

Research on icon design of automotive central control interface for functional semantic cognitive matching

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Abstract: With the development of automotive technology, the complexity and information relevance of the interface of vehicle-mounted interactive systems have been continuously improved. The development of the interface of vehicle-mounted systems has led to the emergence of a large number of functions, and at the same time, visual ICONS representing these functions have also appeared in a large number. However, the disadvantage of this progress is that when drivers use these services, It increases the probability of distraction in the primary task of ensuring safe driving when using these services. In this paper, we propose and validate a method to investigate and optimize icon semantics in safety-critical user interfaces, thus providing icon design insights for matching ICONS and functions to proper usage logic while driving.

Keywords: Semantic research; Icon design; Automotive interaction design; User experience.

1. Research background of automotive head-up display interface design

1.1. Semantic analysis of automobile interaction ICONS

With the development of automotive technology, the complexity and information relevance of vehicular interaction systems are increasing. This improvement in technology means that drivers have access to a growing number of novel in-vehicle applications that can provide more communication, entertainment, route search, and other useful in-vehicle services. However, the downside of such advances is that drivers using these services increase the probability of distraction in their primary task of ensuring safe driving. The development of in-car systems has led to a proliferation of features, along with the visual ICONS that represent these features. In addition, as new applications are introduced into automotive systems, new ICONS that can be easily distinguished are needed to represent these functions and applications. In the case of driving, two seconds to the line of sight is not concentrated on the road is very dangerous, so we design should help drivers to find what they want as soon as possible from the menu function, so you need to find the optimum combination of application icon, so that it can meet the needs of the driver, as long as can see at a glance to recognize its function. Therefore, the realization of effective icon design in human-computer interaction is particularly critical for the interaction between driving and in-vehicle entertainment information. In this interactive context, since attention to the road situation is the top priority, the time spent on processing information from different situations is the key factor. Due to the distraction of attention from other ICONS on the car screen, it may be difficult to select an icon for operation, which requires precise positioning. Therefore, the focus of this paper is to study the corresponding degree of icon semantics and cognitive understanding, as well as the relationship between the visual representation of ICONS and their intended meaning. The icon menu includes a set of ICONS, whose content needs to be distinguished from the meanings represented by other ICONS in the same set. Each icon in the menu needs to be semantically as close to its

intended function as possible, while semantically as far away from the function of other ICONS in the same icon set as possible, so that drivers can quickly identify and select the desired function while driving, improving safety.

1.2. Icon design for the interface of the car interaction system

Modern car interior are equipped with a variety of warning lights and indicators and other auxiliary functions of the control key, the purpose of using ICONS or symbols is to rationalize the function of the car key, so that it can be safe, reliable, efficient operation, is an important link in the design of the car. However, there is an unreasonable man-machine relationship in the interface design of vehicle-mounted interactive system, which may cause safety hazards.

At present, there are some problems in the icon design, such as the design intention does not conform to the user's thinking mode and the orientation deviation of evaluation criteria, which can be summarized as follows:

Focus only on aesthetics. The design should pay attention to the degree of meaning expression of the icon, what are the cognitive characteristics of the user, whether the user can understand, and whether there is ambiguity.

Lack of generality. There is no user involvement in the design, evaluation and improvement process, and the user is disconnected.

The icon integrity, poor connection. ICONS are not a single existence, but in a systematic way to express the information to be delivered, to grasp the connection between ICONS, to avoid a single design and evaluation of design results.

1.3. Research significance and main research routes

ICONS represent the objects they represent, that is, ICONS often derive their metaphors from real objects to emphasize their familiarity (Blackwell, 2006), while in the case of technology products, they can be defined as graphical representations that symbolize actions in a technological environment (Ware, 2004). ICONS are powerful elements in visual communication, and properly designed ICONS can reduce the complexity and psychological burden of a system (Gittins, 1986) and provide better cognitive function than

words (Garcia et al., 1994). In addition, properly designed diagrams are easier to find, recognize, remember, and learn. As a result, ICONS are easier to recognize than textual information (Lodding, 1983), can be recognized quickly (Caplin, 2001), and are well remembered (Weidenbeck, 1999). As a result, ICONS can be perceived immediately and enhance the immediate communication and visual usability of inter-activity systems. This immediateness of perception makes well-designed ICONS easier to grasp and understand (Mullet and Sano, 1995).

Icon design should follow the principle of generality, representing a broader category in a cohesive way in a set of ICONS; The most basic features of an image should be emphasized by the feature; In order to design interactive better, the design needs to conform to the user culture and use environment; In addition to these icon design principles, it is also necessary to understand the efficiency of drivers' cognitive processing of icon semantics in order to conduct safe interaction while driving. In order to make visual information processing effective in the context of time and safety critical interaction, ICONS and functions should match each other to the correct usage logic. However, there is a lack of research on the interpretation and semantics of user's visual icon design in the interface of vehicle-borne interactive systems. Since the number of vehicular applications provided to drivers has increased greatly, it is emphasized that all functions in the interface of vehicular interactive systems should have corresponding descriptive and intuitive ICONS to clearly express their meanings.

2. Design of research experiment on icon cognition of automotive information system interface

2.1. Selection of ICONS

Autohome Research Institute and 21 New Automotive Research Institute jointly released the 2022 China Smart Vehicle Development Trend Insight Report, focusing on users, products, enterprises and other parties through massive big data

And test to get the 2021 smart car ranking. The experimental icon will be selected from the vehicles in the ranking. The icon selection function is as follows: Personal center, personalized Settings, home page, multimedia, Settings, volume, navigation, radio, atmosphere lights, application management, vehicle Settings, driving assistance, a total of 12 functions, according to each function, select five cars from the ranking, from its interactive interface to select the corresponding function of the icon as the experimental material. A total of 60 ICONS were obtained and used as experimental materials.

2.2. Selection basis of tested users

A total of 120 volunteers with more than one year of driving experience in good physical and mental state were recruited to conduct the questionnaire test. Participants were not given hints about the contents of the questionnaire before it was handed out.

2.3. Steps of icon semantic cognition experiment

The experiment was divided into two rounds. In the first round, all ICONS were classified according to their functions, and the subjects were required to classify five ICONS of the

same function according to 1 according to their own experience and understanding. These five options match the icon semantics and functions. Each subject needs to select 60 ICONS in 12 groups according to this method. The results can be analyzed and the ICONS with the highest cognitive degree in each function can be obtained. According to this method, 12 ICONS that are most consistent with the cognition of the function can be obtained. On this basis, the 12 ICONS will be analyzed to obtain their consistent design features, which will be used as a reference, and the design will be improved by combining integrity and universality to obtain a set of 12 new ICONS. In the second round of experiments, the modified new ICONS with the same function were compared with the original reference ICONS, and the AB test was carried out. The results were calculated and the conclusion was drawn. In this experiment, we aim to find the rule that the user's judgment and selection best match the icon's semantic meaning and its function. Based on this rule, the icon design will improve the user's correct rate of icon semantic reading, reduce the driver's mistakes in the driving process, and improve the driving safety.

3. Research on icon cognition of automotive entertainment information system interface

3.1. Icon cognition evaluation

Function Icon	1	2	3	4	5
Personal center					
Personalized					
The home page					
Multimedia					
Set up the					
The volume					
Navigation					
The radio					
Atmosphere lamp					
Application management					
State of the vehicle					
Auxiliary driving					

Figure 1. Materials of Experiment 1

The average	3.943	3.857	3.79	3.895	3.81	3.876
Icon						
The average	3.867	3.848	3.886	3.857	3.91	3.886
Icon						

Figure 2. ICONS in Experiment 1 whose meaning is considered to be the most consistent with each function

In the experiment, it was found that when selecting ICONS with objective objects in the design, such as personal center, Settings, radio and vehicle Settings, subjects tended to choose more specific and objective ICONS that fit the functional image. In personalized Settings, home page, multimedia, atmosphere lamp, volume, navigation, auxiliary driving these no specific image as design based on functional will more choice in linear and high contrast icon, when choosing the application to manage the function corresponds to the icon, more subjects still choose the linear elements, as well as the more familiar elements as the most conforms to the icon.

Therefore, it is speculated that when there is a real object as a reference, the metaphor of the icon usually comes from the real object to emphasize its familiarity, while when there is no real object as a reference, the icon usually represents its function by the symbol of the technical environment.

3.2. Icon Design

In the first experiment, some rules of icon selection were obtained, namely, when there was a real object as a reference, the metaphor of the icon was usually from the real object to emphasize its familiarity, while when there was no real object as a reference, the function of the icon was usually represented by the symbol of the technical environment. In the following, I will follow this rule to improve the design of the 12 ICONS obtained in the first experiment that the participants think the icon semantic is the most consistent with its function, so that these ICONS can have a unified style and a stronger integrity after design, and appear in a system with harmony and no sense of violation.

The improved ICONS are as follows:

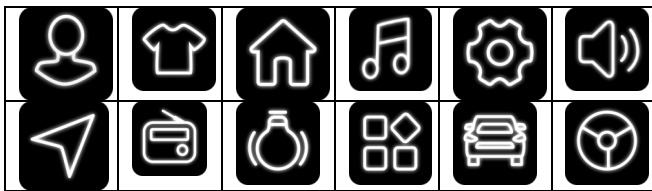


Figure 3. ICONS optimized according to Experiment 1

The icon design is linear, the use of black and white color to make the contrast more prominent, in the personalized Settings, home page, multimedia, atmosphere lights, volume, navigation, application management, driving assistance in the design of these ICONS are more concise, and the symbol of the technical environment atmosphere is more relevant; In the design of personal Settings, Settings, radio and vehicle Settings, the characteristics and shape of the metaphorical objects of the ICONS are more emphasized. The optimized design makes the ICONS more familiar, the semantic and functional relevance of the ICONS are stronger, and it is more convenient for drivers to read the meaning of the ICONS. When using and looking for corresponding functions, the time is reduced, and the road driving safety is increased.

3.3. Design Evaluation

After optimization design, in order to verify the user read the semantic rule is correct, will have the same function of the image set A/B testing group, which has more than one year experience excellent physical and mental state of subjects to choose one of the icon semantics and function of the joint ICONS, each subjects need to choice of 12 groups of ICONS, Thus, the experimental results were obtained for analysis.

In Experiment 2, the subjects chose one of the ICONS whose semantic meaning and function were the most consistent. The selection probability of A/B test was as follows:

Icon function	A set of ICONS	Group B icon
Personal center	 20.95%	 79.05%
Personalization Settings	 20.95%	 79.05%
The home page	 22.86%	 77.14%
Multimedia	 20.95%	 79.05%
Set up the	 23.81%	 76.19%
The volume	 23.81%	 76.19%
Navigation	 15.24%	 84.76%
The radio	 14.29%	 85.71%
Atmosphere lamp	 14.29%	 85.71%
Application management	 16.19%	 83.81%
Vehicle Settings	 20.05%	 79.05%
Auxiliary driving	 18.1%	 81.9%

Figure 4. Materials of Experiment 2

In the A/B test, the percentage of group B was selected was much higher than group A, which proved that the semantic expressed by the icon in group B was more consistent with the function represented by the icon in the subjective perception of the subjects, indicating that the semantic of the icon in group A was enhanced after design optimization, and the matching degree between the icon semantic and its function was greatly enhanced. The results of Experiment 2 confirm that the rule deduced from Experiment 1 is the correct design direction.

4. Conclusion

The number of on-board features offered by modern in-vehicle interactive screens will continue to increase, and the more features there are, the more important it is to optimize the user interface to reduce visual requirements. In this study, we focus on the semantic match with its actual function of ICONS, he can according to the functions and ICONS semantic matching the amount of processing time for guiding the design of the icon, in car head-up display interface interaction design icon, in the design of objective things as a design based on ICONS, more specific objective, joint function image icon, When designing ICONS with no specific image as the design support, linear and strong contrast ICONS will make the icon semantic more consistent with the function. In addition, the more familiar elements will also make the driver's understanding of the icon semantic more consistent with the function.

Future research on icon design in vehicular infotainment systems will benefit greatly from the research on icon semantic understanding and function matching, because the

relevance of the function represented by the icon semantic is related to the mental model of the user's action. Although we focus here on ICONS for the interface of vehicular interactive systems, the current findings, methods, and design principles are likely to be applicable to the design of vehicular user interfaces in general.

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