Innovative application of virtual reality and human-computer interaction in the design of autonomous vehicles

Wenyu Sun

Shandong University of Science and Technology, 250000, Shandong

Received: 25 May 2025
Revised: 26 May 2025
Accepted: 28 May 2025
Published: 29 May 2025

Abstract: With the rapid development of autonomous driving technology, the integration of VR and HCI technology has shown great potential in the design of autonomous driving vehicles. This study explores how VR and HCI technologies can work together to improve the efficiency, safety and driver experience of autonomous driving vehicle design. VR technology optimizes the design and functional testing of vehicles by creating an immersive test environment, while providing drivers with a simulation training platform to help them better cope with various driving situations. HCI technology enhances the trust and communication between drivers and autonomous driving systems through intuitive interactive interfaces and intelligent feedback mechanisms. In addition, this paper also analyzes the technical bottlenecks and challenges in the integration of VR and HCI technologies, and looks forward to the application prospects of these technologies in the field of autonomous driving in the future. In the future, with the continuous development of technology, VR and HCI technologies will further promote the intelligent, personalized and humanized design of autonomous driving vehicles, and improve the safety and efficiency of the overall transportation system.

Keywords: Virtual Reality; Human-Computer Interaction; Autonomous Driving; Vehicle Design; Driver Experience

1 INTRODUCTION

With the rapid development of autonomous driving technology, the automotive industry is undergoing a profound change. Traditional driving methods are gradually being replaced by automated driving. Car design must not only consider performance and safety, but also respond to new technical challenges, such as the integration of human-computer interaction (HCI) and virtual reality (VR) technology. Virtual reality technology can provide designers with an immersive virtual environment, thereby greatly improving the efficiency and accuracy of the design stage, while HCI technology enhances the operability and driving experience of autonomous vehicles by optimizing the interaction between the driver and the vehicle system [1]. In the design process of autonomous driving, the combination of these two technologies can not only improve the interactivity of the vehicle system, but also establish a smoother and more natural communication bridge between the driver and the system.

The application of virtual reality and human-computer interaction technology in vehicle design has become a hot topic in current research and development. In traditional car design, designers usually rely on physical prototypes and two-dimensional drawings to complete design evaluation and functional testing, but this is often limited by cost and time in actual applications. Through virtual reality technology, designers can enter a realistic virtual

environment, conduct comprehensive simulation and evaluation, identify potential problems in the design in advance, and save a lot of physical modeling costs. In addition, with the advancement of autonomous driving technology, how to improve the driver's experience and safety through human-computer interaction systems has become an urgent problem to be solved [2]. Human-computer interaction technology can not only improve the feedback mechanism of the autonomous driving system, but also enable the driver to form a more efficient collaboration with the vehicle system in a complex driving environment.

The main purpose of this study is to explore the innovative application of virtual reality and human-computer interaction technology in the design of autonomous driving vehicles, and analyze its positive role in improving the safety of autonomous driving systems, optimizing driver experience, and promoting the development of intelligent transportation systems. With the continuous advancement of autonomous driving technology, traditional vehicle design methods are obviously unable to meet future needs. Therefore, this paper aims to provide a more intelligent and interactive autonomous driving vehicle design idea through an in-depth discussion of the integration of virtual reality and human-computer interaction to meet the challenges of the new generation of intelligent transportation.

The structure of the paper is arranged as follows: First, Chapter 2 will give an overview of virtual reality and human-computer interaction technology, introducing its basic concepts, development history and its current application status in vehicle design; then, Chapter 3 will analyze the challenges faced by autonomous vehicle design and its demand for virtual reality and human-computer interaction technology; Chapter 4 will discuss in detail the specific application of virtual reality and human-computer interaction in autonomous vehicle design, demonstrating its innovation and practical significance; Chapter 5 will analyze the advantages and challenges brought by the integration of virtual reality and human-computer interaction; finally, this paper will look forward to the future development trends in this field in Chapter 6, and summarize the results and significance of the research.

2 OVERVIEW OF VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION

VR is a computer-generated three-dimensional virtual environment that allows users to feel as if they are in the real world through an immersive experience. The core of virtual reality technology is to enable users to interact with the physical world in the virtual world through multi-sensory input such as vision, hearing and even touch. Virtual reality has a wide range of applications, from game entertainment to medical simulation, to industrial design and other fields, and has achieved remarkable application results [3]. Since the concept of virtual reality was first proposed in the late 1960s, with the continuous development of computer graphics and hardware equipment, virtual reality technology has also experienced a leap from early simple simulation to today's high immersion and high interactivity. In recent years, the application of virtual reality in the design of autonomous vehicles has also made significant progress. Designers can use virtual reality technology to conduct virtual driving tests, optimize the in-vehicle layout, and simulate driver behavior, thereby greatly improving design efficiency and accuracy [4].

HCI is a discipline that studies the interaction between humans and computers and their systems. With the development of computer technology and communication technology, human-computer interaction technology continues to evolve. Traditional input methods mainly rely on physical devices such as keyboards and mice, but with the advancement of technology, voice recognition, gesture recognition, touch screens and other interactive methods have gradually become mainstream. The essence of human-computer interaction is to enable users to interact with computer systems more naturally and conveniently by designing reasonable interactive interfaces and interactive methods. In autonomous vehicles, human-

computer interaction technology not only involves the interface design between the driver and the vehicle system, but also includes the implementation of functions such as intelligent voice assistants, vehicle displays and gesture control. By optimizing these interactive methods, drivers can obtain information and issue instructions more intuitively, improving the responsiveness of vehicle systems and the driver's operating experience.

The combination of virtual reality and human-computer interaction has had a huge impact in many fields, especially in the design and implementation of autonomous driving technology. Virtual reality provides a highly realistic and controllable virtual environment for vehicle design, while human-computer interaction technology provides users with a more intuitive and efficient operating experience in this environment [5]. The fusion of the two allows designers to test and optimize the interactive interface of the vehicle system in a virtual environment, and at the same time, by simulating the driver's response in various complex situations, help design an autonomous driving system that better meets user needs. With the continuous progress of artificial intelligence, sensor technology and computer graphics, the combination of virtual reality and human-computer interaction is developing in a more intelligent and automated direction. In the future, the deep integration of virtual reality and human-computer interaction will not only be limited to the application in the design stage, but may also run through the entire life cycle of autonomous vehicles, from research and development, production to real-time interaction during driving, which has broad application prospects.

3 CHALLENGES AND REQUIREMENTS OF AUTONOMOUS VEHICLE DESIGN

Autonomous driving technology refers to the technology that enables vehicles to drive autonomously without human intervention through computer systems and sensors. Its core technologies include sensor technology, data processing, machine learning, deep learning, positioning navigation, decision planning, etc. Autonomous vehicles perceive the surrounding environment in real time through sensors, analyze the environment through complex algorithms, and make corresponding driving decisions. With the continuous development of artificial intelligence and big data technology, autonomous vehicles have made significant progress in perception, decision-making and execution, and have become an important development direction in the field of transportation. However, despite the broad prospects of autonomous driving technology, it still faces many challenges in technology, regulations and ethical issues [6].

The design complexity of autonomous vehicles comes from many aspects. First, the autonomous driving system needs to accurately perceive the complex and dynamic traffic environment and make correct decisions in any situation. This means that the design team needs to integrate multiple sensor technologies and data processing algorithms to ensure that the vehicle can cope with various complex traffic scenarios, including different weather conditions, road conditions, traffic flow and emergencies. Secondly, the system of autonomous vehicles must have extremely high reliability and safety [7]. During the driving process, the vehicle faces not only normal driving tasks, but also emergency braking, pedestrian avoidance and other emergency handling, which puts very high demands on the real-time and robustness of the system. In addition, the regulations and ethical issues of autonomous driving technology are also an important consideration in the design. Autonomous vehicles must abide by traffic

rules, and how to make ethical decisions in unexpected situations has become an issue that cannot be ignored in the design.

In the face of such complex design tasks, the demand for virtual reality and human-computer interaction technology has become more urgent. Virtual reality technology can provide designers with an immersive and controllable virtual environment to help them perform design verification and functional testing without physical prototypes. Through virtual reality, designers can test the performance of autonomous driving systems in different driving environments, simulate various possible traffic scenarios, and discover and solve potential problems in the design in advance [8]. Especially in the interior design of autonomous vehicles and the interaction between drivers and on-board systems, virtual reality provides a more efficient evaluation platform for the design team, which can conduct comprehensive interactive tests in the early stage of design to avoid unnecessary modifications and duplication of work in the later stage.

At the same time, human-computer interaction technology also plays a vital role in the design of autonomous vehicles. Autonomous vehicles are not just a "driverless" system, they also need to communicate and interact effectively with the driver or other passengers. How to design an intuitive and easy-to-use on-board system interface and how to optimize the feedback mechanism between the vehicle and the driver have become the key to improving user experience. Human-computer interaction technology can enable drivers to easily interact with vehicle systems through voice recognition, touch screens, gesture control, etc. In autonomous driving mode, although the driver no longer needs to directly operate the vehicle, he still needs to understand the status of the system, the current driving mode, and any emergencies that occur [9]. Human-computer interaction technology can provide drivers with clear and timely feedback to help them better understand and trust the system's decisions.

In summary, the design of autonomous vehicles faces many technical and operational challenges, and virtual reality and human-computer interaction technology provide innovative solutions to these problems. Through virtual reality technology, designers can simulate the real driving environment and optimize the design and testing process; and through human-computer interaction technology, the interaction between the driver and the vehicle has been effectively improved, enhancing the operability and user experience of the autonomous driving system. Therefore, virtual reality and human-computer interaction technology not only meet the needs of autonomous driving vehicle design, but also promote technological innovation and application expansion in this field.

4 INNOVATIVE APPLICATION OF VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION IN AUTONOMOUS VEHICLES

The application of virtual reality technology in the design of autonomous vehicles provides the design team with a new way to simulate and train drivers. By building a virtual driving environment, designers can simulate driving in a variety of scenarios such as different road conditions, weather changes, and emergencies. This kind of simulation training can not only help drivers become familiar with the operation of autonomous vehicles, but also improve their ability to cope with complex traffic environments. For example, in cases of emergency

braking, obstacle avoidance, and lane departure, drivers can train in a virtual environment in advance without worrying about the dangers on the actual road. Through virtual reality, drivers can understand the performance of autonomous vehicles under different conditions with the feedback of the control system, further enhancing the driver's trust in autonomous driving technology.

At the same time, virtual reality also provides important support for the construction and testing of virtual driving environments in the design process of autonomous vehicles. By creating a highly realistic virtual environment, designers can perform functional tests on autonomous driving systems without physical prototypes. This method not only saves a lot of time and cost, but also can discover potential problems in advance. For example, designers can use virtual reality to test the reaction speed of autonomous driving systems in different traffic scenarios and simulate the decision-making ability of the system under complex traffic conditions to ensure the reliability and safety of autonomous driving systems [10]. In addition, virtual reality technology can also be used to evaluate the interior design of the car, including seat layout, instrument panel design, information display, etc., to optimize the driver's experience through real-time feedback.

In the design of autonomous vehicles, human-computer interaction technology plays a vital role. The core of the in-car intelligent interaction system is to optimize the interactive experience between the driver and the vehicle through various advanced technologies. These systems include voice recognition, gesture control, touch screens and other natural interaction methods, which enable drivers to communicate with vehicle systems more conveniently and intuitively. For example, the driver can control the vehicle's navigation, audio, air conditioning and other systems through voice commands, and even adjust the windows or the temperature in the car through gestures. The design goal of the intelligent interaction system is to simplify the operation process so that the driver can concentrate on monitoring the vehicle status in autonomous driving mode without having to perform tedious operations.

At the same time, communication between autonomous vehicles and drivers becomes particularly important. In autonomous driving mode, the driver may no longer directly control the vehicle, but still needs to understand the system's operating status and its decision-making process in real time. Human-computer interaction technology can provide timely and clear feedback to ensure that the driver can grasp the vehicle's driving conditions at any time. For example, through the on-board display or augmented reality technology, the driver can see the vehicle's perception of the surrounding environment, the current route planning, and the system's status information. In this way, it can not only enhance the driver's sense of trust, but also help the driver to quickly take over control when needed.

The innovative application of the combination of virtual reality and human-computer interaction technology in autonomous driving vehicles not only improves the driver's experience, but also enhances the reliability and safety of the vehicle system. Through the design of the autonomous driving system interface, virtual reality can help designers better understand the driver's needs, optimize the way of displaying in-vehicle information, and ensure the clarity and timeliness of information transmission. At the same time, the virtualization application of in-vehicle entertainment and auxiliary systems can provide a richer and more personalized user experience. For example, drivers and passengers can enjoy

immersive entertainment content such as virtual travel and movie watching through virtual reality technology, which not only increases the comfort during driving, but also broadens the possibility of in-vehicle entertainment.

Through the deep integration of virtual reality and human-computer interaction technology, autonomous driving vehicle design has entered a new stage. Designers can conduct more comprehensive testing and optimization in a virtual environment, while drivers can enjoy a more intelligent and intuitive driving experience. This innovative application not only improves the safety, comfort and user experience of the vehicle, but also lays a solid foundation for the development of autonomous driving technology in the future.

5 ADVANTAGES AND CHALLENGES OF THE INTEGRATION OF VIRTUAL REALITY AND HUMAN-COMPUTER INTERACTION

The application of the integration of virtual reality and human-computer interaction technology in the design of autonomous vehicles has greatly improved the driver's experience and safety. Through virtual reality technology, drivers can train and simulate in a highly simulated environment, and experience the vehicle's response in different roads, weather and emergencies in advance. This training method not only helps drivers improve their ability to control the vehicle, but also makes drivers calmer and more confident when facing emergencies. At the same time, virtual reality can help designers optimize the in-vehicle layout, display interface, and interactive mode, thereby improving the driver's operating experience. By providing intuitive and clear information display and real-time feedback, the interaction between the driver and the vehicle system becomes smoother and more natural, greatly improving the sense of safety during driving.

At the same time, the combination of virtual reality and human-computer interaction technology helps to optimize the trust relationship between the driver and the autonomous driving system. In traditional driving methods, the trust between the driver and the vehicle is based on long-term driving experience and intuition. However, the introduction of autonomous driving technology has caused the driver to lose direct perception of vehicle control in some cases, which poses a challenge to the establishment of trust. Through the human-computer interaction system, autonomous vehicles can establish a clearer and more transparent communication mechanism between the driver and the vehicle. For example, by displaying the system's perception and decision-making process through the interface, the driver can understand the vehicle's status at any time, thereby enhancing trust in the system. Virtual reality technology can truly reproduce the driving experience in a simulated environment, helping drivers better understand the reaction mode and decision-making logic of the autonomous driving system. This enhanced interaction helps drivers more easily accept the autonomous driving system and establish a stable trust relationship with it.

However, although virtual reality and human-computer interaction technology have shown great potential in the design of autonomous vehicles, they still face some technical bottlenecks. First, virtual reality technology requires high-quality image rendering and real-time feedback, which places extremely high demands on hardware performance. Especially when processing large-scale environmental data, the increase in computing power may cause

delays, thereby affecting the driver's immersion and safety. In addition, the application of human-computer interaction technology in autonomous driving also faces the challenges of complexity and diversity. Different drivers have different needs and preferences for in-vehicle systems, so how to design an interactive system that can meet the needs of most users and can be customized is still a problem worthy of in-depth study. In addition, the complexity of the autonomous driving system itself also requires the human-computer interaction system to have high-precision feedback capabilities and be able to accurately convey the current status and decision-making of the vehicle, which places high demands on the stability and real-time performance of the system.

The challenge of interdisciplinary integration is also an important issue in the application of virtual reality and human-computer interaction technology in autonomous driving design. Virtual reality and human-computer interaction technology involve the intersection and integration of multiple fields such as computer science, artificial intelligence, psychology, and design. To achieve the effective application of these technologies, experts from different fields need to work closely together to jointly solve various problems encountered in the design of autonomous driving systems. For example, in the application of virtual reality technology, not only the support of computer graphics is required, but also the psychological and physiological reactions of drivers must be considered; in the design of human-computer interaction, the scientific nature of user experience and system feedback must be comprehensively considered. Therefore, interdisciplinary cooperation is crucial to promoting the rapid development of this technology. With the continuous advancement of technology, the combination of virtual reality and human-computer interaction technology has a very broad application prospect in the field of autonomous driving, especially with the development of artificial intelligence and big data technology, a more intelligent and personalized autonomous driving experience can be achieved in the future.

6 FUTURE DEVELOPMENT TRENDS AND PROSPECTS

With the rapid development of science and technology, VR and HCI technologies have broad application prospects in the design of autonomous vehicles. In the future, virtual reality and human-computer interaction technologies will be further deepened and tend to be intelligent. The future development direction of virtual reality technology will focus on enhancing its immersion and interactivity. With the continuous improvement of computer graphics and computing power, the virtual reality environment will become more realistic and detailed, and can simulate more complex driving environments, such as more accurate weather conditions, dynamically changing traffic conditions, and diverse road structures. At the same time, the virtual reality system will be more efficient, reduce latency and hardware requirements, and enable drivers to conduct effective training and testing at a lower cost and in a shorter time. In addition, virtual reality technology will gradually be combined with artificial intelligence to further optimize the intelligent level of driving simulation, and enable drivers to receive more targeted training and guidance in a personalized virtual environment through adaptive learning algorithms.

The future development of human-computer interaction technology will pay more

attention to intelligence and naturalization. Through deep learning and natural language processing technology, the future in-vehicle interactive system will understand the driver's intentions and needs more accurately and communicate with the driver in a more natural way. In addition to traditional voice recognition and touch operation, new interaction methods such as gesture recognition and facial expression recognition will be more widely used in the future, further improving the driver's operating experience and the system's response speed. Intelligent interactive systems will not only stop at the transmission of information, but will also incorporate emotional computing and psychology, and will be able to adjust the vehicle's response and prompting methods according to the driver's emotions, status and other factors, creating a more humane driving environment.

In the design of autonomous vehicles, the trend of intelligence will be reflected in all aspects. First, autonomous driving systems will increasingly rely on big data analysis and deep learning technology to continuously optimize decision-making processes and driving strategies. Autonomous driving systems will continuously improve their decision-making capabilities by collecting and processing information from environmental perception systems, on-board sensors and other vehicles in real time, and will be able to dynamically adjust according to roads, traffic and driver behavior. Secondly, with the development of vehicle-to-everything (V2X) technology, autonomous vehicles will be able to interact more intelligently with other vehicles and traffic infrastructure, and improve overall road safety and traffic efficiency through information sharing and collaborative work. In the future, autonomous vehicles will not only be intelligent means of transportation, but will also become part of the intelligent transportation system and be able to play a role in a wider range.

The further integration of virtual reality and human-computer interaction technology will have great potential in the design of autonomous vehicles. In the future, virtual reality and human-computer interaction technology will no longer be independent technologies, but will be closely integrated and mutually reinforcing. Through virtual reality technology, designers and drivers can experience and optimize the various functions of the vehicle in a highly realistic virtual environment, while human-computer interaction technology provides a more intelligent and natural operating interface for this experience. For example, virtual reality can help designers test the effects of new interactive systems in a simulated environment, evaluate the impact of different interaction methods on driver operations, and provide real-time feedback to help adjust and improve the design. In terms of human-computer interaction, virtual reality technology can create a richer and more immersive driving experience. Drivers can interact with the vehicle more flexibly not only through traditional physical interaction methods, but also through natural language, eye tracking and other methods. This integration will promote the development of autonomous driving vehicles in a more intelligent and personalized direction, thereby achieving a safer and more comfortable driving experience.

In general, the application of virtual reality and human-computer interaction technology in the design of autonomous driving vehicles has broad development prospects. With the continuous advancement and innovation of technology, future autonomous driving vehicles will no longer be simple automation tools, but intelligent partners that will be deeply integrated into human life. In this process, the integration of virtual reality and human-computer interaction technology will play an increasingly important role, promoting the development of

autonomous driving technology in a more intelligent, personalized and humanized direction.

7 CONCLUSION

This study explores the innovative application of VR and HCI technologies in the design of autonomous vehicles, and analyzes how these technologies play an important role in improving driver experience, enhancing safety, and optimizing the design of autonomous driving systems. VR technology provides designers with a cost-effective and highly operable test platform by creating a highly simulated simulation environment, which can conduct comprehensive testing in different driving scenarios, detect potential problems in advance, and avoid the expensive cost of physical prototypes. At the same time, HCI technology improves the interaction between drivers and autonomous driving systems by providing intelligent and intuitive operating interfaces and feedback mechanisms, enhancing the ease of use of the system and the driver's trust. Through the combination of these two technologies, the design of autonomous vehicles has not only been improved in safety, but also the driving experience has become more humane and comfortable.

However, although the integration of VR and HCI has shown great potential in the design of autonomous vehicles, it still faces certain technical challenges. The technical bottlenecks of VR in image rendering, real-time feedback, and hardware requirements, as well as the challenges of HCI in diversity, personalization, and accuracy, need to be further addressed. In addition, interdisciplinary cooperation will also be the key to promoting the development of this field. The integration of disciplines such as virtual reality, artificial intelligence, psychology and design will promote the birth of more sophisticated and intelligent autonomous driving systems.

Looking to the future, the deep integration of virtual reality and human-computer interaction technology will continue to play an important role in the design of autonomous driving vehicles. With the further development of artificial intelligence, sensing technology and computing power, these technologies will provide stronger support for the perception, decision-making and execution of autonomous driving systems. Future research should focus more on how to improve the intelligence level of virtual reality and human-computer interaction systems, especially in terms of personalization and real-time adaptability. With the gradual maturity of autonomous driving technology, the combination of virtual reality and human-computer interaction is not only limited to the application in the design stage, but will penetrate into the entire life cycle of autonomous driving vehicles, from research and development, production to real-time interaction during driving, and comprehensively improve the intelligence and humanity of the autonomous driving experience.

In short, the integration of virtual reality and human-computer interaction technology not only provides a new perspective for the design of autonomous driving vehicles, but also lays the foundation for the construction of future intelligent transportation systems. With the continuous advancement of technology, the intelligence, personalization and humanity of autonomous driving systems will bring users a safer, more convenient and comfortable travel experience, and promote the development of the transportation field in a more efficient and sustainable direction.

REFERENCES

[1] Xu, W., Du, F., Zhang, L., & Ge, L. (2024). Introduction to the Special Issue on Human–Computer Interaction Innovations in China. *International Journal of Human–Computer Interaction*, *40*(8), 1795-1798.

[2] Zhu, Y., Geng, Y., Huang, R., Zhang, X., Wang, L., & Liu, W. (2024). Driving towards the future: Exploring human-centered design and experiment of glazing projection display systems for autonomous vehicles. *International Journal of Human–Computer Interaction*, *40*(15), 4087-4102.

[3] Yuan, X., Deng, F., Yao, X., & Wu, Y. (2024). Driving Behaviour Research for Autonomous Vehicle Interaction Design: A Comprehensive Review and Future Directions. *International Journal of Human–Computer Interaction*, 1-21.

[4] You, F., Liang, Y., Fu, Q., & Zhang, J. (2025). Exploring the Role of AR Cognitive Interface in Enhancing Human-Vehicle Collaborative Driving Safety: A Design Perspective. *International Journal of Human–Computer Interaction*, *41*(1), 115-135.

[5] Amin, Y. M., Meftin, N. K., Nas, Y. F., Al-Dulaimi, M. K., Hamid, A. S., Noga, H., & Khlaponina, A. (2024, October). Human-Computer Interaction in Augmented Reality Environments: Design Principles and User Experiences. In *2024 36th Conference of Open Innovations Association (FRUCT)* (pp. 372-380). IEEE.

[6] Liu, Y., & Fu, Z. (2025). What's the Value of Science Fiction for Future-Oriented Human-Computer Interaction: The Role of Innovative Catalysts. In *International Conference on Human-Computer Interaction* (pp. 83-96). Springer, Cham.

[7] Martín Serrano, S., Izquierdo, R., García Daza, I., Sotelo, M. Á., & Fernández-Llorca, D. (2024). Behavioural Gap Assessment of Human-Vehicle Interaction in Real and Virtual Reality-Based Scenarios in Autonomous Driving. *International Journal of Human–Computer Interaction*, 1-14.

[8] Zhang, J., You, F., Yang, J., Zhang, J., Wang, P., Wang, H., & Luximon, Y. (2025). Find My Friend: An Innovative Cooperative Approach of Real-Time Goal Collaboration in Automated Driving. *International Journal of Human–Computer Interaction*, 1-23.

[9] Martín Serrano, S., Izquierdo, R., García Daza, I., Sotelo, M. Á., & Fernández-Llorca, D. (2024). Behavioural Gap Assessment of Human-Vehicle Interaction in Real and Virtual Reality-Based Scenarios in Autonomous Driving. *International Journal of Human–Computer Interaction*, 1-14.

[10] Jain, S., Gandhi, A. B., Mehla, S., Aggarwal, R., & Kwatra, T. (2024, May). Virtual Drive: Immersive VR-Controlled Car with Real-Time Interaction and Live Video Feed. In *2024 International Conference on Computational Intelligence and Computing Applications (ICCICA)* (Vol. 1, pp. 519-525). IEEE.