Rail Noise Simulation Laboratory

Approaches to realistic audiovisual recording, simulation and reproduction of traffic noise and noise abatement measures

Koch, Thomas[1]

[1] Fraunhofer Heinrich Hertz Institute

Summary

Methods for immersive, audio-visual capturing, simulation and reproduction of railroad noise and noise protection methods.

Keywords: Noise Simulation; Visualization; Communication Tools

1 Introduction

In cooperation with the DB AG[14] an innovative simulation and auralization method was developed and implemented in the TiME Lab[15] of the Fraunhofer Heinrich-Hertz-Institute (HHI) in Berlin. Based on spatial sound recordings and acoustic simulations in combination with high-resolution video panoramas or photorealistic 3D computer graphics, the communication format "Infopunkt Lärmschutz" [16], a laboratory for noise simulation, emerged. With the help of a 12 meters wide 180°-panorama projection and a 3D Audio reproduction system based on wave-field synthesis, simulations of railroad traffic noise can be reproduced realistically in an unprecedented quality. Based on the original sound recordings, different conventional and innovative noise reduction measures such as noise barriers or rail dampers are simulated and become audible and experienceable in comparison. In addition, various urban development measures can also be integrated in the audiovisual simulation.

[14] https://www1.deutschebahn.com/laerm/gut_zu_wissen/Interaktive_Kommunikationsformate_-1097158
[15] http://www.timelab-hhi.de/
[16] http://www.timelab-hhi.de/infopunkt-laermschutz

2 Methodology

2.1 3D Audio Recordings for Realistic Noise Reproduction

Special microphone systems are used for audio recording. A 3D microphone array with 14 microphones allows the correct level and localization for sound field reproduction with wave field synthesis technology or binaural rendering.

2.2 Acoustic Simulation of Noise Reduction Measures

The frequency-dependent effects of different Noise Reduction Measures are derived from

a) Existing formulas (e.g. Schall03)
b) Existing measurements (>>100)
c) Spatial recordings for validation of results

As opposed to existing approaches, the resulting formulas where optimized for subjective evaluation and most realistically sounding results. For conventional noise reduction measures such as noise barriers in different heights, but also for some innovative measures like rail dampers or rail web shields, the application of those filters to the original spatial sound recordings proved to be a suitable approach for subjective evaluation. However, for reduction measures that affect the noise emissions of the vehicle (e.g. composite brake shoes) this approach is not applicable.

2.3 High Quality 360° Panoramic Video Recording

The OmniCam-360 developed at Fraunhofer HHI is used for panoramic video recordings. This panoramic camera is equipped with a special mirror rig, which guarantees the simultaneous, parallax-free recording of near and far areas. By using 11 micro-HD and UHD cameras, an extremely high resolution of 10,000 x 3,500 pixels can be achieved.

Picture 1: Example of Omnicam-Capture (180°, Stillframe)

2.4 Integration of Proposed Urban Development Measures

Transport infrastructure as well as building construction and civil engineering, map- and plan data are accurately transferred into a computer-generated 3D representation. The urban development measures are inserted into the real scene in the form of photorealistic computer animation.

3 Usecases

3.1 TiME Lab, Interactive Demonstrator, Tablet, VR

In addition to the representation in the TiME Lab, simplified, mobile versions of the simulator have been developed. The viewer can choose and compare different scenarios via a touchscreen interface. The passing trains are displayed in real time on a HD display (1920 x 1080 pixels, with 50 frames per second). Additionally, an application for Head Mounted Displays (HMD's) allows a full 360°-VR experience with 3D-Audio.

Picture 2: TiME Lab, Iteractive Demonstrator, Tablet & VR

Authors

Koch, Thomas

Thomas Koch is Project Manager for audio related topics at the Capture & Display Systems Group in the Vision & Imaging Technologies Department at Fraunhofer Heinrich Hertz Institute.

His R&D activities are related to the following keywords: 3D Audio, Spatial Audio, Binaural Audio, Virtual Reality, Immersive Media, Wave Field Synthesis, Object-Based Audio, Traffic Noise Simulation and Reproduction.