

The First Automotive Implementation of a Digital Voice Enhancement System

by Shawn Steenhagen, Applied Signal Processing, Inc.

Applied Signal Processing, Inc. (ASP) has applied its knowledge of vehicle acoustics, adaptive modeling, and digital signal processing to implement a Digital Voice Enhancement™ (DVE) system for Volkswagen AG. The system, which uses a Texas Instrument TMS320C55x™ DSP-based controller, is offered as an optional feature to enhance voice communication in the new 2004 Volkswagen Multivan.

Minivans and sport utility vehicles are tremendously popular, but these vehicles have a greater distance between seated passengers and higher interior noise levels. Luxury vehicles typically incorporate significant acoustic treatments, which absorb road noise, but also affect voice communication. These characteristics often make normal conversation among the vehicle occupants difficult.

The ASP DVE system improves the environment for natural conversations in vehicles by using speech-enhancing signal processing techniques to amplify the voice signals, while minimizing the amplification of other noises. Safety is a direct benefit of the DVE system, because the driver does not have to turn his head or take his eyes off the road to converse effectively with the other passengers. Also, passengers are more comfortable when they can speak in normal tones and can hear others without having to lean forward or change seats.

The DVE system uses microphones, mounted overhead, to pick up the occupants' voices. It also deals with non-speech inputs, such as road, wind, engine, and accessory-generated noises. The DVE system applies a discriminating function to detect voice activity from the dynamically changing noise floor. The vehicle's audio system loudspeakers broadcast speech from one zone to another within the vehicle, Figure 1 (above). The DVE system maintains high sound quality and speech intelligibility by properly equalizing the communication channel and integrating

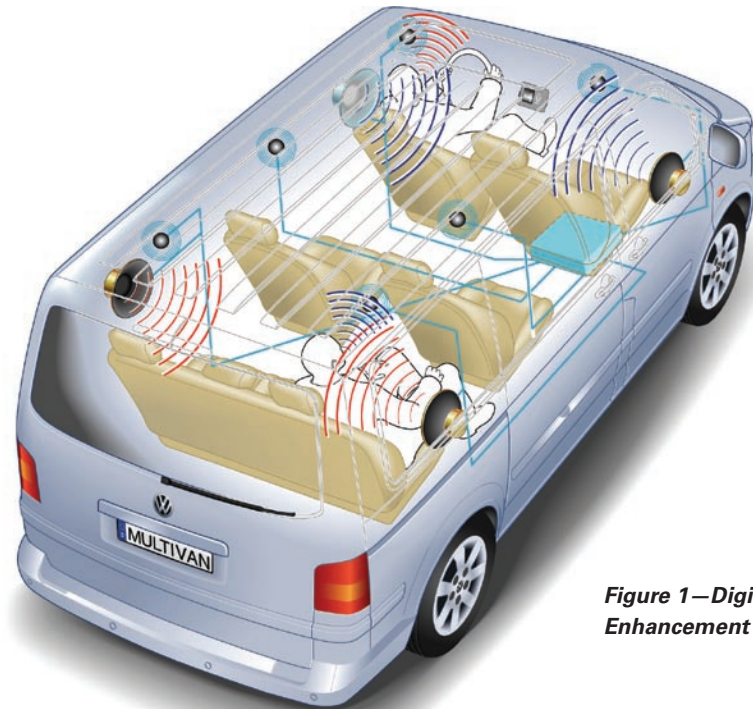


Figure 1—Digital Voice Enhancement System™

vehicle-specific compensation routines for volume and tone. It also addresses classic feedback problems by removing compensating for reverberations and feedback for each of the talkers' microphones. If the optional VW cell phone car kit is installed the DVE system becomes a digital hands-free system in which all passengers can participate in a phone call.

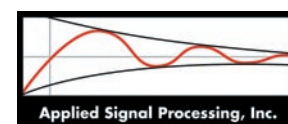
Other technical features of the DVE system include smart-gating and a variety of signal management tools that compensate for voice levels, reception-level requirements, and ambient noise levels. Dynamic Gain Control increases the total dynamic range, effectively equalizing the sound levels of both loud and soft talkers to increase speech intelligibility and listener comfort.

CONCLUSIONS

By utilizing speech microphones, standard audio loudspeakers with amplification, and advanced digital signal processing techniques,

the ASP DVE system allows for conversation within vehicles at normal speech levels. It provides an ideal way to acquire speech signals, giving automotive designers a new gateway for implementing such features as a digital voice notepad, voice recognition systems, and hands-free cellular telephony. It can provide increased driver safety and passenger comfort for a very reasonable cost.

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