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| **Title:** | Proposal of a Braunschweig Database of Dynamically Changing Automotive Room Impulse Responses for Inclusion into FG.VSSR | |

**Proposal of a Braunschweig Database of**

**Dynamically Changing Automotive Room Impulse Responses for Inclusion into FG.VSSR**

In ITU-T Recommendation P.1110 in sections 11.11.6 and 11.11.7 the use of a rotating reflecting surface (a cardboard or similar) is described to test echo performance with time-variant echo path. Although such test is able to capture some realistic aspects of the echo path dynamics and also nonlinearities, it also shows clear drawbacks:

* It takes effort and time to setup the test hardware (rotating reflecting surface, etc. …).
* No reproducibility is given, particularly not with a new installation of the reflecting surface.

Therefore, we propose to additionally include a test condition into FG.VSSR, where echo performance is tested on the basis of automotive room impulse response (RIR) traces. Technische Universität Braunschweig would be willing to provide such data, and invites everybody to contribute as well. The test itself would then run using these dynamically changing RIRs to convolve the “loudspeaker” signal, yielding “simulated microphone” signals in time-variant echo path conditions. Investigations have shown that convolution with such highly time-resolved RIR traces is not only covering dynamics, but also nonlinearities to a good extent [1].

The key advantages of this approach are sixfold:

* With this new methodology *100% reproducible tests in these dynamic conditions* can be performed.
* Reproducible tests are not only possibly with RIR traces related to a rotating surface, but to virtually *any dynamic situation* in a car (moving driver’s knee at a loudspeaker, hands moving in the vicinity of the microphones, …)
* Using a database of a number of cars, time-variant echo path conditions can be easily tested for a *variety of different cars*, without the need of having these cars available in the lab. This is particularly useful during the development phase of automotive hands-free algorithms.
* *Arbitrary “loudspeaker” signals* can be easily processed and used for the test.
* The developer gets a *“ground truth” for the dynamic echo path* at hand, allowing him to compute not only the echo return loss enhancement (ERLE) but also important objective measures such as the system distance.
* *Time and costs are saved* due to the simulative approach.

The core methodology that is needed to acquire such RIR traces for dynamic echo paths is outlined in [1]. It turns out that, e.g., for a test condition very similar to the rotating surface condition, a system distance of about -16 dB is reached, which is a good value for a constantly changing echo path (rotation of the surface once per 4s). Furthermore, the methodology yields RIR traces that – if convolved with some loudspeaker signal – yield some fairly similar “microphone” signal as if the microphone signal were acquired in the real environment.

We ask the FG CarCOM for a *decision to support* the following steps:

1. Common FG CarCOM task: Define – beside the existing described rotating surface – other meaningful test cases, which should be represented in the RIR trace database.
   1. Moving driver’s knee
   2. Moving hand shading and unshading the microphone.
   3. …
2. TU Braunschweig: Performs recordings in a Volkswagen Touran and distributes excitation signals to interested partners who will do similar recordings in other cars.
3. TU Braunschweig: Will compute the RIR traces, and will make available the data to FG CarCOM members.
4. Inclusion into FG.VSSR:
   1. FG CarCOM: Will adopt the RIRs as data delivered along with FG.VSSR.
   2. TU Braunschweig: Will provide some appropriate text for test conditions in FG.VSSR.

Since the requested decision for support will involve a considerable amount of man power efforts at TU Braunschweig, we ask for a general decision of the focus group on the Herzogenrath meeting to go along these lines with the clear goal either to include such RIR trace data into the future FG.VSSR – or not.

[1] M.-A. Jung, L. Richter, T. Fingscheidt, “Towards Reproducible Evaluation of Automotive Hands-free Systems in Dynamic Conditions”, submitted to IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, Canada, May 2013.



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