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Human-computer interaction: Evaluation of trust and emotional

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Abstract. With the advancement of information technology, human-computer interaction is becoming increasingly intelligent. This progress has led to the transformation of the car cabin from a simple driving space to an intelligent mobile life terminal. At the same time, more and more people have psychological problems in modern society, and timely adjustment of their negative emotions is of great practical significance to social harmony and stability. Traditional methods of emotion regulation require a lot of manpower and energy. Hence, this paper presents an approach that utilizes text dialogue and somatosensory interaction to detect the user's emotions and subsequently adjust them. By examining and analyzing the current research landscape, the objective of this study is to offer insights for designing trustworthy and emotionally-responsive interactions in the automotive context. It can bring a better driving experience to smart car users and bring benefits to many companies. It is of great scientific and application value to carry out this research in depth to promote the development of human-computer interaction. Through literature review, case study, theoretical analysis and other research methods. This paper sorts out the establishment of trust degree and recognition of emotional changes in human-computer interaction, and puts forward the role, defects and improvements of trust establishment in human-car cooperation, as well as the reasons affecting user emotions, and how to improve the defects of the application of voice emotion recognition. It also discusses difficulties in establishing trust and misperception of emotions.

Keywords: Human-computer interaction (HCI), Trust, Emotion, Speech emotion recognition.

1. Introduction

Users communicate with and operate the system through the human-computer interface. The intelligent cooperation between humans and vehicles involves three core components: perception, decision-making, and execution. The primary focus of research encompasses essential technologies including environment perception, sensor data fusion, high-precision mapping and positioning, intelligent decision-making and planning, control and execution, and information security [1]. Due to the simplification of the internal mechanism design of intelligent driving vehicle automation, a lot of space pressure can be released. The design of human-computer interaction can achieve customized system optimization according to different scenarios of different users. In the future intelligent era, the key components of the automobile are gradually digitized and intelligent, and the human-machine interaction based on the current intelligent automobile in China will become a variety of human-machine

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interaction using a variety of telecommunication channels to communicate with a variety of computers, adapting to the human-machine natural interaction design standards [2].

As the main interaction space between people and cars, the digital, intelligent and interconnected features of car cabins are increasingly prominent, especially the cockpit design of new energy vehicles, which breaks the traditional interaction mode of car cabins in the era of mechanization and electrification [3], and adopts more multi-channel, intelligent and immersive human-vehicle interaction design schemes. The car cabin is no longer just a simple driving space, but is developing in the direction of intelligent life 'third space' integrating traffic driving, work learning, leisure and entertainment [4]. The rise of the automotive intelligent cockpit research theme is closely related to the development of the new energy automobile industry [5].

As society progresses and the pace of life accelerates, individuals are confronting substantial pressure across various domains. Many people often feel depressed, painful or angry, and thus produce a variety of psychological problems. Slowly more and more people seek appropriate means to regulate and treat the corresponding mental illness [6]. Emotion recognition is an important part of emotional interaction between human and machine, and it is also the premise of emotion regulation. ERPs (event-related potentials) technology can be used to examine the differences in automatic emotion regulation among different age groups, indicating that emotional faces are more attractive and show positive effects in automatic emotion regulation [7]. Traditional emotion regulation methods have limitations, while automatic emotion regulation methods can more effectively reduce negative emotional reactions, and the intention paradigm is used to help people conduct effective emotion regulation [8]. Read the user's brain wave signal through EEG technology, and give corresponding stimulation through VR (virtual reality) virtual environment to regulate emotions [9]. In the interaction with smart devices, humans maintain an appropriate degree of trust in the machine is conducive to improving work efficiency, but also has a positive impact on safety. Within the realm of human-computer interaction, trust is widely recognized as a crucial factor for successful collaboration between humans and computers [10].

2. Research works

2.1. Human-vehicle cooperation trust research

Lee et al. [11] discussed the role of trust in intelligent voice interaction systems, proposed the concept of interaction quality to improve people's trust in voice interaction, and verified it through experiments. Finally, they proposed a voice interaction trust mechanism based on social response theory. Trust can be seen as an attitude, which is based on the information provided by the system, past experience and personal impression. When users come into contact with a system, they will form a sense of trust based on the information obtained, personal impressions, and past experience. The difference in the degree of trust will lead to different degrees of dependence of users on the system. Information plays an important role in building trust. When the system can provide accurate and useful information, and consistent with the user's expectations, the user will be more inclined to trust the system. In addition, the transparency and reliability of the system will also affect the user's trust in the system. Users form a sense of trust in the system based on these factors, and determine their dependence on the system according to the degree of trust.

The current related research mainly focuses on the development of mechanisms, strategies and models to enhance the trust of human-vehicle cooperation. However, the relationship between the influencing factors of human-computer interaction and trust variables needs to be further studied. This includes in-depth discussion of the impact mechanism of HMI design on trust, and how to improve the establishment of human-vehicle cooperation trust by improving HMI design. Such research will help promote the further development and popularization of autonomous driving technology.

2.2. User cognition

According to Pentland et al.'s [12] research, we learned that at the user's cognitive level, the driver's psychological activity and cognitive ability when performing driving tasks will have a certain degree of

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impact on their driving behavior. To enhance the efficiency and safety of human-computer interaction during driving, a systematic approach can be employed to effectively manage and mitigate the adverse effects of this interaction and promote better coordination between individuals and vehicles. This study reveals the important influence of driver's mental activity and cognitive ability on driving behavior. The driver's cognitive ability includes perception, attention, memory, decision-making and so on. These abilities play a key role in the driving process. By systematically coordinating the interaction between people and vehicles, the negative impact of psychological activity and cognitive ability on driving behavior can be reduced. This can be achieved by improving the design of human-machine interface, providing clear and concise information presentation, and reducing the interference factors of distraction. By optimizing the design and implementation of human-computer interaction, drivers can better understand and respond to the behavior of vehicles, perform driving tasks more efficiently, and thus improve the efficiency and safety of driving.

2.3. Emotion

At the emotional level of users, Zhao Xinyu et al [13] pointed out that the driver's anxiety will have a negative impact on safe driving. In order to reduce the driver's anxiety, a specific human-computer interaction design is introduced on the corresponding space-time node to regulate the driver's anxiety when waiting for driving. Ultimately, the Unity production function prototype is utilized to assess the emotional state of the driver, and the evaluation outcomes validate that the design scheme can yield positive outcomes.

According to the research results of Bañuls [14], when the driver faces non-intuitive interface information and defective interactive systems, if these information and systems exceed the driver's cognitive range, it will cause cognitive confusion and lead to confusion. This situation will have a negative impact on the driver's attention and decision-making, and increase the time of operation response. A defective interactive system may also lead to similar effects. For example, if the vehicle's operating control system has a fault or unreliable response, drivers may be confused and uncertain because they cannot accurately predict the behavior of the system.

Hence, when designing interactive interfaces and systems, it is crucial to prioritize the driver's cognitive limitations and abilities. This ensures that the interface information is presented in a manner that is intuitive and easily comprehensible, while offering reliable and predictable interactive operations. By minimizing the likelihood of drivers experiencing cognitive confusion and ambiguity, driving safety and efficiency can be significantly enhanced.

Vaa [15] also points out, through a comparative analysis of theoretical models of driving behavior, that the cognitive abilities and emotional states of drivers greatly influence their ability to make correct driving judgments and decisions. Consequently, the study of user cognition and emotion stands as a significant area of focus within the research on intelligent cockpit design. A depiction of the driver's perceptual and cognitive processes can be observed in Figure 1.

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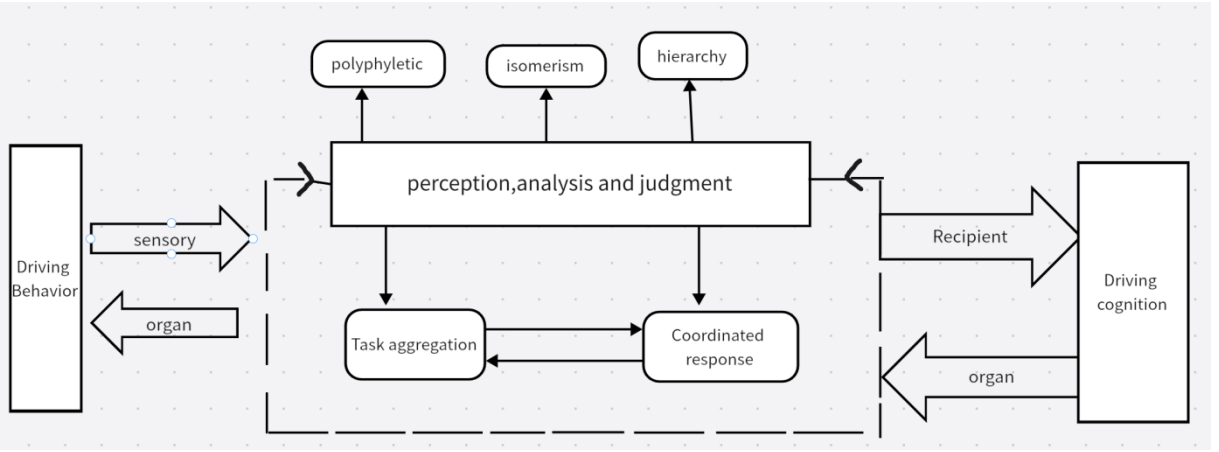

Figure 1. Driving behavior perceptual and cognitive processes [16].

2.4. Applications of speech emotion recognition (SER) in HCI

Speech Emotion Recognition (SER) has the potential for broad applications in Human-Computer Interaction (HCI). The response of human-machine interfaces can vary depending on the user's emotional state, which holds particular significance when speech serves as the primary mode of interaction with the machine. In this context, Speech Emotion Recognition (SER) plays a vital role in meeting the fundamental need of enhancing the human-likeness of numerous applications and further bolstering user acceptance.

Emotion recognition finds application in call centers, where it is employed to detect the emotional state of customers and subsequently handle their inquiries based on the identified emotion. For instance, when customers express anger, service providers can route them to experienced agents capable of resolving issues and implementing appropriate measures to address their concerns effectively. Conversely, when customers are in a calm state, they can be connected to general agents as they may only require general information or assistance. A similar case involving the Wisconsin Physician Services Insurance Corporation (WPSIC) showcases the utilization of sentiment detection tools to preserve their policyholders' fair treatment. By discerning the caller's emotional state, they can promptly connect them to a dedicated agent who can offer suitable support and solutions tailored to their specific situation. This personalized approach contributes to improving the overall customer experience and enhancing satisfaction levels with the company [17].

In summary, the application of emotional speech recognition in call centers provides service providers with better insight, enabling them to make corresponding decisions and actions based on the emotional state of customers. By identifying and responding appropriately to the emotional needs of customers, the company can improve customer satisfaction, increase loyalty, and gain an advantage in market competition.

2.4.1. In-car board system. The integration of emotional speech recognition in vehicle board systems enables humans to perform various driving tasks, such as steering, acceleration, braking, speed control, route planning, maintaining distance from other vehicles, adjusting lighting within the vehicle, operating windshield wipers, and detecting driver blinks. This system leverages natural language processing and emotion recognition technology to offer driving assistance that mimics human-like behavior. For instance, if the system identifies the driver's aggressive or angry mood, it can help alleviate their emotions and ensure safe driving by adjusting the vehicle's driving mode, providing a smoother driving experience, or offering calming audio cues. Similarly, if the system detects that the driver is confused, sad, or drowsy, it can suggest the driver to take a rest, adjust their seating posture, or provide vibration cues to alert their attention [18].

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2.4.2. A diagnostic tool for speech therapists. A speech therapist is an expert in the diagnosis and treatment of various language, speech, and communication disorders. Therapists who possess a deep understanding and empathy for emotional stress and anxiety can gain valuable insights into the patient's distress. icSpeech is a software tool utilized for recording and analyzing comprehensive speech data. Within the healthcare field, effective language communication plays a vital role in enabling patients to provide detailed descriptions of their health conditions. In clinical analysis, the examination of human emotions relies on features associated with prosody, the vocal tract, and parameters extracted directly from the glottal waveform. Extracting vocal emotions from human language allows for the expression and recognition of emotional states [19].

In conclusion, the role of a speech therapist involves the diagnosis and treatment of language and speech disorders, while therapists with expertise in understanding and empathizing with emotional stress and anxiety can gain a deeper understanding of the patient's emotional state. The software icSpeech aids in the comprehensive recording and analysis of speech. In the healthcare field, effective language communication aims to enable patients to accurately articulate their health conditions. In clinical analysis, the examination of human emotions relies on features associated with prosody, the vocal tract, and parameters extracted from the glottal waveform. Expressing and recognizing emotions can be facilitated through the extraction of vocal emotions from human language.

3. Discussion

3.1. Trust problem

The human-vehicle interaction of intelligent cars usually includes voice control, gesture recognition, touch screen and other ways. Although these interaction methods can make it more convenient for drivers to control the car and obtain information, overly complex interaction processes may distract the driver, thus increasing the driving risk. In addition, in the third stage of future intelligent cockpit development, there will be greater human-vehicle interaction trust issues. With the continuous development and evolution of intelligent vehicle systems, drivers need to trust the reliability and safety of the system in order to better accept and take advantage of human-vehicle interaction functions. If drivers become suspicious or distrustful of intelligent systems, they may refuse to use them or over-rely on them, leading to safety problems. Solving the contradiction between interactivity and security is the key to achieving substantial development of intelligent cabins. When designing the human-machine interface of intelligent vehicles, it is necessary to put the safety of the driver in the first place and reduce the interference of the complex interaction process to the driver. The system should provide clear and concise controls to reduce the possibility of distraction. At the same time, it is also necessary to ensure the reliability and security of intelligent systems through strict testing and verification, and strengthen the trust of users in intelligent functions, and build user confidence by providing accurate and reliable functions and information.

3.2. Emotional perception problems

Perception of users' real emotions is a valuable research direction for multi-channel human-computer interaction, because users may hide real emotions, and different users may have different ways of expression, which brings challenges to the accurate understanding of user emotions, especially for the expression of complex emotions such as weeping. At present, there have been studies in this area [16], trying to combine the information of multiple channels to better perceive the user's real emotions. However, research in this area needs to be further promoted. First of all, it is necessary to enhance the perception ability of the agent so that it can better grasp and analyze the various clues of the user's expression of emotions. This may involve the improvement of computer vision, speech processing, natural language processing and other technologies to capture and interpret users' emotional signals more accurately. Secondly, data fusion and semantic understanding are also problems that need to be solved. How to effectively integrate multi-channel data together, and how to link the perceived emotion

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with the specific semantics to better understand the meaning behind the user’s emotion, is a problem that needs further research.

4. Conclusion

Given the rapid advancement of human-computer interaction technology, there is an undeniable shift towards human-computer intelligent collaboration. However, intelligent systems employed in various domains still have significant room for improvement. Therefore, there is ample research potential in exploring how to foster human-machine intelligent collaboration. This study primarily focuses on investigating human-vehicle cooperative trust and the utilization of user emotion, cognition, and voice emotion in the context of human-computer interaction. The study findings suggest that varying levels of trust influence the extent to which users rely on the system. Information plays a crucial role in establishing trust. Intuitive and easily comprehensible interface information facilitates reliable and predictable interactive operations. Such attributes effectively minimize cognitive confusion or ambiguity experienced by drivers, consequently enhancing driving safety, efficiency, and the overall benefits of speech emotion recognition for diverse users and companies. The study further delves into the challenges associated with trust and emotional aspects. To put it simply, as human-computer interaction technology advances, the transition towards human-computer intelligent collaboration is inevitable. However, intelligent systems in various domains are still in their early stages, leaving ample room for investigation into how to enhance human-machine collaboration. This research primarily focuses on human-vehicle cooperative trust and the application of user emotion, cognition, and voice emotion in human-computer interaction. The study highlights that different levels of trust lead to varying levels of reliance on the system, with information playing a critical role in establishing trust. Intuitive and easily understandable interface information fosters reliable and predictable interactions, reducing cognitive confusion and improving driving safety, efficiency, and the benefits of speech emotion recognition for users and companies. The study also addresses the challenges related to trust and emotional factors.

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