

MODELLING THE INTRUSIVE FEELINGS OF ADVANCED DRIVER ASSISTANCE SYSTEMS BASED ON VEHICLE ACTIVITY LOG DATA: CASE STUDY FOR THE LANE KEEPING ASSISTANCE SYSTEM

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ABSTRACT—Although the automotive industry has been among the sectors that best-understands the importance of drivers' affect, the focus of design and research in the automotive field has long emphasized the visceral aspects of exterior and interior design. With the adoption of Advanced Driver Assistance Systems (ADAS), endowing 'semi-autonomy' to the vehicles, however, the scope of affective design should be expanded to include the behavioural aspects of the vehicle. In such a 'shared-control' system wherein the vehicle can intervene in the human driver's operations, a certain degree of 'intrusive feelings' are unavoidable. For example, when the Lane Keeping Assistance System (LKAS), one of the most popular examples of ADAS, operates the steering wheel in a dangerous situation, the driver may feel interrupted or surprised because of the abrupt torque generated by LKAS. This kind of unpleasant experience can lead to prolonged negative feelings such as irritation, anxiety, and distrust of the system. Therefore, there are increasing needs of investigating the driver's affective responses towards the vehicle's dynamic behaviour. In this study, four types of intrusive feelings caused by LKAS were identified to be proposed as a quantitative performance indicator in designing the affectively satisfactory behaviour of LKAS. A metric as well as a statistical data analysis method to quantitatively measure the intrusive feelings through the vehicle sensor log data.

KEY WORDS : ADAS, LKAS, Vehicle activity log data, Intrusive feeling, Affective design

1. INTRODUCTION

The automotive industry has long been among the sectors that best-understands the importance of drivers' affect and is making much effort to incorporate the affective attributes in their product (Chang *et al.*, 2006; Helander *et al.*, 2013; Khalid *et al.*, 2012; Schütte and Eklund, 2005). To date, affective design studies in the automotive sector have emphasized 'appearance' or 'visceral' aspects such as colour, texture, and shape of exterior (Suzianti *et al.*, 2016) and interior (Ersal *et al.*, 2011; Gkouskos and Chen, 2012; Leder and Carbon 2005) design. As the Advanced Driver Assistance System (ADAS) gets installed in the vehicle, however, the factors affecting the driver's emotion are expanding beyond the appearance to the entire run. ADAS is a system that helps people drive more safely by notifying drivers and actively controlling the vehicles in advance of a dangerous situation through visual, auditory, and tactile (Bishop, 2005; Jones, 2002; Vlacic *et al.*, 2001). Since

ADAS often intervene in the human operations directly or indirectly, such as interrupting or changing the driver's control actions (Strand *et al.*, 2014), driver's interaction with the system can induce negative feelings, which can then ruin the driver's experience. On such a background, this study aims to investigate the intrusive feelings caused by the Lane Keeping Assistance System (LKAS), which is a type of ADAS most popularly deployed recently by premium car brands. Intrusive feelings can be defined as unusual and undesirable feelings that can adversely affect the driver's experience as a result of unexpected actions of the ADAS. To minimize these negative feelings, it is necessary to calibrate parameters related to the behaviour of LKAS control. In this study, both expert designers, the designated personnel of the manufacturer, and normal drivers participated in the LKAS evaluation.

In addition, suggested in this study is a metric as well as a statistical data analysis method to quantitatively measure the intrusive feelings through the vehicle sensor log data.

The paper is structured as follows. Section 2 describes the related work including LKAS concept. Section 3 then

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