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CONNECTED AUTOMATED VEHICLES AND ITS, ELECTRICAL AND ELECTRONICS, HUMAN FACTORS AND ERGONOMICS

Evaluation of Display Configuration and Seat Orientation Considering Various Automated Driving Situations Using a Vehicle Simulator

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Abstract
This study examines vehicle interiors in terms of display configuration and seat orientation from a user experience viewpoint using a driving simulator. Sixteen volunteers were sat in the driver's seat to evaluate visibility and mental comfort scores of three display configurations used in the vehicle (i.e., floating, flush, and large display). Another sixteen volunteers were sat in the passenger's seat to evaluate mental and physical comfort scores of three seat orientations (i.e., forward-facing, 15° inboard, and rear-facing seats). The display configurations were evaluated in the movie-watching, the driving-monitoring, and the control takeover situations, while the seat orientations were evaluated in the movie-watching, the conversation, and the driving-monitoring situations. The large display enhanced for movie-watching. However, it was found to be unsuitable for driving-monitoring. The rear-facing and 15° inboard seats were more suited to the conversation situation from the physical comfort viewpoint. The rear-facing seat was found to be unsuitable from the mental comfort viewpoint in the driving-monitoring situation. The effect on drivers and passengers was different depending on the vehicle interiors and the situations. A thoughtful selection of display configuration and seat orientation, considering the context, is vital to enhance driver and passenger comfort. These findings could aid future user-centric vehicle development.

Keywords User experience · Driving simulator · Vehicle interior · Display configuration · Seat orientation · Usability

Abbreviations

FF	Forward-facing seat
IN	15° Inboard seat
RF	Rear-facing seat
MW	Movie-watching
DM	Driving-monitoring
TO	Control takeover
CO	Conversation

1 Introduction

SAE J3016 classifies automated driving into 6 levels from 0 (no driving automation) to 5 (full driving automation). The role of the driver is contingent upon the level of automation implemented. In the context of level 3 or higher automation, the Automated Driving System (ADS) assumes full responsibility for executing the Dynamic Driving Task (DDT) while actively engaged.

At level 3, the driver takes on the role of a fallback-ready user, while the ADS executes the DDT, relieving the driver from the requirement of actively monitoring the driving situation (SAE J3016, 2018). In contrast, at level 4 or beyond, the driver is relegated to the position of a mere passenger as the ADS undertakes the entirety of the DDT. In other words, passengers can perform activities that are not related to driving, such as conversation, business, and sleep, if the vehicle automation level is adequately high. In 2019, research firm Capgemini surveyed 5538 people about their desired activity in Automated Vehicle (AV) (Capgemini, 2019). Socializing was found to be the most desired action at 68%, followed by

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