Advisory Cruise Control Device for an Intelligent Vehicle-Highway System

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ABSTRACT
The Intelligent Vehicle-Highway System in this paper is built for a Cooperative Adaptive Cruise Control system. In this system, vehicles communicate with each other through wireless means, where they coordinate each other's speed for better traffic flow. In this paper, we describe the design and evaluation of the interface between vehicle and driver, where the system takes an *advisory* role. The interface was developed into two prototypes where one has guidance mode and the other has explanation mode. We conducted a test on a driving simulator using both prototypes, in order to find which prototype is preferred and why.

Categories and Subject Descriptors
H.5.2 [**Information Systems**]: User Interfaces – *Evaluation/methodology, Prototyping, Screen design, User-centered design.*

General Terms
Management, Measurement, Performance, Design, Experimentation, Human Factors, Verification.

Keywords
Multimodal interface, Automotive, Cooperative Cruise Control

1. INTRODUCTION
Cooperative Adaptive Cruise Control (CACC) is the next generation of Adaptive Cruise Control (ACC), where there is a communication between vehicles in addition to sensor capabilities of each vehicle to adapt speed to other vehicles in order to make a smooth traffic flow and optimize traffic throughput. This speed adaptation is automatic, i.e. done by the cruise control system of each vehicle. In addition to the automatic system, we also proposed an advisory system: Cooperative Cruise Control (CCC). This device is intended to be built as an aftermarket device, which will have better market penetration thus increasing the number of users in the traffic.

According to a survey on Advanced Driver Assistance System (ADAS) [1], more than 42% of the respondents liked to be supported during congestion driving in motorways, and more than 90% of the respondents wanted to be warned for upcoming traffic conditions e.g. congestion and road works. We focus on speed for guidance, because according to a survey on speed choice [2], drivers' reasons to obey speed limit are safety and avoiding fine. Unintentionally 15% of drivers exceed the speed limit.

A preliminary study through two focus groups of 10 and 11 participants showed a preference for advisory over automatic systems. Moreover, participants considered information about traffic jams, unavailable roads, traffic density, environment (speed limit, safety level, traffic regulation, etc) as important. In the case of an advisory system, participants wanted to know the reasons for the system's advice. Participants strongly disliked intrusive auditory signals, so visual feedback was considered. To increase multitasking ability [3], the visual feedback should be glanceable.

2. PROTOTYPES
In order to answer the question of what, how, and when to present advices from a CCC device, several prototypes were developed and tested. Preliminary study and several visual and audio design iterations resulted in two prototypes. They both inform users about speed choice in three states {Too Fast, Appropriate, Too Slow}. In the Guidance prototype, users are only presented with colors, numbers, and sounds. In the Explanation prototype, additionally users are presented with icons and can interact with buttons for more information (explanation/consequences).

Each of 24 test participants was asked to do 10 to 15 minute driving using both prototypes (one at a time) on a driving simulator. They were asked to rate each interface element of the prototypes through a questionnaire, asked to express their understanding on the icons, and interviewed to get forced preference of prototypes, modalities, and elaboration on questionnaire results.

The results show that people liked the extra information for triggering action and sensing high urgency. They judged the color changes presented in the periphery of the visual field as more action triggering than audio signals.

3. REFERENCES
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