DOI: 10.54254/2755-2721/34/20230331

A reshaped intelligent autonomous driving by using the influence and progress of human factor engineering concept

Qiwei Fan

Jiangxi Hanvos High School, Nanchang, China

Qiwei.Fan@calhoun.edu

Abstract. In modern society, with the improvement of people's taste of life and the change of people's consumption awareness and lifestyle, cars are no longer just a driving tool or means of transportation. People's requirements for cars are constantly improving, such as the comfort of car seats and the convenience of reversing radar. This paper examines the role of human factor engineering in the intelligent driving and gives some examples of the usage of the human factor engineering, and analyse it by Single-vehicle level analysis and Macro system level analysis. Then, the paper lists different human factor problems affecting intelligent driving. The paper discusses one iHCl system of human factor engineering which based on the Cognitive theory at three levels of perception. The paper analyses two cognizant. For the human users, it has the three-layer scene elements, data-driven, and goal-driven information processing mechanisms utilize dynamic mechanisms for information collection and subsequent response, allowing human users to perceive the updated information obtained in the dynamic environment. For intelligent system, For intelligent systems, it has a "top-down" decision-making processing mechanism. The feedback mechanism is composed of subjects such as goals, plans, and tasks.

Keywords: Human factor engineering, Intelligent driving, IHCL, Human factor system.

1. Introduction

As the income level of society increases and utilization of technology-oriented products is further embraced by customers, automobiles are no longer considered just a transportation means. Users' expectations and requirements for cars are constantly advancing such as the comfort and functionality of several components or a higher comprehensive performance level [1]. Hence, smart car designers should pay more attention to the personal preferences and expectations of drivers. One of the key constituents used for intelligent autonomous driving is called human factor engineering which plays a leading role in ensuring personal safety in intelligent autonomous driving, thus improving the driving conditions of cars [2]. Moreover, the research and implementations of human factor engineering in driving have won the great attention of experts. As a result, the comfort of interior design and the operating efficiency of cars could be further improved [3]. In the system enabling the interaction between a driver and an automobile, a driver continuously plays a key role when human factor engineering is under consideration [4].

Both the continuous improvement of engine technology and the automation level have substantial advancements in autonomous driving. Besides, car designers are expected to pay attention to the humanistic requirements of design. Thus, more focus needs to be directed and applied to the principles

DOI: 10.54254/2755-2721/34/20230331

of human factor engineering to design cars. One of the tools dealing with this is to construct a system enabling man-machine interaction that satisfies the ease of riding, driving safety, and operation agility of the car. In the process of research focusing on both development and design, the several applications of human factor engineering used by manufacturers are of great significance. According to the "Eight Mainstream Application Scenarios of Autonomous Driving - 2021 Inventory" released by the CSDN: some enterprises such as APOLO and YUTONG have begun to test intelligent autonomous vehicles that combine human factor engineering called Robobus and planned to start mass productions

The manuscript mainly introduces the concept of what human factor engineering means and explains its impact on intelligent autonomous driving. Some analyses are presented. At the same time, it will analyze some external factors that would highly affect intelligent autonomous driving, and discuss the application of intelligent autonomous driving systems combined with the concepts of human factor engineering. Some crucial suggestions are proposed. The rest of the article is outlined as follows: Section 2 presents some important key research and its results. Section 3 presents the discussion. Section 4 concludes the conducted research

2. Main body

2.1. The different aspects that human factor engineering affect intelligent driving

2.1.1. Why should human factors engineering be applied to intelligent driving cars. The research and application of human factors engineering into intelligent autonomous vehicles could bring many benefits. Both driving conditions and passengers' comfort and safety would be improved, thus better-protecting drivers' and passengers' physical and mental health, ensuring the life safety of users and improving vehicle amenities and operation efficiency. The research's results of the human factors engineering could be implemented in the design and development of intelligent autonomous vehicles, and new models with higher technological advantages will be introduced to strengthen market competitiveness which would lead to great social and economic benefits. Figure 1 showed the design concept of user-centric intelligent human-computer interaction.

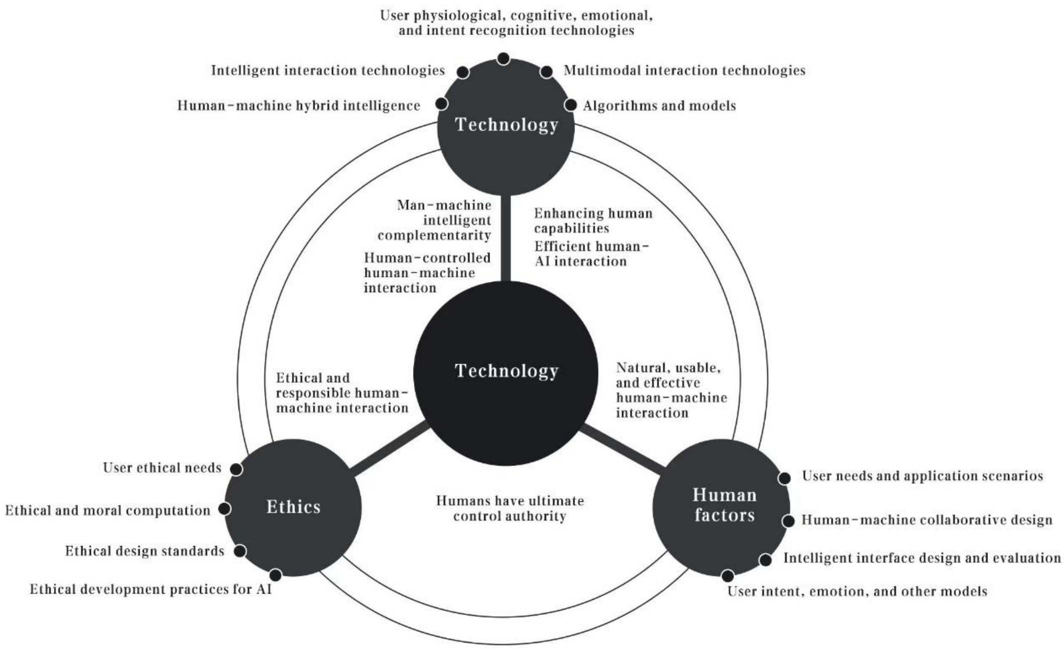

Figure 1. Design concept of user-centric intelligent human-computer interaction (iHCI).

The concept of the Roewe Vision-i applied to vehicles is an illustration of the utilization of human-factor engineering. It uses a technology called emotional intelligent assistant (EIA) embedded into cars. So, drivers' emotional moods, and habits are recognized through collected facial information, and the needs and actions of drivers are understood. Hence, EIA upgrades and improves its capability based on collected data [5]. Kia's new Habaniro concept car, which implements V-Touch gesture control technology utilizing a 3-dimensional (3D) camera to chase movements of both the eye and finger, is another example. Drivers manage some features such as entertainment, lighting, and air conditioning without needing to push buttons. The Kia company is more focused on drivers' experiences and driving innovations by employing human factor engineering in joint research with MIT. Therefore, further advances in technology lead to generating more possibilities regarding the design [5].

2.1.2. Human factor engineering analysis of intelligent driving vehicle and man-machine shared driving. The research on human-computer interaction technology has led to continuous development and integration of artificial intelligence (AI) technology resulting in a product called iHCI, which has a strong connection with human factor engineering. iHCI utilizes the interaction visually and auditorily to improve the effectiveness of human-computer interaction and develops a computational framework by using drivers' physiology and emotions and intentions. Moreover, iHCI pays attention to "user-centered" man-machine interrelation (See Figure 1) [6].

2.1.2.1. Single-vehicle level analysis. Considering a single vehicle with intelligent properties, the human-machine co-driving mode coupled with AI is achieved using the iHCI human factors engineering. Actually, an intelligent autonomous vehicle is a robot that can learn from the collected data just as drivers do. It is equipped with a certain degree of perception system, intelligent interactive interface, and learning capabilities and could cope with various problematic occurrences when moving [7]. Figure 2 showed the conceptual diagram of Factors Engineering framework for HCI.

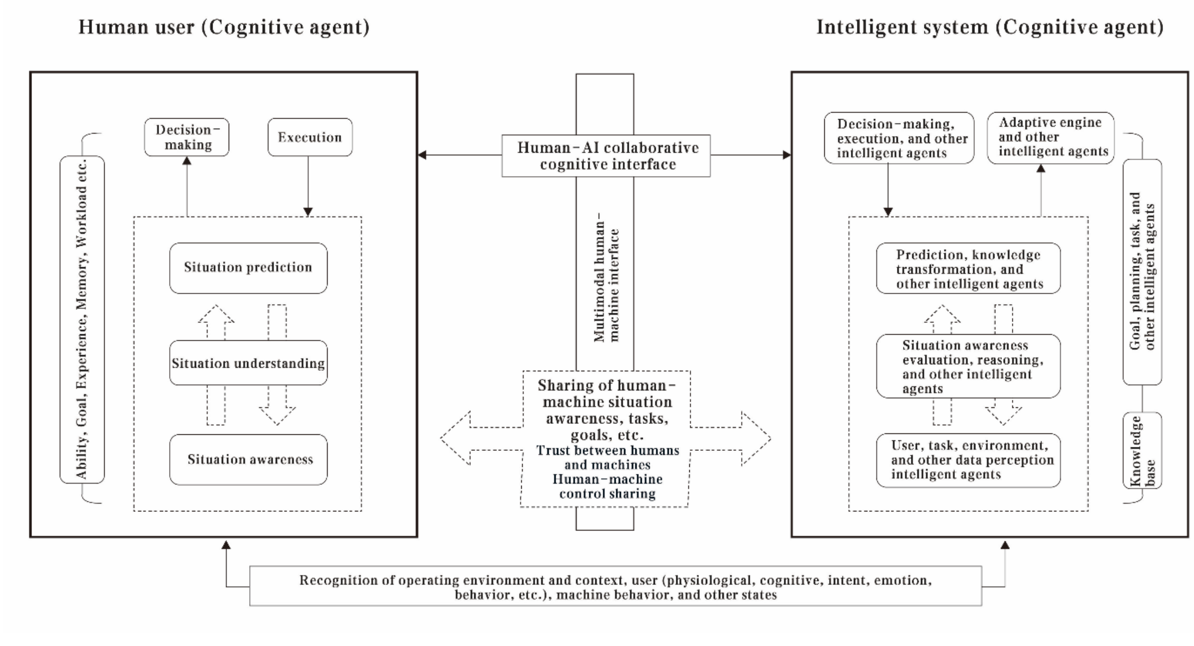

Figure 2. Conceptual diagram of Factors Engineering framework for HCI [4].

When a car is equipped with the iHCI system, a driver and the embedded system are considered two cognitive bodies capable of crunching collected information to do some tasks, So, a collaborative cognitive system used for intelligent autonomous driving is constructed. Hence, a better system for intelligent autonomous vehicles with similar cognitive characteristics to human beings is achieved.

Drivers could execute two-way interaction and cooperation with the iHCI to increase effectiveness since states of drivers and environmental conditions are perceived, identified, learned, and deduced independently in real-time. Finally, man-machine co-driving is carried out (See Figure 3) [6].

2.1.2.2. Macro system level analysis. Considering the level of the social macro technology system, the iHCl, network interconnections, AI and cloud computing should be considered comprehensively to ensure a safe and effective intelligent transportation system. Moreover, collaborative interaction between drivers, vehicles, roads, and the environment is required [8]. Figure 3 showed the human-computer interaction.

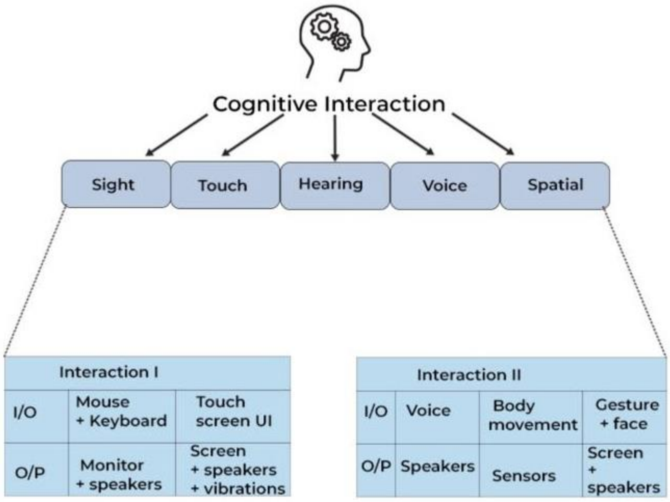

Figure 3. Human-computer interaction [5].

2.2. Human factors problems affecting self-driving

2.2.1. In terms of user intent requirement identification. The human-computer system runs interactionally when intelligent autonomous driving occurs. The machine should perceive the intention of a driver and the environment in which vehicles move. Then, it is expected to conduct adaptive interactive operations based on the intention of a driver.

Intention recognition requires the physiology, cognition, and emotional information of a driver to be understood and uses computational modeling to generate an action. A driver's intention recognition could be realized through multi-modal information, including the computation of a driver's physiology (movement, vision, hearing, EEG, etc.), the motor intention of a driver (surface electromyographic signal, EEG signal, ophthalmic signal, etc.), the body movement of a driver (finger, hand, head movement, etc.), and the calculation of a driver's nervous system signals (See Figure 3) [8].

On the other hand, reasoning is another key point to recognize a driver's intention. The reasoning of a driver's intention is composed of mainly two aspects: 1. the reasoning of a driver's interaction intention, and 2. the reasoning of human-computer interaction based on both situation and context [9]. For example, the Bayes method, big data, and portrait modeling are employed to understand and extract a driver's intention.

2.2.2. From the man-machine cooperation. Different from the conventional human-computer interaction system, human-computer collaborative cooperation could be regarded as a novel system between two cognitive bodies, which is man and machine. The "interaction" between humans and agents is based on the cooperation between team members, which is determined by the characteristics of human factor engineering concepts such as bidirectionally active, shared, complementary, replaceable, adaptive, goal-driven, and predictable. As the improvement of the autonomy degree for machine intelligence grows, these characteristics would become more obvious [10].

However, the study of man-machine cooperation is at an initial stage. In other words, research and implementation still have been at a stage called a transformation from "conventional human-computer interaction" to "primary human-computer cooperation" and farther away from a comprehensive treatment. Thus, it is concluded that ideal requirements have not been still reached.

The collaborative interaction of human-computer looks like a "double-edged sword". On the one hand, intelligent systems can use big data, AI, deep learning, and other technologies to integrate group intelligence based on experts' knowledge, and actively help human operators to resolve problems in potentially abnormal scenarios that were not resolved by single knowledge or operation in the past. In other words, conventional non-intelligent systems fail to resolve complicated issues. On the other hand, if the concept of "human-centered" AI is not followed, there is no guarantee that humans would have ultimate decision-making control over the system. The results of autonomous and independently executed intelligent systems may bring ethical and safety risks [6].

3. Discussion

The application of iHCL-based human factor engineering systems underlines some suggestions as follows: The iHCL-based human factor engineering system (See Figure 3) shows that situational awareness with the three-level "cognitive theory" should be adopted, which means that the driver's cognition should be directed to the current environment such as situation perception and understanding and prediction of future scenario, including human-machine interface, operation environment, teamwork. The model also includes the cognitive interaction between situational awareness and memory capacity.

On the left side of the system, a driver uses the SA composed of three layers of scenario elements (perception, understanding, and prediction) and information processing mechanisms based on data-driven approaches, which understand and predict scenarios using perceived data and goal-driven concepts, which verifies based on perceived data and objectives and current understanding and prediction. With the help of a dynamic feedback loop mechanism of collected information and subsequent response, drivers could perceive the dynamic environment information and update the acquired information.

For the intelligent system, a "top-down" decision-making system is suggested. The middle level is composed of the intelligent assessment and reasoning of situational awareness. The upper level transforms knowledge and predicts the possible events of the current situation. Objectives, planning tasks, and others constitute the feedback loop mechanism.

4. Conclusion

By analyzing some causes and factors in intelligent autonomous driving, the research proposed an iHCI based on human engineering factors that could help drivers. At the same time, the human engineering factor framework of iHCI is analyzed from both robotic and human cognitive aspects. The role of the human engineering factor in intelligent autonomous driving based on the iHCI system is further analyzed. Some suggestions are also made to improve the human factors engineering as follows: Many external conditions could affect human cognition such as pressure, fatigue, distracting events, and so on. Machine cognition could help deal with those distractions to enhance the prediction and perception of such scenarios. For example, a quick prediction should be needed for the next action through human facial expressions and some subtle actions. Moreover, more accurate monitoring, recognition, and understanding of drivers' physiology, emotion, driving behaviors, habits, and intentions are also required to further improvement of such a system.

References

[1] Endsley, M.R. (1995). Toward a theory of situation awareness in dynamic systems. Human Factors, 37: 32- 64.

[2] Endsley, M.R. (2015). Situation awareness misconceptions and misunderstandings. Journal of Cog- nitive Engineering and Decision Making, 9(1): 4- 32.
[3] Zhang J. (2018). Application of Human Factor Engineering in Automobile , Shandong Industrial Technology 260: 209.
[4] Jeong, K.A. (2019). Human-system cooperation in automated driving. International Journal of Human-Computer Interaction, 35(11), 917-918.
[5] Xue, N. (2019). The New era of intelligent cockpit: People who are more comfortable and understand you better, Intelligent Connected Vehicle, 06**,** 90-93.
[6] Xu, W. (2018). Six views on user-centered design: A human factor Engineering approach to intelligent human-computer interaction, J. Appl. Psychol. 28, 195-213.
[7] Ma, N, Gao, Y, Li, J and Li, D. (2018). Interactive cognition in autonomous driving. Science in China: Information Science, 48**,** 1083-96.
[8] Tan, Z. Dai, N. Zhang, R. and Dai, K. (2020). Research status and prospect of human-computer interaction in intelligent connected vehicles. Computer Integrated Manufacturing Systems, 26.
[9] Yi, X. Yu, C. and Shi, Y. (2018). Bayes approach to user intent reasoning in pervasive computing environments. Science in China: Information Science.
[10] Xu, W. and Ge, L. (2020). Engineering psychology in the age of intelligence, Adv. Psychol. Sci. 28, 1409-25.