Approaches to Realistic Audiovisual Recording, Simulation and Reproduction of Traffic Noise and Noise Abatement Measures
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2008 – 2010: Fraunhofer IuK; Future Media Development
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Introduction

What do orchestras and rail traffic have in common?
What do orchestras and rail traffic have in common?
HHI – VIT Activities: TiME-Lab
1. Introduction
2. Project objective
3. Methodology
4. Realisation
5. Presentation formats
6. Conclusion / Outlook
1. Introduction

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Customer Request

- Development of new communication tools for transport service providers by the use of SOTA audiovisual capturing and reproduction technologies

- Close-to-reality reproduction of rail noise and the sonic effects of noise reduction methods, such as:
  - Conventional and low noise barriers
  - Rail dampers and rail web shields
  - Composite breaks
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Methodology: Principle Idea
Methodology: Preliminary Study

Principle Idea

- Derive Filterfunctions on the basis of existing datasets

- Apply filters to audio-recordings of trains without noise reduction methods
Available datasets: Noise barriers

- Analysis of >>100 sets of measurements
- Analysis of audio recordings
- Analysis of mathematical approaches

Results

- Good data basis & mathematical approximations for simulation of conventional noise barriers
Methodology: Preliminary Study

Validation of simulation: Train without noise barrier
Validation of simulation: train with noise barrier
Validation of simulation: train with simulated noise barrier
Available datasets: Innovative noise reduction methods

- (Limited) datasets available
- Method of auralisation not applicable to methods affecting noise creation

→ Need for recording of both scenarios
Audio recordings as basis for auralisation

- Complex spatial structure of sound source:
  - Monophonic / Stereophonic approach not sufficient
  - Need for high spatial resolution in recording and reproduction

→ Evaluation of different microphone setups in combination with reproduction by high resolution audio rendering systems (WFS).
Methodology: Preliminary Study

Microphone Setup: Tests

Linear array, logarithmic spacing

Linear Array, linear spacing
Visual components

• Need for realistic visual reproduction as reference:
  • Distance, type and speed of train
  • Visual impact of noise reduction method

→ 180° Panoramic video recording and reproduction
Methodology: Preliminary Study

Videocapturing: Omnicam360

- 360°-UHD Camera System
- 10x 36 degree segments
- 10 HD-cams
- Resolution: 10k x 2k
- Vertical FOV: 60 degree
- Weight: 16kg (35lbs)
- Max width: ca. 500mm
- Height: ca. 600mm
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Burgdorf (Cuxhaven – Lehrte)

- Freight trains (ore) with gray iron / composite breaks
- 180°-Videocapturing at 25 m and 12.5 m distance to railroad
- Audiorecording at camera positions with microphone arrays optimized for high-resolution audio reproduction
Realisation: Recording

Wernitz (Wustermark)

- ICE-trains with high velocity (<200km/h)
- 180°-Videocapturing at 25 m and 12.5 m distance to railroad
- Audiorecording at camera positions with microphone arrays optimized for high-resolution audio reproduction
- Additional microphone arrays at 25m and 12.5 m behind 2m high noise barrier (reference)
Realisation: Recording

Wernitz (Wustermark)
Realisation: Auralisation

Process

• Derivation of third-octave band filter functions for chosen scenarios
  • According to distance, velocity, type of train, type / height of barrier

• Auralisation
  • Application of filter functions to audio recordings

• Validation against own measurements
• Validation after reproduction
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Tomorrow’s Immersive Media Experience Laboratory
TiME-Lab: Video

- 180° Panoramic Multiprojection
- 7 / 14 HD projectors (2D / 3D)
- Ultra High Resolution (7000 px * 1920 px)
- Real-time corrections of blending areas
- Real-time geometrical image correction (warping)
TIME-Lab : Wave Field Synthesis

- Realtime-Rendering of TIME-Lab’s 138 loudspeaker channels
- Object-based sound reproduction system
- Able to reproduce the acoustic character of environments such as churches or concert halls
- No ‘sweet spot’
TiME-Lab : Wave Field Synthesis

wave field synthesis principle

virtual acoustic sources

Position Data

synthesized wave fronts

elementary wave

Renderer

WFS Principle

© Helmut Oellers
S-Bahn - 5 m Lärmschutzwand - Abstand 100 m

Gesamtklasse ca. 70 km/h
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Conclusion

• High quality auralisation / visualisation of noise reduction technologies can be used to demonstrate the effects of noise reduction methods
• Better datasets / different methods needed for more flexible and precise results

Outlook:

• Possible extension of methods:
  • Predictive simulations
  • Interactive simulations
  • Perceptually based design of noise reduction technologies?
  • Possible tool for noise effect research?
Thank You!

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