Research status and prospect of human-computer interaction of connected vehicles based on intelligent network

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Abstract: With the development of the times and the progress of science and technology, the automobile industry has developed rapidly. China's automobile ownership is rising year by year, and the automobile technology is constantly updated in this process. The intelligent networked automobile came into being and became the focus of development. For ordinary car users, especially drivers, the man-machine interaction system in the cockpit (such as on-board information system) is the main interaction object of the main task and sub-task of driving, which has an important impact on driving safety.At present, there are various ways of interaction, and more and more human-machine interface designs tend to combine multi-sensory channels such as vision, hearing, and touch. Safety and anthropomorphism have gradually become important considerations in automotive human-machine interface design. Automatic driving, as the embodiment of the core function of intelligent networking, is about to enter the development stage of L3 man-machine driving technology. People and machines share the driving right of the vehicle and can complete the driving task independently by the auto drive system in a specific scene. At this time, the complexity of man-machine relationship puts forward new design requirements for man-machine interaction. The problem of driving right handover has become an urgent problem for man-machine interaction.

1. Introduction

With the global motorization process dominated by automobiles and the development of users' psychological and spiritual needs, automobile products have gradually become a personalized mobile space for users, and the safety, comfort and efficiency of the driving process has become the focus of competition in the automotive industry [1]. Deeply understand the development status and intelligent level of intelligent networked vehicles, understand the research and development status of automotive human-computer interaction, put forward the research background and significance of the paper, and determine the research content and technical route of the paper [2]. Since the 1990s, the world automobile industry has experienced a sustained growth of nearly 10 years, and has entered a mature market stage dominated by updated demand. However, some markets are still in the market development stage of rapidly expanding output, and China's automobile industry is in this development stage. After entering the 21st century, the growth rate of the global automobile industry began to slow down, and China's automobile industry has also entered a mature market stage dominated by updated demand after the rapid expansion of blowout products in the last decade [3].

The intelligent active safety system is actually a very complex closed-loop system, and the driver is a very important part of it [4]. The safety system needs to provide information to the driver in real time, and the driver also needs to make corresponding response according to this information. In this process, there is always information interaction between the system and the driver [5]. Intelligent networked car refers to a new generation of cars equipped with advanced on-board sensors, controllers, actuators and other devices, which integrates modern communication and network technologies to realize the exchange and sharing of intelligent information among cars, roads, people, clouds, etc. It has the functions of complex environment perception, intelligent decision-making, collaborative control, etc., and can realize safe, efficient, comfortable and energy-

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saving driving, and finally replace people to operate [6]. ICV combines the technical advantages of autonomous smart cars and connected cars. It can be said that it is a fusion product of the Internet of Vehicles and smart cars. Intelligent cars can obtain information, make decisions and control autonomously. Internet technology can establish the connection between people and vehicles, vehicles and roads, vehicles and vehicles, and vehicles and all things, and provide intelligent dynamic information services.

2. Analysis of human-Computer interaction mode

2.1. Interactive channel analysis

Every day we live, we feel the digital life brought by interaction design all the time. Every second, tens of millions of people browse the web, use smartphones, play games, send WeChat, etc. While enjoying the convenient interaction brought about by the development of technology, we will also suffer from bad interaction design. For example, we don't know how to turn on some functions of the car, use navigation but get lost or detour, and the steps of website page design are cumbersome when online shopping and payment, etc. [8]. The vehicle running on the road, the driver in the vehicle and the road environment together constitute a typical man-machine environment system [9].When the vehicle is driving, driving behavior is a continuous reciprocating information processing process composed of information perception, judgment, decision-making and operation. Perception affects the operation after judgment and decision-making.As input, human beings have senses (hearing, sight, touch, smell and taste). As output, people's main strength and torque are output by hands and feet, but there are also sounds and position symbols (such as gestures or eye movements) [10]. Other possibilities are also being studied (for example, the current in the brain when reading). Control and manipulation design is one of the key issues in the design of automobile human-machine interface. A good control and manipulation design can greatly improve the driver's driving efficiency, improve driving safety, and maximize the performance of the vehicle. These four common operation and interaction methods are applicable to any level of smart cars before the highest level of FA smart cars, as shown in Figure 1.

Figure 1 Vehicle basic control and manipulation equipment

As the control equipment with the most human-computer interface in the automobile, most of the buttons are soft buttons using silica gel as elastic medium. Its advantage is that unlike mechanical buttons, they need long-term force application. Soft buttons only need fast operation and obtain instantaneous contact feedback. The basic driving behaviors controlled and manipulated are determined by the requirements of driving safety laws and regulations. They are the most basic control equipment. When studying the driver's operating behavior or vehicle dynamics model, we usually collect the steering wheel angle, brake pedal, accelerator pedal, clutch and other information, and use their data to make corresponding analysis. In this continuous cycle, drivers' visual channels, auditory channels, tactile channels and other channels often need to coordinate with each other and act together on the interaction process between drivers and vehicles.

2.2. Interactive design trend

Through the analysis of human-computer interaction systems of different car brands, the current

display devices in automobiles generally have the following three ranges: instrument panel, central control display screen, and front windshield (HUD). They each have different characteristics. More and more automobile brands choose to integrate road condition information and real-time navigation into the center of the instrument panel, close to the main field of vision, so as to facilitate the driver's observation. With the application of material technology, flexible electronic technology and nanotechnology in the field of tactile sensors, high-performance tactile sensors have been developed rapidly and put into use in vehicle human-computer interaction.

Vehicle interactive gesture recognition includes static gesture recognition and dynamic gesture recognition. Use a variety of advanced vehicle sensors to detect gestures, such as deeply trained convolutional neural network to recognize dynamic gesture information. Head posture information is highly correlated with eye movement information, so in eye movement information recognition, head movement information is usually collected at the same time, and the data fusion between them is considered. The basis of pleasure guidance is the result of the pleasure degree test and evaluation. Based on the evaluation results, the mechanism of low pleasure degree of the product is analyzed. Combined with the development of technology and the needs of target users for existing products and future products, the design and development can meet the needs of a certain period of time in the future. Products that meet the needs of users and can improve driving safety performance. The most important role of pleasure guidance in the in-vehicle information interaction system is to improve driving emotions in a confined space, reduce the danger caused by emotions to driving, and thus improve safety performance. The use of visual elements affects the style orientation of the interface. Visual interaction is the most widely used in human-computer interaction interface. The technology is the most mature. As we all know, human beings perceive and understand all kinds of things outside through visual organs and visual system, and use the brain to think. The blind people do not have the function of visual perception, so they can't transmit information for them through visual display. At present, the most commonly used auditory display is the alarm sound presented by the reversing radar and the language navigation in the car to plan the route. In the human-computer interaction system, the driver, as a complex human perception processing action system, has three basic functions in the interactive system: one is to complete the information input perception function through the human perception system; the other is to complete the information analysis, Processing, storage and processing functions, and the third is to control the vehicle through the human motion system. Figure 2 shows the interaction between human and vehicle systems.

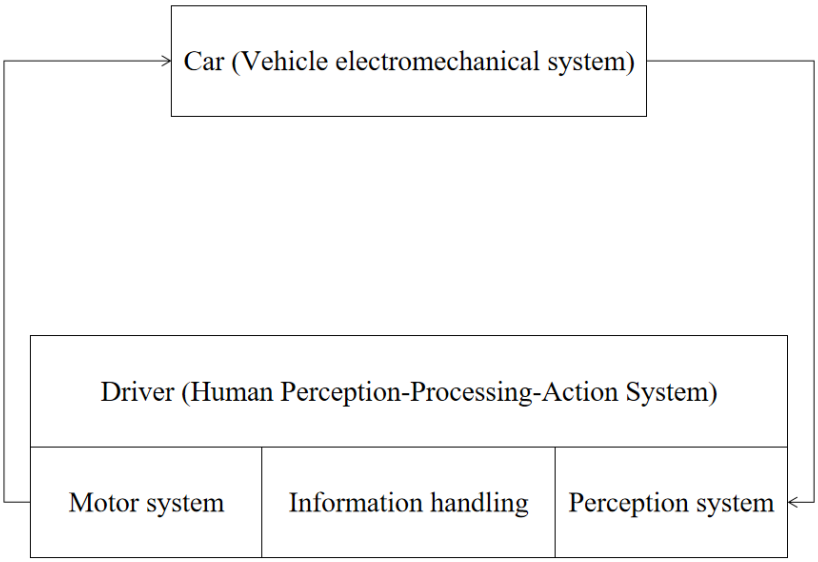

Figure 2 Person car system

3. Research on the visual design of the central control of the human-machine co-driving vehicle

3.1. Influence of human-computer interaction on central control visual design

According to the multi-sensory channel man-machine interaction design mode, the central control design of man-machine co-driving vehicle needs to balance the proportion of sensory information acquisition, divide the functions into modules, comprehensively consider the information acquisition efficiency and entertainment function experience, and weigh the three design elements of efficiency, safety and entertainment. As the main carrier of carrying functions, the screen is based on the realization of multi-sensory channel voice, gesture, eye movement, tactile and other interactive methods to provide technical support for the separate control of screen functions. It is a multi-screen display, and the screen functions are reset according to the user's habits, preferences and needs according to different driving scenarios of the user.

In the process of driving, users hope to improve the driving fun as much as possible, and audio is a good pastime. Although today's vehicles have multimedia video and audio functions, which can play music, radio, talk show and other programs. When you are depressed, you want to listen to soothing and decompressed music; When there are children in the car, you want to play cute cartoons, stories, etc. to meet individual needs. You can customize multimedia menus, set favorite music lists, and provide different types of audio and volume for different driving situations. In the intelligent driving stage, AR HUD can be superimposed with the actual scene, which can improve the user's cognitive grasp of the situation by visually guiding the road surface when the automatic driving encounters problems, thus shortening the user's access to information and reaction time. ICVs can obtain more information by detecting the status of the vehicle and associated vehicles, and collect, filter, and display information on the designed HMI interface. Real-time recording of driving parameters (such as vehicle speed, acceleration, offset distance, etc.) during driving, in which the voltage value of driving parameters directly output by the sensor is converted from analog signal to digital signal by the data acquisition card and transmitted to the virtual scene simulation system. software section.

3.2. Operation mode analysis

At present, the mainstream manipulation methods mainly include physical manipulation, touch screen manipulation, voice manipulation and gesture manipulation. Physical manipulation is to control the vehicle through physical buttons, knobs, paddles, etc. Gesture manipulation is to install a sensing module in the system, and through the analysis of the driver's specific gestures, it is converted into instructions for operation. This technology has great potential for energy recovery methods and efficiencies, electromechanical compound braking control, and control of drive motors and power converters. The display screen in the central control area can place the basic control, vehicle information, service settings, multimedia entertainment and other functions of the vehicle to reduce the visual fatigue caused by the accumulation of functions. One screen is multi-purpose and split-screen control is completed through natural voice. Passive interaction satisfies the visual interaction experience in different driving scenarios. Although a lot of research work has been carried out on human-computer interaction, at present, the development of most vehicle intelligent HMI products focuses on how to add more functions, but does not pay attention to the user experience of products. In particular, there is still a gap in the development of such products between vehicle enterprises and technology companies.

The main achievements of vehicle-mounted human-computer interaction focus on the recognition technology of human-computer interaction instruction based on bioelectrical signals (EEG, EMG, ECG, etc.) and facial expressions. Among them, the human-computer interaction instruction recognition technology based on bioelectrical signals can perceive people's implicit interaction intention, and obtain interactive input instructions through the recognition, analysis and characterization of tiny bioelectrical signals, so as to assist ordinary drivers and physically handicapped people to realize vehicle control.With the maturity of behavior observation equipment

such as facial expression recognition system and finger movement tracking system, further research has been done on user experience evaluation criteria, and the evaluation indicators based on user behavior/psychological mobile phone-car interconnection product experience test are also more strict and scientific.

4. Conclusions

With the transformation of vehicle driving from manual to automated development, the user's identity in the car will change from a driving operator to a driving experiencer in the automatic driving system mode. The change of user identity will lead to a different way of human-computer interaction in the central control area. Compared with the previous design requirements, more consideration should be given to the combination of human-machine relationship, visual display, and vehicle control.Intelligent networked vehicle is the direction of future vehicle development. It can connect vehicles with other information, which will greatly change vehicles and traffic. Intelligent driving is the focus of current research. The interactive mode of intelligent driving will also be the direction of intelligent driving research in various industries. From the development status of automobile human-computer interaction interface, there are many ways of automobile human-computer interaction. More and more human-computer interface design tends to combine multi sensory channels such as vision, hearing and touch. Safety and personification have gradually become important considerations in automobile human-computer interface design. According to the design of the new human-computer interaction mode, the central control visual display design will also be changed accordingly.

References

[1] Tan Zhengyu, Dai Ningyi, Zhang Ruifo, et al. Research status and prospect of intelligent networked automobile human-computer interaction [J]. Computer Integrated Manufacturing System, 2020,26(10):18.

[2] He Keyan, Yu Shucong, Meng Jian. Automobile interaction design in the era of intelligent networking [J]. Automobile and Accessories, 2019(15):2.

[3] You Zuolong. Intelligent networked automobile simulation test method [J]. Automotive Engineer, 2019(4):4.

[4] Zhang Guoyang, Wei Lidan, Xu Li, et al. Talking about the development and application of automobile human-computer interface [J]. Enterprise Technology and Development, 2017(1):4.

[5] Zhang Chengye, Zhang Xianmin. Technical challenges and application ideas of human-computer interaction driven by artificial intelligence [J]. Digital Technology and Application, 2018(5):2.

[6] Ocean. Innovative exploration of human-computer interaction design curriculum under the trend of intelligence-a review of Human-computer interaction design and artificial intelligence [J]. Journal of Chinese Education, 2022(2):1.

[7] Li Xia, Sun Ningze. Application of human-computer interaction technology in automobile field [J]. Computer nerd, 2018,000(020):253.

[8] Tan Hao, Sun Jiahao, Guan Daisong, et al. Research on the development trend of intelligent vehicle human-computer interaction [J]. Packaging Engineering, 2019,40(20):11.

[9] Chai Runze, Sun Mingyang. Research on the design of automobile voice assistant based on human-computer interaction technology [J]. Industrial Design, 2021(1):2.

[10] Wang Lei, Pang Youjun, Wang Yafang. Analysis of HMI experience and future trend of intelligent cockpit [J]. auto time, 2021(3):4.