Research on the Design of Vehicle-mounted Full-LCD Instrument GUI

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Abstract. As a special kind of intelligent mobile device mounted in vehicle, Full-LCD instruments are replacing mechanical pointer instrument at a faster pace. The requirements of design quality of vehicle-mounted full-LCD instruments are getting higher and higher. This paper mainly studies the design problem of vehicle-mounted full-LCD instrument GUI. The particularity of vehicle-mounted full-LCD instrument in interactive mode, function setting and application scene is analyzed. This paper reveals the new changes when applying MVC architecture pattern to realize the layered design of vehicle-mounted full-LCD instrument GUI. A visual communication design method is proposed to enhance user experience and promote user cognition through overall layout design, graphic symbol design and color matching design.

Keywords: full-LCD instrument, graphical user interface, MVC architecture, visual communication, data-driven

1 INTRODUCTION

Vehicle-mounted instruments is the necessary equipment to ensure safe driving[1]. With the help of vehicle-mounted instruments, drivers can grasp the driving status without delay and properly handle the sudden traffic situation on the spot. According to the external form and internal function, the evolution of vehicle-mounted instruments has mainly gone through two stages of development: mechanical-pointer instrument and full-LCD instrument. With the rapid development of networking and intellectualization of automotive products, the trend of full-LCD instrument gradually replacing mechanical pointer instrument is becoming more and more obvious[2]. Compared with the vehicle-mounted mechanical pointer instrument, the vehicle-mounted full-LCD instrument can realize the visualization of driving state information more comprehensively in a richer form as shown in Figure 1, so that the driver can more intuitively recognize the favorable and unfavorable driving States, so as to better drive safely. At the same time, the vehicle-mounted full-LCD instrument can bring the owner a comfortable visual experience in the whole driving process, and will enhance the brand competitiveness and influence unintentionally. In recent years,

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more and more people begin to study the design of vehicle-mounted full-LCD instrument.

Fig. 1. Mechanical-pointer instrument and full-LCD instrument.

2 FULL-LCD instrument is a special intelligent mobile device

Vehicle-mounted full-LCD instrument is essentially an intelligent mobile device, which has the basic attributes and characteristics of intelligent mobile devices[3]. The general principles and methods in the design of intelligent mobile equipment can be used for reference in the design of vehicle-mounted full-LCD instrument, and the special functional requirements of vehicle-mounted full-LCD instrument should also be considered. The particularity of the vehicle-mounted full-LCD instrument is mainly manifested in the following aspects.

2.1 Different modes of interaction

Intelligent mobile devices usually realize human-computer interaction bidirectionally, that is, people send operation instructions through human-computer interaction interface or buttons provided by intelligent mobile devices, and intelligent mobile devices respond to the operation results generated by human-computer interaction in time. The interaction process of the vehicle-mounted full-LCD instrument is slightly complicated. Firstly, the human-computer interaction process of the vehicle-mounted full-

LCD instrument is to input instructions through various buttons and operating levers configured by the driver to the vehicle, and the vehicle-mounted full-LCD instrument generates and displays relevant information of the driver's driving behavior according to specific instructions. Second, the vehicle-mounted full-LCD instrument should display relevant information in a more vivid, more standardized, more cognitive and more emotional way[4].

2.2 Different function settings

First, Intelligent mobile devices usually pay more attention to the intention of the user's current operation, and highlight the information display that the user is most concerned about[5]. But the vehicle-mounted full-LCD instrument usually pays more attention to the driving state of the vehicle, highlighting the most harmful information display to driving safety. Second, intelligent mobile devices can save historical information and look back when necessary. Vehicle-mounted full-LCD instruments usually hide conventional historical information in the current data.

2.3 Different application scenarios

The fundamental role of intelligent mobile devices is to meet the needs of general users to choose, purchase and enjoy services, and to achieve a bridge between businesses and customers. The vehicle-mounted full-LCD instrument is the basic way to ensure the driver to obtain the driving state, vehicle information, road information and other environmental information. Different brands and models of vehicles provide different degrees of completeness of vehicle information, road information and other environmental information, and different ways of data visualization[6].

3 Architecture Design of the GUI

The overall architecture of the vehicle-mounted full-LCD instrument can be divided into two levels: hardware system and software system. The hardware system takes MPU as the core, which is the basis of carrying and driving the software subsystem. The software system consists of three layers from bottom to top: the driver, the embedded operating system and the graphical user interface program. Among them, the graphical user interface layer is the visible layer to complete the human-vehicle information interaction, and it is also one of the most noteworthy contents in the design of vehicle-mounted full-LCD instrument[7]. The design of graphical user interface (GUI) program of vehicle-mounted full-LCD instrument can use Model-View-Controller (MVC) architecture for reference to achieve hierarchical design, enhance the cohesion of functional modules, reduce the coupling of functional modules, and improve the re-usability of code.

3.1 Basic idea of MVC architecture

MVC architecture pattern is a software design specification formed in the 1980s, which organizes code by separating business logic, data and display, and realizes the diversification of the same program form. The MVC architecture pattern was originally used for desktop application development, but later it was widely used in Web application development. There are two aspects to be considered when applying the MVC architecture pattern to design an application program:(1) The respective functions of the constituent elements. (2) The interaction between the constituent elements.

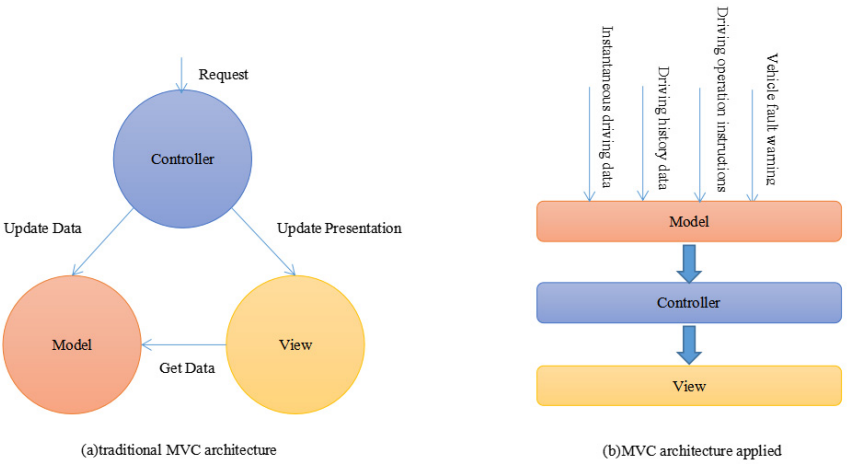

Fig. 2. MVC architecture and the application.

In the Web application based on MVC architecture shown in Figure 2, the model, view and controller play the following roles:(1)The model is responsible for the logical processing of data according to business rules, and realizes the access operation of data.(2)The view is responsible for selecting a specific form to present the visual data to the user and completing the information interaction with the user.(3)The controller is responsible for receiving and forwarding the request from the client, and sending the generated view to the client for display after correspondingly processing the request.

The request from the Internet triggers the response process of the Web application to the request. The controller is the portal through which the Web application receives and responds to requests, and is responsible for parsing requests into instructions that the model and view can understand. The view receives the instructions sent by the controller, obtains the data requested to be consulted from the model, and realizes data visualization according to a specific form. The model receives the instructions sent by the controller, completes the data access operation, and provides the original data to the view.

3.2 Application of MVC architecture pattern

Vehicle-mounted full-LCD instrument is user-oriented, although the number of users is huge, the basic functional requirements of graphical user interface tend to be consistent[8]. The amount of data processed by the vehicle-mounted full-LCD instrument is relatively small compared to the Web application. All in all, there are many differences between an application for a full-LCD meter in a car and a Web application. Therefore, this paper advocates the idea of using MVC architecture in Web application design for reference, and refuses to copy it completely.

The information to be displayed by the vehicle-mounted full-LCD instrument mainly includes driving instantaneous data, driving historical data, driving operation instructions and vehicle fault warning as shown in table 1.

Table 1. Category of the data processed by vehicle-mounted full-LCD instrument.

Category	Examples
Instantaneous driving data	Engine speed, instantaneous speed, instantaneous fuel consumption, water temperature and other driving conditions, etc.
Driving history data	Total mileage, remaining fuel, maintenance information, etc.
Driving operation instructions	Vehicle start, current gear, steering indication, door not closed, etc.
Vehicle fault warning	Engine fault, ABS system fault, gearbox fault, etc.

The above data can be obtained from the underlying layer by the model through the appropriate communication interface protocol. The model does not necessarily need to understand the meaning of a certain data, but it can optimize the combination of data according to a certain format. The controller obtains the data from the model, understands the data and determines whether the data needs to be displayed and the priority when displaying, and sends display instructions to the view. After receiving the display command, the view parses the value from the command and visualizes the value in an appropriate form.

The following changes have taken place in MVC in the design of vehicle-mounted full-LCD instrument, as the right diagram shown in Figure 2:(1)The model becomes the GUI of the vehicle-mounted full-LCD instrument and the portal to receive external data.(2)The controller is not driven by an external request and does not need to respond to an external request.(3)The manner in which the view presents the data in accordance with the instructions of the controller.(4)The GUI workflow of the in-vehicle full-LCD meter based on MVC framework is data-driven, unlike Web applications, which are external request-driven.

4 Visual communication design of the GUI

The practical value of the vehicle-mounted full-LCD instrument is to present the current driving status information to the driver timely and effectively. Driving safety depends not only on whether the information is timely and comprehensive, but also on whether the information can be recognized by the driver in the shortest time. Therefore, the design of visual communication is particularly important. In the design of visual communication, factors such as the width of driver's vision, the intensity of attention and the balance of vision must be considered. In the design of visual communication, we should focus on the overall layout, graphic symbols and color matching of the vehicle-mounted full-LCD instrument.

4.1 Overall layout design of visual communication

The layout design of the Vehicle-mounted full-LCD instrument can draw lessons from Mies van der Rohe's "less is more" design style. The simple, beautiful and generous Vehicle-mounted full-LCD instrument is conducive to enhancing the driver's visual experience, quickly gaining the user's recognition, and also conducive to timely conveying more important driving status information to the driver to enhance the safety performance of the vehicle. In terms of depth, the flat design concept should be followed to minimize the display level of driving status information, and the hierarchical layout should be extended from the top to the depth according to the importance of driving status information. The width is restricted by the resolution and size of the Vehicle-mounted full-LCD instrument. It is necessary to ensure that the quasi-materialized components in the LCD instrument match the physical components in the mechanical pointer instrument in terms of size and physical space layout, and also to ensure that the key information of interest to the driver is clear and discernible.

4.2 Graphic symbol design for visual communication

Unlike the graphics and symbols in other intelligent mobile devices, which can be infinitely integrated into the artistic creativity of designers, the graphics and symbols used in Vehicle-mounted full-LCD instruments follow the industry specifications and standards such as ISO2575-Identification of Road Vehicle Controls, Indicators and Signal Devices, which is the preferred option for the design of Vehicle-mounted full-LCD instruments. Therefore, the design results of vehicle full-LCD instrument have a certain degree of versatility[9]. The graphic symbols in the Vehicle-mounted LCD instrument not only convey specific information through specific shapes, but also distinguish the critical or harmful degree of information through their own colors and flashing frequency, so as to achieve the purpose of promoting driver's cognition. If the information to be conveyed by some graphic symbols is too professional, it is also appropriate and necessary to explain it with the help of short words.

4.3 Color matching design for visual communication

Vehicle full-LCD instrument color matching, first of all, should make the driver feel comfortable physically and mentally, secondly, it should be coordinated with the interior of the vehicle, and finally, it should incorporate enough artistic elements. With beautiful lines and smooth animation, drivers can enjoy the advanced sense of fashion and cool sense of technology. The color matching of Vehicle-mounted full-LCD instrument should be able to adapt to the change of illumination outside the vehicle and maintain sufficient brightness when driving day and night, and should also have the ability to customize the color matching scheme according to personal preferences.

4.4 Experiment and verification

As shown in Figure 3, a GUI is designed by applying the ideas and methods proposed in the paper. (1) In the overall layout, a centrosymmetric scheme is used to accommodate the driver's attention. Driving conditions that are critical to the driver, such as engine speed and current driving speed, are rendered near the center. On the other hand, less important information is placed far away from the center. Like the temperature of the water and the amount of fuel left. (2) In order to ensure the accuracy and real-time performance of visual communication, in Figure 3, the skeupoid design concept is selected to render the instrument panels of water temperature, engine speed, current running speed and fuel remaining amount in the way of mechanical pointer instrument, and the pointer position will point to the current value in real time. Messages such as high beam lights, low temperature outside the car, and open trunk were rendered with specific graphics that met the specifications. (3) In color matching, black is used as the background, white, red, green and other bright colors are selected to convey the necessary driving status information. Green is used to render normal driving conditions. Red is used to remind drivers of traffic accidents or dangerous abnormal events. Milder colors are generally used to suggest some normal or less dangerous driving conditions.

Fig. 3. An example of GUI design.

5 Conclusion

The essential attribute of vehicle-mounted full-LCD instrument is a special intelligent mobile device, whose primary function is to ensure driving safety. Vehicle-mounted full-LCD instrument is the window of human-vehicle interaction, accurate and timely display of driving status information is the primary task of graphical user interface design. Good visual communication design can promote the driver's cognition[10], but also quickly win the emotional recognition of users. The graphical user interface program design based on MVC architecture is the solution to the above goals. The views put forward in the aspect of visual communication also fully reflect the value of "people-oriented". The most important thing to point out is that GUI design is by no means an easy job. It is the designer's expression of art, but also the reflection of the designer's own values.

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