Science for a moving society

FINAL REPORT

1327 | 2023 – Frankfurt am Main

Störgeräusche im Fahrzeuginnenraum mit elektrifizierten Antrieben

Kenngrößen zur Quantifizierung der Lästigkeit von Störgeräuschen im Innenraum von Fahrzeugen mit elektifiziertem Antrieb

Interference Noise in the Vehicle Compartment with Electrified Drives

Characteristics for quantifying the annoyance of interference noise in the compartment of vehicles with an electric drive system

Interference Noise in the Vehicle Compartment with Electrified Drives

Project no. 1369

Characteristics for quantifying the annoyance of interference noise in the compartment of vehicles with an electric drive system

Final report

Abstract: With increasing electrification of the powertrains of road vehicles and the elimination of the combustion engine as a masking component, new challenges arise in vehicle acoustics. Interior noise is increasingly determined by tire and wind noise as well as components of the electric powertrain. The latter, in particular, have a high-frequency tonal character and often have a negative influence on the perceived noise quality of the vehicle. Acoustic optimization is a complex and time-consuming process based on the precise identification of the originators of the noise components. This optimization effort can be significantly reduced by the calculation tool developed in this research project.

As a basis for all analysis steps within the calculation tool, the tonal components of the overall noise in the vehicle interior are identified automatically based on image processing. Due to the low signal-to-noise ratio (SNR), the application of image filters is necessary to detect tonal orders with the Hough-Transformation. These are assigned to the causative components by means of geometric correlations or machine learning. The noise share can be approximately divided into a tire and a wind component. In addition, the speed of the electric machine and, in vehicles with asynchronous machines, the slip can be determined from a noise signal. The input signals can also be evaluated psychoacoustically using a long short-term memory (LSTM) model. The psychoacoustic parameters loudness, tonality and sharpness were calculated and used as model parameters. The model was developed by comparing model predictions with experimental data of pleasantness ratings of recordings of interior vehicle noise as well as augmented sounds. For the augmented sounds, already existing components of the recordings were modified in level or new components were added. It is also possible to determine the audibility of tonal components, since only audible components can contribute to the perceived pleasantness. Within the Software-Tool, which summarizes the developed methods in a user-friendly way, the influence of possible optimization measures can be simulated by overlaying partial noises, which are individually weighted. In addition, subharmonics of the extracted components can be added to the sound to generate a new artificial sound that has the potential to enhance the pleasantness of clearly audible tonal components.

The objective of the research project was achieved.

Duration:	01.09.2019 – 31.10.2022
Funding organisation(s):	FVV eV // Science for a moving society (FVV)
Funding number(s):	FVV 601369
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Related reports: R603 (2022)

Acknowledgement

This report is the scientific result of a research project undertaken by the FVV eV and performed by the Chair of Thermodynamics of Mobile Energy Conversion Systems (TME) at RWTH Aachen University under the direction of Univ.-Prof. Dr.-Ing. (USA) Stefan Pischinger and by the Department of Experimental Audiology (EXA) at Otto von Guericke University Magdeburg under the direction of Prof. Dr. rer. nat. Jesko Verhey.

The FVV would like to thank professors Pischinger and Verhey and their scientific research assistants – M. Sc. Katja Fröhlingsdorf (TME) and M. Sc. Florian Doleschal (EXA) – for the implementation of the project. The project was conducted by an expert group led by Dr.-Ing. Stefan Heuer (MAN Truck & Bus SE). We gratefully acknowledge the support received from the project coordination and from all members of the project user committee.

The research project was self-financed (funding no. 601369) by the FVV eV.