

# Collision-avoidance system using auditory and haptic feedback

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## ABSTRACT

Human performance and inattention while driving a vehicle are themes that call the scientific community attention in the area of human factors. Several researches have been focusing the ways drivers interact with the vehicle, seeking to comprehend the influence that the modern technological devices have over the errors committed by drivers. According to DNIT [1], the National Department of Transportation Infra-structure, more than 9% of the accidents in Brazilian roads in the year 2008 are resultant of lateral obstruction, when one vehicle blocks another's path. From this kind of accident, more than 50% results in wound or loss of life, what suggests that technological aid could improve safety in such situation.

In this work, we develop a driver assistance system to warn the driver that a lateral collision with other vehicle may be imminent, when the rear mirror observation is insufficient or the driver is distracted. The system is composed by an activation module and a warning module. The activation module detects the dangerous condition by sensors placed around the vehicle and on the identification of a lane departure tendency.

This paper focuses on the warning module, which proposes the usage of tridimensional sound together with vibration stimulus. The selection of the warning combined with auditory and haptic is based on studies that suggest the usage of more than one perceptual channel as a mean to reduce reaction time [2]. Additionally, the high visual demand of the driver indicates that other perceptual channels should support the functions of the vision.

The proposed device aims to optimize the variables determinant for the reaction time in the selection of an action to be taken: stimulus modality, intensity, expectation and compatibility between stimulus and action [3]. The proposed interaction modalities, auditory and haptic, are used because the auditory stimulus is processed significantly faster than the visual one and the haptic stimulus strengthens the auditory one guiding the human motor system to an action to be taken. Besides calling the driver attention, system makes available earlier the information that the vehicle is in collision path with another vehicle. We expect that

once the confidence in the system is built, the driver will reduce time to action instead of looking for environment cues to understand the surrounding situation.

A simulation environment is proposed to reproduce in laboratory the environment where the driver actuates. In this environment, the subject is requested to play a driving game projected in the frontal wall using a steering wheel, pedals to accelerate and brake and a gear shift. The seat is equipped with the vibration and auditory stimuli generator elements. While the driver conducts the vehicle over the game route, the stimuli are activated.

Experiments are done in the environment described above to justify the usage of the proposed system. First, the kind of action which the driver takes when the vehicle is about to collide laterally is evaluated. The intention is to understand the behavior pattern regarding braking and trajectory change when such situation is identified. Second, reaction times in the execution of the identified action in the first part of the experiment are measured, when the subject is submitted to different stimuli. This way, the reaction time measurements are registered, allowing a comprehension of the influence of each kind of stimulus in the driver performance. Subjects are also inquired about the utility and annoyance of the applied stimuli, as qualitative evaluation of the experience with the system. Since this is a work in progress, quantitative and qualitative data from the experiments are not yet available.

## Keywords

Multimodality, warning design, automotive interfaces, driver-vehicle interaction, driver assistance system.

## Acknowledgement

Authors thank Continental do Brasil and Universidade de São Paulo for the support in this work.

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