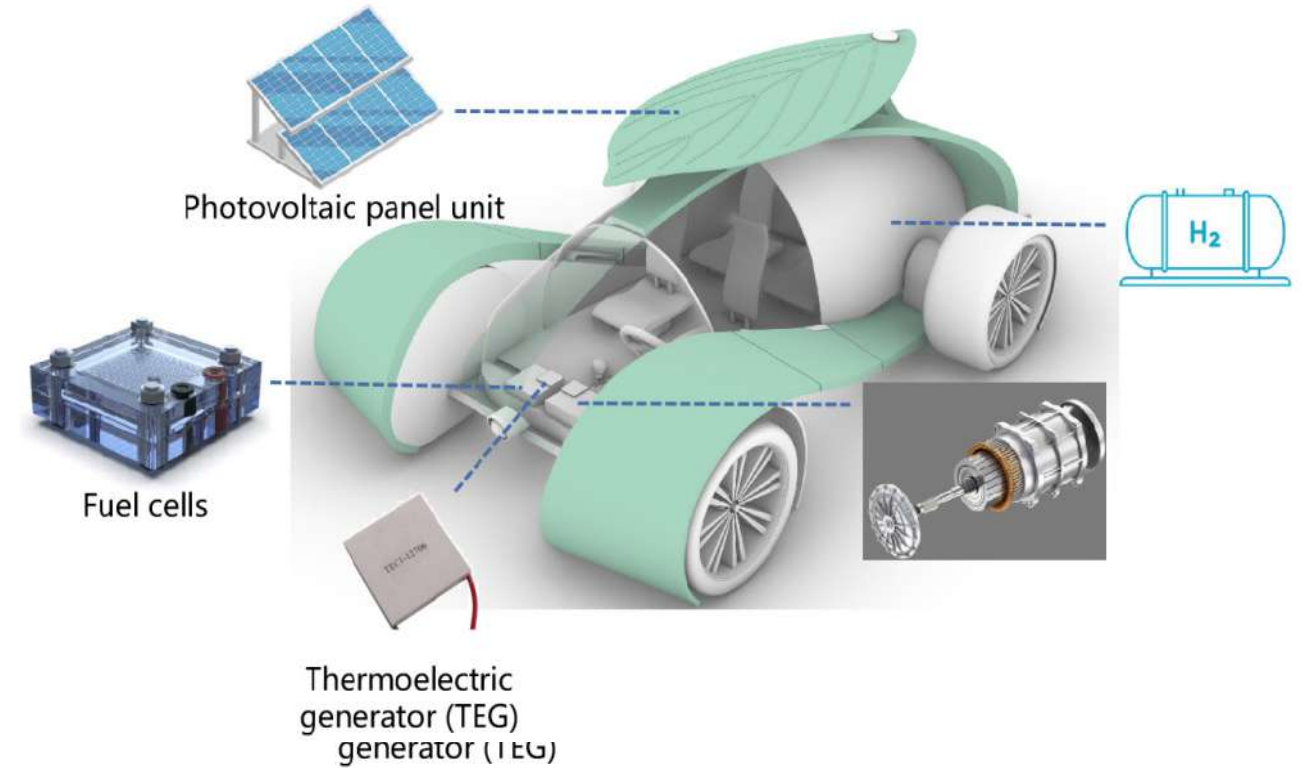
Design

1.Name and slogan:

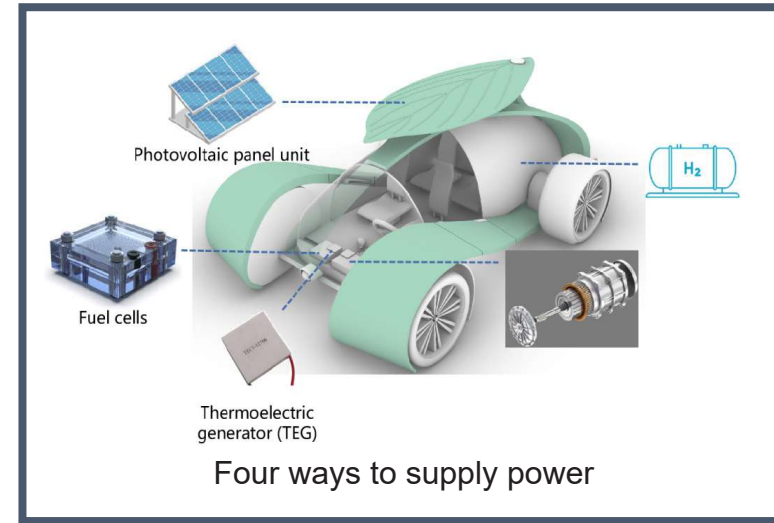
Leaf Vehicle to Cool City (LV2C)

Revolving around the leaf-shaped vehicle, we try to make contribution to cool the city, to mitigate the heat island effect, and also optimize the energy transition within urban system.

2.Design appearance



Detailed design of LV2C and energy transition pattern



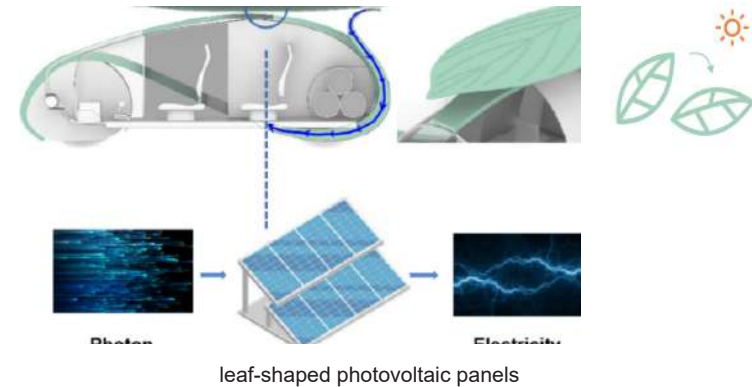
six working modes of LV2C

- Pure electric mode
- Charging mode
- Regenerative braking mode
- FCS + power battery driving
- Pure FCS mode
- Parking charging mode

Pure electric mode indicates that when the power demand is large, the fuel cell and power battery are supplied simultaneously. **FCS + power battery charging mode** refers to the output of fuel cell to charge the power battery and provide power output to the driving motor through the inverter when driving normally. **The pure FCS mode** refers to that only the FCS system provides energy to drive the vehicle, and the power battery is neither charged nor charged.

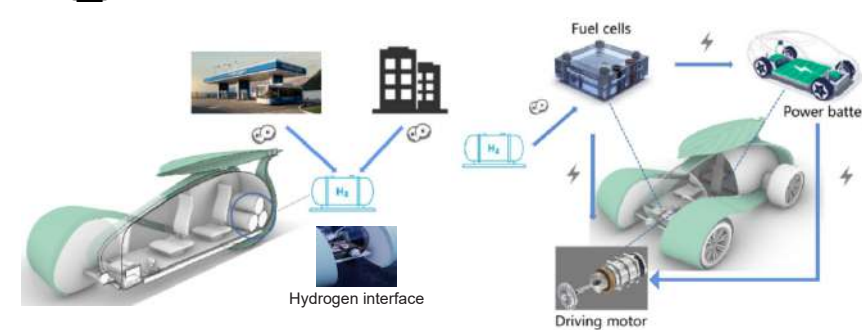
Solar To Electricity (The leaf-shaped surface layer)

The leaf-shaped photovoltaic panels cover its whole roof and hood to charge the car, whenever there is light radiation on the top. Each panel unit will **adjust its angle according to different illumination angles** to ensure efficient light absorption. The photovoltaic panels on the roof and side of LV2C body can absorb solar and light radiation to generate electricity **without pollution and greenhouse gases released**, which can **be stored** in the battery of the car, saving lots of electricity for charging the car.



LV2C, with 5 m² of photovoltaic panels, can add about **96 km driving capacity** by stalling for **8 hours** in sunny days. When the electric energy runs out, the photovoltaic energy storage **can continue supporting the car** to drive for a long time without recharging.

Hydrogen to Electricity (The Hydrogen tank and fuel cells)



Equipped with **three identical hydrogen storage tanks** (Figure 4), **52.2 L in volume**, the hydrogen storage capacity of the LV2C is significantly enhanced.

The **waste electric energy in the building** will be used to **electrolyse water to produce hydrogen**, and stored in hydrogen storage tanks to recharge hydrogen for vehicles. Also, LV2C can be hydrogenated from hydrogenation stations.

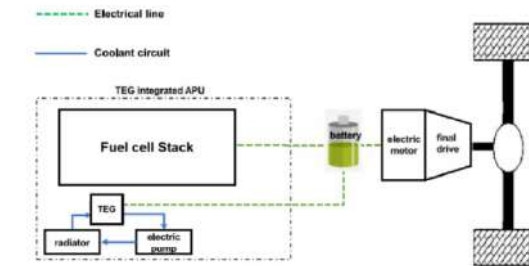
The LV2C transmits electric energy to the driving motor through the fuel cell. Hydrogen and oxygen react in fuel cells, produce electricity and heat, and transmit electricity to motors and batteries. The whole process realizes zero **emission without pollution**.

Heat to Electricity (Thermolectric generator)

The thermoelectric generator (TEG) has been identified as **a reliable solid-state technology** for power generation.



The heat energy transferring from the hot engine muffler surface to the cool side of TEG surface activates the motion of electrons and holes. When the fuel cell is activated, the generated **waste heat can be used for battery charging**. To recover the waste heat from fuel cell stack (FCS), the TEG needs to be integrated with a cooling circuit, acting as a cold sink for the heat rejected by TEG cold junctions.



The regenerated electrical power from TEG are stored together in the battery. A new TEG integrated auxiliary power unit (APU) is shown in Fig 7. The heat recovery system can absorb most waste heat and improve the power generation efficiency of hydrogen fuel.

Power battery

The battery pack has a capacity of 1.56 kW.h and is made up of four modules and 64 cells. When the vehicle load is low, the power battery can be utilized to power the drive motor, and the fuel cell stack can be charged to the power battery by generating energy. The power battery aids the fuel cell in meeting the vehicle's high acceleration power need.

Application scenarios of LV2C

1. Associated with building

Team leading by Jiang Yi of Tsinghua University proposed PSDF building power distribution system. (introduced in the background).

When the owner is at work, LV2C parking near the building can be used **as a building battery to charge and discharge**.

In order to cooperate with the development of light storage flexible system, LV2C is **equipped with power conversion system (PCS) + battery**, which can realize bidirectional charging between vehicles and buildings. The bidirectional energy conversion can support the power grid, ensure stable operation of the power grid system, and provide functions such as short-term shock resistance, smooth power supply, energy storage, peak shaving and valley filling.

Our **Energy Tree** and **Energy charging underground garage** will serve as a medium for energy conversion and exchange.

Energy tree

Function: **Absorbs light energy and converts it into electricity** to charge LV2C.

At the same time, as **a charging and discharging medium for buildings and vehicles**, it contributes to the **flexible electricity consumption of cities**.

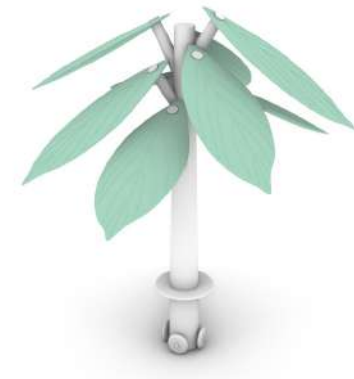
Venticooler

Heat release into a well-ventilated area disperses this heat, reduces the concentration of heat and also decreases the immediate local impact, thus decreasing the UHI effect. It can be charged by buildings or venticooler.

Function: Cool and ventilate the surrounding environment.

Energy charging underground garage

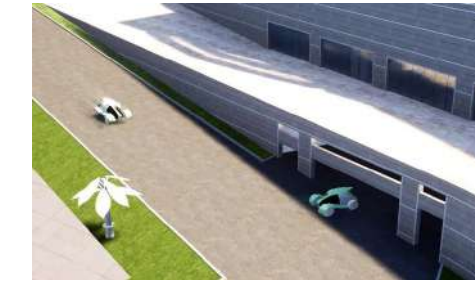
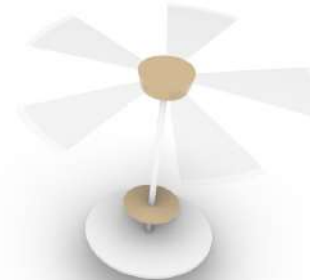
Function: Provide **electric changing service** for electric vehicles and serve **as charging and discharging medium** between LV2C and buildings.



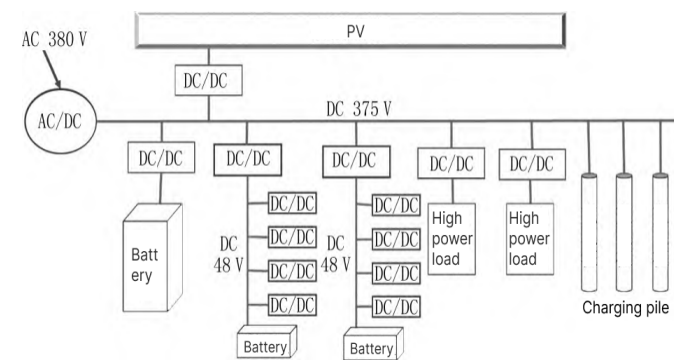
Energy tree



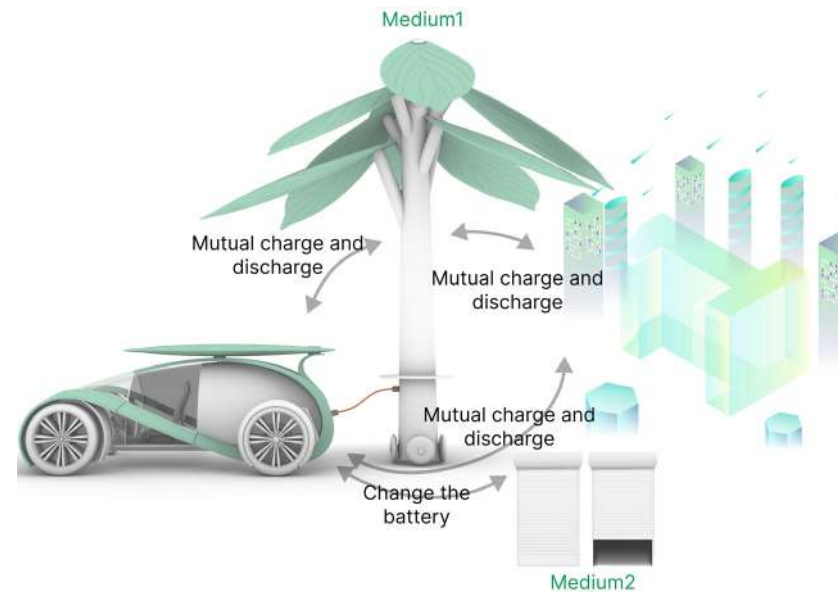
Venticooler



Energy charging underground garage

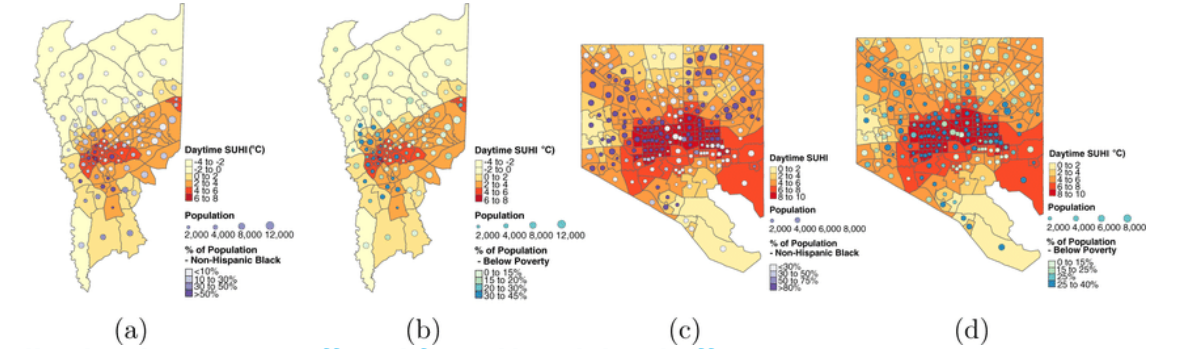


PSDF building redischarge framework



Building vehicle energy exchange system---Cool charging station

2. Associated with Surface Urban Heat Island (SUHI) Mapping

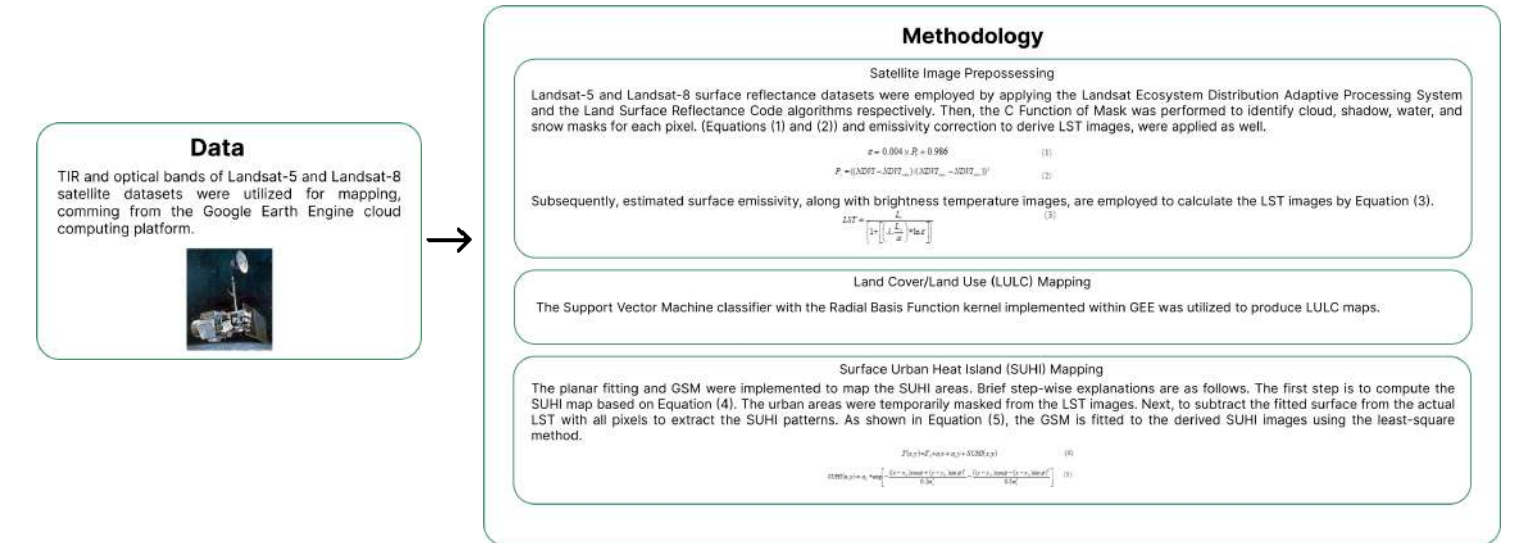


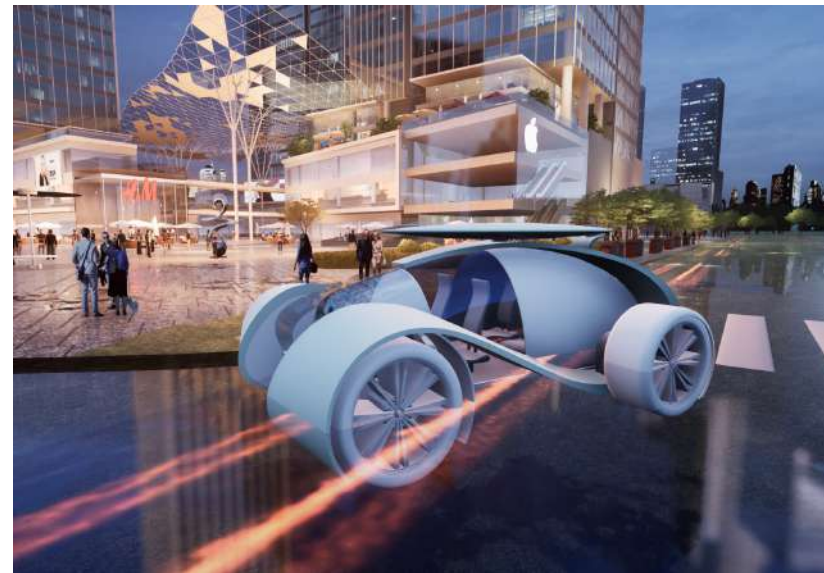
Identify district that most suffered from Heat island effect

- Venticooler is arranged in areas with severe heat island effect in long-term to relieve heat and cool city.

- Real-time heat island effects are used for LV2C path planning and will be discussed in detail later.

The way to form SUHI mapping



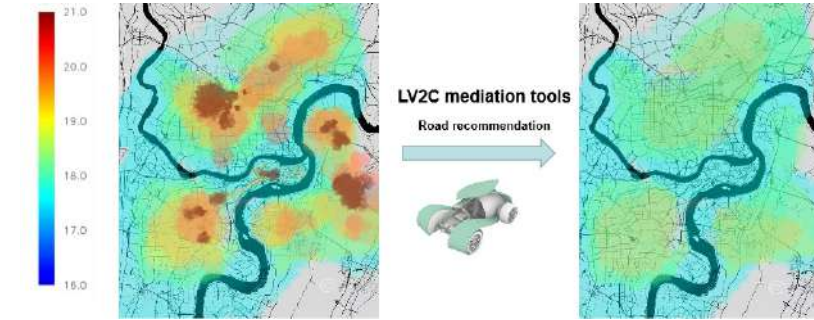


3. Associated with Urban service

Road recommendation towards dynamic heat balance

An increasing amount of vehicles from the road generate heat. Therefore, reducing the number of vehicles is a direct approach to reducing heat production, which mitigates UHI. Reducing traffic to **areas with high heat island effects or congestion** is a sensible way to mitigate UHI.

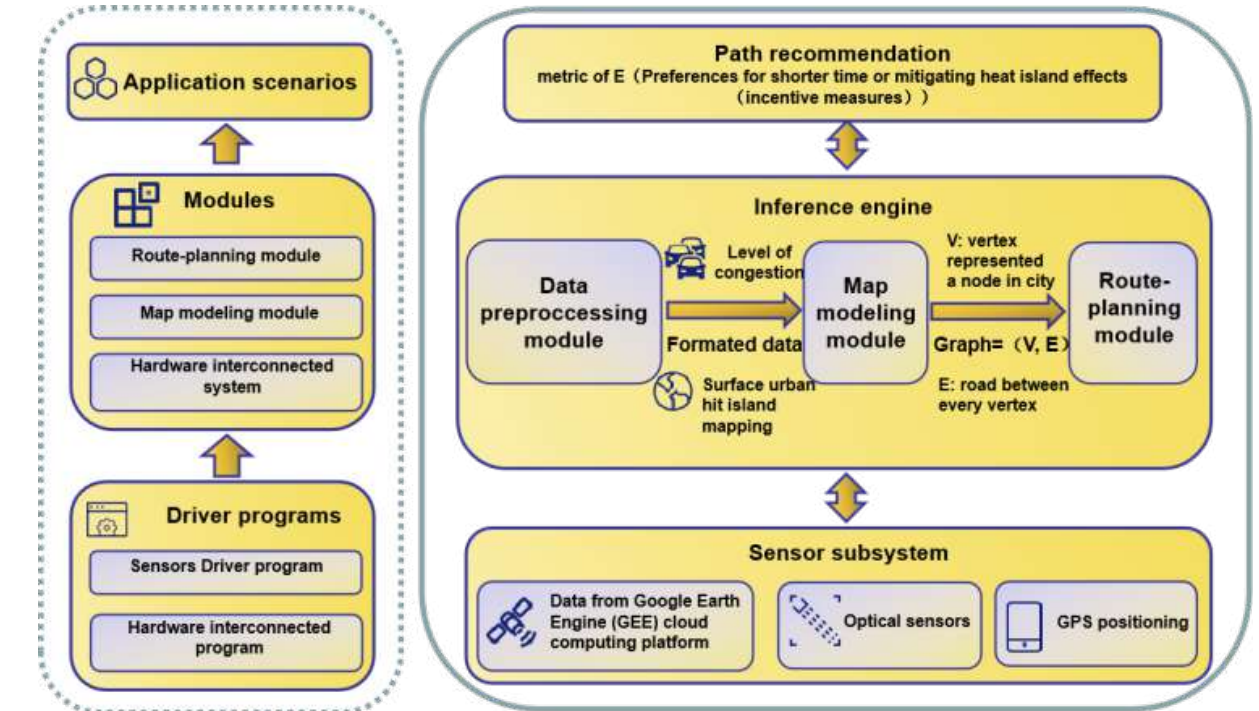
The purpose of road recommendation to mitigate heat island effect here is to **avoid excessive local heat** in our city which may bring many problems not only to people but also the whole city, so that the heat in the city tends to **a dynamic balance**.



Avoid excessive heat accumulation by LV2C



The road choosing interface of the LV2C



Algorithm framework for path recommendation

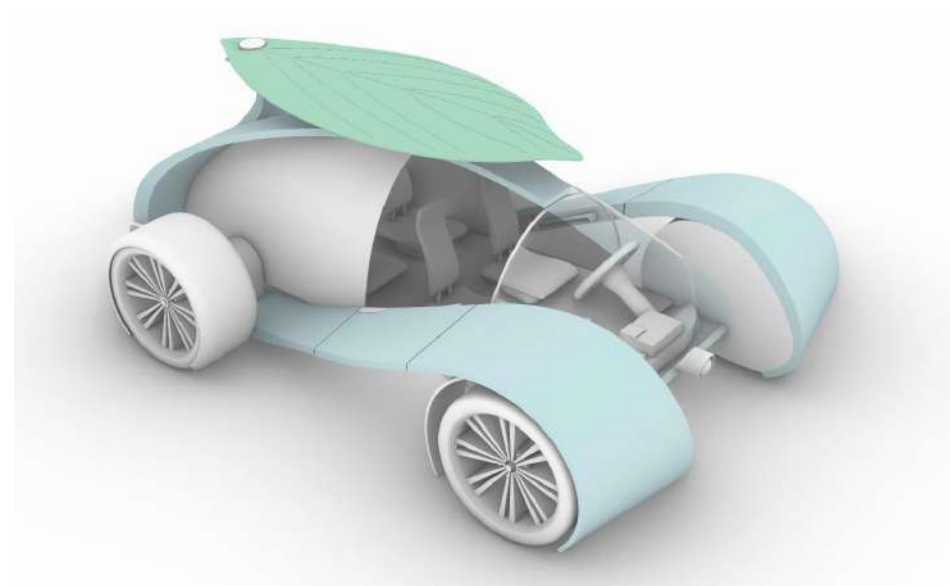
Self-Organized Traffic Control

Sensors in LV2C not only detect the external and thermal environment (temperature, moisture, CO2, etc.) It also involves the **geometric perception of the car like computer vision**. It works as a virtual traffic light protocol that can **dynamically optimize the flow of traffic** in road intersections without requiring any roadside infrastructure. It can also inspect the surrounding car to **avoid car-to-car collisions**, prevent unnecessary congestion, **recognize and sense the surrounding cooling charging station**. Vehicle-to-vehicle and vehicle-to-roadside communications architectures will act in balance to provide road safety, navigation, and other roadside services.

Searching for the Cool Charging Station

LV2C carries **the convenience and intelligence of the IOV (Internet of Vehicles)**. Each vehicle is like a node on a network, capable of recording its location on the map in time. With the organic integration of timely record and map, it can **match the nearest Cool Charging Station in real time** according to the battery capacity information, helping users to quickly go to the destination and carry out energy recharge, repair and replacement.

Public service-- logistics services



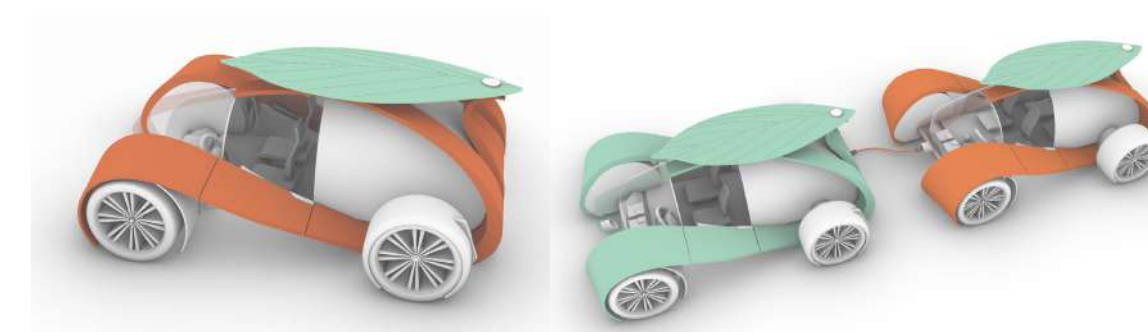
Blue LV2C are used for public services like logistics services. Logistics services are mainly divided into **daily logistics** and **special logistics**. Daily logistics is to help city residents to **carry out physical transportation**, such as take-away, letters, parcels, garbage transportation, etc. And special logistics is mainly to **cope with the current epidemic-ridden environment**, which can be used to transport medical specimens, medical devices, nucleic acid sampling, etc. to ensure fast, sterile and contamination-free.



Mobile charging service

Energy replenishment is a problem for many users and can only be done in specific locations or garages. LV2C has a mobile charging car that **can charge vehicles anywhere**, anytime to keep them going. For the shortest amount of time, LV2C allows users to **get the longest driving time**.

Mobile charger car can also be used in **emergency situations**, such as rescue and other medical fields.



Orange mobile charging and emergency rescue LV2C

Click the link to watch video of LV2C:
<https://youtu.be/96MQJ8oKwCQ>



Speculation: human cyberg Intelligent people

This work starts from the perspective of human and technology development from the perspective of narrative, and develops the possibility of symbiosis and confrontation between technology and human beings, as well as the speculation on the boundaries of technology development. Mainly through a story-based mirror space production, it shows confrontation and symbiosis respectively.

Individual project 2021.10-2022.6
Spatial narrative Interior design Video clip Arduino installation EEG test

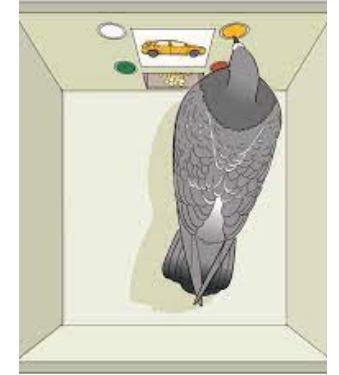
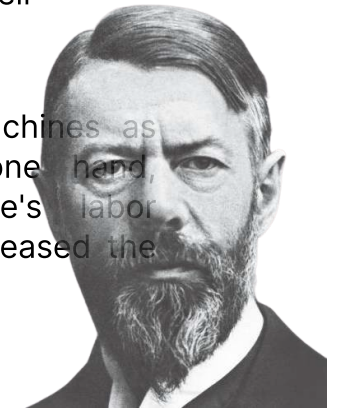
INSIGHT1

Mobile phone seems to be an organ of the human body



Phone is like our brain. The transmission of information is like blood, and the app is like a functional cell

It was Marx who first regarded machines as **extended human organs**. On the one hand, machines greatly improved people's labor efficiency, and at the same time increased the degree of human alienation.



We're like Snagin's pigeons in our time with our phones. **Contribute a steady stream of time** to your phone and apps.

Our basic necessities of life are inseparable from the help of mobile phones, but at the same time, it seems to be controlled by it. This seems to be a **dual attribute** that many technological developments will accompany.

But where is the boundary between us as an organism and as an electronic device?



Pictures are from altered carbon by artists pangmaokun

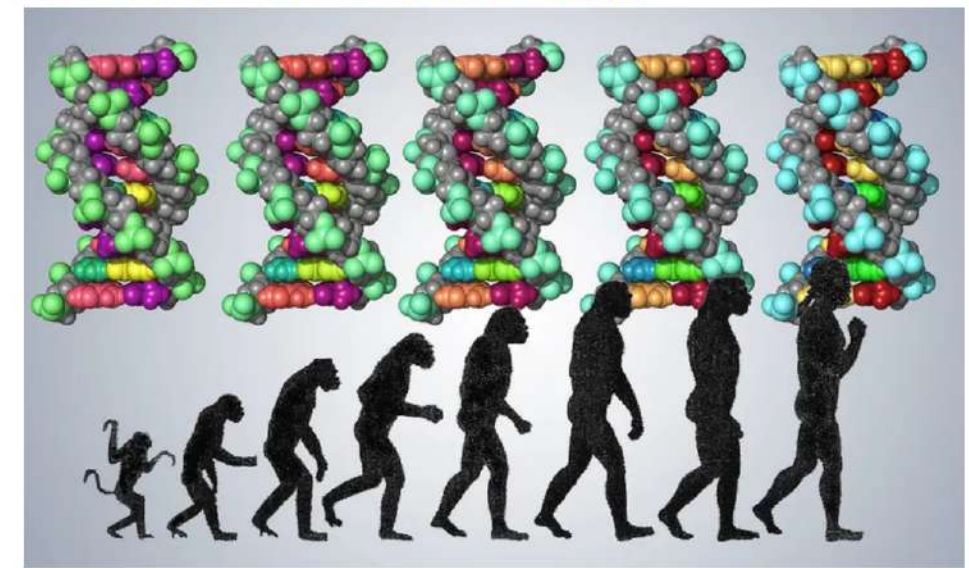
Why are we human? What's the difference between us and making precision life entity?

INSIGHT2

Four stages of development, are we still the same as us? Is it upgrade human or is it controlling and being controlled?

1.Human

Humans (Homo sapiens) are the most abundant and widespread species of primate, characterized by bipedalism and large, complex brains. This has enabled the development of advanced tools, culture, and language.



2.Robot/Android

A robot is a mechanical inorganic body with built-in AI, some of which are human-shaped and some are animal-shaped. These AI mechanical bodies with bodies are not only powerful, but also more flexible and powerful than humans. Going up and down the mountains, going to the sea, and flying in the sky.

The robot is either a very powerful helper or a very destructive killer (tragedy)



MAARS weaponized robot



Robonaut2 aboard the ISS. Image: NASA

3.Cyberg-humans



With the development of modern biology and robotics technology, human beings are increasingly inclined to enhance their abilities through genetic modification and mechanical integration, such as using exoskeletons or replacing diseased bones and organs, and even implanting electrodes in their brains to connect their brains with computers to enhance their intelligence. This hybrid of humans with computers and machines is called a cyborg.

Cyberg's body modification can help, but it can also lead to disaster

It's completely conceivable that in the not-too-distant future, permanent, fully integrated prosthetic limbs and bionic implants will be widespread.

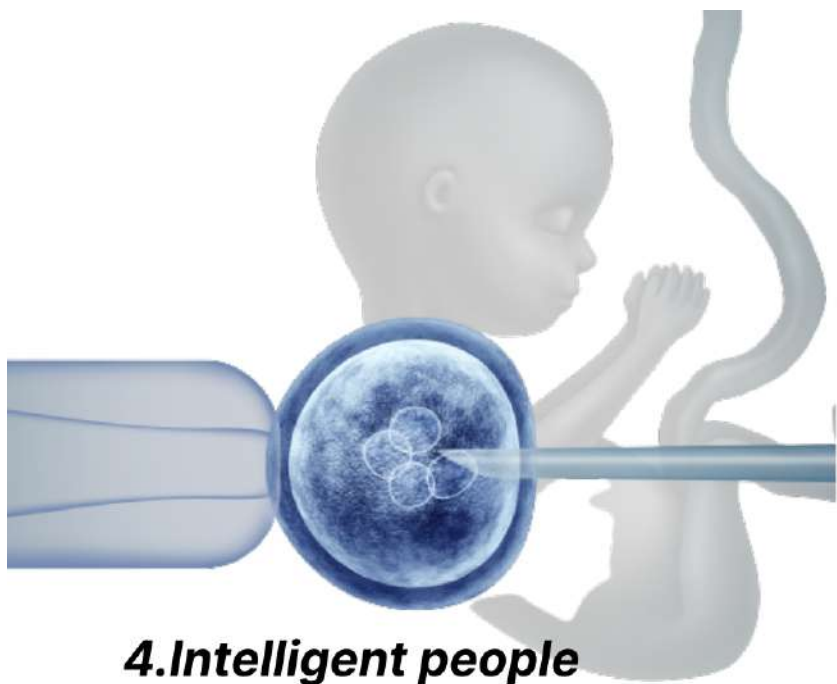
Upgrade people as well as control people.



Bionic lenses that can replace the natural lens in the human eye through the most common cataract surgery. This lens is made from bio compactable, inert and polymeric material that does not cause any bio-physiological changes in the human eye.



A mind controlling helmet might make you think about gaining telepathic abilities just like X-men's Professor X. Developing such a tech might require more years, but DARPA's mind controlling helmet does help to control a person's mind to some extent



4. Intelligent people

Technologies meddling with the very blueprint of life, the genetic code, may change you forever and not only you but also the next generations. Gene editing technologies, such as CRISPR, bestow scientists the power to add, alter or remove parts of any creature's DNA.

Gene editing saves lives but also creates wider social divides. The four stages of human exploration are full of promise and hidden dangers. Where are the boundaries? When should we stop ?



Scientist edited the genes of two baby girls so that they could resist future HIV infections.



Gene editing could go far beyond treating diseases. Parents could design the perfect children based on their best possible traits. This may lead to serious social problems.

A STORY

*I wrote a story which is called mirror about **Intelligent people and human**, I want to explore the relationship between **technological development and people themselves***

This is a somewhat whimsical story. Some people say that the sea is the sky upside down. And then we see the sky, will it be the sea of another time?

Is it possible that the life you live is also planned? Human beings created intelligent people, so will human beings be created one day? The story may not give you the answer, because it is just a story, but over time, it may not just be a story. We may see a different world when we step out of the trap of self-righteousness.

protagonist



Lin Yi

a human science fiction writer, himself somehow are trapped in another parallel world mirror space. With the desire for superpowers, write the story of superpower painter Yi Ling.

At the end of the year, the light of the candle broke through the boundary, and Lin Yi followed the boundary to the mirror space which is also Yi Ling's world. There's no telling what the unthinkable things will happen next.



Yi Lin

Intelligent human painter, due to the cultivation of the ability, He is closed at the junction of the cliff seaside space, but does not know that the story of his comic strip actually affects another parallel time and space. (The comic strip protagonist Lin Yi is trapped in the space of the parallel time without knowing the reason.)



Part1

Lin Yi put down the pen, get up, move his sedentary body. At this time, there is "da da da da" sound from behind, like a countdown. "This clock usually has no sound." Lin Yi felt a little strange. Looking at the calendar on the clock, Lin Yi suddenly realized: "So I have lived in this house for 11 months and 29 days, and after today it will be a whole year."

It was already late in the evening, and he was a little hungry. He walked to the elevator and the door opened automatically, sending him to the first floor. Bypassing the spiral ramp, Lin Yi went to the kitchen to get food and went up the spiral ramp. Every day Lin Yi would take a closer look at the trees that spiral around the ramp. The tree, it seemed, was growing taller every day, and at the moment, it was only a fingernail's crack from the ceiling. Lin Yi

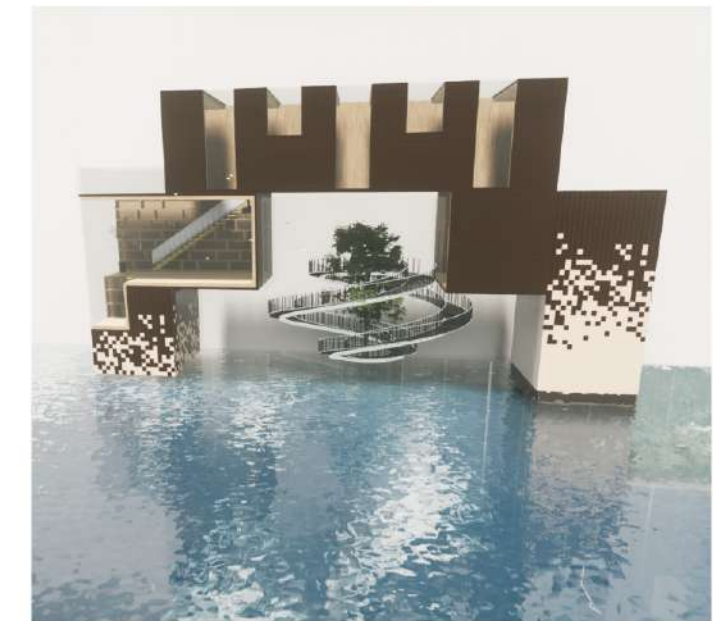
Remembered that the first time he saw this tree, he was as tall as himself, and at that time, he had just opened his eyes and found himself lying under this tree. "It's been a year, and the tree has grown at a rate that amazes Lin Yi. And this house amazed him a lot more, with its back against the cliff, and as if floating on the sea. It was like being on an isolated island. He didn't even know how he got here. And all this doubt seems to be related to one thing. He touched his pocket, took out the candle - the thing that was in his shirt pocket when he woke up - and gazed at it, hoping to provide some inspiration for the lifting of the doubts.

After returning to his senses, Lin Yi picked up his pen and wrapped up the novel that had taken almost a year to write.

It was already dark when he lit the candle, and the whole space was flooded with a yellow glow. This candle has been used for a year, but it neither gets shorter nor loses wax.

In no time, Lin Yi was engrossed in the alien world he shapes about intelligent people, a story about a super-powered painter. The main character, the super-powered painter Yi Ling, holds almost all of Lin Yi's beautiful fantasies.

Lin Yi's room

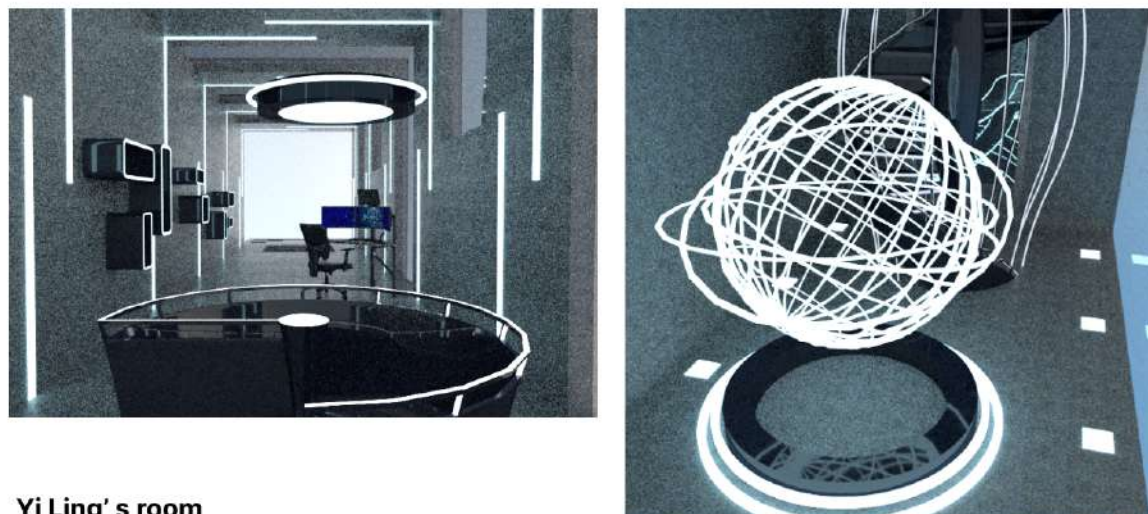


Part2

Yi Ling sat at the table, lit a candle, ready to start his comic book creation. Tonight's candlelight extra wavering, the space illuminated more brightly than usual. He gazed at the candlelight and sighed, "I, too, am different from before!" Previously, because his drawing ability did not meet the requirements of the current intelligent human society, he was enclosed here to hone his drawing skills. In his curiosity about humans, a race he had not seen, he drew a set of comics about humans based on the various information he had about them over the past year, and he named the protagonist of the novel - Lin Yi.

About the intelligent people's hatred of humans, is engraved to the bone. It all, perhaps, stems from the arrogance of humans. Intelligent people, too, are human.

Once, country A launched the "Human Transformation Project" with the aim of making human beings more perfect. People who have special abilities in a certain respect are locked up and their genes are studied through human experiments to discover the secret behind "genius". For 10 years, that lab site was filled with screams and blood. Until one day, there was a mistake in the injection of reagents, and the ability of the controlled people were strengthened. The powerful people destroyed the experimental base, and human beings could not control them. They rebelled against the rule of human beings and trapped human beings in the dungeon. And they, a group of superhumans, set up their own kingdom, named themselves intelligent people.



Yi Ling's room

Part3

The obsidian clock on the wall emitted a louder "da, da, da" sound, and the candlelight was unusually swaying and dancing in a way that made Lin Yi feel a little strange. He looked at the "da, da, da" sound to the clock, and just at the moment the hands pointed to 12, there was a loud boom. The whole space began to shake, the glass broke the ground, the candle went out, the whole space instantly darkened. The candle rolled off the table, Lin Yi was looking down to pick it up, but the candle rolled all the way to the elevator. Lin Yi chased after it, all the way to the light room. Lin Yi stood at the door of the light room, only to see the candle's light converge into a path of light downward extension, penetrating the sea. Lin Yi close to the light path to explore, but inadvertently sucked in. "Ah" Lin Yi shouted. The light pierced Lin Yi could not open his eyes. The strong sense of weightlessness made Lin Yi uncomfortable to the extreme. He was sucked into the light stream.

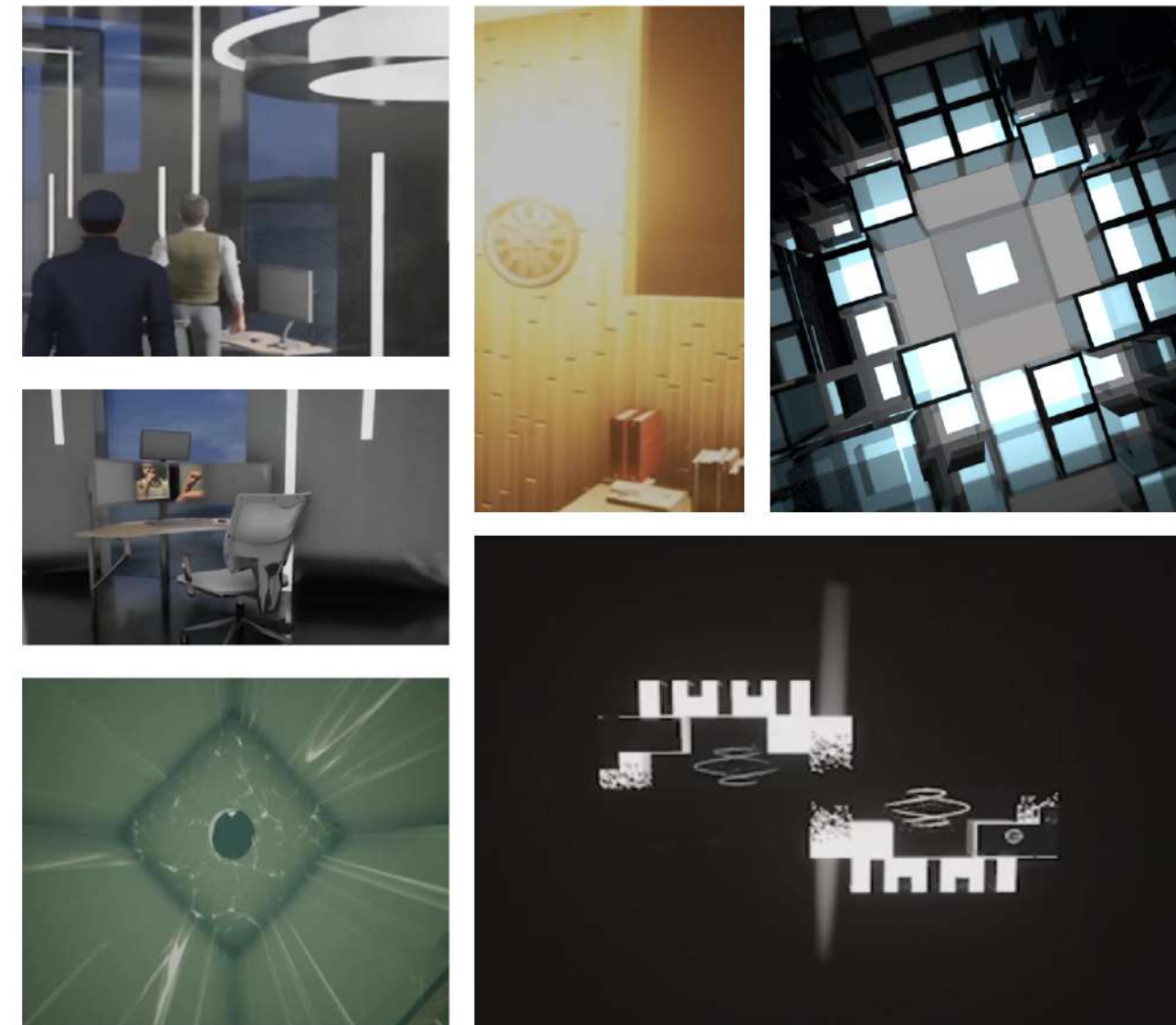
The light, gradually dimmed, as if the air could be felt again, but the air is filled with the smell of candles burned out. However, the body still continues to fall, Lin Yi grabbed the wall next to him, hoping to get out of this uncomfortable unease and he slowly struggled to a board.

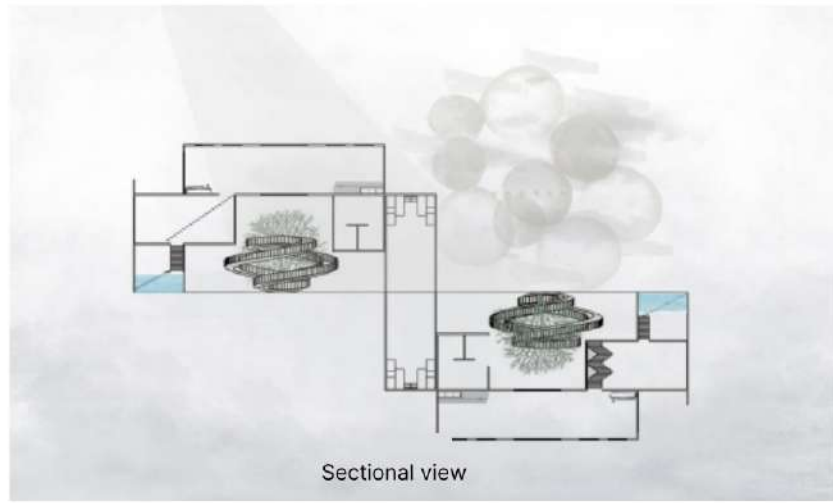
Before he could catch his breath, the board rose slowly.

This feeling seems like déjà vu.

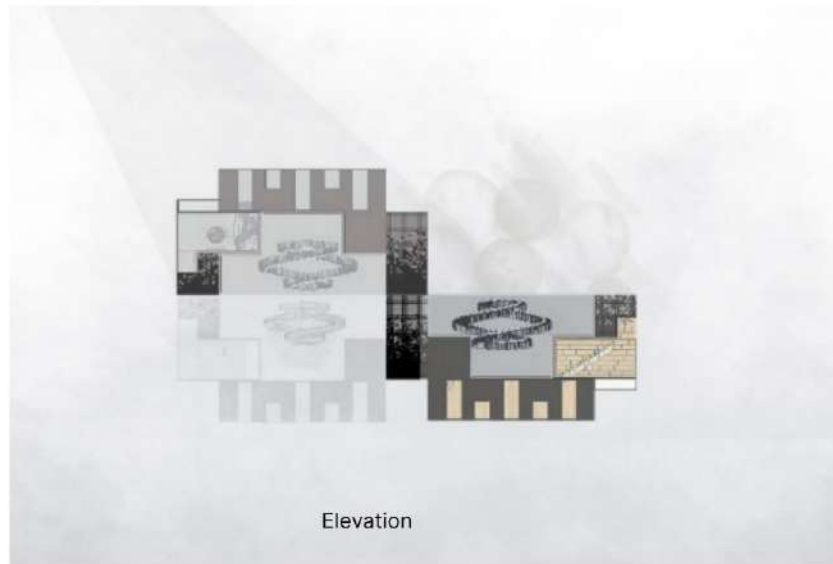
As the board rose, Lin Yi only to see a tree inside the nave with the same room as his own, the same spiral ramp, a space surprisingly similar in structure to the space he had been enclosed in for a year. Lin Yi got up and saw the house just like his own writing room, only what was on the table was a computer not papers, and he walked forward to it. But when he saw what was on the computer, he couldn't make a sound in shock.

Just then, a cold voice came from behind: "How can it be you?"





Sectional view



Elevation



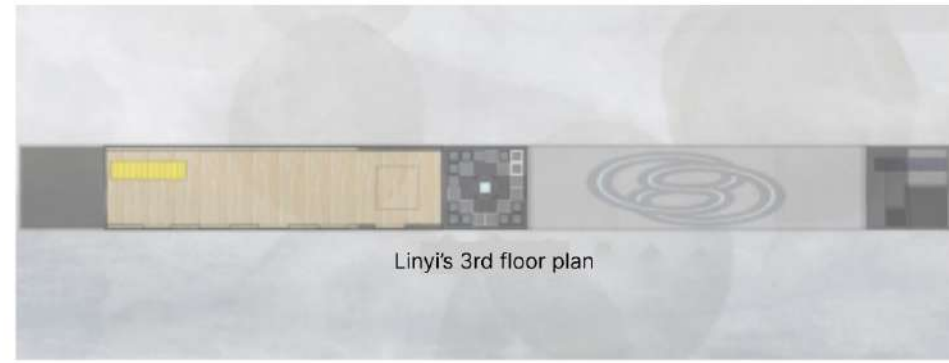
Yilin's 3rd floor plan



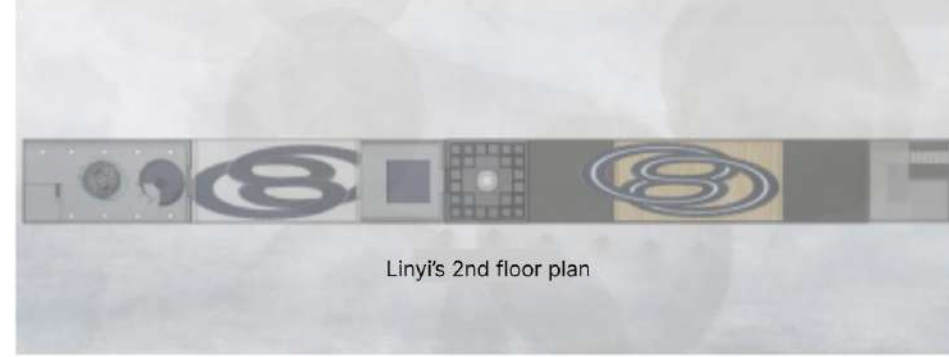
Yilin's 2nd floor plan



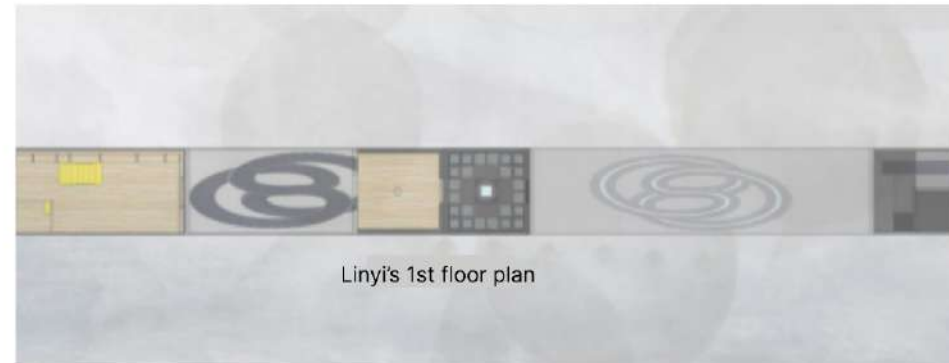
Yilin's 1st floor plan



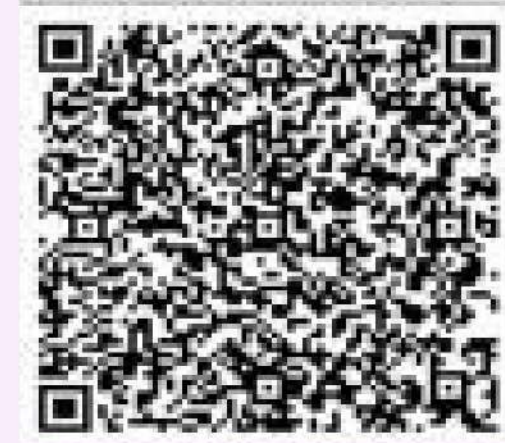
Linyi's 3rd floor plan



Linyi's 2nd floor plan



Linyi's 1st floor plan



Scan the QR code to see the 3D details of the mirror space



Click the link to watch the story

<https://www.bilibili.com/video/BV1P5411r7Hr>
share_source=copy_web

In this story, Intelligent people and Human are restrained and controlled by each other. Is this the way it should end? Is there a better way forward?



9

This is a personal hand-painted work, drawing inspiration from animal gestures for styling design



Group work: Liu qianxi Fu kexue

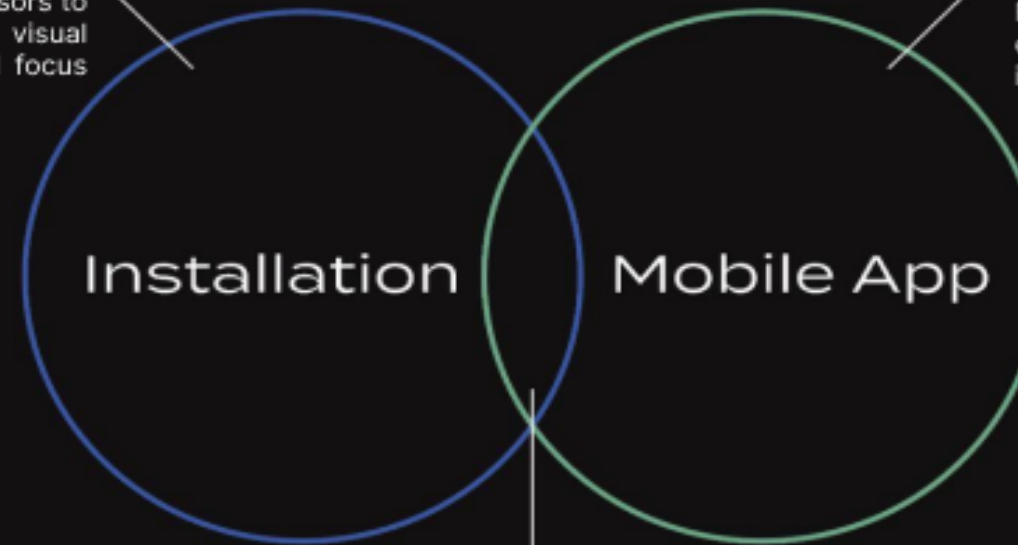
Participate in: Arduino making Concept iteration

https://www.bilibili.com/video/BV1NY4y1P7gy?share_source=copy_web&vd_source=766595a2b21b34373ac4fa3a8fba5e8a

moodies • detailed functions

#1 Emotional autonomic regulator installation

Brainwave data read by sensors to identify tension and use visual elements for breathing and focus regulation



#2 Negative emotion confession and transformation platform

Convert negative emotions into artwork through sound visualization

Emotion recording and empathy Emotion recording and empathy function #3

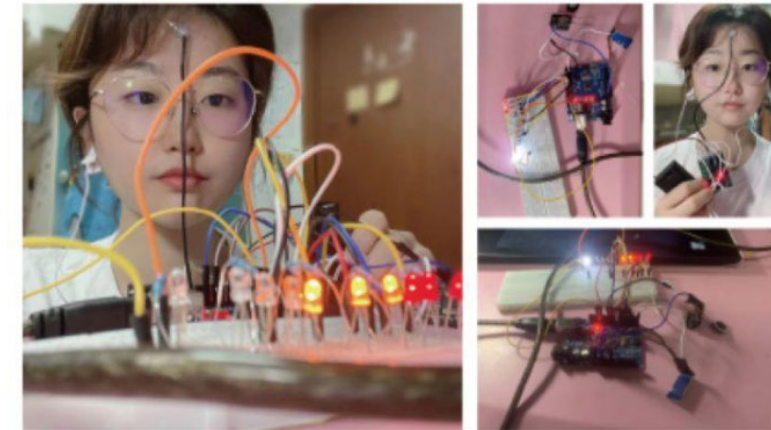
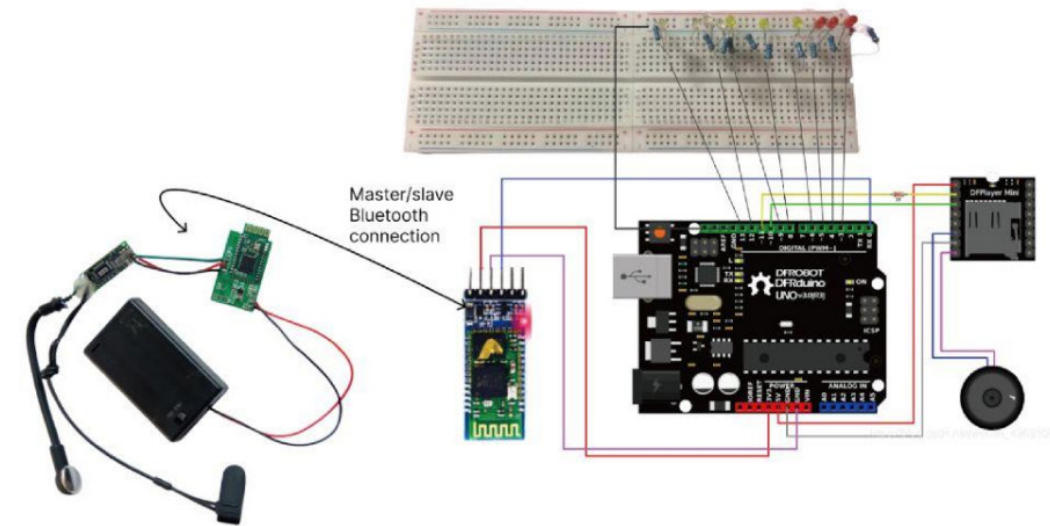
Record personal emotions and generate emotional profiles, empathize with others in the community, and visualize empathy.

1. Preliminary solution: Obtaining user's focus data and take visual guide

Brainwave module identifies stress and anxiety level



Dfplayer module plays different music for anxiety relief according to the level of tension and anxiety, and the small light color visualizes the level of anxiety



1. Program Iteration : Obtaining user's focus data and take visual guide

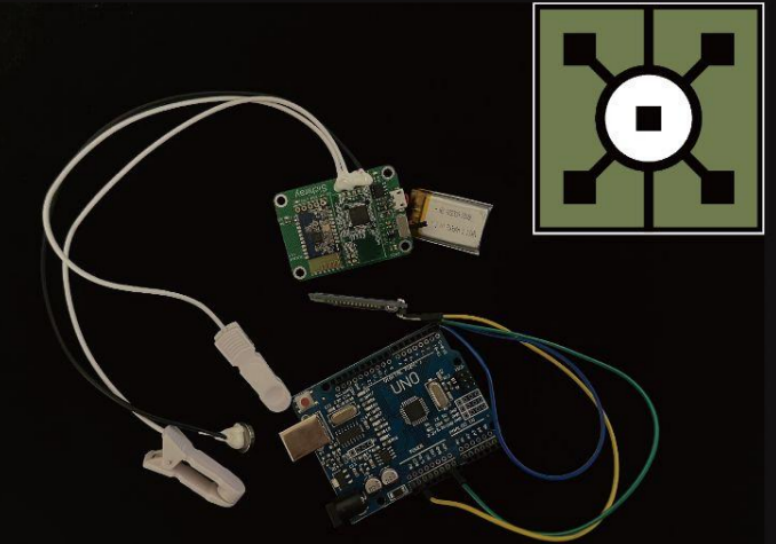
Brainwave module identifies stress and anxiety level



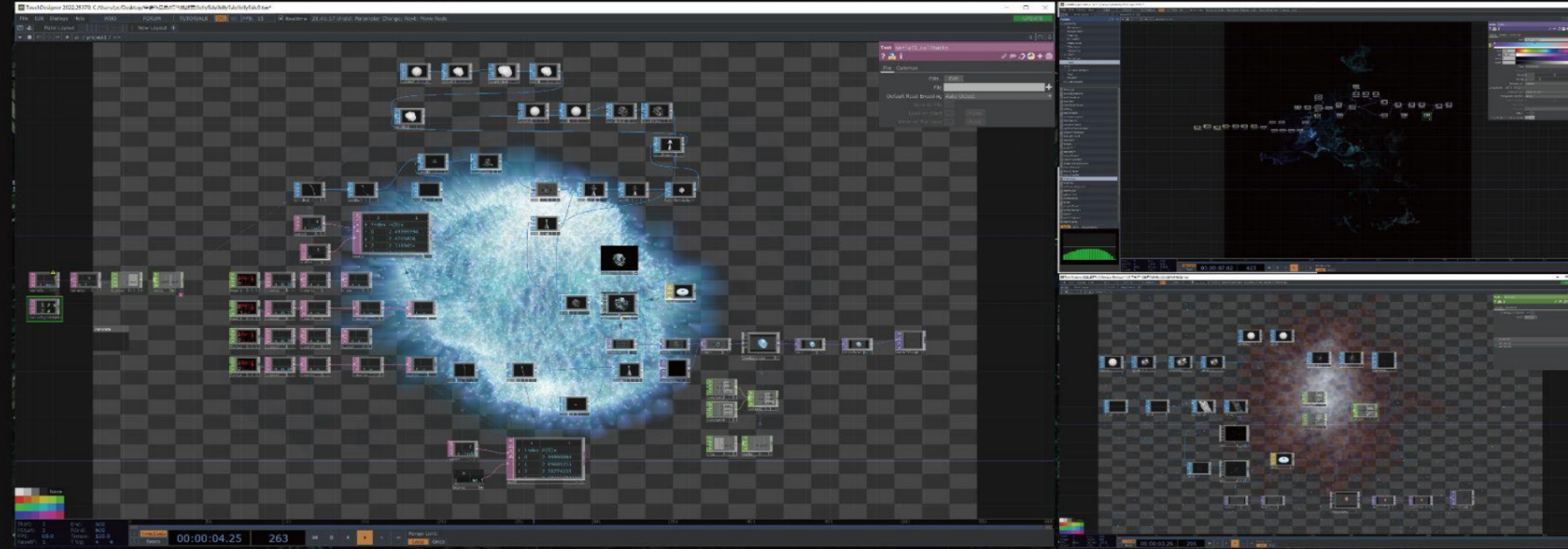
Visual visualization of anxiety level + breathing guidance through color changes + music interaction to relieve anxiety

The limitation of initial prototype :

- Due to the time and site conditions of the challenge camp, the successful welding of the dfplayer module could not be carried out.
- The visual presentation effect is insufficient, turning to touchdesigner for the emotional regulation of the combination of visual and audio effects.



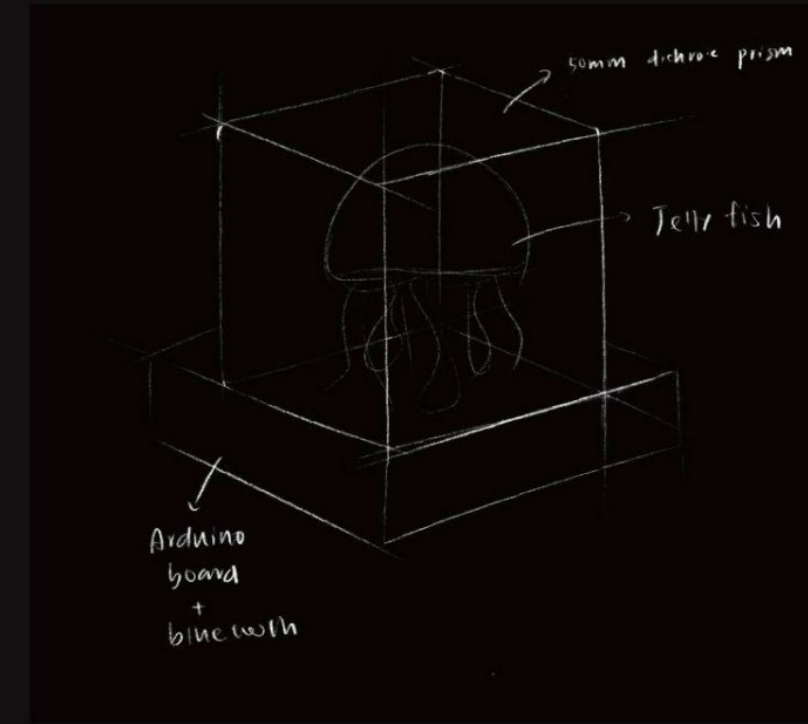
● 2. Interaction effects production



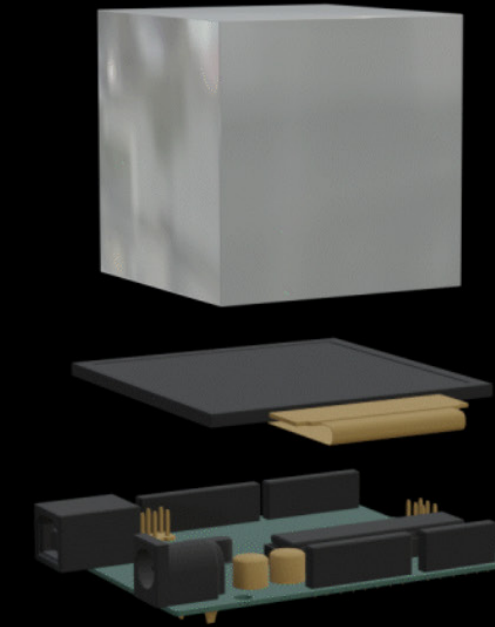
Interaction effects production

Real-time web data + visual interaction

● 3. Installation appearance production



Creating a pseudo-holographic projection effect using spectral prisms



moodies • manufacturing process

● APP Architecture Design

