APPENDIX

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APPENDIX A – Small Satellite Features

1. Lower R&D cost

The cost of a conventional large satellite may be as high as 500 million euros, in contrast, a nanosatellite can be built and placed in orbit for only 500 thousand euros (Alén Space, 2021).

- Small satellites usually only need a short development period and a small development team (Lal et al., 2017).
- The TheCubeSat standard can lower the development cost of small satellites because most CubeSats are made of COTS (Commercial-Off-The-Shelf) products (Facchinetti, 2016).
- CubeSat adopts standardized cube and modular design, which can achieve mass production and lower the production cost (Facchinetti, 2016).
- CubeSats simplify the integration of launch vehicles, which can further reduce the production and launch costs (Lal et al., 2017).

2. Faster iteration

Usually, an ordinary large satellite project needs 5-15 years to determine the demand and place it in orbit (Alén Space, 2021).
The long R&D period means the inability to quickly update the changing technology, and a high risk of market demands change after the project is completed (Alén Space, 2021).
Instead, a typical CubeSat project can be conceived to launch in less than 8 months, which means that small satellites can be continuously updated to maintain the most advanced system by the latest technology (Alén Space, 2021).
Furthermore, compared with large satellites, small satellites have more open standards for the used components, and have no restrictions on the instruments required to be carried (Facchinetti, 2016). This means that small satellites can be propelled by advanced technologies outside the aerospace field.

3. Higher risk tolerance

Small satellites are usually grouped into constellations to jointly complete space missions, so each satellite can divide the risks into smaller parts. Even if some satellites are lost or some components fail, they can be quickly replaced within a feasible period of time and at a reasonable cost (Alén Space, 2021). On the contrary, the failure of a large satellite is likely to endanger the entire mission.

4. Powerful data collection capabilities

Lower costs and risks enable small satellites to be produced and launched in large quantities at the same time to form a satellite swarm, so it can cover more comprehensive space and update data more quickly, to provide strong overall data collection capabilities that large satellites do not have (Saeed et al., 2020). Meanwhile, small satellites are usually deployed in low-earth orbit (LEO), thereby have less communication delay and signal attenuation and be able to provide low-latency communication (Saeed et al., 2020).

APPENDIX B – The Factors of Market Growing Interest in Small Satellite

1. Reduce the difficulty of entering space

The entire process of small satellites from design, manufacture, launch to orbit operation can be controlled within one year and cost within US$5 million, which much reduces the barriers to access to satellite technology and market, that provide opportunities for emerging space forces that lack technology accumulation to enter space (Yao, 2019).

2. Reduce the cost of manufacturing

CubeSat adopts standardized and modular design, which not only need low development cost and a short developing period, but also can be mass production and simplify the integration of launch vehicles, that largely reduce the cost of manufacturing (Yao, 2019).

3. More complex payload and lighter weight

With the development of high-tech breakthroughs in microelectronics, micro-electro-mechanical, micro-optical-electro-mechanical systems, new materials, advanced manufacturing, and nanotechnology, etc, the electronic equipment in the commercial sector is also gradually miniaturizing (Yao, 2019). This allows small satellites to carry more complex payloads to complete the tasks previously responsible by large satellites.

4. Small satellite swarms

Low-cost small satellites can coordinate into swarm through networking to complete space missions that conventional large satellites cannot. Therefore, many space start-up companies aim to break through the traditional space industry model, establish a large number of small satellite swarms to open up new markets and provide new services to users around the world (Yao, 2019).

5. Increasing awareness of the potential value of access to geospatial information

Space technology is changing the traditional way of monitoring infrastructure and providing services (Facchinetti, 2016). Low-cost small satellites have become the main choice to meet the medium and low orbit communication and remote sensing needs. In addition, small satellites have the advantage of task-oriented design, that focus on the actual needs of users and design specialise function, which has the ability to provide task customization and rapid response services (Yao, 2019).

APPENDIX C – Development Trends and Challenges of Small Satellites

1. Development Trends of Small Satellites

Small satellite is still an immature field, new advances and discoveries are emerging every year to provide various new opportunities for the market. It is hard to imagine what exactly the future small satellite will look like or can do, some trends already emerge as a reference.

Lower price and longer service life

As the number of satellite launches continues to increase, the swarm investment will be unprofitable if the cost of a single satellite is too high (Science and Technology Observation, 2019). Meanwhile, short service life (the current lifespan of small commercial satellites is only 3 to 5 years) will also limit the commercial value of the satellite due to the high annual depreciation rate and the negative impact on the stability of the system (STO, 2019). In order to have better commercial viability economically, small satellites need to be developed towards lower prices and longer service life.

Better resolution performance

Commercial customers usually have high requirements for service quality and experience. Satellite data with an optical resolution higher than 1m has limited application and is difficult to profit (STO, 2019). In order to ensure sufficient market competitiveness and flexibility, commercial satellite manufacturers need at least the following capabilities in terms of remote sensing: manufacture hyperspectral remote sensing satellite of visible light with a spatial resolution of 1m and below, SAR with a spatial resolution of 10 meters and below, and spatial resolution of 5 meters and below (STO, 2019).

Ubiquitous network

Consumers expect to be able to use digital services anytime, anywhere. Although the fifth-generation (5G) infrastructure has been launched, many regions around the world do not even have second-generation (2G) infrastructure (Sweeting, 2018). Through the integration of small satellite communications and next-generation wireless networks, satellite networks can provide 5G services to all parts of the world at an affordable price (Saeed et al., 2020).

High data processing and transmission requirements

With the rapid development of information technology and business models, small satellites will also need to conform to the requirements big data era. The most typical requirement is the data processing and transmission capabilities, which is one of the most important technical challenges faced by small satellites in the new space age (Saeed et al., 2020). In addition, it is necessary to add value to the satellite data by integrating the information with artificial intelligence and other technologies to form comprehensive prediction, mining and analysis capabilities (Saeed et al., 2020).

Super "constellations" and assembled in orbit

In order to provide ubiquitous support to any place in the world, a large number of satellites need to be deployed on multiple planes. Only up to now, the total number of small satellites proposed for various constellations is already close to 25,000 (Sweeting, 2018). Besides, in order to achieve more functions and applications, on-orbit assembly is required to combine multiple small satellites into a larger structure just like lego, and those small Lego satellites can even be reconfigured in orbit to meet changing mission goals (Sweeting, 2018).

2. Development Challenges of Small Satellites

Although the possibility of small satellites in the future sounds very attractive, the real development and implementation and will also encounter many challenges, which are described below.

Size limitation

The size of small satellites limits the amount of hardware they can carry, which restricts some high-performance devices that require more space, and indirectly affects the performance of the payload. This is an international problem that restricts the research and application of small satellites (Sweeting, 2018).

High cost of launch

Timely and low-cost launches into orbit have been the main constraints on the growth of the small satellite market. Although some companies are producing more cost-effective large and small launchers, there is no good solution yet (Sweeting, 2018).

Propulsion system limitation

The performance of the propulsion system determines the speed of the celestial body and the mass of the payload. Although small satellites have solar and lithium battery power sources, they lack large power sources or large propulsion systems. This is one of the major obstacles to be overcome in the field of small satellites (Sweeting, 2018).

Data storage and processing costs

Hundreds of satellite constellations, especially satellites with earth science imaging capabilities, will generate large amounts of data. However, so far, the return of data from small satellites will be limited by the availability and cost of the ground station, and the demand for data storage and processing will become increasingly large (Lal, et al., 2017).

Privacy concerns

As small satellites entered the business world, the line between public and private information began to blur. The emergence of satellites that provide high temporal and spatial resolution has raised concerns about national security and personal privacy. Such concerns may undermine the business case for using remote sensing satellite data (Sweeting, 2018).

Space debris

Small satellites are usually launched in densely populated orbits but lack the mobility required to move, so space debris may pose a threat to small satellites. At the same time, space debris may increase the number of debris due to collisions or system failures (Aglietti, 2020).

APPENDIX D – List of Trends Found in DESTEP Analysis

1. Demographic

Aging society

In the next 10 years, China's population structure will diverge significantly into two extremes. By 2030, the population of young people (under 40) in China will drop by approximately 40% from 554 million to 325 million (Nitu, 2020). On the contrary, the elderly population (over 65) will reach 248 million by 2030 (Nitu, 2020). This means that China's aging society is coming.

Increasing upper and middle class lead to upgrade consumption

The rapid growth of the upper and middle class in China has made more Chinese families keen on consumption. Customers are becoming more mature, their demand for consumption is getting more refined, and quality requirements are getting higher (Wei et al., 2017). It is expected that China's upper and middle class will drive 75% of consumption growth (Wei et al., 2017).

More people choose to be single

More and more people choose to become "single aristocrats" among customers who have stable economic income and received good education. With the increase of singles and the increasing acceptance of singles in society, a new type of consumption of "one person" has been born, which promotes convenience, light consumption, emphasis on enjoyment and high-quality life (Wei et al., 2017).

Live away from the city centre

As people's travel methods become more convenient and the sense of distance shrinks, people in urban centres will tend to live in further suburbs. At the same time, with the popularity of "work from home" and the development of the "15-minute living circle" (referring to residents can get everything they need in daily life within a 15-minute walk, other things that cannot be bought can be delivered to door), people will pay more attention to the consumption, services and activities of the local life circle, and the population density of the city centre will decline (Carat, 2021).

2. Economic

Consumption is the main driving force of economic development

With the increase in per capita disposable income, China's economy will shift from investment-led to consumption-led, and consumption will become the main driving force for economic development (Wei et al., 2017). China is one of the fastest-growing consumer markets in the world (Nitu, 2020).

Business collaboration

Companies in different fields began to provide services jointly to create a one-stop shop (Carat, 2021). In order to provide more competitive and comprehensive services by expanding the original service scope to other areas.

Sharing economy

Digital platforms make it possible to share personal resources. By establishing shared resources platform, people can create according to individual needs, and they can also find common interests for collaborative innovation and jointly create value (European Commission, 2013).

New generation consumers have huge consumption potential

Chinese born in the 80s, 90s, and 00s are often referred to as the "new generation". Compared with their parents, "new generation" were born in an era when supplies were abundant. So their demand for consumption is more diverse and grow more rapidly. Understand the division and preferences of different "new generation" groups is the key to a company's success (Wei et al., 2017).

3. Social

Healthy lifestyle

Under the epidemic, more and more people started to pay attention to health, and hope to have healthier lifestyle.However the modern fast pace often make people lack the sense of self-control. Therefore, people began to seek for product/service that can help them improve their emotions and establish healthy habits (Qin, 2016).

Smart lifestyle

With the rapid development of the Internet of Things, people can remotely control all home appliances. At the same time, smart wearable devices can help people better track their physical condition and health, which makes people's lives become simpler, intelligent and humane (Art and Design, 2018).

Online lifestyle

Chinese consumers spend time on digital devices (smartphones, laptops, and tablets) at the forefront of the world. This is due to the extremely high online convenience provided by the devices, enabling all-day social, transportation, food, entertainment, consumption, etc. The full coverage of all aspects of life leads to the integration of the online and offline worlds (Wei et al., 2017).

Work from home

The spread of the epidemic has forced companies around the world to switch to a "work from home" operating model. Many people feel the convenience and benefits of this kind of way of working during this period, and many of them are willing to retain this working mode even after the epidemic (Frog, 2021).

Elderly lifestyle is becoming more proactive and diversified

According to a global aging population study that the mentality of the elderly is now becoming younger. The retirement life of the elderly is no longer content with staying at home, they become more willing to walk out and pursue a more colourful life. Elderly preferences are particularly obvious in terms of travel, cultivating hobbies, engaging in re-employment/volunteer work, and physical exercise (Wei et al., 2017).

Experience-driven consumption

Consumers have different attitudes and ways of life, and strong demand for individualization. They enjoy experiential consumption and are willing to pay for the experience (Nitu, 2020).

Flexible and convenient

Uncertainties in society are constantly increasing, which prompts consumers to prioritize more flexible options, such as flexible leasing. Meanwhile, more "convenient" products not only mean speed and portability, but also help people make plans in advance. Therefore, people can more easily obtain products and services that were previously unavailable (Mintel, 2021).

Green consumption

Now Chinese consumers have an unprecedentedly high willingness for green consumption and environmental protection.

They advocate living and consuming in a healthy and sustainable way on the basis of coordinated development with nature. Consumers are not only more willing to choose more green and environmentally friendly products, but also hope that their consumption behaviour can be more in line with environmental protection standards (Wei et al., 2017).

Online and offline combination

The popularity of smartphones has prompted changes in consumption patterns. Mobile Internet has become an important way for consumers to purchase products. However, highly fragmented shopping channels and massive information sources make it more and more expensive for consumers to make choices. Therefore, the seamless integration of online and offline digital experiences is vital to future consumers (Wei et al., 2017).

Virtual experience

With the development of virtual reality and augmented reality devices, consumer experience will gain a new definition between reality and virtuality. People can receive a brand new virtual reality experience at home such as shopping, watching movies, participating in concerts, and even enter the world of games (Li, 2015).

Demand for the community

As the collective trauma caused by the epidemic isolation will continue to have an impact in the future, people are eager to establish more connections with the community and gain more sense of belonging and unity. At the same time, the community can better gather resources, develop new models of community life such as sharing and cooperative crowdfunding, so that residents can get more welfare (European Commission, 2013).

Show personality

With the increase in the degree of social openness in China and the diversification of culture, people are no longer limited to solid social identities and groups, they become more daring to show their preferences and personality (Wei et al., 2017).

Reflect individual value

With the improvement of quality of life, people began to pursue the satisfaction of spiritual life. People are willing to spend more time, energy and money on things that can reflect their individual values, such as special hobbies (Nitu, 2020).

Ethical transparency

People are paying more and more attention to the company's impact on the surrounding world, hoping that the company can assume more social responsibilities. Since the information behind the products can help consumers make choices that conform to their own values when consuming. This requires higher transparency to let consumers know the story behind the products they buy (Frog, 2021).

Respect privacy

Frequent user data leakage incidents have caused people to worry about data security. Consumers have put forward new requirements for security and digital trust in commercial institutions, hoping to better control personal data, and be able to independently agree or refuse the use of personal data (Carat, 2021).

Outdoor oasis

The epidemic has forced people to stay at home longer than expected, and reduce contact with the outside world. People are eager to be able to reconnect with nature while maintaining safety, so more leisure activities have begun to be held outdoors or in remote places that have less population density (Mintel, 2021).

4. Technological

Smart society

With the development of informatisation, cities in the 21st century will become smarter, be able to sense, analyse, and integrate various key information of the city's operating system. So as to make intelligent responses to various needs including people's livelihood, environmental protection, public safety, urban services, industrial and commercial activities, to create a better life for people (European Commission, 2013).

Intelligent transportation system

Intelligent transportation systems can connect pedestrians, drivers, vehicles, and roads into a unified dynamic network to more effectively manage resources and solve traffic problems, in order to achieve fast, efficient traffic. At the same time, it is conducive to the construction of the urban logistics system (Carat, 2021).

Robot automation

With the development of automation and robots, robots will replace humans in the future to undertake more high-risk, high-repetitive and high-precision jobs, and emerge in the service industries of housekeeping, education, health, etc. (Carat, 2021).

Automatic driving

By connecting to the Internet, cars can grasp real-time traffic conditions and vehicle conditions, automatically under planned routes, which can free people's hands and realise efficient movement (Qin, 2016).

Blockchain to ensure digital safety

As a breakthrough technology, blockchain represents a new method of exchanging information and value. Blockchain can verify the integrity and source of data in the value chain to establish higher transparency, trust and efficient environment, to ensure the security of the data (Shen, 2019).

Internet platform for sustainable industry ecosystem

It is possible to integrate the entire value chain from upstream to downstream through Internet, which allowing all steps to use data on one platform. In order to better complement the missing parts in the chain and add more value to the data, thereby forms a sustainable industry ecosystem (Saeed et al., 2020).

Big data and Artificial intelligence

People have mastered various technologies to obtain massive amounts of data, but it is more important to dig out the required information from it. Artificial intelligence (AI) has brought new opportunities to solve this problem through big data mining. AI technologies can integrate various industries and professional information for comprehensive forecasting, information mining and analysis (Saeed et al., 2020).

5. Ecological

Maximum protection and restoration of habitat

With the increasing awareness of environmental protection, people began to pay more attention to the environmental destruction of natural ecology. And make more active efforts to maintain and restore habitats, better manage forests and agricultural landscapes, to protect our environment for future generations (Fujian Development and Reform Commission, 2021).

Control plastic pollution

The unrestricted use of plastic products has made a huge impact on our planet. The non-

degradable plastic waste has polluted the soil and poses risk to marine life. Therefore, more and more region governments are required to reduce the accessability of disposable plastics and use more environmentally friendly and degradable materials as substitutes (Energywatch, 2021).

Net-zero emissions are becoming popular

More and more companies have included achieving net-zero emissions as one of the company's development goals, and are committed to limiting the global average temperature rise to 1.5 degrees Celsius. Some companies even put forward the concept of negative carbon, promising to remove more carbon dioxide from the atmosphere by 2030 than they emit (Energywatch, 2021).

The ongoing climate crisis

In 2020, the emergence of extreme weather that exceeds people's expectations has caused huge losses to society. Governments and companies began to realise the huge threat posed by climate change, and pay more attention to early intervention in extreme weather (Restorick, 2020).

Regenerative agriculture

Regenerative agriculture is an agricultural strategy that prioritizes soil health, land management and biodiversity during the cultivation and harvesting of food products. In regenerative agriculture, conscious practice can minimize the loss of necessary soil nutrients and minerals, thereby protecting the life of the soil. More and more governments and farmers began to implement measures to maintain soil health and vitality (Essel Environmental, 2020).

6. Political

Privacy challenge

In the past, high-resolution remote sensing from space was directly controlled and protected by the government. However, with the commercialization of small satellites, the line between public and private information has become blurred. Individuals or small and medium-sized enterprises can access remote sensing data online in a value-added manner through processing. This raises issues of national security and personal privacy, and challenges the relevance and practicability of existing policies and regulatory mechanisms (Sweeting, 2018).

Space debris management and supervision

Current guidelines on mitigating space debris are often not implemented or are not applicable to small satellites (Behrens & Lal, 2019). In view of the low cost and short life of small satellites, it is important to avoid the interference and collision problems caused by the increasing number of aircraft (Behrens & Lal, 2019). Many countries have committed to further formulating and implementing the current regulatory framework to manage the increasing "space traffic" and reduce space debris (Sweeting, 2018).

Open sharing of remote sensing satellite data

The open sharing of earth observation big data can promote scientific research, stimulate private sector business plans, and promote sustainable human development (He et al., 2018). Developed countries represented by the United States and some European countries have successively formulated policies for the open sharing of Earth observation data in order to improve international competitiveness and regulate domestic markets (He et al., 2018). China is also actively promoting open sharing to improve the integration of massive data in the field of earth science (He et al., 2018).

Laws for compensation for damage to the ecological environment

In 2021, China clearly stipulates the restoration and compensation rules for ecological environmental damage, committed to protecting the ecological environment and strengthening ecological restoration. People or organizations that cause damage to the ecological environment will be required to take the responsibility and cost for restoring the ecological environment (Interface News, 2021).

Action plan for peaking carbon emissions by 2030

China has formulated a plan of action to control national carbon emissions, through developing new energy sources, promoting new energy-saving and environmental protection technologies, and building a national energy rights and carbon emission rights trading market (Interface News, 2021).

APPENDIX E – The Framework of Smart Tourism

1. The Overall Framework of Smart Tourism

The framework of smart tourism is mainly composed of two parts. The first part is the tourism data perception system that collects, transmits and processes data. The second part is the Data application to apply and visualise the insights from Data perception to support different needs of Smart Tourism. The overall framework can be seen in Figure 1.

The purpose of the framework is to actively perceive and analyse required information such as tourism resources, economy, and tourist's activities through ICT technologies such as the IoT, 5G, and cloud computing, so as to achieve the integration of all information. Thereby, improve the quality of tourism services through the efficient transmission of tourism data and sharing of resources (Han & Huang, 2021).

Each part of the framework will be explained in detail below.

Tourism data perception

The tourism data perception is the first part and the foundation of the smart tourism framework, it consists of three steps: data collection, data transmission, and data processing.

First, data collection. Tourism-related data will be collected from various sources. The sources are diverse, including the Internet, social media, physical sensors, mobile devices, wearable devices, cards, etc (Fuchs et al., 2014).

Second, data transmission. All collected data will be transmitted and integrated into databases, which owns by different owners. In ideal smart tourism, all databases can be exchanged or shared to ensure that everyone can get the information they need. But in reality, the degree of data sharing is very low, and only a few tourist destinations

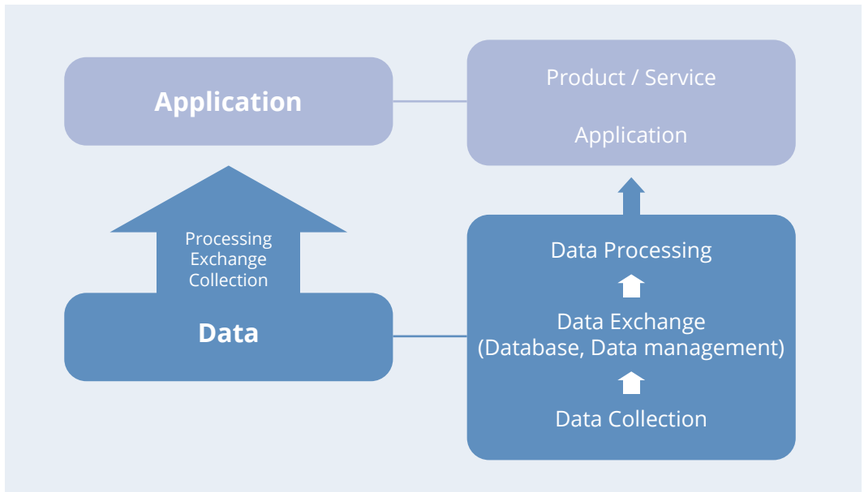


Figure 1. Smart Tourism overall framework (Lee et al., 2020)

support real-time communication and open data plans (Fuchs et al., 2014).

Third, data processing. The data in the database will be analysed and processed into insights for decision making or practical application. The methods of analysing and processing big data include artificial intelligence technologies such as data mining, neural networks, machine learning and supervised learning, etc. (Fuchs et al., 2014).

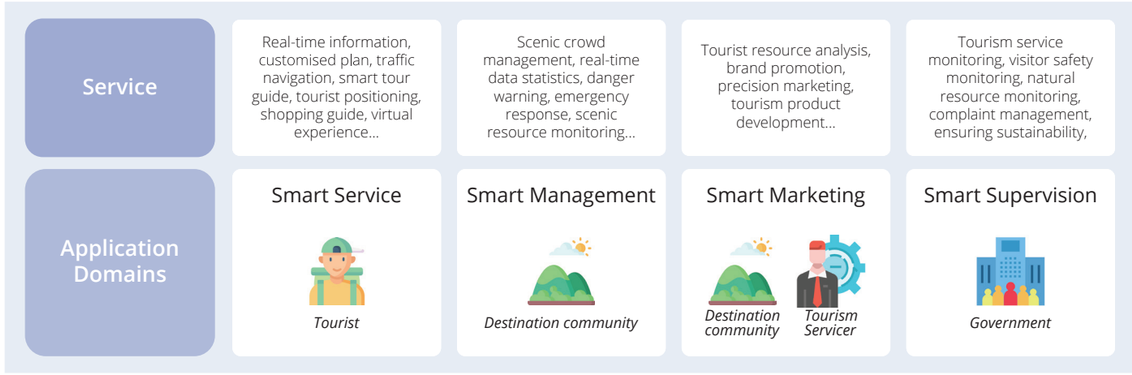


Figure 3. Smart tourism data applications (Lee et al., 2020)

Tourism data perception

The tourism data perception is the first part The second part of the framework is responsible for applying and visualising the insights gained from the first part of data processing, thereby adding value to the original data. The final application of data usually includes the four aspects of smart tourism: smart service, smart management, smart supervision, and smart marketing (Han, 2021).

The main applications for smart services include meeting the information needs of tourists at different stages of travel; providing personalised travel routes and traffic guidance; providing tourists with suggestions for entertainment activities; providing higher quality interactive navigation services; helping better share travel experiences and so on (Zhang, 2019). Which aims to bring a better travel experience to tourists by increasing the customisation, interaction, safety and satisfaction of tourist activities (Tu & Liu, 2014).

The main applications for smart management include integrating and distributing the tourism resources; improving process automation and work efficiency; obtaining the real-time situation of the attractions for effective management; discovering potential crises in time and making effective decisions (Fang, 2019); promoting services to enhance the tourist experience, predicting tourist demands to develop new products and services, improving the competitiveness of tourist attractions, etc. (Liu, 2018). So as to facilitate the resource and tourist management of the attraction (Shafiee et al., 2019).

The main applications of smart supervision include monitoring the real time tourism situation of the destination; maintain the normal operation and regulation of the market; solving the impact of excessive tourism on local residents; managing the tourism resources to ensure sustainable development, etc. (Fang, 2019). In order

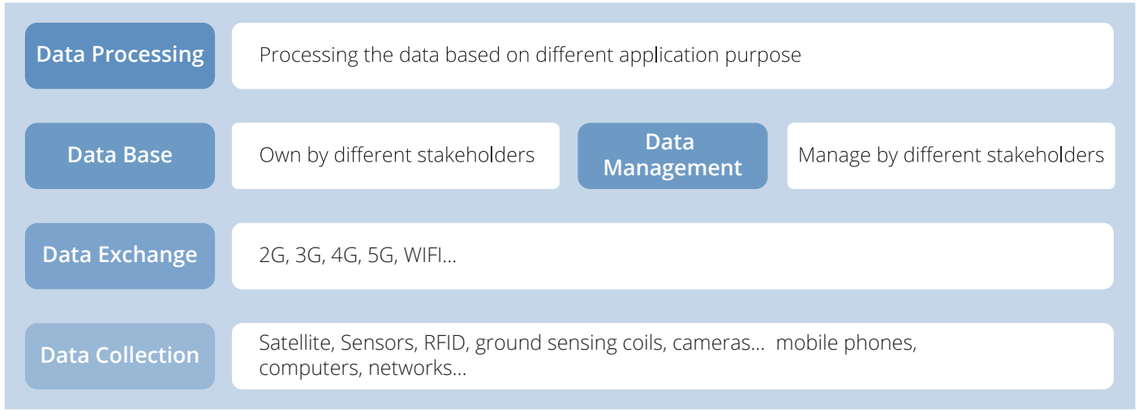


Figure 2. Tourism data perception (Lee et al., 2020)

to improve government management and public service capabilities, thereby enhancing the competitiveness of the city, increase the quality of life of residents and ensure sustainable development (Lee et al., 2020).

The main applications of smart marketing include identifying the target group to achieve precision marketing; digging out the potential interest points of tourists through public opinion; developing new routes/ products with discovered resources, etc. (Liu, 2018). In order to attract more tourists to the destination for activities and consumption.

The position of satellites in the smart tourism

It can be seen from the above smart tourism framework that the small satellite can be located in the first part - the tourism data perception system and be responsible for data collection and transmission. Regarding data collection, as knew from the previous small satellite capabilities that small satellites are able to provide various spatial geographic information through remote sensing, as well as position information for locating and tracking targets; meanwhile, provide weather information for early warning of disasters, which is one of the key factors affecting the tourism industry; and provide environmental information for monitoring the impact of tourism activities, and so on. Regarding data transmission, satellites can provide communication for remote areas without the internet to ensure that the collected data can be transferred to the database.

In general, this section has shown from the preliminary research of smart tourism that small satellites can be used to strengthen the foundation of smart tourism's framework by collecting and transmitting more data to obtain the required information.

APPENDIX F – Summary of Satellite Technologies A&D for SWOT analysis

1. Satellite remote sensing

Advantages

- **Be able to cover wide, inaccessible areas**
  Remote sensing technology can cover a very wide area and can identify large features. In addition, satellite remote sensing is not restricted by ground conditions, can easily and timely obtain valuable information in areas with extreme natural conditions that are difficult for humans to reach, such as deserts, swamps, and high mountains.

- **Macro perspective**
  The data remote sensing collects covering all the things at the same time period in the area, which shows a macroscopic scene that expands people's visual range. The data (such as satellite images) can comprehensively present the natural and human phenomena on the earth, and truly reflect the characteristics of geology, landforms, soil, vegetation, hydrology, artificial structures, etc. It fully reveals the relevance of geographical things, which is extremely important for the analysis of the earth resources and environment.

- **Dynamically track the changes of observation objects**
  As satellites revolve around the earth, they can obtain the latest data of various natural phenomena in the area they pass through to update the old data every day or even every few hours, which is impossible for manual field measurement and aerial photogrammetry. This can help people dynamically track and discover the changes of many things on the earth through the acquired remote sensing data. For example, studying the changing laws of nature, monitoring weather conditions, natural disasters, environmental pollution and even military targets.

- **Faster and cheaper access to information**
  Remote sensing is a fast process, the sensors on the satellites used to measure the reflected light from the surface can cover a large area in a short time, and the cost is lower than manual field measurement and aerial photogrammetry.

- **Will not interfere with the observation object**
  Satellites use remote sensors to measure the reflected light from the ground, which means that passive remote sensing will not interfere with objects or areas of interest.

- **Reduce on-site workload**
  Compare to manual field measurement and aerial photogrammetry, satellite remote sensing measurement does not require personnel to arrive at the site for operation, and the collected data will be analyzed in the laboratory, thereby minimizing the work that needs to be done on-site.

- **Data can be repeat used**
  The images collected by satellites can be analyzed and interpreted repeatedly for different applications. For example, data collected to survey construction sites can also be used to analyze and plan new roads, the data collected from forests to monitor wildfire risks can also be used to monitor biodiversity. There is no limit to the range of information collected from a single remote sensing image.

Disadvantages

- **Not suitable for measuring small areas**
  Satellite remote sensing can be more expensive when measuring or analyzing smaller areas.

- **Require additional training for using the technology**
  Additional training is required for using the technology, because the remote sensing instruments needs to be calibrated before use to ensure accurate measurement, otherwise the measurement data will be inaccurate. Also, remote sensing image analysis requires high professional requirements that many influencing factors must be considered.

- **Require large data storage space**
  If users need to collect high-resolution remote sensing data, large-scale project data may require hundreds of GB of storage space, which is difficult to store.

- **Unable to provide real-time data yet**
  Since satellites can only obtain data when passing through the observed area, they cannot provide real-time data all the time.

2. Satellite communication

Advantages

- **Ubiquitous network coverage**
  Although the ground network has been extended to many parts of the world, there are many areas that are still not connected, such as sea or air and sparsely populated areas. And satellite can provide important communication links for these remote areas where ground networks are unavailable or inaccessible.

- **Fast installation and high flexibility**
  There are mobile or portable satellite Internet solutions that can be installed and used in less than ten minutes, which be able to provide important network connections in some emergency situations and can be used in various locations.

- **Not affected by ground factors**
  Unlike ground network equipment that may be unable to use due to ground factors, satellite communications can resist the challenges brought by difficult terrain, remote locations, bad weather and ground obstacles, and quickly provide stable and reliable connections.

- **Lower cost compared to ground network**
  The deployment cost of ground networks in remote areas is very high, in sparsely populated places, satellite communication can provide a relatively cheaper option, and its ground station site is also easier to install and maintain.

- **Connect remote assets**
  Satellites are a key communication method for business operations extended to geographically remote environments to perform remote facility monitoring and real-time asset management on unmanned sites and offshore platforms.

Disadvantages

- **Slower network speed longer delay**
  Although satellite communications are cheaper than existing ground network solutions, the network speed provided by the existing technology is slower than the networks we are used to, and the delay is also longer, that not able to replace the existing ground network solutions.

- **Cannot connect directly with existing mobile devices**
  The operating frequency of satellite networks is different from the mobile devices that are commonly used, it requires using ground facilities to convert satellite signals into WIFI signals. Therefore, where there are no ground facilities, people need more expensive specialized satellite devices to communicate.

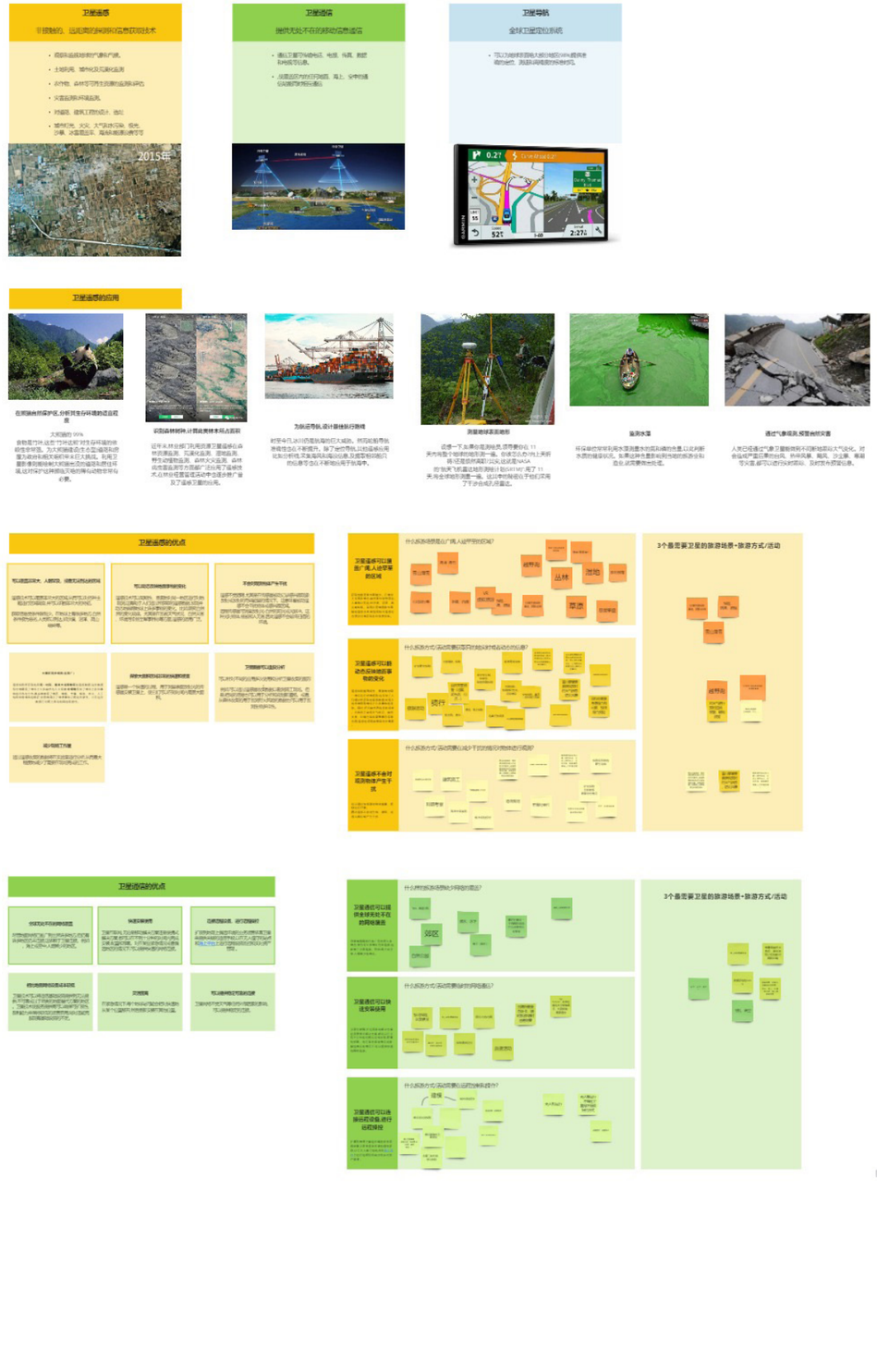
- **Can be affected by space activities**
  Although satellite communications are not affected by ground factors, space activities such as sunspots and star eclipses can affect satellite signals and may interface with the normal operation of the satellite.

APPENDIX G – Brainstorm Session Records and Result Analysis

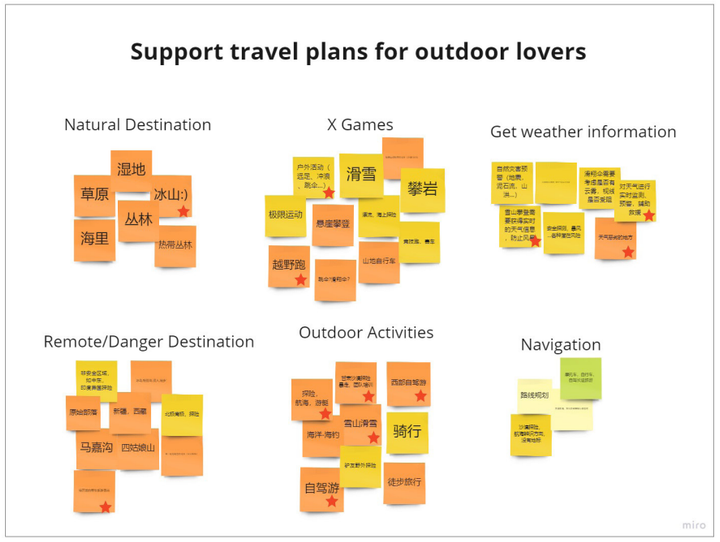
Since all participants are from China, the sessions were conducted in Chinese.

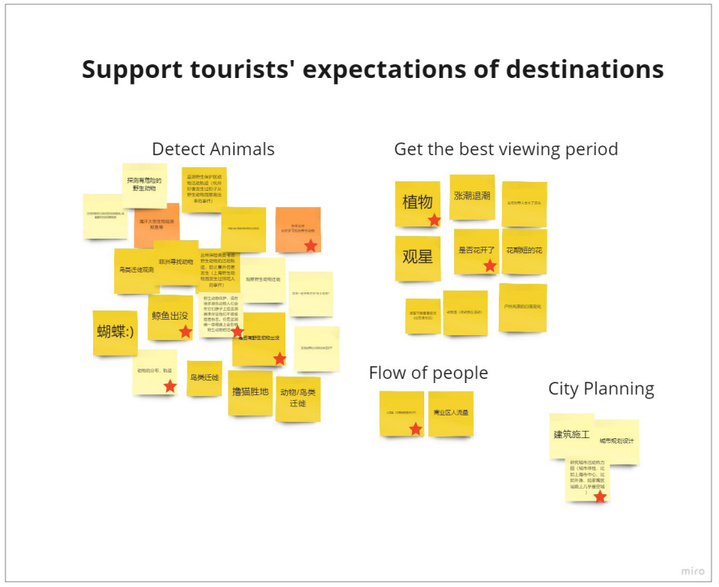
1. Brain Storm Session Record 1

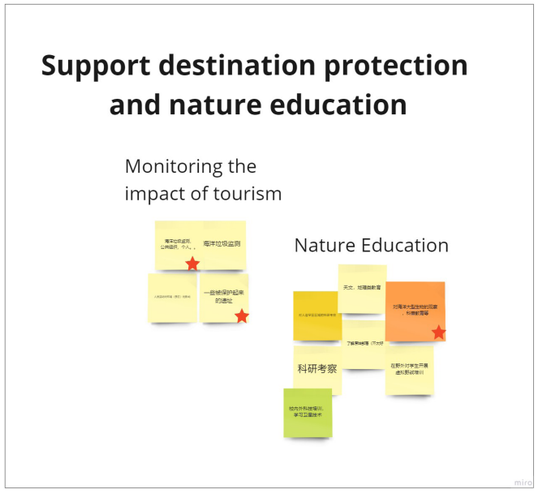
2. Brain Storm Session Record 2

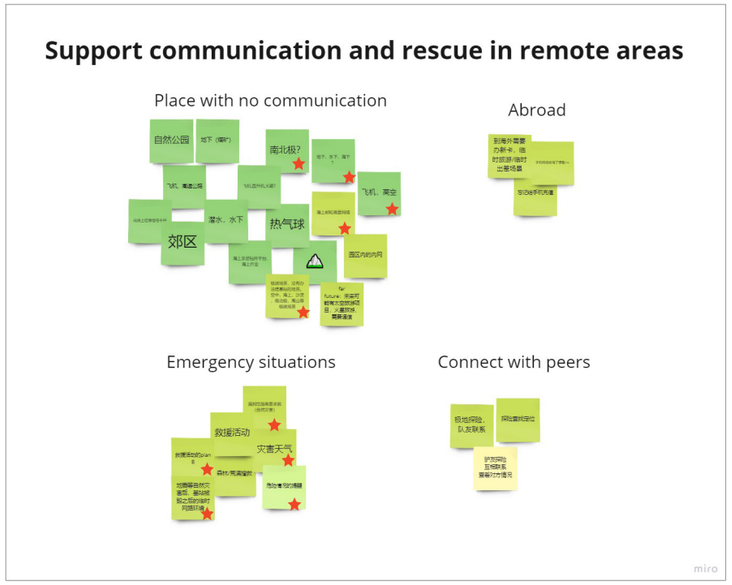


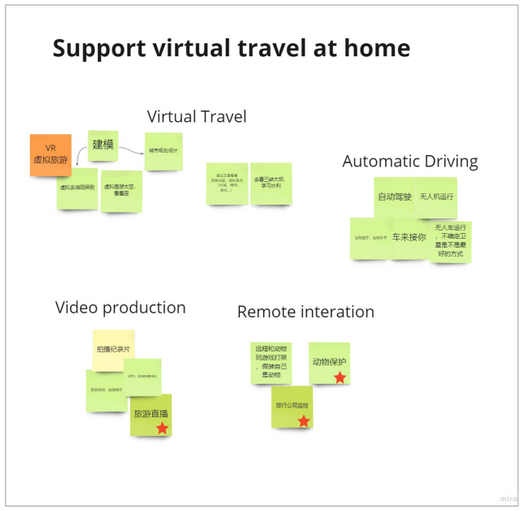
3. Brain Storm Session Result Analysis











APPENDIX H – Future Travel Trends Found from Research

Business leisure travel - Combine work and leisure

Business leisure travel is a combination of the possibility of work and relaxation, so that people have the opportunity to enjoy some leisure time in the destination during business travel. The travel plan may be planned in advance, or it may be decided after the work finish. This type of travel that combines work and entertainment has grown rapidly, especially when remote work became popular during the COVID-19 pandemic.

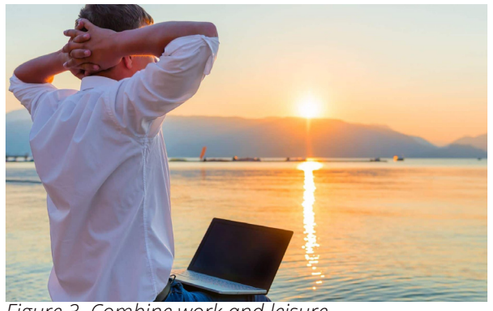


Figure 3. Combine work and leisure

Sustainable travel - Reduce negative impact on environment

More and more tourists start to consider the environment when making travel decisions, hoping to reduce the negative impact of travel. Around 69% of global tourists want the tourism industry to provide more sustainable travel options (Paolinelli, 2021). Sustainability is not only about the environment, it also involves the culture, the economy and the people who live in the destination (Nyorani, 2021). The United Nations defined sustainable travel as "While ensuring the promotion of the local economy, tourism should also reduce its impact on the local environment and society." (Baidu, 2018).

Figure 4. Reduce negative impact on environment

Eco-travel - Learn and care about nature

The concepts of eco-travel and sustainable tourism are partly overlapping, that is, the same emphasis on protecting the natural environment and maintaining the lives of local people (The Central People's Government of the People's Republic of China, 2005). The difference of eco-travel is that it focuses more on tourism activities based on the natural environment and has a strong sense of environmental protection. The purpose of eco-travel is to allow tourists to learn about nature and ecology in the natural environment and enhance the awareness of protection to better care for nature (Tuliu, 2016). And finally achieved the goal of promoting ecological protection with tourism while promoting tourism with ecological protection (The Central People's Government of the People's Republic of China, 2005).

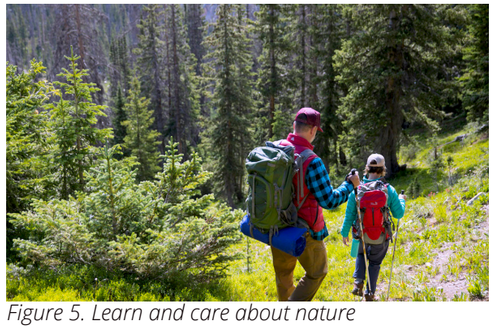


Figure 5. Learn and care about nature

Culture travel - Experience the culture of the destination

Tourists began to look for more authentic experiences in their travel destinations, looking forward to interacting with locals and experience their culture instead of staying in culturally isolated areas designed for tourists (Revfine, 2021). Tourists want to deeper integrate and participate in local culture, from enjoying local cuisine to celebrating regional festivals and holidays.

Figure 6. Experience the culture of the destination

Health travel - Travel with healthy purpose

Health travel is travel for the purpose of promoting health and well-being, usually related to medical travel (Wikipedia, 2021). Tourists can choose a suitable tourist area according to their own condition and doctor's advice, enjoy health service while travelling, and carry out effective health management to achieve physical and mental health (Baidu, 2019).

Figure 7. Travel with healthy purpose

Virtual reality travel - Visit unreachable places with VR

VR subverts the traditional way of travel, allowing people to experience local things without reaching the destination. Through online VR guided tours, customers can experience the interior of the hotel, restaurant, and outdoor tourist attractions at home. This is not only very useful in the context of COVID-19 to encourages people to travel in the future, but also can help tourists make better decisions in the planning stage (Revfine, 2021).

Figure 8. Visit unreachable places with VR

Augmented reality travel - AR to better view the destination information

Unlike VR simulating the entire environment and experience, AR combines the experience of the real world with virtual elements. By superimposing virtual elements on the real environment, visitors can better view the information of the area they are exploring through the smartphone AR application. For example, museums are increasingly using AR to allow visitors to view cultural relics with original appearances in a virtual superimposed manner (Revfine, 2021).

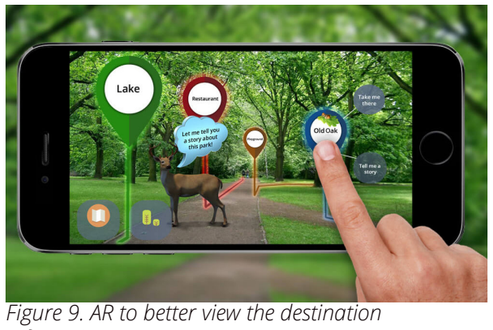


Figure 9. AR to better view the destination information

Rural and nature travel - Relax in rural and nature

Rural travel has recently been regarded as a better choice than urban travel. More and more people go to small communities located in rural destinations to learn about their lifestyles and culture (Nault, 2020). Meanwhile, nature tours focusing on wilderness and relaxation in nature are also becoming more and more popular (Nault, 2020).

Figure 10. Relax in rural and nature

Travel locally - Discover the local destination beauty

The COVID-19 pandemic has made people more cautious in their travel choices. Even after everything return to normal, the confidence of people to travel will take time to rebuild. Therefore, tourists will still stick to the old destination that they know well for their first trip (McGonagle, 2020). According to an Airbnb report, nearly half of the tourists surveyed want to take a vacation within driving distance of home (Nault, 2020).

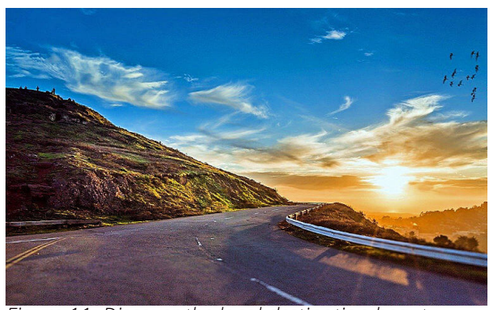


Figure 11. Discover the local destination beauty

Outdoor travel - Close to nature in more remote place

Due to the social distance requirement during COVID-19, tourists prefer to stay away from crowded cities and travel to more remote areas (Paolinelli, 2021). At the same time, this way of more active and closer to nature travel is prefered by tourists that is tend to continue in the future (McGonagle, 2020).

Figure 12. Close to nature in more remote place

Travel alone - Achieve personal growth in travel adventure

Statistics show that more and more people choose to travel alone (Nault, 2020). Some people just want to travel without being distracted by their peers. Some people may travel alone in order to complete their personal growth in this single travel adventure. Whatever the reason, this trend is still growing (Nault, 2020).

Figure 13. Achieve personal growth in travel adventure

Self-driving travel - Travel more freely with car

Booking.com found that in 2021, nearly half of tourists tried to avoid public transportation when travelling (Nault, 2020). This will lead to long-term changes in the way people travel, more people will choose to rent or use their cars (Paolinelli, 2021).

Figure 14. Travel more freely with car

APPENDIX I – Interview Result codebook

Interview Participants

Destination management department staff

P1 Female, age 36
Worked at Langshan Tourism Authority, responsible for the development of local tourism industry.

P2 Male, age 41
Worked at Nanshan Tourism Authority, responsible for managing the comprehensive affairs of the destination.

Tourism company staff

P3 Female, age 28
Worked in a tourism project planning and promotion company, responsible for marketing and promotion of tourist destinations.

P4 Male, age 39
Worked in a travel agency company, responsible for formulating travel routes.

Landscape designer

P5 Male, age 25
Worked in a landscape design company and participated in the design project of urban nature reserve.

P6 Male, age 28
Worked in a landscape design company and participated in many tourism destination design projects.

Codebook 1

Theme	Group	Quote
Resources and its changes are presented datally to enhance communication and understanding among different stakeholders	The tourism development is based on local natural and cultural resources, as well as climate and environment	"What can affect travel? The answer is the surface resources, climate and cultural resources." (P3) "The development of scenic spots mainly depends the local natural and cultural resources." (P3) "Put the bussiness on line in advance, by making the idea into products, pre-sale to attact people, if the response is good, the investment will be more targeted, which will reduce investment and risk." (P3) "A lot of small towns are idle. The key is to revitalize these resource by discovering some features to make it different from others, which is the attractor to the visitors." (P3)
	Satellites are used to discover the potential tourist destinations	"Satellite remote sensing has long been used in the field of tourism planning.Using satellite meteorological data, we found that the meteorological temperature in one place is a little higher than elsewhere, and so named Warm Valley for development." (P3)
	Satellite are used to assess local tourism indicators	"Use meteorological data to issue tourism brands, such as suitable whether for health tourism, local negativeion content, oxygen content" (P3)
	Better presentation of the resources to attract investment	"I am in charge of tourism development and recommendation. The Homeland Planning Bureau gives us the resources of the recommended places, and we build it into a tourism product and promote it out. We invite professional tourism institutions to make planning, to find out what kind of products this resource is suitable for development, and then attract investment, and recruit some large capital enterprises on the basis of planning. If the companies are bullish on the resources, they will spend more money." (P1)
	The design results are expressed digitally for better presentation	"When we report to others, we will talk about a lot of raw data, if it can be calculated into some indictors, which will help us to better persuade them." (P6) "When the land property is determined, the implementary plan is designed by the landscape designer, the plan should consider the function of the land, the form of the functions, the organized streamline. Take park as an example, it has a lot of indicators, such as green covering rate, the width of road, and the service radius of service facilities." (P5)
	Workload is increased for insufficient communication and the different presentation from different majors	"Now the technology becomes complicated, leading to insufficient communication between each major. It is hard to obtain the data needed in the time, slowing down the progress of the project, sometimes it is carried out by imagination, which leads to bad results being inconsistent with the actual situation, and the work should be done again." (P6) "The specifications or limitations of the design are mostly presented in the form of text, assisted by a small number of pictures." (P5) "In addition to the design major, in fact, many majors are expressed in text or simple illustrations." (P5) "The most difficult part is the coordination of the work, which involves many departments and people, and will shirk each other" (P5) "Standards such as ecological protection red line were not considered in the early design process, which result that the previous work can not be used." (P5) "The generally obtained data materials are text, as well as plane plan, or cad files, no actual terrain model, need the designer to model themselves, spend very time, resulting in serious overtime." (P6)

Codebook 2

Theme	Group	Quote
The actual situation and restrictions will be more intuitively presented, so that the stakeholders can better understand the field situation, so as to make a better landing plan	The biggest problem in tourism project development lies in the difference between design and reality, which leads to the difficulty in landing	"The biggest problem is the conflict between the concept of design and the implementation of activities. Because the actual measured data is lack, the research and development is mainly based on the ideas of the designers, which make it hard to carry the plan into reality. We can only rely on the later field investigation to solve this problem." (P4) "Route development mainly depends on manpower for reconnaissance, with no scientific and technological content.Cultural brigade is very primitive, the work is done mainly by people." (P3) "The biggest problem is that there are too few professionals, and few knowledge about the area." (P3)
	There are many restrictions on national protection, and the traditional tourism development cannot be carried out	"Langshan has a number of national brands, each has corresponding industry norms, many preferential policies and many bound policies. Most of the scenic spots are included within the scope of protection, can not be used in development and tourism projects. There is a contradictory contradiction between development and protection." (P1)
	Satellites are used to monitor ecological red lines	"Satellites can identify illegal buildings and monitor ecological red lines" (P5)
	Garden design needs to consider many practical factors and obtain more data in the field	"The design should take impact on the ecological protection and the environment into consideration, whether interrupt the migration path of the animals, and whether cause damage to the ecological balance. These need to be built on the site of the original landform, biosphere, animal number data." (P6) "There are many factors affecting garden design, like cable, highway, subway, underground pipe network" (P5) "Now sponge city is expected, if more data is provided, such as on where there are lakes, which can help us choose the place suitable for drainage." (P6) "It is hoped that the satellite can provide data on: Vegetation cover rate and species, the outline of the village and the slope of the terrain, which has a great impact on the design." (P5) "It is difficult to obtain source data, for lacks of open-source information. All the data should be gotten from the Planning Bureau." (P5)
	Lack of actual terrain model, only by imagination, make the work inefficiently, even difficult to implement	"We have troubles on the projects with complex terrain. Party A cannot provide a terrain model consistent with the site, and the designer can only calculate according to the drawings, or imagine what the space looks like." (P6) "Every meeting, we have no actual model and specific size, only imagine it in air, so unable to draw conclusions, which make the work inefficiently" (P6) "The most important thing about landscape design is the landing nature. If the plan cannot be landed, it will make the workers be very hard, work overtime every day and the project is not pushed." (p6)
	It is hoped that spatial data models that can reflect the actual situation are obtained	"If you can help me form a very accurate space model, it can save me a lot of work." (P6) "I think a spatial model is very important to me, directly reflects the scene and the actual situation will help me much in design biochemical project." (P6) "If you can make everything parameterized, digitaled, and automatically generate models, you can greatly save manpower and cost." (P6) "It can help you work better if a 2D one is converted into a 3 D working interface" (P5) "It is hoped that there is higher accurate geospatial data to present the terrain more in line with the actual situation." (P5) "Three-dimensional data prefer to tow dimensional ones, which can identify the facade" (P5)
	Visitors hope to have a more understanding of the destination and get an in-depth experience	"Generally, white dolphins can not be met, it has close relationship with the weather and water quality" (P4) "Travel of glance will become less and less, visitors now will want to go deeper into the local area to get some experience" (P4) "Nowadays, young people do not like the traditional travel agency way, don't care how much money to spend, they care about the whole travel experience to be very systematic,therefore, which promote the birth of tourism customized division." (P3) "There are a lot of people willing to travel to more primitive places to learn more about the unique knowledge, but the content is unique." (P3) "The Education Bureau issued an order to study while playing, and have a better in-depth experience." (P3)
	A third party is needed for census and evaluation, it take a long time	"Planning is conducted once in five years, the government buys a large planning company to conduct a comprehensive survey of resources." (P1) "Ecological assessment will irregularly refer to third parties to evaluate, and reflect the effectiveness and change of protection through physical detection." (P2) "It is also just started to do ecological assessment, do protection land started later." (P2)
	The preliminary detection work is slow, leading to the next planning and design work cannot be promoted, and the project is inefficient	"The objective work in the early stage, compared with the analysis of geological detection data and collected these objective things, could not be assigned to us in the first time. As a result, we entered the preliminary work too early, did a lot of useless work, and became very tired.If the data design can be made more accurate and more efficient, it will be of great help to the advancement of a whole project." (P6) "In China, many projects are carried out at the same time, and the data requiring preliminary detection cannot be reached by the designers in time, resulting in the very passive back work and the reduced efficiency" (P6)
	The acceptance of large-area projects has great challenges	"The acceptance of the project mainly depends on people on the spot. If the area is very large, you need section acceptance, and it is difficult for the overall acceptance." (P5) "General engineering acceptance is based on CAD, as well as general mapping on site to check data on key projects." (P6)

Codebook 3

Theme	Group	Quote
The possible application of the satellites	There is a need for real-time cover monitoring and management of scenic	"The intelligent management platform of Nanshan is under construction, which is the protection and management of the comprehensive restoration of Nanshan, including the monitoring of animals and plants, environmental monitoring, and the management of tourists." (P2)
	Satellites are used to monitor vegetation gains	"Satellites can judge the plant rise." (P5)
	Satellite are used to regulate land use	"It is used by the country to supervise land indicators, guarantee agricultural land, and prevent its use for other construction or purposes." (P3)
	Satellite are used to monitor heritage status for protection	"Explore how to apply it to heritage protection, for example, monitoring Great Wall weathering, or stealing Great Wall bricks" (P3)
	A deeper understanding of the target tourists is needed	"AI is used for customized travel routes.Reference cases were generated through machine learning by collecting data on monitoring visitor pathways and behaviour.Visitors can match the recommended itinerary and route by entering their needs." (P3) "If you do not understand the source group and age group, you will not develop projects that meet the source" (P4)
	Satellite can be used in the tourist rescue market	"Venture with research teams, satellite phones is needed,even for the adventure Travellers.The rescue is a big market." (P3)

Codebook 4

Theme	Group	Quote
Provide cheaper and more convenient satellite services	Not understand the role of the satellite, I hope it can be easy to operate	"I don't know what kind of empowerment and functions of the satellite. I only know these high-tech things should has the landing ability, one is not cost too much money, the other is easy to operate. Be able to simplify the complex problems." (P1)
	The main reason for not using advanced technology is limited funding	"The smart tourism, including satellites, is basically blank. Although it is a very important, it cannot be supported due to the lack of local finance." (P1) "The government pay much attention on this work, but due to the limited funds, it can only support the most urgently needed problems, and tourism ranks

APPENDIX J – Project Brief

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	He	4837	
initials	Qian	given name	
student number	5121388		
street & no.			
zipcode & city			
country			
phone			
email			

Your master programme (only select the options that apply to you):

IDE master(s): ( ) IPD ( ) DfI (★) SPD

2nd non-IDE master:

individual programme: - - (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Prof. dr. Schoormans, J.P.L.	dept. / section:	DOS
** mentor	Dr. Cankurtaran, P.	dept. / section:	DOS
2nd mentor	Founder/CEO. Cao, D.Z.		
	organisation: Star Detect		
	city: Beijing	country: China	

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

comments (optional): Jan is the expert on customer behaviour, he understands customer very well. Besides, Pinar is the expert on strategy, she is good at considering from the business side. Their expertise combination can supervise this project perfectly.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

TU Delft

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair Prof. dr. Schoormans, J.P.L. date - - signature

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 27 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 27 EC

List of electives obtained before the third semester without approval of the BoE

(★) YES all 1st year master courses passed

( ) NO missing 1st year master courses are:

name J. J. de Bruin date 16 - 03 - 2021 signature

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: (★) APPROVED ( ) NOT APPROVED

Procedure: (★) APPROVED ( ) NOT APPROVED

comments

name Monique von Morgen date 29 - 03 - 2021 signature

Initials & Name Qian He 4837 Student number 5121388

Title of Project Bring small satellites to market

Personal Project Brief - IDE Master Graduation

TU Delft

Bring small satellites to market — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 11 - 03 - 2021 — 30 - 07 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

With the growth of the geographic information industry, there is an increasing request for more high-precision, high-quality, and high-security spatial geographic information services (LeadLeo & Shan, 2020), strong demand in the market for cost-effective satellites is raising. (iResearch, 2019). The founders of Star Detect had sensed the need for the satellite industry, they founded the Star Detect to focus on small satellite payload technology, aiming to provide a one-stop service for customers who have the need to observe space astronomy or earth geography. Including payloads designed according to customer needs; launching small satellites with payloads; managing satellite operations and providing corresponding data acquisitio and preprocessing services.

Star Detect is a young company and was just created in 2020 April with the background of starting a business on the campus of Tsinghua University. By the end of 2020 Dec, with Tsinghua University, Star Detect launched their first small satellite for detecting space astronomy. Meanwhile decided long term cooperation with Tianyi Research Institute and Nebulas, the leading companies in the small satellite industry. Star Detect has the planning to develop three generations of products, first generation focuses on space sensing and data acquisition, second generation focuses on satellite operation and data processing, third-generation focus on earth real-time perception. For now, Star Detect already realized the first generation product and has made advances on the second generation.

Star Detect has the ability to develop new technology and service, but it is facing the challenge of commercialization. This is because current China's remote sensing satellite market is not yet forming an industrialization effect in the market, has few technical application scenarios, limited service targets, and unclear business models. The end user of satellite are still mainly government and research institutions, other potential customers in the commercial market have little awareness of the value of using satellite remote sensing data, or hard to apply the data (iResearch, 2019). If Star Detect can find a way to introduce the small satellite payload technology into the market, it can take the lead in the market.

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introduction (continued): space for images

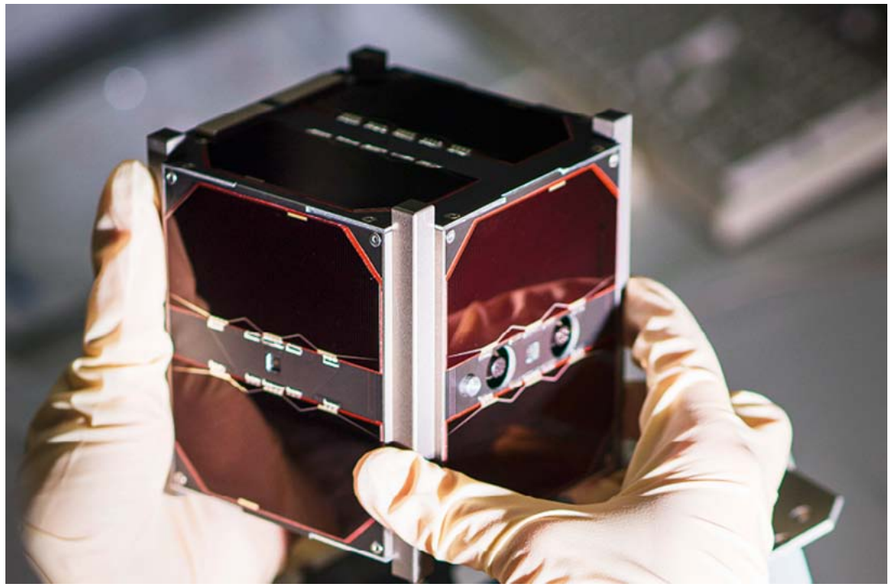

image / figure 1: The key product Star Detect developing - Cube satellite with payload

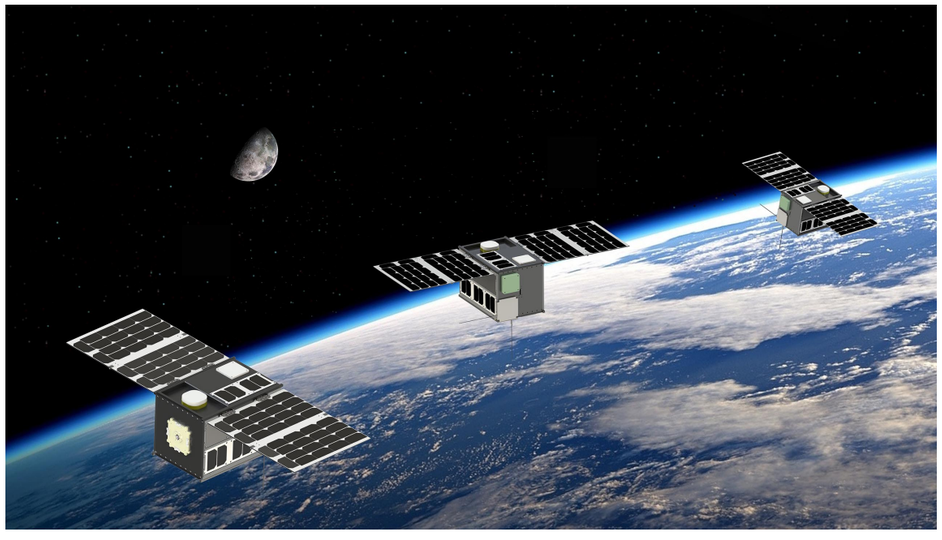

image / figure 2: Small satellites in the space

Personal Project Brief - IDE Master Graduation

TU Delft

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Under the low commercialisation business environment, as a start-up company, Star Detect is currently facing the dilemma that it is difficult to found business opportunities in the market. This is because satellite remote sensing in the past was mainly applied by professionals such as governments and research institutions, it was difficult to be used by the public and was not well introduced to the market. Even now through small satellites, remote sensing can be more affordable by private capital, potential customers in the market have little awareness of the value of using satellite remote sensing data, at the same time, there is not yet shown a matured profitable business model.

Therefore, the aim of this graduation project is to design a strategic plan for Star Detect to help them introduce the small satellite payload technology into specific markets, develop a profitable business model, also, and establish strategic advantages for sustainable development in the market. The following questions will be answered during the project.

1. What are the markets where that use small satellite payload technology? And in which markets may it be applied in the future?
2. What is the future vision of Star Detect?
3. What are the strategic steps to realise the vision? What markets should Star Detect enter and in what order?
4. Who are the competitors in the target market? And what is the positioning of Star Detect in the market?
5. What measures should Star Detect implement to enter the market?
6. How to form a profitable business model?
7. How can Star Detect be sustainably developing in the market?

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

In this project, I am going to explore the market opportunities and business resources of small satellite payload technology, and design a strategy for Star Detect to enter the business market and be sustainable. The end result will include a roadmap that guides Star Detect from the first horizons to the future vision, which detail by implementable plans through new product or service, and a business model to prove the concept's feasibility in the market.

This project will be guided by Vision in Product design (ViP) method and supported with strategic tools to address the complexity within the context. ViP is an approach that aims to design towards the desired future in which a product fits, it includes two phases - deconstruction and designing. The main task of deconstruction is to analyse the current product, consider the factors of its interaction with people and the context in which it is used. In the deconstruction phase, I will first learn a basic understanding of small satellite payload technology, search about its current application and relative rules & regulations; then analyze the existing small satellite market and stakeholders to understand the context; besides, explore future market opportunities through trend analysis and get inspiration from existing examples that introduce new technology into the market, and compare them with explored possibilities. After researching external factors, I will focus more on the internal factors - the company itself, the tools that will be used in this part include SWOT analysis, interview the employees and relevant stakeholders. Base on the findings from the deconstruction phase, in the designing phase, future vision will be decided together with Star Detect through co-creation, and verify by getting feedbacks. Then specific markets that Star Detect plan to enter will be defined, and further research will be done to discover the context factors, including analysing the market, competitors and customers. Afterwards, the company's position in the market will be determined and corresponding ideas will be developed and selected. Lastly, the chosen concept will be made into the prototype and evaluate with the customer and company, this process may need to be iterated several times to improve the quality of the final concept.

The final outcome of this project is expected to be a strategic plan for Star Detect to enter and sustain in the business market, including creating a future vision and developing a detailed roadmap to reach the vision. The strategy will be implementable through a concrete new product or service. Also, the business model will be created to prove the

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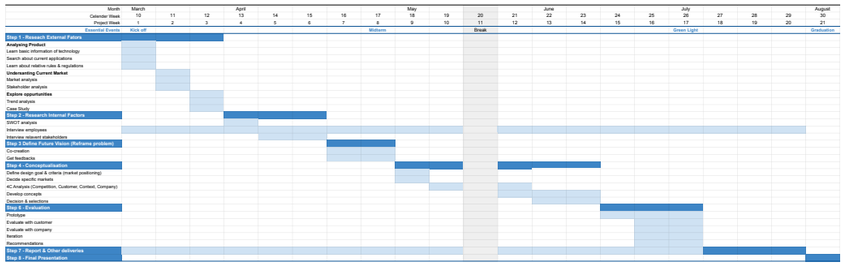
PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 11 - 3 - 2021 30 - 7 - 2021 end date



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MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

Usually people think that the satellite is not only far from us, but also far from our lives, only official organisations like the government or research institute have the power to launch and operate it. But Star Detect told me that satellite is actually very close to us, for example, it applies in the navigation software we use for finding roads, and help us know about the weather every day. And with the development of the commercial satellite market, satellite is becoming more and more closely related to our lives, it can help farmers better manage their lands, and providing real-time warning of natural disasters. My motivation for this project is to expand the application of small satellite payload technology, to make it has more contributions to people's wellbeing.

As a strategic designer, our strength is to exploit business resources and market opportunities for the companies and translate their strategy into a strong product or service portfolio. In this project, I want to prove to the company the power of design in the business world, help the company develop and launch products and services with social significance and commercial success. Besides, as a graduating student, I want to prove to the faculty that my knowledge, skills and abilities can provide effective solutions to the current and future changing complex social problems, and be able to well apply design theory and methods, prototyping and visualization skills in the project.

My ambitions in this graduation project are:
1. Help Star Detect better face the dilemma of technology commercialization with an implementable result.
2. The results of this project can have social significance, can meet one or several SDG goals (Sustainable Development Goals).
3. Expand my ability on research, design methodology and skills

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name Qian He 4837 Student number 5121388

Title of Project Bring small satellites to market

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