IN-CAR COMMUNICATION AND KARAOKE SYSTEM IN PASSENGER VAN

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DESCRIPTION OF VEHICLE DEMONSTRATOR

In cars, it is often difficult for drivers to converse with rear-seat passengers because of the driving noise and the high acoustic loss when speaking from front to back. Meanwhile there are several car lines equipped with a so-called In-Car Communication (ICC) system that facilitates front-to-rear communication by utilizing the existing microphones and loudspeakers of the vehicle's entertainment system to reinforce in-vehicle conversations. The background noise and in particular the coupling of the loudspeaker signals into the hands-free microphones put high demands on the signal processing algorithms of such an ICC solution, which must prevent feedback and howling to ensure stable operation of the system even at higher speech amplification.

A special form of realization of an ICC system is an in-vehicle karaoke system which allows driver and passengers to sing along with the audio signal of the vehicle entertainment or a special karaoke application. Analogous to the ICC system, the main challenge is the stabilization of the electroacoustic loop due to the loudspeaker feedback of the music and the amplified vocal signals into the hands-free microphones.

The ICC demonstrator is realized as a bi-directional speech communication system in a passenger van (Mercedes V-Class). The driver and passenger speech signals are picked up by seat-dedicated microphones and are reproduced via the loudspeakers in the 2nd and 3rd row of the vehicle. The microphone signals of the rear passengers are mixed depending on the speech activity of the passengers and reproduced via the front loudspeakers. The setup in the demo vehicle is illustrated in the schematic in **Fig.1**.

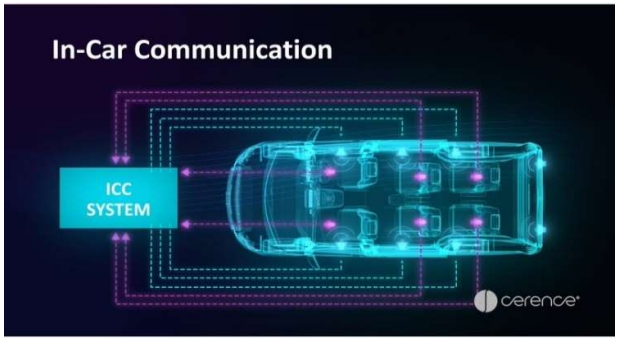

Fig. 1. Schematic of the bi-directional ICC-System

The demonstrator is PC based, but fully integrated into the vehicle's sound system.

The implemented signal processing algorithms attenuate interfering noise, suppress loudspeaker feedback and reinforce the speech signal (**Fig. 2**). The speech amplification is automatically controlled by the background noise level in the vehicle to ensure an unobtrusive and pleasant-sounding speech reproduction.

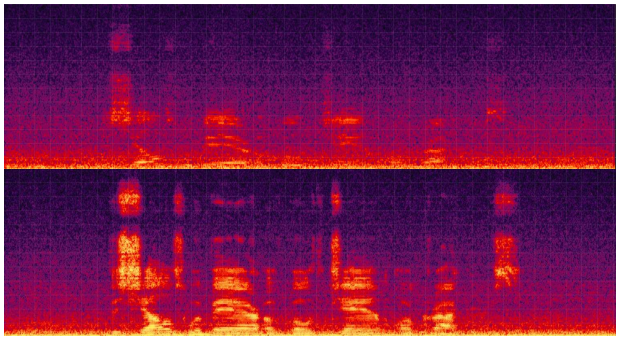

Fig. 2.: Spectrograms of the driver signal recorded at the rear passenger's ear in the 3rd row. Top: ICC off, bottom: ICC on

The in-vehicle karaoke solution is a special feature of the ICC system. It includes multiple configurable vocal effects to enhance the singing experience of the driver and front passenger. In contrast to the ICC system, the amplified vocal signals of driver and passenger are reproduced via all vehicle loudspeakers. Like the ICC demo, the solution utilizes the available hands-free microphones and does not require any additional hand-held microphones like currently available systems.

Interested visitors are also welcome to try out the karaoke system for themselves.

The vehicle demonstrator complements the talk of Kaspar Müller at this conference on *Model-based Estimation of In-Car-Communication Feedback applied to Speech Zone Detection* were critical integration aspects of multi-zone speech applications with ICC systems are discussed.