

Impact of Screen Size and Structure of IVIS on Driving Distraction

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Abstract. With the development of in-vehicle information system (IVIS), more and more touchscreens have been applied to the IVIS to upgrade driving experience. During the process of using IVIS, driver needs to identify complex information system and process the information, thereby prolonging the reaction time of the driving behaviour, and the IVIS causes the driver to distract the attention and shift the sight. In order to reduce the impact of IVIS on driving distraction and ensure driving safety, this paper studies screen size and information structure of IVIS. In this paper, we designed nine kinds of IVIS for simulation in urban road and urban highway driving scenarios, and collected the data of relevant driving performance and eye movements. Based on experiment data, this paper evaluates and analyses the strategy of screen size and structure of IVIS for use safety. This paper is expected to provide reference for the design of the touch screen of the IVIS.

1. Introduction

The In-Vehicle Information System (IVIS) [1] is a system in which a driver can interact but does not directly influence the driving strategy and is independent of the driving operation level. Recently, the IVIS has been more and more electronic, networked and intelligent, and has become an in-vehicle integrated information processing system with an independent central processor and internet service. However, the IVIS also brings a safety hazard that indirectly causes traffic accidents while providing drivers with an all-round driving experience upgrade. Due to the short time that touch screen technology is applied to IVIS, the research on the impact of touch screen on driving distraction is still in the early stage of research. The choice of touch screen size and interface design of IVIS has been a major problem for automotive engineers and designers.

Driving distraction is the driver's active or passive transferring to a task away from safe driving. This task forces or induces the driver to divert attention and reduces the driver's environmental awareness, decision-making level, and operational skills, which adversely affects driving safety [2, 3]. During the driving process, if the driver is completing the sub-task while driving, such as operating IVIS, the driver's attention energy is occupied, resulting in reducing driving performance and affecting driving safety [4]. In order to provide drivers with convenient IVIS service and to improve the safety of touch screen, research on the design of IVIS supplies theoretical and practical value. In order to meet the increasing information needs of drivers, the size of IVIS screen has increased gradually, from 5-inch, 7-



inch, to 10-inch, 12-inch. There is even a 17-inch screen used in Tesla. Different car manufacturers have released various IVIS while applying the touch screen. From the traditional list structure to the palace format, display, label, hybrid and other structures. The differences in human-computer interaction between touch screens of different sizes and different structures are significant.

The main research topics of this paper can be refined into the following three aspects:

(1) Based on the driving simulation, IVIS with different screen sizes and structures were tested and the experiment data were analyzed to show the impact of screen size and structure on visual characteristics and driving performance.

(2) Based on the evaluation theory and driving simulation experiment, suitable evaluation indicators were selected to establish touch screen evaluation system and comprehensive evaluation model.

(3) Based on experiment data and evaluation model, analyze the impact on driving distraction under the combination of different screen sizes and structures to obtain the optional touch screen structure under the given screen size.

2. Experiment

2.1. Method

Driving simulation test on driving distraction research is a complex human-computer interaction problem. The main experimental methods include real-world driving test and driving simulation. Considering that real-world driving may cause potential traffic accidents and driving simulation test can save time and cost, and can be widely applied to road and traffic safety research [5]. Most of the researchers use the Driving Simulator (DS) to obtain data [6]. Therefore, in order to study the impact of touch screen size and structure on driving distraction, we designed driving simulation with Driving Simulator-DS and eye tracker glasses to get driving data.

2.2. Participants

16 drivers participated the experiment, among them 11 male, 5 female, aged 22-42 (Mean=30.6 SD=6.4). Each participant had at least 2 years' driving experience and had no adverse reactions such as dizziness or vomiting during the test. Considering that all drivers needed to wear eye tracker glasses to collect visual information data, participants were required to have naked eyesight or corrected vision wearing contact lenses.

2.3. Equipment

The test is based on the driving simulator platform jointly developed by Tongji University and PSA China. The needed equipment includes driving simulation system, tablet and eye tracker glasses. The driving simulation system includes three modules: driving simulation cabin, driving simulation environment and data acquisition system, mainly performs driving environment simulation and data collection. Tablet is a third generation Microsoft Surface and is used to simulate different sizes and structures of IVIS. The eye tracker glasses are used to collect participants' visual information.

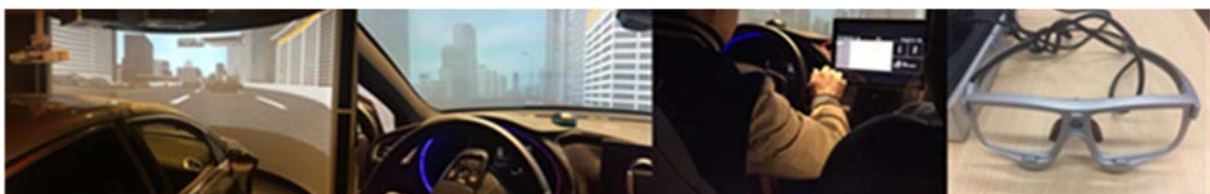


Figure 1. Experimental equipment.

The simulation environment includes 2 parts: urban road and urban highway. The urban road has a total length 26km and the speed limit is 40km/h. urban roads have high density of vehicles with traffic

lights, crosswalks, non-motor vehicles and pedestrians to simulate a real driving environment in urban CBD area. The urban highway has a total length of 32km and the speed limit is 80km/h.



Figure 2. Simulation environment.

The mainstream size of touch screen of IVIS is 8-inch while 10-inch and 12-inch screens are becoming more and more popular. Most car IVIS screen is designed as landscape and 16:9 is the most common screen aspect ratio. Therefore, we designed screens as 8-inch, 10-inch and 12-inch with 16:9 landscape screens to ensure the consistency of visual and operational characteristics. But due to the size and scale of the Surface, the screen can't directly simulate the 12-inch with 16:9 landscape screen. So the designed 12-inch screen is 25.99cm long, 14.62cm wide, and the screen is 11.74-inch actually, which is 97.83% of 12-inch size. And we designed 3 types of interface with Mockplus for each size screen, which were palace format structure, label structure and display structure. We selected three functions for test sub-task: navigation, air conditioning and music, which were the most frequently used functions on the IVIS.



Figure 3. Designed IVIS for simulation.

2.4. Test process

After a participant arrived at the laboratory, we would confirm the participant's age, driving experience, vision, and promised to be responsible for the confidentiality of the information privacy. Then we would introduce the subject and the flow of the test. The preparation phase was approximately 15 minutes. In order to avoid experimental errors caused by unfamiliar driving sub-tasks, we would train the participant 15 minutes to use the touch screen. Then we would guide the participant to adjust cockpit, steering wheel and fasten the safety belt. Then participant would spend about 30 minutes driving the simulation car for getting used to the driving condition and road condition. Finally, the formal driving test started. Participants should wear eye tracker glasses and operate the following sub-tasks during driving: zoom in and out the map, increase the temperature to 27°C, adjust the air volume to 1, and play music. The driving sub-task operations cover click gesture, continuous click gesture, zoom gesture, and swipe gesture.

The formal test process is as follows:

Table 1. Test process.

Test process	Screen size (inch)	Information structure
1	12	Palace format
2	12	Label
3	12	Display
4	10	Palace format
5	10	Label
6	10	Display
7	8	Palace format
8	8	Label
9	8	Display

3. Experiment Results

3.1. Analysis of Data

During the test, the driver was required to complete the driving sub-tasks at specified driving scenario. The moment the driver received the mission and completed the mission were recorded by the tester. Thereby, the corresponding driving performance data and eye movement information data were collected. The driving performance data was processed by the SCANeR™ Analysis module function. The eye movement information data was collected and analyzed by the BeGaze data analysis system, which was the corresponding software of SMI GRT II eye tracker glasses.

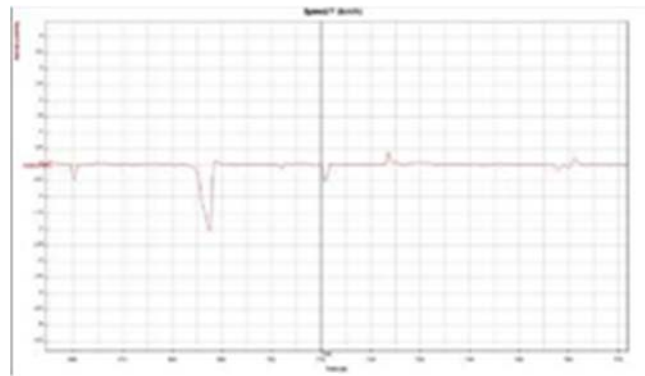


Figure 4. Driving performance data collected by SCANeR™ Analysis.

In the test, for a specific driving distraction index α , we get the experiment data $\alpha(i, j, m, n)$. Among them, i represents the screen size (8-inch $i=1$, 10-inch $i=2$, 12-inch $i=3$). j denotes the screen structure (palace format structure $j=1$, label structure $j=2$, display structure $j=3$). m indicates the number of participants and $m=1, 2, 3 \dots 16$. n indicates the test driving scenario (urban road scenario $n=1$, highway scenario $n=2$).

For the experiment data, three points need to be verified:

- 1) Are there any significant differences in the performance of the distraction driving test and the normal driving test on a specific driving distraction index α ?
- 2) Are there any significant differences in the performance of the distraction driving test of different screen size of IVIS in a certain driving distraction index α ?
- 3) Are there any significant differences in the performance of the distraction driving test of different structure of IVIS in a certain driving distraction index α ?

For 1), we believe that the driving distraction index α of different samples is normally distributed, so the significance level $\alpha=0.05$ is selected and a one-sample T test is performed. For 2) and 3), we need to compare the significant differences between the driving distraction indicators α of the three group's samples. Based on the comparability, normality and homogeneity of the three sets of experiment data, the analysis of variance will be used, that is, Analysis of Variance Method.

In this paper, the outliers are processed by the quartile test. The quartile test formula is

$$IQR=UQ-LQ \quad (1)$$

First, all experiment data of the same type is sorted according to the numerical size, and the upper quartile UQ and the lower quartile LQ of all experiment data are determined. Calculate the difference IQR by Equation (1). Then calculate the critical point of the outliers $UQ+1.5IQR$ and $LQ-1.5IQR$. For all experiment data larger than the critical value $UQ+1.5IQR$ or less than the abnormal value critical point $LQ-1.5IQR$, they will be judged as the experiment abnormal value and be eliminated.

3.2. Driving Performance

We select 6 indicators that reflect driving performance.

Longitudinal velocity (km/h): The average longitudinal velocity reflects the driver's control level of the longitudinal velocity of the vehicle.

SD of longitudinal velocity (km/h): The standard deviation of longitudinal velocity reflects the driver's ability to maintain the longitudinal velocity of the vehicle.

SD of lateral position (cm): The standard deviation of lateral position reflects the driver's control level of the lateral velocity of the vehicle.

Steering entropy: The steering entropy measures the steering smoothness, which reflects the driver's workload.

Proportion of fixation duration (%): The proportion of fixation duration measures the degree of concentration of the driver's attention and reflects the driver's visual distraction level.

Scanning velocity ($^{\circ}/s$): Scanning is a process in which a person's eyeball searches for target information through a fast, leaping movement. Drivers will increase the velocity of the scanning to get and process visual information faster when driving distraction happens.

After processing, we get the following data:

Table 2. Distraction data in different sizes of IVIS in urban road scenario.

Urban road	Normal driving	8-inch	10-inch	12-inch
AVG of longitudinal velocity(km/h)	38.36	26.54	30.05	30.91
AVG SD of longitudinal velocity (km/h)	6.24	9.72	8.90	8.23
AVG SD of lateral position(cm)	17.44	29.15	27.84	25.74
AVG of steering entropy	0.60	0.80	0.78	0.76
AVG of proportion of fixation duration (%)	96.76	85.40	88.79	91.80
AVG of scanning velocity ($^{\circ}/s$)	63.54	114.15	109.60	107.98

For the data in normal driving situation and the data in sub-task driving on the different sizes of IVIS in urban road scenario, the significance test is carried out and the results are shown in Table 3.

Table 3. Significant test result of distraction data in different sizes of IVIS in urban road scenario.

Urban road	8-inch	10-inch	12-inch
AVG of longitudinal velocity(km/h)	0.000	0.000	0.000
AVG SD of longitudinal velocity (km/h)	0.000	0.024	0.034
AVG SD of lateral position(cm)	0.000	0.000	0.000
AVG of steering entropy	0.003	0.017	0.032
AVG of proportion of fixation duration (%)	0.000	0.000	0.000
AVG of scanning velocity (°/s)	0.000	0.000	0.000

For the experiment data in urban road scenario, the variance analysis of the three sizes of IVIS is performed, and $F > F_{0.05(2,141)} = 3.06$, i.e. $p < 0.05$, there is a significant difference.

Table 4. Distraction data in different sizes of IVIS in highway scenario.

Highway	Normal driving	8-inch	10-inch	12-inch
AVG of longitudinal velocity(km/h)	76.94	57.72	63.32	65.11
AVG SD of longitudinal velocity (km/h)	8.26	13.21	11.92	10.73
AVG SD of lateral position(cm)	18.52	29.48	27.47	25.80
AVG of steering entropy	0.45	0.58	0.56	0.53
AVG of proportion of fixation duration (%)	95.42	85.68	89.29	90.32
AVG of scanning velocity (°/s)	42.76	105.31	101.46	95.49

For the data in normal driving situation and the data in sub-task driving on the different sizes of IVIS in highway scenario, the significance test is carried out and the results are shown in Table 5.

Table 5. Significant test result of distraction data in different sizes of IVIS in highway scenario.

Highway	8-inch	10-inch	12-inch
AVG of longitudinal velocity(km/h)	0.000	0.000	0.000
AVG SD of longitudinal velocity (km/h)	0.000	0.025	0.043
AVG SD of lateral position(cm)	0.000	0.000	0.000
AVG of steering entropy	0.007	0.019	0.034
AVG of proportion of fixation duration (%)	0.000	0.000	0.000
AVG of scanning velocity (°/s)	0.000	0.000	0.000

For the experiment data in highway scenario, the variance analysis of the three sizes of IVIS is performed, and $F > F_{0.05(2,141)} = 3.06$, i.e. $p < 0.05$, there is a significant difference.

Table 6. Distraction data in different structures of IVIS in urban road scenario.

Urban road	Normal driving	Palace format	Label	Display
AVG of longitudinal velocity(km/h)	38.36	27.14	29.81	30.55
AVG SD of longitudinal velocity (km/h)	6.24	9.77	8.83	8.25
AVG SD of lateral position(cm)	17.44	29.78	26.78	28.17
AVG of steering entropy	0.60	0.82	0.74	0.78
AVG of proportion of fixation duration (%)	96.76	84.92	89.55	91.52
AVG of scanning velocity (°/s)	63.54	117.24	106.40	105.42

For the data in normal driving situation and the data in sub-task driving on different structures of IVIS in urban road scenario, the significance test is carried out and the results are shown in Table 7.

Table 7. Significant test result of distraction data in different structures of IVIS in urban road scenario.

Urban road	Palace format	Label	Display
AVG of longitudinal velocity(km/h)	0.000	0.000	0.000
AVG SD of longitudinal velocity (km/h)	0.000	0.012	0.017
AVG SD of lateral position(cm)	0.000	0.000	0.000
AVG of steering entropy	0.002	0.033	0.020
AVG of proportion of fixation duration (%)	0.000	0.000	0.000
AVG of scanning velocity (°/s)	0.000	0.000	0.000

For the experiment data in urban road scenario, the variance analysis of the three structures of IVIS is performed, and $F > F_{0.05(2,141)} = 3.06$, i.e. $p < 0.05$, there is a significant difference.

Table 8. Distraction data in different structure of IVIS in highway scenario.

Highway	Normal driving	Palace format	Label	Display
AVG of longitudinal velocity(km/h)	76.94	58.53	63.20	64.42
AVG SD of longitudinal velocity (km/h)	8.26	12.94	12.04	10.88
AVG SD of lateral position(cm)	18.52	29.13	26.21	27.41
AVG of steering entropy	0.45	0.58	0.54	0.55
AVG of proportion of fixation duration (%)	95.42	85.68	88.43	91.18
AVG of scanning velocity (°/s)	42.76	105.92	99.27	97.07

For the data in normal driving situation and the data in sub-task driving on different structures of IVIS in highway scenario, the significance test is carried out and the results are shown in Table 9.

Table 9. Significant test result of distraction data in different structures of IVIS in highway scenario.

Highway	Palace format	Label	Display
AVG of longitudinal velocity(km/h)	0.000	0.000	0.000
AVG SD of longitudinal velocity (km/h)	0.003	0.011	0.020
AVG SD of lateral position(cm)	0.003	0.000	0.000
AVG of steering entropy	0.000	0.036	0.024
AVG of proportion of fixation duration (%)	0.000	0.000	0.000
AVG of scanning velocity (°/s)	0.000	0.000	0.000

For the experiment data in highway scenario, the variance analysis of the three structures of IVIS is performed, and $F > F_{0.05(2,141)} = 3.06$, i.e. $p < 0.05$, there is a significant difference.

As the six driving distraction indicators were obtained through driving performance and eye movement behavior, the effects of different sizes and information structures of IVIS on driving distraction were compared.

For the size of IVIS, the 12-inch touch screen has the least impact on driving distraction, followed by 10-inch, and the 8-inch touch screen has the greatest impact. The larger the size of the touch screen, the less average of longitudinal velocity of the driver decreases, the smaller the standard deviation of the longitudinal velocity is, the stronger the driver's ability to maintain the longitudinal velocity and stability of the vehicle, the smaller the standard deviation of the lateral position of the driver is, the smaller of the steering entropy is and the stronger ability to control the lateral stability of the vehicle, the proportion of fixation duration is larger, the average scanning velocity is smaller, the driver's visual distraction and cognitive load are smaller, and the attention can be better focused on driving. Therefore, among the three sizes of IVIS: 8-inch, 10-inch, and 12-inch, 12-inch screen has the least impact on driving distraction, and is recommended to use.

For the information structure of the IVIS, the palace format structure has the greatest impact on the driving distraction. The label structure has the least impact on the lateral control of the vehicle. The display structure has the least impact on the longitudinal control of the vehicle and eye movement behavior. The display structure has the least decrease in the average of longitudinal velocity and the standard deviation of the longitudinal velocity is the smallest, the proportion of fixation duration is the largest, and the average scanning is the smallest. The label structure has the smallest standard deviation of the lateral position and the smallest steering entropy. Therefore, in the three structure IVIS, label structure and display structure are recommended, and it is not recommended to use the palace format structure.

3.3. Evaluation System Construction

Based on the experiment data, we established an evaluation system to evaluate the safety of IVIS.

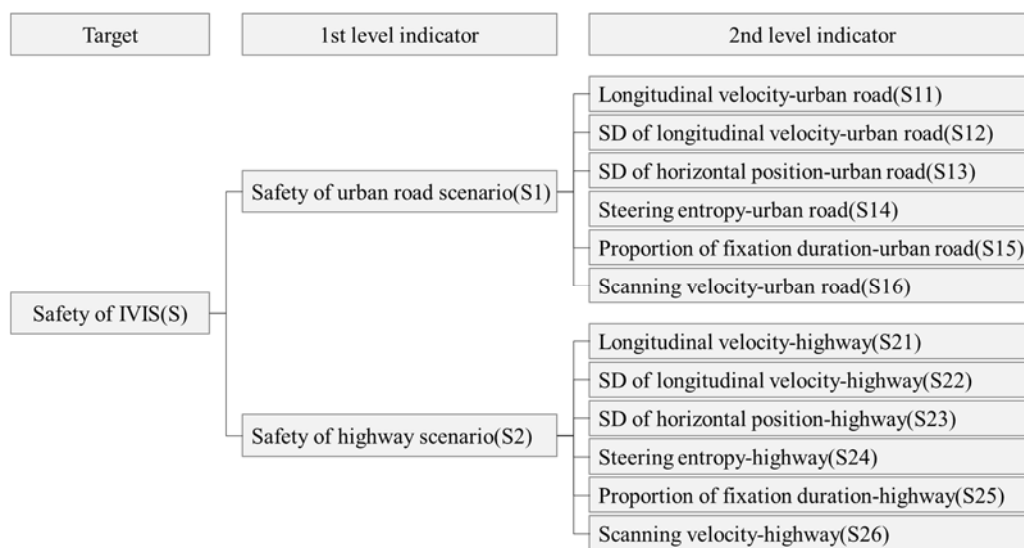


Figure 5. Evaluation system.

So we can get the indicator factor set is

$S = \{S1, S2\} = \{\text{Safety of urban road scenario, Safety of highway scenario}\};$

And each 1st level indicator is associated with six 2nd level indicators:

$S1 = \{S11, S12, S13, S14, S15, S16\} = \{\text{Longitudinal velocity-urban road, SD of longitudinal velocity-urban road, SD of lateral position-urban road, Steering entropy-urban road, Proportion of fixation duration-urban road, Scanning velocity-urban road}\};$

$S2 = \{S21, S22, S23, S24, S25, S26\} = \{\text{Longitudinal velocity-highway, SD of longitudinal velocity-highway, SD of lateral position-highway, Steering entropy-highway, Proportion of fixation duration-highway, Scanning velocity-highway}\}.$

The weight between the target layer and the 1st level indicator is recorded as the vector $W0$, depending on the frequency of use of different scenarios and the awareness of importance of security in related road scenarios. This part has strong subjectivity and needs drivers to analyze according to their subjective evaluation. In order to improve the effectiveness of subjective evaluation, fuzzy analytic hierarchy process will be adopted.

Firstly, we establish an $n \times n$ fuzzy consistent judgment matrix. Since only $S1$ and $S2$ are considered here, $n=2$. We selected five experienced drivers for comparison assignment. We constructed the discriminant matrix A and asked the decimals that were tested between 0.1 and 0.9 to be compared to $a1$ and $a2$.

$$A = \begin{bmatrix} 0.5 & a_1 \\ a_2 & 0.5 \end{bmatrix} \quad (2)$$

The meanings of different decimals are shown in Table 10, and the sum of a_1 and a_2 must be equal to 1.

Table 10. Fuzzy Number Assignment.

Scale value	The relationship between two indicators (S1 and S2)
0.9	S1 factor is extremely important than S2 factor
0.7	S1 factor is very important than S2 factor
0.5	S1 factor is as important as S2 factor
0.3	S2 factor is very important than S1 factor
0.1	S2 factor is extremely important than S1 factor
0.2, 0.4, 0.6, 0.8	Median of two adjacent judgments

Secondly, we perform a consistency test on the fuzzy judgment matrix. The necessary condition of $R(r_{ij})$ $n \times n$ to be a fuzzy uniform matrix is that the difference between the corresponding elements of any two lines is constant. If $R(r_{ij})$ $n \times n$ is not a fuzzy uniform matrix, arithmetic synthesis can be performed by the following formula.

$$r_{ij} = \frac{1}{n} \sum_{k=1}^n (r_{ik} - r_{jk} + 0.5) \quad (3)$$

Thirdly, calculate the weight value w_i of factor i from $R(r_{ij})$ $n \times n$ matrix by the formula:

$$w_i = \frac{1}{n} - \frac{1}{2a} + \frac{1}{na} \sum_{j=1}^n r_{ij} \quad (4)$$

In the formula, a is the adjustment parameter and $a \geq (n-1)/2$. Usually $a = (n-1)/2$. In this paper, we take $a = (n-1)/2$. After the calculation, $W_0 = (0.62, 0.38)^T$.

The weights between the 1st level indicators and the 2nd level indicators are recorded as vectors W_1 and W_2 . We train W_1 and W_2 on driving performance and eye movement behavior data in two scenarios, and use the support vector machine (SVM) model to solve the corresponding weights.

In the use of the support vector machine, it is necessary to determine the model training samples and the model verification data. For urban road scenario, safety S1, 210 data were selected for model training, and another 200 data were used for model verification. For highway scenario, safety S2, 215 data were selected for model training, and another 203 data were used for model verification. For each sample, the driving safety is divided into 0-dangerous, 1-ordinary, 2-safe according to the feedback rating of the subject after each driving sub-task.

Since each indicator has a dimension, it needs to be dimensionless, which can avoid the impact caused by the difference between the data, and finally makes the evaluation factor range of 0-1. For any evaluation factor t , there is the following transformation formula:

$$t_{i,j,k} = \frac{T_{i,j,k} - T_{i,min}}{T_{i,max} - T_{i,min}} \quad (5)$$

For the non-dimensional evaluation factor, a forward transformation is needed, so that the indicator of the negative relationship can better reflect the function change. It can be seen that the larger the value of the standard deviation of longitudinal velocity, the standard deviation of lateral position, the steering entropy, and the average scanning velocity, the more unsafe driving, so the four indicators are negative relationship indicators. Since the dimensionless evaluation factors have the value range of 0-1, we use $t_{positive} = 1 - t_{negative}$ to process and complete the forward conversion.

Then, we use the RBF(radial basis function) function to construct a support vector machine for the kernel function. The function expression is

$$K(x, x_i) = \text{Exp}(-\gamma \|x - x_i\|^2), \gamma > 0 \quad (6)$$

It will be realized by SPSS. It is necessary to determine the value of the penalty parameter C and the kernel function parameter γ . The role of the penalty parameter C is to adjust the proportion between the complexity of the model structure and the empirical risk. In this paper, the cross-validation idea is selected to optimize the parameters. The samples are divided into n mutually exclusive subsets for cross-validation. The first one is used as the test set, and the remaining $n-1$ subsets are used as the training set to obtain the precision a_1 . Then we use the other second part as the test set, leaving $n-1$ parts as the training set, and then press each analogy to test and train each one, and select the parameter with the smallest average generalization error as the model parameter. In the actual parameter selection operation, the function SVMcgForClass is used to realize the optimization of specific parameters. The optimal parameter selection result is Best $C=2$ and Best $g=0.1$, and the classification accuracy rate is 96.758% in urban scenario and 97.496% in highway scenario. Finally, we process the data with the RBF-SVM model in SPSS and predict the importance of parameters by substituting them into the model. Therefore, based on support vector machine, the secondary indicator weights of S1 and S2 are:

$$W_1 = (0.151, 0.176, 0.155, 0.181, 0.163, 0.174, 0, 0, 0, 0, 0, 0)^T$$

$$W_2 = (0, 0, 0, 0, 0, 0, 0.154, 0.188, 0.145, 0.182, 0.160, 0.171)^T$$

Combine W_0, W_1, W_2 , we get the final evaluation weight vector:

$$W = (0.094, 0.109, 0.096, 0.112, 0.101, 0.108, 0.059, 0.071, 0.055, 0.069, 0.061, 0.065)^T$$

Taking the average of each classification and multiplying it by the comprehensive evaluation weight vector, we get the final evaluation results in Table 11.

Table 11. Final evaluation results.

Score	8-inch	10-inch	12-inch
Palace format structure	0.355	0.441	0.516
Label structure	0.472	0.557	0.663
Display structure	0.395	0.593	0.704

In the process of automobile design, engineers usually select the size of the touch screen to determine the position of the product. Therefore, it is of great application value to screen out the most suitable structure of IVIS under the premise of fixed screen size.

- (1) For the 8-inch IVIS, label structure has the best use safety performance;
- (2) For the 10-inch, 12-inch IVIS, the display structure has the best use safety performance.
- (3) Regardless of cost, 12-inch display structure IVIS will provide drivers with the highest driving safety performance.

4. Conclusion

In this paper, we compared the driving performance and eye movement behavior on different sizes and structures of IVIS in six indicators. We get the following results from experiment data: the larger the size of the touch screen, the smaller the impact of the IVIS on the driving distraction; The palace format structure of IVIS has the greatest impact on the driving distraction, and the label structure of IVIS has the least impact on the vehicle lateral control, and the display structure of IVIS has the least impact on vehicle longitudinal control and eye movement behavior. Regardless of the cost, it is recommended to use a 12-inch touch screen of IVIS in label structure or display structure.

Besides, this paper combined fuzzy analytic hierarchy process method and support vector machine method to establish a safety evaluation model for the touch screen of IVIS and evaluated the nine kinds of IVIS in different screen size and information structure in this experiment. It is found that for the 8-

inch IVIS, the label structure is the safest while being used; for the 10-inch and 12-inch IVIS, the display structure is the safest while being used. It is hoped that the research results of this paper could provide reference for the design of IVIS.

5. References

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