Hindawi

Retraction

Retracted: Design of Human-Machine Interaction Interface for Autonomous Vehicles Based on Multidimensional Perceptual Context

Scientific Programming

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Lu, J. Ma, and Z. Gong, "Design of Human-Machine Interaction Interface for Autonomous Vehicles Based on Multidimensional Perceptual Context," *Scientific Programming*, vol. 2021, Article ID 5859800, 8 pages, 2021.

Research Article

Design of Human-Machine Interaction Interface for Autonomous Vehicles Based on Multidimensional Perceptual Context

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The objective of the study is to provide guidance for automobile human-computer interface design through the research, practice, and evaluation of intelligent driving automobile human-computer interfaces. In this study, the methods of intelligent vehicle automatic cruise control function, theoretical models of the situation analysis, and a three-level information architecture are proposed and designed. During the study, interface space layout is combined with the interactive interface design. The results obtained on the basis of the proposed three levels of perception and prediction of situation awareness are combined with typical application scenarios. The information on AR-HUD and W-HUD in anterior cingulate cortex (or ACC) function is analyzed. The feasibility of the theory is verified through the design practice of information architecture design, key prototype, and typical effect diagram. The human-computer interaction interface based on situational awareness can effectively clarify the display content and process of information and improve the usability of the interface.

1. Introduction

The current driving technology of most smart cars is mainly in the transition stage of L2~L3, where the vehicle can drive automatically for long or short distances under the supervision of the driver. In this stage, the driver's workload is reduced and the vehicle takes over more driving tasks. From the point of view of performing driving tasks, the autonomous driving function reduces the driver's workload and situational awareness of the surrounding environment. However, in complex driving scenarios, there is also a risk that the autonomous driving system will not be able to handle the situation. If the driver cannot handle unexpected situations in a timely manner and maintain a certain level of situational awareness, then there is a high risk of traffic accidents. The car interface is an important window for humans to obtain information, so the reasonable allocation of the content appearance and arrangement of information through theories related to situational awareness can help improve the interaction efficiency and driving safety of the smart car interface [1, 2].

Situation awareness (SA) is a perceiver's ability to understand the current situation dynamically and holistically based on environmental factors, thus enhancing the ability to identify, understand, analyze, and respond to security risks in order to make final decisions and actions [3]. Endsley's study divided situational awareness into three levels [4–6], the first level being perception of the elements in the environment, the second level being the understanding of the current situation, and the third level being the prediction of the future state (see Figure 1). The development of situational awareness was made possible by theoretical research in the field of aviation [7]. The development of information and automation technologies has improved the way pilots and associated staff work and reduced the physical burden but increased the cognitive burden. In some cases, the ever-increasing amount of information and increasingly complex operations have caused pilots to lose their way in the ocean of information, and instead of helping the pilot, the display of the human-machine interface makes it unclear what is happening in the system and how it will change afterwards, which leads to loss of situational awareness [8]. In contrast, since the 20th century, with the application of automation technology in automobiles, it has been discovered that there are many commonalities between the
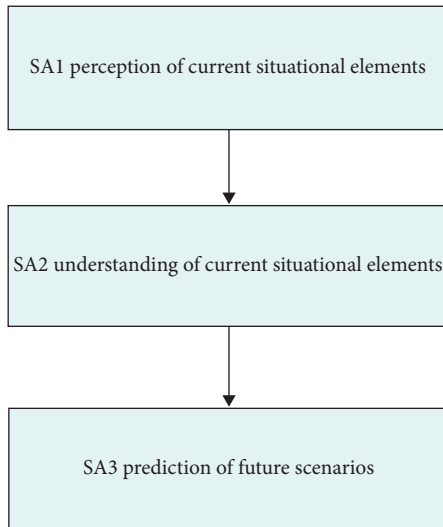
Figure 2: Driver's gaze point (red circle) shown in the eye-tracking video screenshot.

Figure 3: Trajectory of the vehicle in the driver's cognitive field of view.

contextual elements under each stage, and focuses on the interface design of AR-HUD and W-HUD. Taking the cut to driving scenario as an example, this case carries out the analysis of auxiliary vehicle travel trajectory based on the driver's cognition, clarifies the information content of AR-HUD and W-HUD, establishes dynamic information architecture, and carries out the prototype design [17].

3.1. Functional Analysis of Driver Use of ACC in Cut Scenarios.
ACC (adaptive cruise control) is a driver assistance system that controls the longitudinal movement of the vehicle and is one of the main functional requirements of today's autonomous vehicles [18]. ACC is developed from the cruise control (CC) function, where the vehicle can travel at a preset speed. The ACC system uses a sensor system and a distance control system, where the radar on the vehicle is set to detect only the vehicle ahead in the lane where the ACC function is enabled. The control system includes a speed controller and a headway controller that switches between distance control and headway control based on the data obtained from the sensors [19]. When the sensors do not detect a vehicle ahead, the vehicle will travel at a set speed. When a vehicle is detected in front, the car controls the headway to follow the vehicle. In order to realize the control

of speed and headway, ACC has the control of throttle and brake [20].

Before a driver can use the ACC system, he/she must first identify whether the driving environment can use the ACC function, and the ACC system needs to identify/detect whether the current road condition is suitable for using the ACC function, and if so, the driver is advised to use it. Once the driver turns on the ACC function and sets the speed and distance, the driver can drive continuously in an accident-free environment. When an unexpected situation occurs, such as a cut-over scenario where an auxiliary vehicle appears to the side and rear of the vehicle trying to cut into the lane, a system change occurs [21]. Firstly, the ACC system needs to recognize the vehicle and tell the driver that it is being recognized; secondly, some control strategies such as brake/accelerate/hold are to be taken, and then the driving status is maintained. The human needs to check if the ACC system can recognize the vehicle that is about to cut in front of him and detect if the ACC system has taken certain actions. If no action is taken, then the person can exit the ACC system by applying the brakes or accelerating (see Figure 4).

3.2. Application Scenario Design.
In the above cut scenario, if the driver uses the ACC function, the driving scenario is
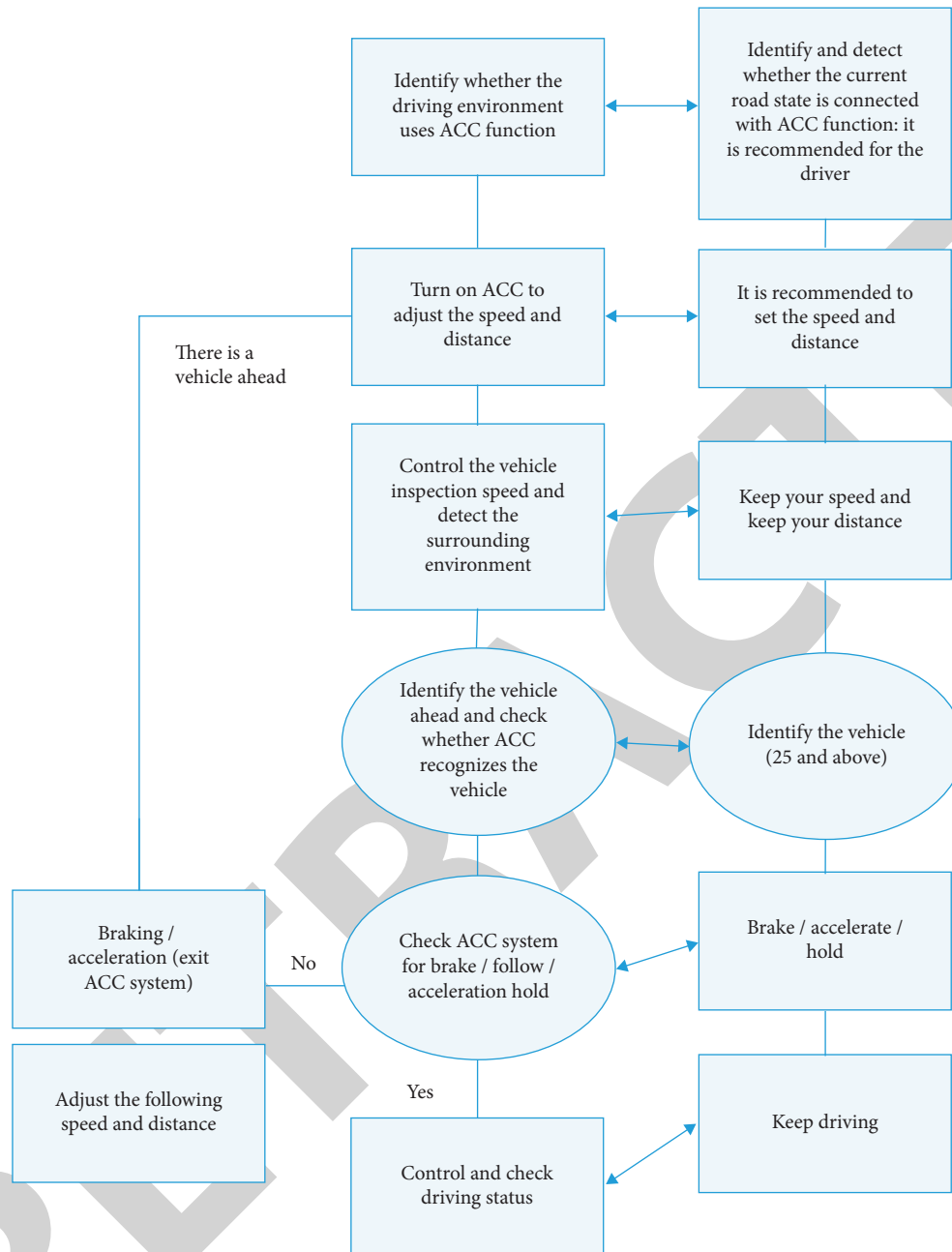
FIGURE 4: :Functional flow of the driver using ACC in a cut-in scenario.

divided into two phases (see Figure 5). The crossing of the lane line by the front right wheel of the auxiliary test vehicle (car F) is the demarcation point, and the first stage ahead and the second stage behind are the judgment nodes.

The first phase consists of two states: driving state and change adjustment 1.

The second phase includes two states as well: change adjustment 2 and steady following. In the driving state, the driver sets the ACC speed; in change adjustment 1, car F starts to overtake and starts to prepare to cut into the lane of the main test vehicle (car S); in change adjustment 2, car F starts to cut into the current lane, and this scenario change may also affect the driver of car S to adjust the ACC setting

and have a greater impact; in the following state, car S follows car F at the speed of car F. Functional flow of the driver using ACC in a cut-in scenario is shown in Figure 4. Application scenarios for ACC-enabled vehicle entry are shown in Figure 5.

3.3. Trajectory Analysis of Auxiliary Vehicles under Driver's Perception. In order to better understand the trajectory of the auxiliary test vehicle in the driving field, several drivers were invited to drive in the simulation simulator to experience the ACC function in a cut-in scenario. The drivers monitored the driving environment in real time through the

Stage 1: the right front wheel of vehicle f before cutting in does not cross the middle lane line		Stage 2: after cutting in, the right front wheel of vehicle f drives over the middle lane line	
Status 1 Cruise	State II change adjustment 1	State III change adjustment 2	State IV stable car following

Figure 5: Application scenarios for ACC-enabled vehicle entry.

front windshield, inside rearview mirror, and left and right rearview mirrors during the driving process. According to the eye-tracking video, the basic sweeping path of the driver is the left outer mirror (inner mirror), left window, left lane, and current lane (see Figure 2).

Combining the driver's visual sweep analysis and the vehicle's own driving trajectory, the driver monitors the driving trajectory of the vehicle. The approximate sequence of the trajectory is left rearview mirror/internal rearview mirror-left window-front windshield left lane, the origin in the figure represents the vehicle trajectory node, 1–3 is the driver's recognition range, 4–6 is the driver, and the vehicle 4–6 is the driver and the vehicle's common recogni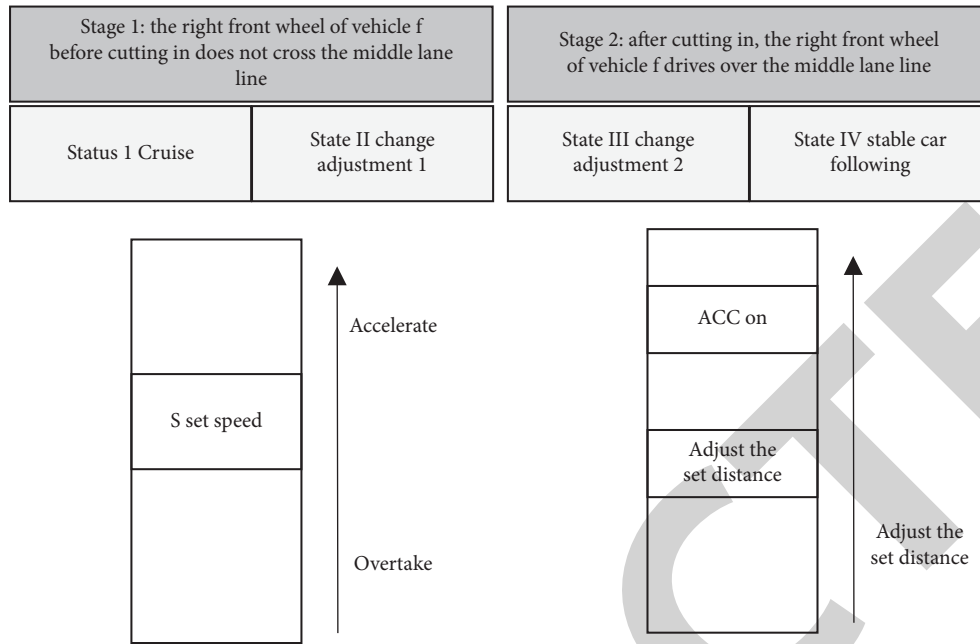tion range. When the vehicle is driving in the 4-5 area, the driver and the vehicle need to judge whether the state of the vehicle in front will affect the use of the ACC function of the vehicle and whether the driver needs to adjust the ACC setting speed and setting distance. Therefore, in this case, 4-5 is designed to help the driver determine the trajectory of the vehicle in front, enhance situational awareness, reduce the driver's workload, and make effective judgments and actions in a timely manner. Trajectory of the vehicle in the driver's cognitive field of view is shown in Figure 3.

4. Situational Awareness-Based Human-Machine Interface

In this section, situation awareness scenario is explained in which focus is given to the layout design.

4.1. In-Vehicle Human-Machine Interface Display Space Layout Design. From the total in-vehicle human-machine interface (HMI) layout design, we consider modularizing similar contents, constructing information modules, considering the information interaction between screens, and distributing information modules in a regular manner in the in-vehicle space. Some studies point out that a modular visual information interface can effectively save users' cognitive resources and help them improve the efficiency and accuracy of processing information. The head-up display (HUD) contains basic driving information and information about ACC functions, making it easier to obtain information while driving. However, in many designs, the AR-HUD and W-HUD information is duplicated, which may cause confusion to the driver, so this paper mainly puts the display information in the head-up display area and analyzes and studies the ACC-related visual information.

4.2. ACC Interface Design for Typical Application Scenarios. The basic information of the ACC function was first classified and laid out in a modular way, and the design elements were standardized (see Figure 6). The final interface design is shown in Figure 7. After the SA analysis, the real-time speed information was expressed in a hollow circle, which visually makes the speed information clearer and distinguishes the real-time speed from the ACC set speed. The vehicle icon changes from white to blue when the car has recognized the vehicle in front of it. In AR-HUD, the "prerecognition" status of the vehicle ahead is expressed in the form of a "checkbox." When the car recognizes a vehicle in front or in the next lane, the recognition information is white and a white checkbox appears. When the car recognizes the vehicle ahead, the driving mode changes to follow mode and the recognition information is blue, i.e., a blue checkbox appears. The interface design effect is shown in Figure 8.

By using 3 time distances for distance information expression, it is visually clearer to judge the change in distance caused by increasing or decreasing time distances. In AR-
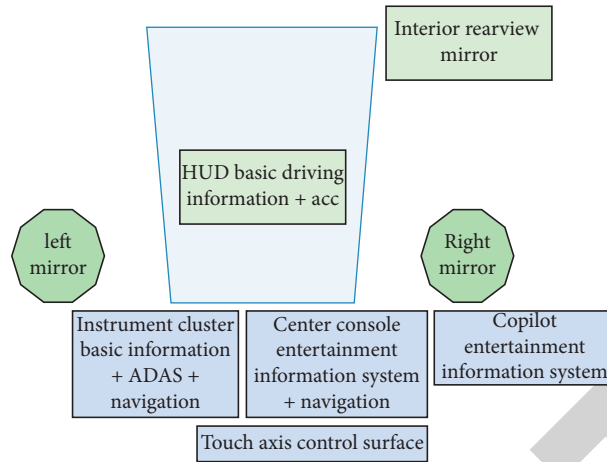
FIGURE 6: In-vehicle HMI display space layout.
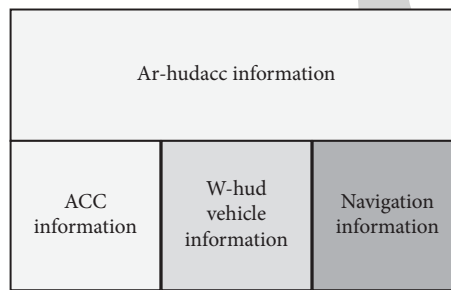
FIGURE 7: HUD display space layout and interface design element specification.

FIGURE 8: Interface design effect.

HUD, the ACC function mode has been added logically. When the car is in driving mode, the distance rectangle is hollow; when the car is in following mode, the distance rectangle is solid, and the distance rectangle of AR-HUD shows that the distance following the car in front changes in real time. In W-HUD, the distance display is the driver's set time distance and does not change with the real-time time distance, providing the driver with the original set information accurately. Visually, the different levels of information in the SA are distinguished by color and gradient.
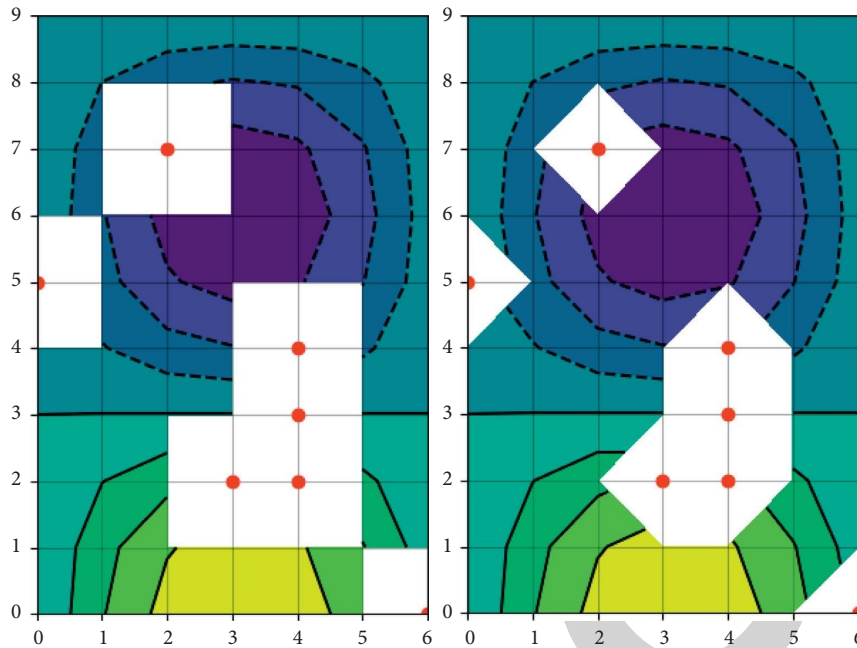
FIGURE 9: Clustering results of average speed difference coefficient and maximum speed difference coefficient.

5. Risk Level Analysis

Using the road test data, the risk avoidance disengagement scenarios are screened. With the constructed speed indicators, the classification model such as BP neural network supervision can be used to classify the risk level of the risk avoidance disengagement scenarios during the road test. The three speed indicators are combined in pairs and clustered according to the original record of disengagement reasons, and the classification results are shown in Figure 9.

Since there are many outliers in the data distribution of "maximum speed difference coefficient" and the data are relatively concentrated and not sufficiently discrete in the graphs classified according to the reasons for disengagement, "average speed difference coefficient" and "speed coefficient of variation" were selected as classification indicators.

6. Conclusions

Here, the generation process of user situational awareness in the cut-in scenario of the adaptive cruise function of smart cars is analyzed, and the design strategy of HUD interface is proposed based on the situational awareness theory, and the design practice work is carried out. The research in this paper provides a certain reference value for the design of human-computer interaction interface of smart cars. In the future, user interfaces with learning experience (UX) capabilities will become mainstream.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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