Human-Computer Interaction Design of Mobile UI Interface for Autonomous Intelligent Vehicles

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Abstract: In response to the problems of poor interactive feedback, easy distraction of drivers, and cumbersome operation in the current mobile UI interface of intelligent vehicles, visual communication technology would be used to study the mobile UI interface of smart cars and improve its aesthetics. Through a survey questionnaire, this article surveyed the interface requirements of 170 users to understand their requirements for the interface and clarify the ultimate goal of mobile UI interface design. It then utilized visual communication technology to apply it to the numbering brought by interface design and conducted research from three aspects: color, icon, and layout. This article conducted human-machine interaction on the designed interface and tested its interactivity. The user rating of the interface constructed based on visual communication technology was above 9.29, and the average score of the 30 users selected was 9.5 out of 10; by utilizing visual communication technology, a user-friendly, easy-to-use, and safe driving interface can be designed. This can make the UI interface more concise and clear, with key information easily identifiable and placed in important positions, promoting the development of smart cars.

Keywords: User Interface; Intelligent Vehicles; Human-Computer Interaction; Visual Communication Design; User Satisfaction
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1. INTRODUCTION

With the integration and development of transportation, artificial intelligence, and information network technology, the automotive industry has given birth to new development opportunities. For car users, cars have already surpassed their status as vehicles, bringing them other experiences and generating new demands. At present, the automotive industry is constantly developing in terms of technology, the level of automotive intelligence is constantly improving, and the amount of information available is constantly increasing. People can receive more information and complete more tasks in their cars. The traditional human-computer interaction interface of automobiles often has poor feedback in information display, and less consideration is given to the impact of the environment on human-vehicle interaction during vehicle movement. This leads to a failure to meet users' psychological expectations in terms of mobile UI interface and human-computer interaction. Therefore, this article utilizes visual communication technology to adjust the design philosophy of designers, to better adapt to constantly changing business and customer needs, and to integrate complex and ever-changing situations into the design process. Real-time interaction of information during car driving can be achieved according to user needs.

The user experience of human-vehicle interaction creates multi-dimensional content, which can be improved through interaction design to improve data communication and collaboration between users and vehicles, achieving safe, efficient, and comfortable interface information transmission [1-2]. UI interface design is a comprehensive design for the aesthetics and interaction of software interfaces [3-4]. Guney Zafer discussed visual design in the fields of instructional design and technology and reviewed the definition of visual principles in user interface design or user experience design [5]. Zhao Fen proposed a new application model for human vehicle interaction based on semi-supervised multi-granularity convolutional neural networks, which consisted of a two-view embedding module and a multi-granularity convolutional neural network module [6]. Ruijten, Peter AM used personification to shape the automotive interaction interface and applied the Gricean criterion to construct a simulator. The simulator uses graphics and dialogue to design the automotive UI interface [7]. Smith, Karly A. introduced a gesture recognition technology that utilizes millimeter wave radar sensors to achieve in-car infotainment control. This technology is becoming a more prominent form of human-computer interaction to provide a safe and intuitive control interface, limiting driver distraction [8]. To fill the gap between automatic entry and human-machine control systems, Wang Xumeng integrated visual human-machine interaction into the intelligent vehicle system and proposed several simulation scenarios and cases for future intelligent transportation systems [9]. Shaikh, Asadullah believed that human-computer interaction technology was becoming increasingly popular in the automotive industry. The main purpose of the study is to discover how the UI interface in vehicles improves the safety of drivers using mobile phones and other electronic devices while driving [10]. Zhang Hui proposed three hypotheses about color preference based on the mechanism of color preference among different populations. The selection of car fuel level indicators is mainly red, warm colors are recommended for warning areas, and cool colors are recommended for other areas [11]. In summary, although research has been conducted on human-vehicle interaction and some research results have been achieved, there are still issues with poor interaction feedback and unattractive interfaces. To this end, visual communication technology can be used to solve these problems.

Visual communication design usually presents page layout from a visual perspective, and the presentation method is usually double-sided. In this process, text can create good effects, provide users with a pleasing visual experience, enhance the overall display effect of the interface, and effectively improve the design aesthetics of the work [12-13]. Tian Yuyang analyzed the language characteristics and advantages of dynamic page layout design in the new media era, given the widespread popularity of screen media. He believed that it could attract people's attention through dynamic effects and use visual communication technology to subtly convey information, effectively improving the aesthetics of the interface and the expression of information [14]. Ren Siwei designed the interactive interface of the ship navigation system based on visual perception technology to optimize the visual effect of the interface, making the system's interactive interface more concise and beautiful [15]. Jiang Qianni used visual communication forms such as text, graphics, and projection to convey the status of the vehicle. He conducted experiments on real road sections and evaluated the impact of interface usage on pedestrian crossing intention [16]. Wu Haotian studied the interactive behavior of users when using smartphones and analyzed the visual factors of smartphone interfaces. He ranged from the level of user interaction and user operation modes, from visual expression to commonly used interface modes and UI component spaces [17]. Overall, using visual communication technology for human-computer interaction and UI interface design can effectively improve the aesthetics of the interface and enhance the display effect of system information.

In recent years, with the rapid development and application of the Internet, artificial intelligence, and big data in the transportation field, intelligent vehicles have gradually become popular, providing unique experiences for drivers. As an important support tool for future driving behavior, the design of smart car mobile UI interfaces has become increasingly important. The existing design has a problem of poor interactivity. Therefore, this article would use visual communication tools to create a powerful UI interface, to provide users with better interactive content. This article hopes to meet better people's demand for a beautiful and concise interface and also to help facilitate information and resource interaction between users and the system, thereby visualizing the layout.

2. USER REQUIREMENTS FOR HUMAN-VEHICLE INTERACTION INTERFACE

Human-computer interaction refers to people-oriented, user-friendly, and simplified information display [18-19]. Establishing a relationship with users in design is the bridge between users and data. By using appropriate changes and interactive messages, users can improve their experience and attract their attention. Human vehicle user interface design refers to the design of a user-friendly vehicle interface and human vehicle interaction process by observing and recording the interaction process between the driver and the car and understanding the user's needs and expectations for the car and vehicle. This is to create a user-friendly car interface and human-vehicle interaction experience [20].

2.1 User Survey

The purpose of analyzing user characteristics is to understand the audience characteristics of the product. Each user's physical characteristics are different, which makes the problems and needs encountered by users in the process of using the product different. By summarizing and classifying user features, this article creates a user model that helps clarify design goals and is more scientific and comprehensive. At the same time, to ensure the scientific nature of the experimental results as much as possible, this study conducted a questionnaire survey to investigate the needs of car users for UI interface introduction and human-computer interaction. This article has placed 180 survey questionnaires on Questionnaire Star, excluding 10 invalid questionnaires. Finally, 170 valid questionnaires were obtained, with an effective rate of 94.44%. The basic information of the users selected for the survey is shown in Table 1.

Classification	Content	Sample number	Percentage (%)
Gender	Male	88	51.76
	Female	82	48.24
Age	18-25 years old	15	8.82
	26-35 years old	34	20
	36-45 years old	64	37.65
	46-55 years old	42	24.71
	Over 56 years old	15	8.82
Do you have a driver's license?	Yes	162	95.29
	No	8	4.71
Education	Primary school and below	10	5.88
	High school and elementary school	40	23.53
	Undergraduate and Junior college	100	58.82
	Master's degree and above	20	11.77
Driving frequency	1-3 times a month	35	20.58
	1-2 times a week	85	50
	3-5 times a week	25	14.71
	Every day	25	14.71

Table 1: Analysis of basic user information.

As shown in Table 1, the tested users cover multiple age groups, with most of them concentrated over the age of 36. Users in this age group have strong economic capabilities, and most can own their cars. The proportion of male and female users selected is relatively balanced, and the difference in the number of users is relatively small. The proportion of users who have driver's licenses among the selected users is very high, accounting for 95.29%. The educational background of users is mostly concentrated in undergraduate and associate degrees, accounting for 58.82%. The frequency of users driving the most frequently sampled is 1-2 times per week, accounting for 50%. The proportion of people who need to drive every day has also reached 14.71%.

2.2 Data

From Table 1, it can be seen that 170 special cases of users have been extracted, which makes it easy to calculate the corresponding request behavior for each request. This article classifies them and accurately determines the features requested by each user. The results are shown in Table 2.

Demand number	Demand name	Very much needed (A)	Need (B)	No sense (C)	No need (D)	Very unnecessary (E)	Property classification
		Number (position)					
1	Speed display	70	50	30	10	10	A
2	Power consumption display	38	66	25	21	20	B
3	Play Music	26	25	44	37	38	C
4	Range	45	85	10	15	15	B
5	Total mileage	40	40	50	25	15	C
6	Air conditioning temperature	27	33	41	44	25	D
7	Distance ahead	40	50	30	30	20	B
8	Current road conditions	33	50	32	34	21	B
9	The speed limit of the road section	25	45	30	40	30	B
10	Limit line tail number	20	35	35	50	30	D
11	Time display	34	36	40	31	29	C
12	Current navigation	42	58	33	22	15	B
13	Road marking	25	32	53	36	24	C
14	Road Name	58	53	25	21	13	A
15	Vehicle marking	10	30	30	60	40	D
16	Weather conditions	65	45	20	20	20	A
17	Signal light	22	31	48	28	41	C
18	Play video	20	25	35	40	50	E
19	Parking space information	35	55	30	20	30	B
20	Driving mode	20	30	35	45	40	D

Table 2: Classification of user requirement attributes.

As shown in Table 2, a total of 20 user requirements were studied. Belonging to very much needed requirements are numbered 1, 14, and 16, while belonging to very unnecessary requirements is numbered 18. The requirement numbers assigned to no-need items are 6, 10, 15, and 20, respectively. Most of the needs belong between necessity and insensitivity.

A survey was conducted on the interface features that were most commonly used by these 170 users while driving the car. The specific survey results are shown in Figure 1.

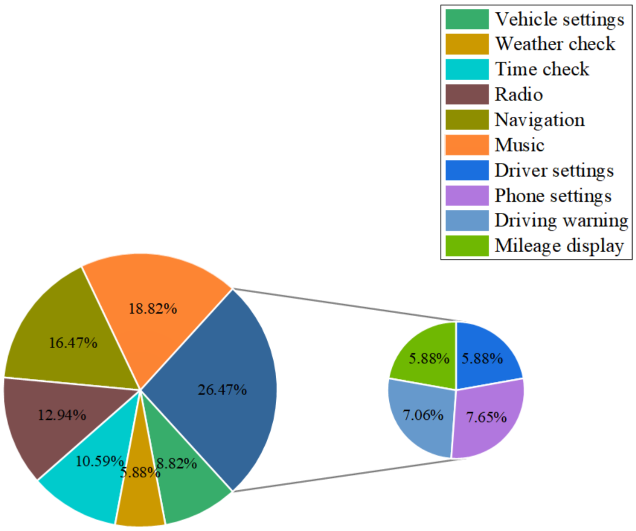


Figure 1: Distribution of commonly used functions by users.

As shown in Figure 1, the interface functions most commonly used by users while driving the car are music and navigation, with 32 and 28 people expressing their needs, accounting for 18.82% and 16.47%, respectively. Next is the radio station, with 22 people choosing, accounting for 12.94%. The demand for mileage display and weather viewing is not very high, with ten people choosing each, accounting for 5.88%. Because driving a car is a task that requires a lot of vision, the demand for functions that excessively distract the driver's vision and attention during the driving process is not high, which also leads to a small proportion of demand for videos. In addition to specific vehicle speed and distance between front and rear vehicles, navigation is also an important function of the car UI interface. Music, as a function that affects human hearing, can add some fun to users while driving and become a commonly used function.

2.3 Requirement Results

This article analyzes a survey questionnaire of 170 users, selects the most representative data, and designs the interface based on specific questions. Based on the above analysis, there are several user requirements: 1. fully ensuring driving safety, the vast majority of investigators are very concerned about driving safety, believing that excessive content in human-computer interaction interfaces may affect driving safety. 2. They need strong demand for social entertainment. Most users indicate that current mobile UI interface devices are not highly entertaining, especially in situations of long-distance driving, where users have the strongest demand for entertainment and a sense of intimacy.

3. VISUAL COMMUNICATION DESIGN IN MOBILE UI INTERFACE DESIGN

Traditional automotive mobile UI interface design often focuses on a direct and clear functional layout. Such interfaces usually use more conservative color combinations, such as black, white, gray, and brand colors, to ensure good readability under different lighting conditions. In the layout of the interface, key functions such as navigation, music, telephone, and air-conditioning control are placed in a prominent position to facilitate the driver to operate quickly while driving. The icon design pursues intuitive and easy-to-understand, reduces the burden of visual cognition, and ensures that the driver can quickly recognize and perform the required functions. However, compared with the modern smart car machine UI, the traditional interface is relatively single in terms of interactive experience and often relies on the combination of physical buttons and touch screens. Animation effects and transition processing are relatively simple, lacking layering and fluency. In addition, personalized customization options are limited, making it difficult to meet the diverse needs of different users. With the progress of technology and the changes in user needs, the traditional automotive mobile UI interface design is gradually developing in a more intelligent and personalized direction. Nevertheless, its advantages in terms of functional directness and ease of operation are still favored by many drivers, especially in the pursuit of simple and practical car use scenarios. The traditional car mobile UI interface is shown in Figure 2.

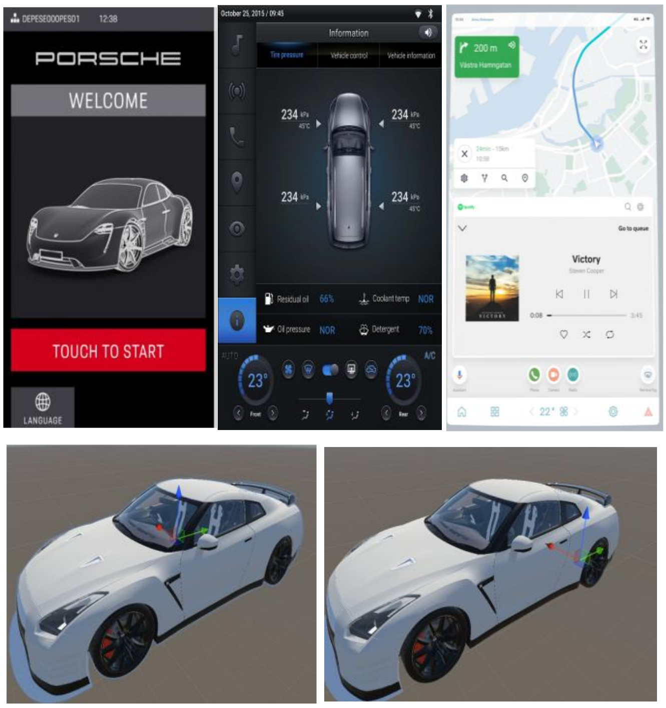


Figure 2: Traditional car mobile UI interface.

3.1 Automotive Interface Design Elements in Visual Communication Design

Visual communication design generally achieves effective communication effects by planning and applying multiple elements, allowing the audience to receive interesting information and providing motivation for the user experience. In the information age, the creation of visual communication is a comprehensive human-machine relationship that can achieve the transmission of beauty through the appropriateness of graphics [21-22]. Vision mainly refers to what people see through their eyes in daily life, and it is also a symbol. It conveys information in a certain way, including communication between individuals or groups [23-24]. The mobile UI interface design, supported by internet data, can connect to the network at high speed, display corresponding content on the network, and provide good services. During this process, based on the design of mobile UI interfaces, users should learn the corresponding usage patterns and experience the use of the application [25-26]. Currently, the design of mobile UI interfaces is gradually meeting the needs of new users. The importance of visual communication design has begun to expand, and the entire trend is developing in different directions [27-28]. Visual design plays an important role in the mobile UI interface of smart cars. By using appropriate elements such as colors, icons, interface layout, etc., it can effectively improve the interaction and visualization between users and cars. Designers can use visual communication to create a simple, intuitive, and easy-to-use mobile UI interface based on user needs and behaviors, combined with aesthetic and human-computer interaction concepts.

In the human-machine design process of intelligent vehicle interaction devices, in addition to the most basic features of points, lines, surfaces, and bodies, they also include text, symbols, images, colors, etc. Each element has different visual characteristics. By combining them, the information conveyed by visual images can often appear in an abstract and concise form. In the design of human-machine interaction devices for intelligent vehicles, the introduction of visual communication elements is shown in Table 3.

Reorganize the concentrated areas of spectral power, select the features of image communication in the human-computer interaction interface, perform surface transformation on the unsmooth areas, and achieve information weighting to obtain:

$$m(x,y) = \frac{1}{H(x)} \exp\left(-\frac{d(x,y)}{f^2}\right) \tag{1}$$

Among them, $H(x) = \sum_{y \in \phi} \exp\left(-\frac{d(x,y)}{f^2}\right)$ is the composite window template, and f is the data inside the window. By combining sparse feature fusion, the region division function of the visual communication image of the human-computer interaction interface is obtained:

$$g(i,j) = h(i,j) + \beta(i,j) \tag{2}$$

Among them, $h(i,j)$, $g(i,j)$, $\beta(i,j)$ represent the pixel intensity of visual communication images in human-computer interaction interfaces.

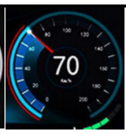
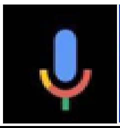
Serial number	Name	Conventional signs	Analysis
1	Color	 	Color design can improve operating efficiency, safety, and comfort, and the tone should be uniform and in line with aesthetic laws.
2	Symbol	 	The direct use of symbols can make the use of the car UI more convenient, fast, safe, pleasant, and efficient.
3	Text	 	Words are mainly used to convey information, and they should give people a clear visual impression. First of all, it must be concise, generous, and easy to identify, and then improve and select font characteristics according to specific needs.
4	Graphics	 	Graphics emphasize the linguistic role and symbolic meaning of visual symbols, which are aimed at conveying information.

Table 3: Introduction to visual communication elements.

3.2 Color Elements

Color is the psychological perception of light by the brain and the naked eye. It is the first element of human vision and one of the most important means of visual communication [29-30]. In the human-machine design of smart car mobile UI interface devices, appropriate color design has given life to new devices from another level, allowing them to communicate with people. The use of appropriately colored automotive UI interface devices in this article can improve driving safety, and the probability of malfunctions during operation is very low. Creating UI devices with the best visual effects can make drivers feel relaxed and improve the safety of driving a car. Therefore, it is necessary to achieve the optimal performance of vehicle-machine interaction devices by designing colors.

This article uses visual communication technology to study the color changes in the design of smart car UI interfaces, focusing on the dashboard of smart cars. In the interface design of the instrument panel, the mechanical pointer instrument panel has been changed to a liquid crystal instrument panel [31]. Although the mechanical pointer instrument panel is more stable than the liquid crystal soup panel, the pointer panel can also reflect process changes and patterns at the same rate. Its measurement is greatly affected by light, and users may experience excessive visual burden, which is not conducive to driving safety. The LCD (liquid crystal display) instrument panel can enable drivers to see and receive the required information faster and can adjust the image brightness based on the light intensity to meet the visual needs of drivers under different lighting conditions. The schematic diagram of the dashboard with different colors is shown in Figure 3.

As shown in Figure 3, in terms of color design, the background color of the entire dashboard is black. The speed of cars in cities is usually 35-60 kilometers per hour. Therefore, when the car' s speed is below 35 kilometers per hour, the background color of the dashboard is green. Green represents nature, health, and safety, with weak visual stimulation to the driver, as shown in Figure 2A. When the vehicle speed is between 35-60 kilometers per hour, the table color is orange, which has a quiet and bright visual characteristic. The visual stimulation to the driver is also relatively weak, as shown in Figure 2B. When the car' s speed exceeds 60 kilometers per hour, the table is red, which can create visual pressure on the driver and form visual attention, as shown in Figure 2C.

3.3 Icon Symbols

In the creation of interactive interface icon symbols, visual communication technology can be used to redesign intelligent vehicle UI interface icon symbols [32]. In terms of icon design, it is possible to follow existing icon design standards as much as possible to reduce user training costs and adopt a separate method to design icons on menus. This icon is usually circular and placed on the bottom layer, saving space in the interface and making it easy for users to click. At the same time, there is a difference between selected and unselected icons. In the creation of hard interaction icon symbols, the main functions of the interface are displayed, and icon images that are in line with public aesthetics are selected to represent each function. This avoids being too abstract, making it difficult for drivers to understand and potentially leading to an increase in accident rates, which is not conducive to driving safety. The icon is shown in Figure 4.

A: Green dashboard

B: Orange dashboard

C: Red dashboard

Figure 3: Schematic diagram of the dashboard with different colors.

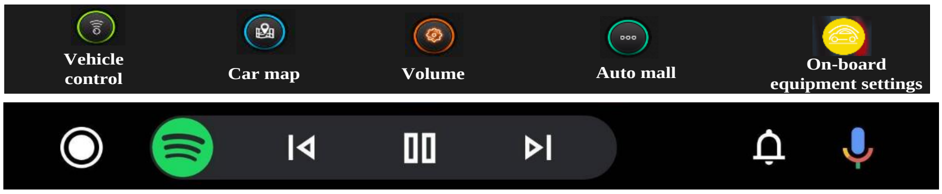


Figure 4: Icon schematic diagram.

3.4 Application Layout Design

The most important purpose of visual communication technology is the transmission of information, so applying it to UI interfaces can better layout the interface layout and make information transmission more effective. Usually, user interface designers can use visual communication technology to express their design concepts and ideas better to improve the user experience. At the high fidelity level of the interface, it uses image processing software to draw the final effect of the intelligent vehicle interface, making the overall interface look simple and elegant. The schematic diagram of the automotive mobile UI interface based on visual communication technology is shown in Figure 5.

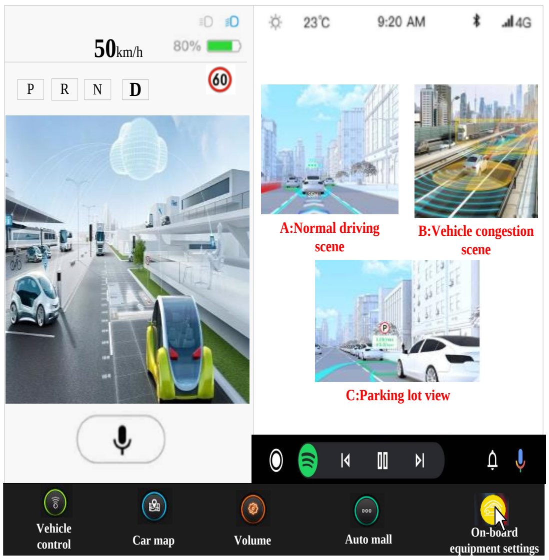


Figure 5: Schematic diagram of automotive mobile UI interface based on visual communication technology.

4. DESIGN OF HUMAN-COMPUTER INTERACTION INTERFACE ON VISUAL COMMUNICATION TECHNOLOGY

The human-machine interface is a place for information exchange between people and machines, where people and machines can communicate with each other, which is also the quality of human-machine interface design. It would affect the user's final experience and whether the machine's operability is excellent [33]. When users drive smart cars, the dashboard is the easiest place for the driver's eyes to see, but multi-level information can distract users' attention and affect driving safety. Therefore, in the operation of the dashboard information interface, vehicle status information is created to meet the needs of driving, while the music and video functions are designed to meet the needs of secondary driving tasks. The data architecture of the dashboard is shown in Figure 6.

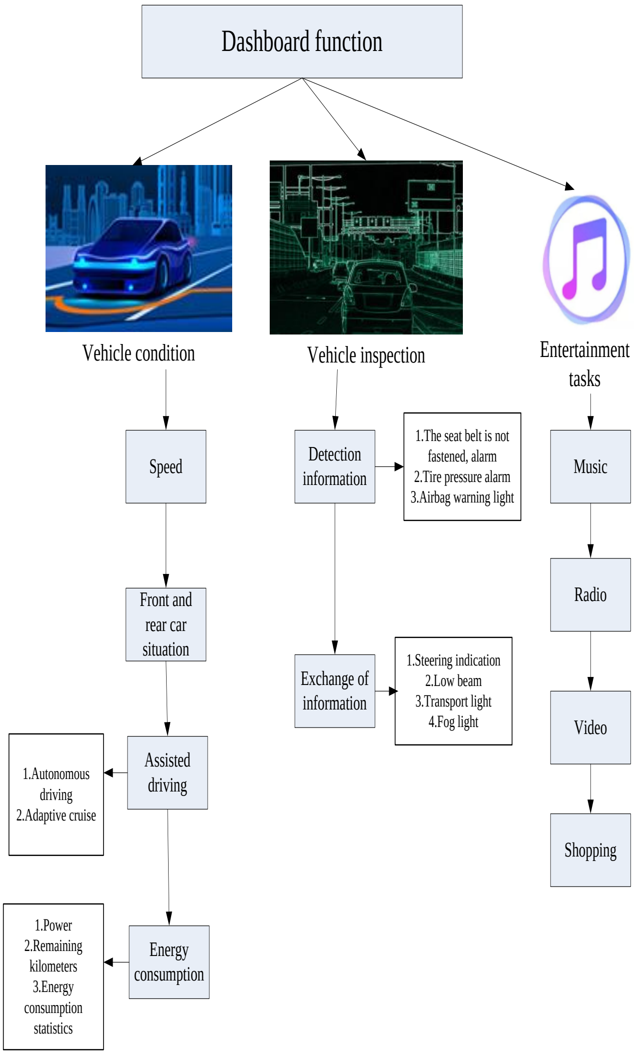


Figure 6: The information architecture of the dashboard.

Based on the analysis of user characteristics and behaviors, the vehicle-machine interaction control interface of intelligent vehicles uses visual communication technology for human-machine data interaction design. It can effectively reduce user learning and implementation costs and provide customizable content, thereby reducing training costs for new users and improving user experience. The vehicle control interface is the default interface for human-machine information interaction in intelligent vehicles, and its main functions include controlling the internal and external lighting of the vehicle and the driving situation of the vehicle. The detailed design is shown in Figure 7.

The intelligent vehicle navigation system in this design is the destination navigation system. The design of the destination navigation system includes many functions that incorporate mobile map applications, allowing users to navigate back to the car in car navigation from mobile devices such as mobile phones. In the user's navigation interface, the driving information and media music area information are designed in a drawer style to reduce the amount of information in the interface and alleviate the cognitive burden of users while driving. The detailed design is shown in Figure 8.

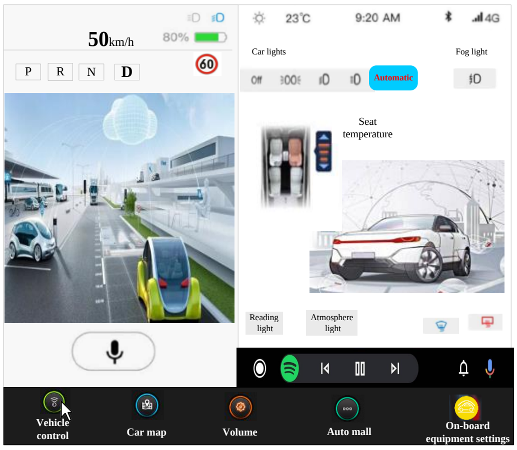


Figure 7: Human vehicle interaction interface based on visual communication technology.

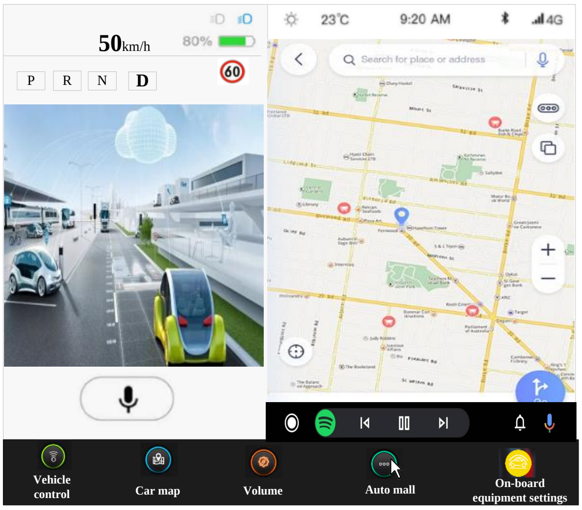


Figure 8: Detailed schematic diagram of the navigation interface.

5. UI INTERFACE TESTING ON VISUAL COMMUNICATION TECHNOLOGY

5.1 Experimental Indicators

When designing the mobile UI interface of the vehicle, due to the inability of intelligent vehicle devices to fully ensure the balance of the product itself, it is necessary to adjust the color scheme to achieve the desired visual effect of the product. The calculation formula is as follows:

$$\frac{X_i * H_i}{X_j * H_j} = \frac{F_i}{F_j} \tag{3}$$

Among them, X_i represents the brightness value of color block I; X_j represents the brightness value of color block J; H_i represents the purity level of color block I; H_j represents the purity level of color block J; F_i represents the area of color block I; F_j represents the area of color block J.

The evaluation model for color-based mobile UI interface design is as follows:

$$B = \alpha_b * B_1 + \beta_b * B_2 + \gamma_b * B_3 \tag{4}$$

Among them, α_b, β_b, and γ_b are the weight coefficients of B_1, B_2, B_3.

The calculation formula for the color softness and uniformity B_1 of manufacturing equipment is as follows:

$$B_1 = \sum_{i=1}^{m} |(X_{max} - X_i) * \frac{F_i}{F}| \tag{5}$$

Among them, the smaller the B_1, the higher the overall softness and uniformity of the manufacturing equipment color.

The interface functional consistency indicator B_2 is as follows:

$$B_2 = \frac{|A_1 - x_1| + |Q_1 - x_2| + |P_1 - x_3|}{3} \tag{6}$$

Among them, A_1 represents the brightness value of the alarm key; Q_1 represents the brightness value of the pause key, and P_1 represents the brightness value of the operation key.

To better understand whether the intelligent vehicle human-machine interaction UI interface can better meet the usage and needs of target users, this article mainly evaluates the design scheme from three aspects. They are product satisfaction, interface operability, and cognitive efficiency satisfaction. This evaluation method adopts a predictive evaluation method that relies on users to evaluate the advantages and disadvantages of the current interface. The quantitative standards are shown in Table 4.

serial number	Evaluation dimension	Evaluation breakdown	Scoring
1	Product satisfaction	Product form, color, and ease of use.	1-10
2	Interface ease of operation	Interface color, button layout, functional area layout, and operation fluency.	1-10
3	Cognitive efficiency satisfaction	Visual perception speed, attention to fatigue reduction, reaction time.	1-10

Table 4: Quantitative standards for satisfaction of user operating UI interface.

As shown in Table 4, the scores of the sub-indicators for each evaluation dimension are summarized, and the closer they are to 10, the stronger the user's recognition of this design.

5.2 Experiment

As shown in Table 4, a survey was conducted on the satisfaction of the UI interface based on Visual Communication (VC) Technology research according to the evaluation criteria in Table 4. It mainly involves randomly selecting 30 users from the 170 users in Table 1, scoring them, and assigning 1-30 numbers to these 30 users. To make the experimental results more advantageous, this article would obtain the experimental results. It is compared with UI human-machine interaction interfaces built based on User Experience (UE), Situational Consciousness (SC), Emotional Design (ED), and Analytic Hierarchy Process (AHP). The specific comparison results are shown in Figure 9.

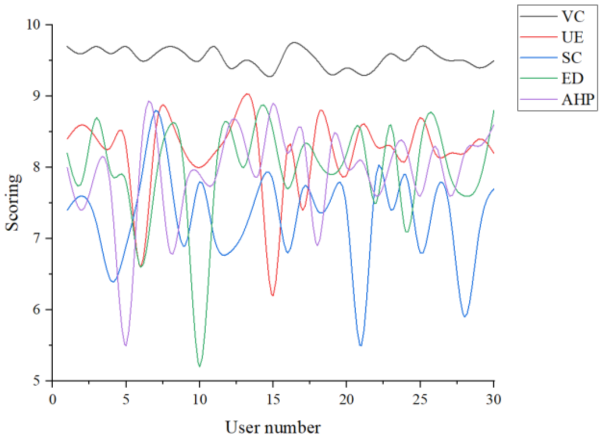


Figure 9: Comparison of user ratings for UI interfaces under different methods.

In Figure 9, the x-axis represents the extracted user number, and the y-axis represents the scored value. As shown in Figure 8, this article uses visual communication technology to design the UI interface of cars, and the user rating of the designed interface is much higher than that of UI interfaces constructed by other methods. Among them, interface users built based on VC scored above 9.29 points, while UI interface users built based on UE, SC, ED, and AHP methods scored below 9.01 points, below 8.81 points, below 8.81 points, and below 8.91 points, respectively. At the same time, the average score for UI interface design based on VC technology among the 30 selected users is 9.5. They scored 1.3 points, 2.2 points, 1.5 points, and 1.6 points higher than those based on UE, SC, ED, and AHP, respectively. The score distribution of users using VC for UI interface design is more uniform and the fluctuation is relatively small. This also indirectly reflects that users are more satisfied with the methods studied in this article, and the interface designed using VC technology also presents better results.

Through a survey of users' needs for UI human-computer interaction interfaces, it was found that they are very concerned about whether they can ensure safety during the driving process, which is also the most important demand point. This article simulates 170 users in Table 1 to study the accident rate caused by different UI interfaces and conducts multiple experiments on the data. This article will obtain the prediction results of the final accident rate for each experiment, and compare the obtained results with the possible accident rate prediction results of UI interfaces constructed based on UE, SC, ED, and AHP. The specific comparison results are shown in Figure 10.

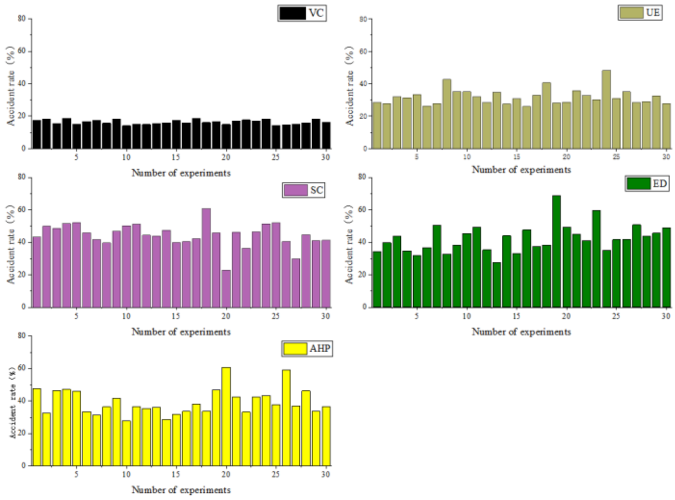


Figure 10: Comparison of accident rate prediction results for different interfaces.

In Figure 10, the x-axis of all graphs represents the number of experiments, with a total of 30 experiments conducted, and all y-axis represent the accident rate. The lower the accident rate, the higher the safety. However, the accident rate caused by the VC-designed human-vehicle interaction interface in this article is much lower compared to other interfaces. This also once again indicates that the interface designed using VC technology can effectively ensure the safety of driving and meet the needs of users. Among them, the accident rate caused by the interface studied in this article is below 18.7%, while the accident rates caused by interfaces constructed based on UE, SC, ED, and AHP are above 26.01%, 22.85%, 27.67%, and 27.65%, respectively. Meanwhile, this article conducted 30 experiments. The average accident rate of the 30 interface experiments studied in this article is 16.39%, which is 15.64%, 28.26%, 26.07%, and 23.03% lower than the average accident rate caused by interfaces based on UE, SC, ED, and AHP, respectively.

From the above, it can be found that when designing mobile UI interfaces, using visual communication technology is of great help for the color, icons, and layout of the interface. This article asks users to rate these three indicators from comfort, aesthetics, function, and fluency, with a score of 1-10. The higher the score, the higher the satisfaction level in all aspects, and the final result is the average score of the extracted users in Table 1. This article compares the results obtained with the scoring values of UI interfaces constructed based on UE, SC, ED, and AHP. The specific comparison results are shown in Table 5.

Evaluating indicator	VC	USE	SC	ED	AHP
		Color			
Comfort	9.4	8.3	7.8	8	7.6
Aesthetics	9.5	8.4	7.6	7.9	7.8
Function	9.45	8	7.4	7.5	7.3

Fluency	9.35	8.1	7.4	7.6	7.5
		Icon			
Comfort	9.7	8.4	8	8.1	8.3
Aesthetics	9.6	8.5	8	8.3	8.2
Function	9.5	8	8	8	8
Fluency	9.5	8	8	8	8
		Layout			
Comfort	9.6	8.2	8	7.7	8
Aesthetics	9.6	8.2	7.8	7.8	8.1
Function	9.6	8.2	7.6	7.5	7.5
Fluency	9.6	82	7.6	7.5	7.4

Table 5: User ratings for different human-vehicle interaction interfaces under different indicators.

As shown in Table 5, this article selected three evaluation indicators: color, icon, and layout, and rated them from four aspects: comfort, aesthetics, function, and fluency. The average user rating of interfaces built based on VC technology is much higher than that of interfaces designed using other methods. Among them, based on VC technology, the average score for all four aspects of layout indicators is 9.6 points. This indicates that using visual communication technology can better lay out the interface and present a more aesthetically pleasing layout. In terms of color, the highest aesthetic rating based on VC technology is 9.5 points, which is 1.1 points, 1.9 points, 1.6 points, and 1.7 points higher than the interface color aesthetic ratings based on UE, SC, ED, and AHP, respectively. In terms of icons, the comfort rating based on VC technology is the highest, with a score of 9.7, which is 1.3 points, 1.7 points, 1.6 points, and 1.4 points higher than the interface icon comfort ratings based on UE, SC, ED, and AHP, respectively.

6. CONCLUSIONS

Design is a good practice and problem-solving ability. Human activities are different, and design can provide a good perspective to make human activities and behaviors better. With the advancement of technology, the performance of automobiles has become richer in the process of intelligent development, and the complexity of products has also shown a geometric progression of growth. Cars face a very complex human-vehicle interaction environment when driving, and it is particularly important to provide users with appropriate information or services at the right time and place. The intelligent vehicle UI interface can help people interact with car information very well, but currently, many car UI interfaces have poor interactivity issues. Therefore, this article applied visual communication technology to mobile UI interface design, utilizing colors, icons, and layouts in visual communication design for mobile UI interface design. It effectively ensured the innovation of the mobile UI interface, ensured the output of key content, and brought a beautiful feeling to users. Overall, the application of visual communication design in the mobile UI interface and human-machine interaction of big data Autonomous Intelligent Vehicles can improve the user experience. By properly applying visual design principles and techniques, a more attractive and user-friendly mobile UI interface for Autonomous Intelligent Vehicles can be created.

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