Smart Information Service Design Based on Autonomous Vehicles

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Abstract. With the development of information technology, automobile is moving from manually-controlled mechanical products to smarter system-controlled products. The paper talked about the change of the human-machine interaction and the corresponding smart information service design for autonomous vehicles. In particular, the paper analyzed what would happen on driver's disappearance and the changes of the interior space, in particular, how to afford the transferring of multi-functions and sharing. Through the study of the relationships between people, vehicles, information and environment, the paper explored the possible contents of smart information service, interaction ways provided by driverless vehicles and solutions for other public services except for transportation.

Keywords: Information service design · Autonomous vehicle
Interaction design

1 The Background of Autonomous Vehicle

Automobile is a product of technology and many innovations happens in the car industry. Nowadays, with the developments of autonomous vehicles, automobile is moving from manually-controlled mechanical products to smarter system-controlled products. As a result, the functions and usages of automobiles have changed a lot, from purely means of transportation to functional mobile spaces, which afford both mobile and various of services. Autonomous car refers to a new generation of car with partial or full automation by incorporating advanced sensor, control, actuator system and other devices, utilizing new technologies such as information and communication, internet, big data, cloud computing and artificial intelligence. Obviously, we have already lived in a multiple-screen environment visible or invisible, more intelligent in-car life and smart service based on the deep user research need to be discussed, and there should have been many possibilities and innovations.

Autonomous vehicle is the vehicle that is capable of sensing its environment and navigating without human input. (Gehrig and Stein 1999) A well-known autonomy level

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definition[1] is from the Society of Automotive Engineers, which defines five levels of autonomous vehicles: Drive Assistance, Partial Automation, Conditional Automation, High Automation and Full Automation, whether Automated driving system monitors the driving environment is a watershed, and the last 3 phases is much more closed to "no-driver" cars, Although there are different directions to achieve "no-driver" execution (Fig. 1).

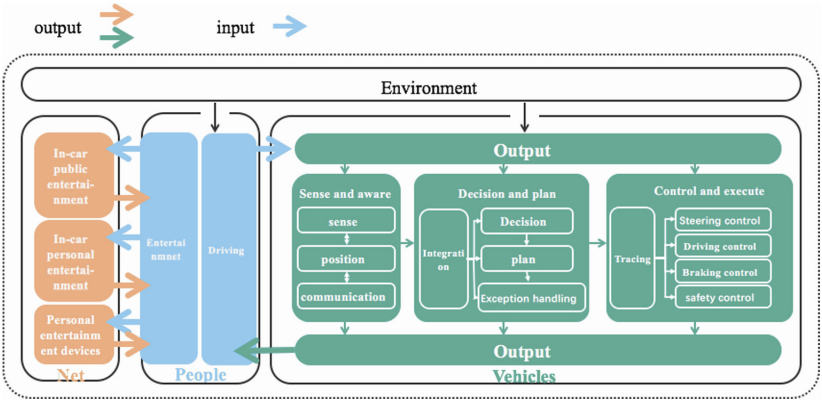

Fig. 1. The technical frame

2 The Interaction Design of the Autonomous Vehicles

Interaction is the way people use machine. Since the birth of the car, the interaction between people and vehicles has been an important topic. In addition to driving, the basic control, most people now have a certain degree of smart interactive experience between people and vehicles: such as easily obtaining vehicle state information (speed, mileage, current location, vehicle maintenance information, etc.), traffic information, cruise control, Bluetooth hands-free settings, air conditioning and sound settings.

[1] (1) Drive Assistance: automated system is a driver assistance system, driver and automated system shares control over the vehicle.
(2) Partial Automation: the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task.(3) Conditional Automation: the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene,(4) High Automation: the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene.(5) Full Automation: the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver.see also at https://en.wikipedia.org/wiki/Autonomous_car.

Human-machine interaction on autonomous cars obtained more attention. The communication and interaction between human and intelligent vehicles through images, sounds, vibrations, etc. is the way to use cars, and people can fully understand the information about vehicle operation and traffic environment, and make autonomous cars fully understand people's intentions and needs only through careful design.

Not only as a transportation vehicle, but as an important living space for people, the interior design of the car has never been reduced to pursuit of entertainment and comfortable life. Nowadays, with the rapid development of internet technology, a variety of connected services flooded, and there are huge increasing needs for in-car interaction. As shown in the Fig. 2, a taxi driver in Beijing use different mobile phones to communicate, receive travel services and entertainment.

Fig. 2. The multiple screens provided by mobile phones in a Beijing Taxi

More and more car manufacturers, including Tesla, Mercedes-Benz have introduced cars with a huge tough screen and many LCD screens. The integration of multiple screens including the LCD instruments, HUD, the control screen and the car information terminal, HMI entertainment screen in the rear seat, inside and outside the rearview mirror and other carriers is a hot topic. Especially when sharing is considered to be a promising direction with the development of autonomous vehicles, the connection between personal equipment and car equipment should be considered seriously.

Liberated from driving, people in-car can take their time freely and with the convenient internet service, more information service and applications will make the car to be a special information "terminal". Cars are no longer simply transportation tools from point A to point B. More human-machine (HMI) interfaces appear on the road, advanced in-car interaction with more intelligent interaction, such as voice control, touch control, gesture recognition, facial expression recognition, VR\MR, and even artificial intelligence was shown in the car. Real-time information services related to transportation greatly affect the transportation experience, which in turn affects the operational efficiency of the entire urban transportation system, at the same time, a large number of cars form a huge network of urban traffic awareness and the collected information will

further optimize the quality and efficiency of real-time traffic information. Big data provides the foundation for broader connectivity, greater awareness and deeper intelligence. The change brought about by new information should not only be efficiency, but more innovative ideas, products and services. Therefore, it is particularly important to study and explore the information service from the perspective of design (Fig. 3).

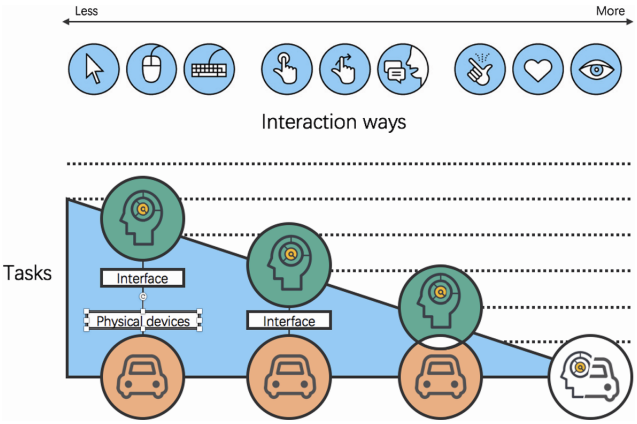

Fig. 3. Development of automobiles HMI

3 Smart Information Design for Driverless Vehicles

With the development of self-driving vehicles and related information technology, the interior space, human-computer interface and interactive process of automobile are undergoing a revolutionary change, and the automobile is gradually completed the change from a delivery machine to an intelligent agent provide mobility, communication and entertainment service, new applications on autonomous vehicles are booming, such as mobility office, digital consuming and online education.

Since the autonomous vehicle will take over all the driving work, the driver of the vehicle will become relatively free within a certain space. The car at this time to the people inside, no longer means the traditional delivery tools, people are not forced to sit in just for mobility, but to have a relatively private space for work, entertainment, and other actions. The car interior design will focus on making people feel free in the future.

In a flexible car interior space, screen visible or invisible can be everywhere in the future. People in car can use a variety of devices for online shopping, watching movies, and even playing VR games. Self-driving vehicles armed with huge screen display, projection, gesture control, voice recognition and AR technology could afford a complete virtual world for passengers.

Some new innovations on material, information technology will enrich the in-car experience. For example, the seat can record passengers' physical information, such as heart rate, weight, so as to change according to different acquirements, and the seat can become a massage seat, offering massage treatments to passengers. Perhaps in the future

only serious medical needs such as major surgery will be performed in physical hospitals, some simple treatments can be finished on the car on the way to hospital.

The impact of self driving on vehicles can make most vehicles lose the "privatization", while greatly expanding their "personalization" for individuals. It is said that shared cars would be accepted by most people with the development of autonomous car technology, that is, people do not need to have their own cars, the interior will become detachable and customizable through the Internet platform, people can set and make their own interior settings. The interiors could serve with different appearance in different sceneries even though in sharing, and it is also the best stage for the passengers to show their personality.

In the new space of autonomous cars, people can sit relative to each other due to changes in the layout of the seats, thus increasing the interactivity between passengers and many new possibilities on how to make use of the time in car. It is possible that the overall seating arrangement is like a small conference room or playroom where people can meet and talk, or make more free interactions.

4 The Project on Information Service Design and Interaction Design of Shared Driverless Vehicles

This year, Tsinghua University and UISEE Co., Ltd. plan to launch a project on information service design and interaction design of shared driverless vehicles. In the project, we will mainly explore the design of the autonomous vehicles for short-haul access, which refers to the transportation of people or goods between two fixed locations within a relatively short distance (usually within 10 km), such as the transportation to the aircraft far from airport lounges, transportation between communities and subway, bus and other transport hubs, transportation between different attractions within the scenic areas.

4.1 Key Questions

The key questions are as following:

1. Human-Machine Interaction of shared driverless cars
   In the project, we will discuss the interaction design for the people before, during and after using the shared driverless vehicles, explore how to effectively convey the vehicle's action plans and intentions to the passengers, pedestrians and how to use the vehicles.
2. The resource utilization of driverless vehicles
   To explore how to make use of the mobility and huge information processing capability of driverless vehicles to provide city public services other than transportation.

4.2 Main Tasks

1. User research on taking shared driverless vehicles

To analyze the different driving scenarios and user psychology based on the driver's disappearance and the changes of the interior space, in particular, how to afford the transferring of multi-functions and sharing. Before people really trust a driverless car, people must have confidence in the basic way they interact with the car. The project will focus on the research of operating authority priority and interaction rights settings among passengers.

2. Information and interactive design of shared driverless vehicles

David Benyon argued that people, activity, context and technology are four key factors for designing interactive systems. In the project, we will study the relationships between people, vehicles, information and environment, and discuss the contents of smart information service and interaction ways provided by driverless vehicles. The interactions between people and vehicles involve not only the passengers in the car, but also passengers outside the car and pedestrians. Besides, the interaction between vehicles and environmental facilities also has a significant impact on the use of vehicles. The project will focus on information and interaction design between passengers and vehicles. The interior space of the driverless car could provide many new experiences: windows (including sunroof) as a smooth surface in the vehicles are suitable for touch operations; with voice, gestures and other new interactive ways, multiple users can complete independent or collaborative operations easily. We will study many use scenarios and interactions with the car, such as reservation, controlling, emergency handling, parking, obtaining safety aids, navigating, communication, entertainment, real-time monitoring, redundant alarm, equipment interconnection and other information services (Fig. 4).

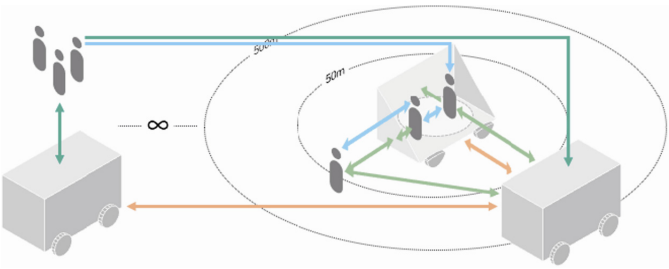

Fig. 4. Interaction model of driverless cars

The city transportation information service is very important for the city trip, which refers to the real-time information to the citizens about road traffic conditions, time interval between transfer stations, best transfer station, cost, weather conditions, destination status and other information through the whole trip. Normally, those information is provided through the mass communication, network, vehicle-mounted devices, roadside screens, etc. for citizens to choose appropriate transportation ways with efficiency. The great computing capability of driverless car could provide information service for the passengers in much more exciting ways, which is definitely worth discussing.

3. Public service design based on driverless vehicles

Operating costs for driverless vehicles are greatly reduced, and with a smart, removable space, driverless vehicles can afford many urban public service functions. The project will fully study the new public service design chance provided by driverless vehicles, such as express delivery, car renting, temporary functional space, etc.

The level of public service design not only reflects the design level of a country or region, but also reflects its design ethical standards. Only by digging out the essential needs from the interaction between people, cars and environment, and solving the problems in a larger ecosystem, can we give full play of public services and achieve the best social benefits. In the project we will study the whole service process by bringing together the needs of service providers and other relevant people for co-creating, emphasizing the involvement of all stakeholders. In the information service design system, the subject of experience is not merely from the passengers in car, but extends to other related people and a larger group. The project will explore new feasible service design by studying the existing context composed by vehicles, pedestrians, non-motor vehicles, signal lights, traffic signs and many other related factors.

4.3 Scheme and Some Concepts

The project will focus on the core interaction between people and driverless vehicles and carry out the research from the theory and method, as well as the design practice. At the theory and method level, the focus is on user psychological analysis, behavior analysis, putting forward the interaction design flow, method and evaluation system.

At the practice level, the focus is innovation design and demonstrating applications design on information service and interactions between people, shared driverless vehicles and the environment. We will explore some use scenarios to find some directions, such as work and entertainment. For example, with smart information service, passengers can easily organize their work, personal schedule, and get the information they need for the destination more conveniently. AR, VR and smart automatic control system (including temperature, light, odor, even the scenery around etc.), the multi-screen system can afford an amazing, unforgettable, and pleasing experience to every passenger by games, movies, online shopping, internet surfing and so on.

Here is an example about working in car, which will be easily to carry out. The screens in car can be used as expansion screens of personal devices. Passengers can log into the cloud platform, and the system would provide the access to download, upload, review, edit, and also guarantee the privacy (Fig. 5).

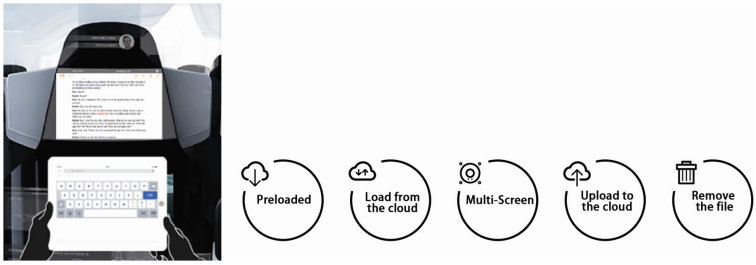

Fig. 5. Expansion screens and cloud service in autonomous cars

Some location-based service would be interesting. For example, passengers could connect to the scenery nearby through AR or VR facilities, or they may also find hidden massages on the way left by people outside the car from the window. If they found something outside they were interested in, like a charity donation massage from the house pass by, they could instantly go-for-it, or be involved (Fig. 6).

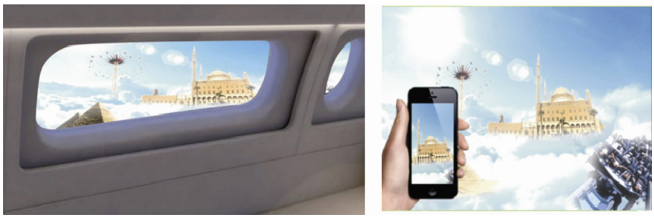

Fig. 6. Location based service

4.4 Possible Innovations

1. The change on driverless vehicles will have a significant impact on people's behavior, interaction and cognitive habits. The research is from the perspective of passengers and related people, through the analysis and research on the information and interaction design between people, vehicles, environment and information, combining the development of multi-channel interactive technology. It will present some innovative smart information service designs of driverless vehicles in a more complete human-machine interaction dimensions. These problems are quite different from how people control and use machines for decades, thus the solutions and achievements are very innovative.
2. The project will innovatively try to put forward the interactive performance evaluation standards from the perspective of users for driverless vehicles. As to the new vehicles, data will be the main index of cars instead of horsepower, living will be the main use of the vehicles instead of driving, interactions will be the main content of car evaluation instead of the traditional ones. The new evaluation standards will be presented on the basis of evaluation criteria of traditional cars and smart terminals,

and it will play an important role on the long-term development of driverless vehicles.

3. The project will propose some possible new public services and corresponding service designs based on driverless vehicles except transportation service. Driverless vehicles not only provide new transportation ways, but also have a great deal of potentials with the flexible space, the powerful information processing capabilities and the mobility, which can afford a variety of urban public services and be beneficial to save resources and sustainable developments.

5 Conclusion

In any case, interaction is just the way that the car is used. How to make fully use of the smart mobile agent is still on the way. In the future, autonomous cars will become people's intelligent mobile terminal, and more mobile-based services will be spewing out, bringing new business models and opportunities. The situation is almost the same with smart phones, calling is just one of many services ultimately serving people, and those truly affected peoples' life are the applications.

There are already many changes in the industry. Mercedes-Benz CONNECT was created to rebuild the brand as a lifestyle instead of transportation manufacturer. It supported to connect Mercedes-Benz vehicle at anytime and anywhere, and gave you fast and easy access to help and supports, like emergency call, remote diagnosis, and so on. All these are convenience, infotainment, safety and security, connected by the Mercedes-Benz CONNECT mobile app. Many automotive manufacturers sought cooperation with those companies providing information service, such as DIDI, APPLE with MOBILES, UBER,GOOGLE with TOYOTA, LYFT with GM.

Obviously, technology is always evolving, which make us expect for future smart cars,and innovative design will ultimately meet people's needs and carry people's imagination.

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