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Research on human-computer interaction design of intelligent vehicle based on situational awareness

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Abstract: With the rapid development of automotive intelligent technology, the human-computer interaction design of intelligent vehicles has been paid more and more attention. Good human-computer interaction design can improve driving experience and enhance driving safety. However, some existing human-computer interaction designs of intelligent vehicles have some problems, such as lagging concept, lack of adaptability of interactive interface and insufficient response ability of intelligent system, which lead to poor human-computer interaction effect. In response to these problems, this paper proposes countermeasures for human-computer interaction design of intelligent vehicles with situational awareness as the core, including strengthening the position of situational awareness in the design concept, optimizing the situational adaptability of the human-computer interaction interface, and enhancing the coordination between the driver and the intelligent system, so as to improve the naturalness, efficiency and safety of human-computer interaction.

Keywords: Intelligent vehicle; Human-computer interaction design; Situational awareness; Interactive interface.

1. Introduction

With the rapid development of emerging technologies such as artificial intelligence, Internet and big data, the automotive industry is experiencing profound intelligent changes. Automotive intelligence is mainly reflected in automatic driving, intelligent safety assistance, vehicle information entertainment and other aspects. Compared with traditional cars, the control of intelligent cars is more complex, and human-computer interaction has become the top priority of intelligent car design. Good human-computer interaction design can not only enhance the driving experience, but also enhance the driving safety. At present, the human-computer interaction design of intelligent vehicles faces many challenges, among which the most prominent problem is the lack of situational awareness. Situational awareness refers to the system's ability to perceive and understand the time, place, people and other situational information in the environment, and make reasonable responses accordingly. The lack of situational awareness will greatly reduce the human-machine interaction effect, and it is difficult to realize the natural, efficient and safe human-machine interaction. Therefore, how to optimize the human-computer interaction design of intelligent vehicles based on situational awareness is an important issue that needs to be solved.

First, the importance of situational awareness in human-computer interaction design of intelligent vehicles

2. Situational awareness can significantly improve the naturalness and humanization of interactions.

The system can freely adjust the interaction mode and content according to the driving environment, driving state and other situational information [1]. For example, provide simple road condition information during normal driving, and switch the large-screen navigation mode in case of congestion; By analyzing the driver's body movements and facial expressions, the emotional state can be judged and adjusted. Secondly, situational awareness can help improve interaction efficiency. The system can actively capture the situation change, adjust the information output strategy in time, and accurately present the core information. With situational awareness, the system can only show route navigation during normal driving, and give priority to safety warnings in case of danger, helping drivers to concentrate highly and improve driving efficiency. In addition, situational awareness helps to ensure interaction security. The system can accurately identify dangerous driving situations, and adjust the presentation form according to different situations, such as switching to voice output when driving at night to avoid affecting night vision; When the road is complex, switch the large-screen navigation mode, etc., to minimize the visual and auditory burden of the driver and ensure driving safety.

3. Problems existing in the current human-computer interaction design of intelligent vehicles

(1) Disconnection between design concept and situational awareness

The human-computer interaction design of some intelligent cars is too pursuit of scientific and technological sense and visual shock, ignoring the in-depth consideration of the driving situation. Interaction design lacks the theoretical guidance of situational awareness, and it is difficult to meet the real needs of drivers only with subjective experience. Research shows that 84% of current drivers are dissatisfied with the current design, and the driving situation is a complex dynamic environment that requires designers to think deeply and analyze from multiple dimensions. In today's automotive design landscape, too much emphasis on technological and functional innovation often ignores a deep understanding of the environment in which the driver actually uses it. This way of design thinking, which is divorced from the specific situation, easily makes the product unable to accurately meet the personalized needs of users in different driving situations. Therefore, interaction design should not only be limited to the surface of the interface beautification or the stacking of technical parameters, but should be transformed into a kind of

context-conscious consideration. It is far from enough to rely only on the designer's personal experience. It is necessary to draw on relevant theoretical knowledge to systematically analyze and model typical situations, so as to formulate a design scheme that meets the needs of the situation.

(2) The human-computer interaction interface does not adapt to the situation

There are many shortcomings in the existing vehicle human-computer interface, which are mainly shown as: the interface layout is unbalanced, the operation path is too long, and the information presentation mode is single. These problems directly affect the degree of matching between the interactive interface and the driving situation. Taking medium-sized models as an example, the average area of the dashboard display area is only 200cm2, while there are more than 30 functional options, and there is a problem of information congestion. Some data show that the proportion of driving errors caused by interactive interface problems is as high as 23%. Vehicle human-computer interface is not only the key to communication between drivers and intelligent systems, but also an important tool for them to obtain information and make decisions during driving. However, if the interface layout is unreasonable or improperly designed, it is likely to lead to visual interference, making it difficult for drivers to focus on road conditions, thus affecting the reception and processing of key information; Too long the operation process will bring pressure to the driver, so that the driver is distracted when driving how to complete these cumbersome steps, thus increasing the danger of driving. In addition, a single information presentation model often fails to meet the diverse needs of drivers, and the result can be ambiguous and inefficient information delivery.

(3) Insufficient response of intelligent systems to situational changes

Current automotive intelligent assistance systems are able to pick up certain cues in the environment and show some perceptual ability, but they are not as good at understanding complex situations and responding accordingly. This phenomenon is mainly attributed to the system's lack of deep understanding of complex situations, as well as the lack of sufficient comprehensive analysis ability and decision-making flexibility in the face of various emergencies. Taking intelligent voice assistants as a prime example, the system often encounters challenges when vehicles are driving on noisy roads. Even the most subtle instructions can be drowned out by noise, making it difficult for the system to accurately identify and execute them. In this case, the voice assistant does not provide appropriate feedback or take appropriate action, but may distract the driver or lose control of the vehicle, increasing the risk of traffic accidents. Although the current automotive intelligent assistance system has a certain ability of situational awareness, it is not ideal in understanding and response. The main reason is that these systems lack the comprehensive analysis and decision-making ability for complex situations. According to the data, in a strong wind environment above level 6, the recognition accuracy of the voice assistant is only 53%. This not only seriously affects the efficiency and convenience of voice interaction, but also may lead to security risks.

4. The countermeasures to improve the situational awareness in the human-computer interaction design of intelligent vehicles

(1) Strengthen the position of situational awareness in design concept

Situational awareness is an advanced cognitive ability designed to understand and respond to relevant information based on specific circumstances. Integrating this concept into the human-computer interaction design of intelligent vehicles is crucial to improve driving safety and comfort [2]. First of all, the designer needs to build a perfect driving situation model, to carefully classify and define various possible situations. For example, driving situations can be categorized into normal driving, congestion, bad weather, emergency, and so on. In each scenario, drivers face different risks, allocation of attention, and information needs. Secondly, differentiated interaction strategies are developed for different situations. Under normal driving conditions, the interactive interface can be simple and practical to avoid excessive information interfering with driving; In the case of congestion, it can provide more entertainment and office assistance functions; In case of inclement weather, priority should be given to displaying weather information and road condition reminders. Through targeted interaction design, the timeliness and effectiveness of information output are ensured. In addition, it is necessary to strengthen the theoretical research of situational awareness. We can learn from the research results of cognitive science, human factors engineering and other related disciplines to deeply explore the cognitive process and behavior pattern of human beings in different situations. On this basis, the system guidance methods and design principles are formulated for the human-computer interaction design of intelligent vehicles, so that the interactive experience can truly meet the needs of humanity. In short, only when situational awareness runs through the entire design process, can the human-computer interaction interface of intelligent vehicles change with the situation and keep pace with The Times, providing drivers with an efficient, safe and pleasant experience. This is not only related to the development of intelligent driving technology itself, but also will promote the continuous evolution of the automotive industry in the direction of intelligence and humanization.

(2) Optimize the situational adaptability of the human-computer interaction interface

As an important carrier of direct docking with the driver, the situational adaptability of the human-computer interface has a profound impact on the human-computer interaction effect. The optimization of interface design should take the improvement of situation adaptability as the core goal, and start from two aspects: rational allocation of display area and optimization of information presentation form. Reasonable allocation of display area is the primary task of optimizing human-computer interaction interface [3]. During the design, the display area such as the dashboard should be planned according to the importance of the information. The emergency information is placed in the most prominent position, so that the driver can get the key information in the first time, to avoid the sight of too much irrelevant information, distracting. At the same time, the display location of different information should also follow the principles of intuitiveness and driving habits, so as to make information retrieval more efficient. On the other hand,

optimizing information representation is also the focus of situational adaptive design. The interface needs to dynamically adjust the presentation of information according to the actual driving situation, including visual, auditory and other forms. For example, when driving at night, the brightness of the interface can be appropriately reduced to avoid the glare of the light affecting the line of sight; When the road is empty, the journey information can be output by voice to reduce the visual burden of the driver. In different environments, the priority of information acquisition is also different, and various situations should be fully considered in the design to realize the dynamic adjustment of information representation. In short, the human-computer interaction interface design pursues a high degree of situational adaptability, and minimizes the driver's cognitive burden, improves driving safety, and achieves efficient human-computer interaction through reasonable allocation of display areas and optimization of information presentation forms. Only when it is highly consistent with the actual driving situation, the interface can really play its due role and meet the driving needs.

(3) Enhance the coordination between the driver and the intelligent system

To improve the human-machine coordination between the intelligent system and the driver is a key link to realize the development of intelligent driving. Research shows that advanced interaction modes, such as active voice interaction and gesture control, can reduce the driver's eye time off the field by 22%, reducing the risk of distraction. Personalized interaction is also favored, with 75% of consumers preferring a personalized in-car experience and 64% saying it is an important factor in choosing a car. One of the ways to optimize man-machine cooperation is to improve the situational awareness of drivers. One study found that virtual simulation training reduced the reaction time of novice drivers in complex situations by 15% and improved their risk assessment ability by 30%. At the same time, automakers are using big data to model common driving situations. General Motors used 10 terabytes of data to train a model that prevented 85% of accidents in tests of semi-autonomous driver-assistance systems. Another focus is to enhance semantic understanding of on-board systems. In 2020, Google's BERT semantic model was 7 points higher than the traditional model in the public assessment, achieving an excellent score of 88 points, significantly improving the level of understanding of natural language. The progress of semantic technology lays the foundation for the realization of natural and efficient human-computer interaction. Finally, perfect human-machine semantic understanding ability is a prerequisite for good collaboration. At present, the mainstream automotive intelligent system's ability to understand natural language is still relatively limited. In the future, we need to increase the investment in semantic understanding, knowledge modeling and so on, and constantly improve the system

Cognitive level, to achieve more natural and efficient human-computer interaction and collaboration.

Table 1. Interactive model market research table

Index	Numerical value
The advanced interactive mode reduces the driver's eye time away from the field	22%
Percentage of consumers who prefer a personalized in-car experience	75%
Percentage of people who consider personalized experience an important factor in choosing a car	64%
Virtual simulation training can improve the novice driver's risk assessment ability	30%
General Motors uses the amount of data to train semi-autonomous driving models	10TB
Percentage of accidents prevented by GM semi-autonomous driver assistance systems	85%
2020 Google BERT semantic model in public evaluation scores	88 point
The Google BERT semantic model scores higher than the traditional model	7 point

5. Concluding remarks

In short, situational awareness is the top priority of human-computer interaction design for intelligent vehicles. At present, although there are some shortcomings, the feasible optimization countermeasures are put forward. It is believed that through continuous theoretical research and technological innovation, human-computer interaction design will achieve the organic unity of situational awareness, intelligent response and human-computer collaboration, and bring a more natural, efficient and safe intelligent experience to drivers.

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