International Journal of Automotive Technology, Vol. ?, No. ?, pp. ?–?(year)

HUMAN-CENTRIC VALIDATION FRAMEWORK FOR MONITORING SYSTEMS EMBEDDED IN PARTIALLY AUTOMATED VEHICLES

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(*Received date ; Revised date ; Accepted date*) * Please leave blank

ABSTRACT– The progress of automated driving technology is accompanied by the enhanced performance of various sub-systems integrated into automated vehicles. The performance of these sub-systems is expected to meet international standards and regulatory guidelines. However, the corresponding performance evaluations often overlook human perspectives, such as those of drivers or passengers, potentially resulting in lack of system safety or customer satisfaction. Therefore, these factors must be considered during testing to ensure the secure and satisfactory operation of automated vehicles. To evaluate the performance of systems embedded in automated vehicles from a human perspective, this paper introduces a framework based on the system-theoretic process analysis, which is a systems approach to hazard analysis. The Driver Availability Recognition System was selected as a verification system, and a full-scale driving simulator was used to create the experimental environment. Forty volunteers participated in the performance verification experiment, and data obtained from the human-in-the-loop experiment were incorporated into the proposed framework. The results demonstrated that the framework can ensure effective performance evaluation from a human perspective and suggest safety requirements. The development and application of the proposed framework is anticipated to facilitate the successful rollout of automated vehicles.

KEY WORDS : Human perspective, System verification, Driver monitoring system, Hazard analysis, Safety requirement derivation

1. INTRODUCTION

With the rapid advancement in automated driving technologies, various safety features are being developed to ensure the safe operation of automated vehicles (AVs). Typically, these features are designed based on standards outlined in documents issued by countries, governments, and international organizations. However, these standards may not always fully consider the perspective of the driver, who is the main user of the system (Park et al., 2023). One critical issue affecting these safety features is the potential for misuse by drivers. For example, drivers have been reported to place objects, such as an orange, on the steering wheel to simulate hand placement and deceive the system into believing that the driver is actively engaged in driving. Such misuse can result in the AV not functioning as intended, posing risks to both the driver and other road users (Robertson, 2021). Furthermore, the advancement of AV technology has been accompanied by the occurrence of new types of accidents or dangerous situations, such as passengers falling asleep while such as passengers falling asleep while riding in an AV and not following the manufacturer's manual (Bell, 2023).

Despite efforts to design algorithms or systems prioritizing safety, while considering ethical dilemmas and safety evaluations during the development of automated driving systems (Guo et al., 2020; Robertson, 2021), accidents and hazardous situations have been occurring more frequently owing to system misuse by the driver or failure to adhere to manufacturer’s instructions. Moreover, manufacturers often struggle to identify and address all potential misuse cases in their designs owing to time and technological constraints. In addition to addressing misuse cases by drivers, investigating driver trust in AVs has emerged as a research hotspot worldwide, given the recognition of driver trust as a crucial factor for the successful commercialization of automated driving technologies (Alawadhi et al., 2020; Yun & Yang, 2022).

Considering these aspects, it is imperative to incorporate user perspectives in the design of AV systems to address potential misuse cases, foster driver trust in the technology, and ensure confident usage of the systems.

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