Approaches to Realistic Audiovisual Recording, Simulation and Reproduction of Traffic Noise and Noise Abatement Measures

Introduction

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Since 2010	**Fraunhofer HHI, Project TiME-Lab**
Since 2013:	**Lectureship UdK Berlin, Raumkomposition**
Since 2016:	**Lectureship HdpK Berlin, Klang und Raum**
2008 – 2010	**Fraunhofer IuK; Future Media Development**
2007 – 2008	**Fraunhofer IDMT, Virtual Acoustics**
2010	**MA Sound Studies 2010**

Introduction

What do orchestras and rail traffic have in common ?

‚Train Conductor' © Tony Zuvela

Introduction

What do orchestras and rail traffic have in common ?

Production: Infopunkt Lärmschutz

Production: Berlin Philharmonics © M. Rittershaus

HHI – VIT Activities: TiME-Lab

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Project Objective

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

Methodology: Preliminary Study

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

Methodology: Preliminary Study

Validation of simulation: train with noise barrier

Methodology: Preliminary Study

Validation of simulation: train with simulated noise barrier

Methodology: Preliminary Study

Available datasets: Innovative noise reducation methods

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

→ Need for recording of both scenarios

Methodology: Preliminary Study

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

Methodology: Preliminary Study

Visual components

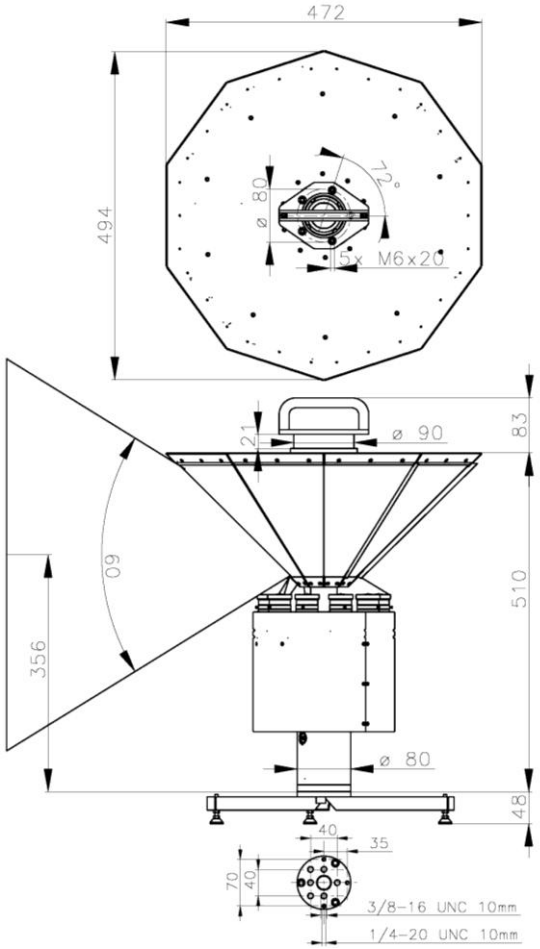
- Need for realistic visual reproduction as reference:
  - Distance, type and speed of train
  - Visual impact of noise reduction method

→ 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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Realisation: Recording

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

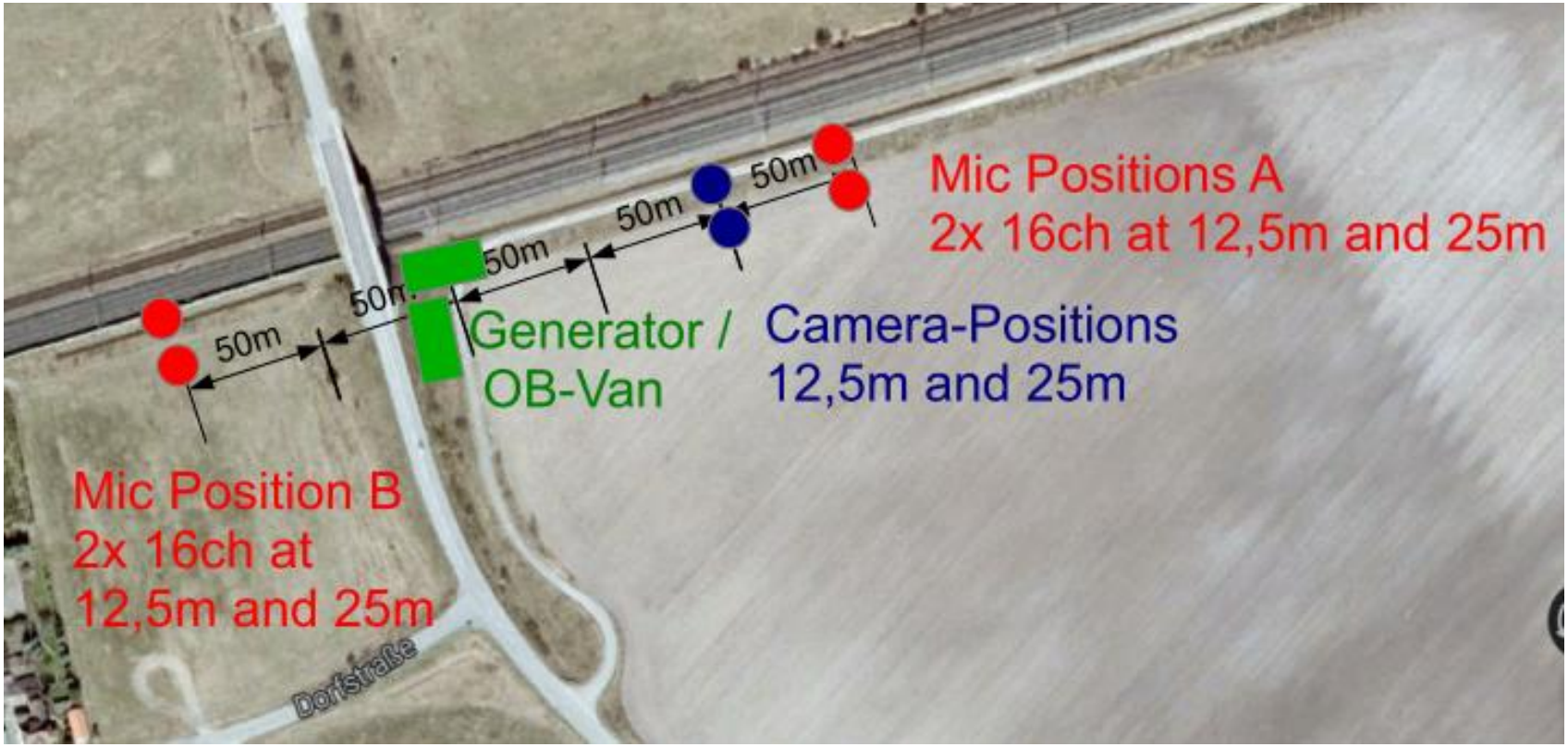
Realisation: Recording

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 **I**mmersive **M**edia **E**xperience **Lab**oratory

TiME-Lab

© Tony Zuvela

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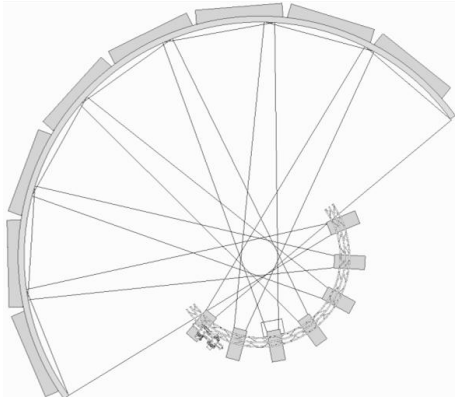
TiME-Lab: Video

- 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)



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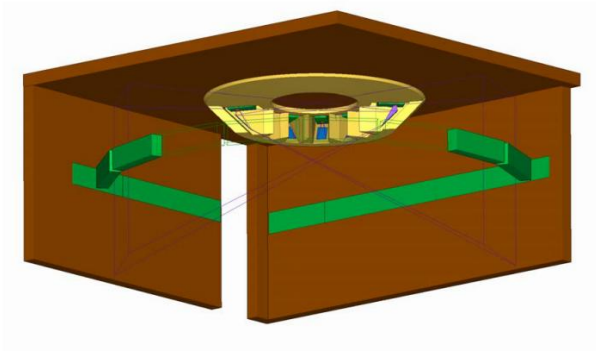
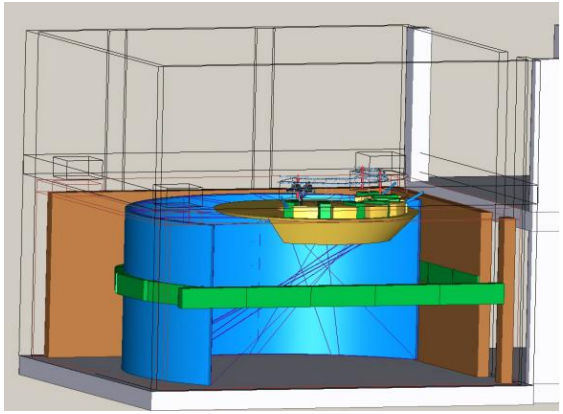
TiME-Lab : Wave Field Synthesis

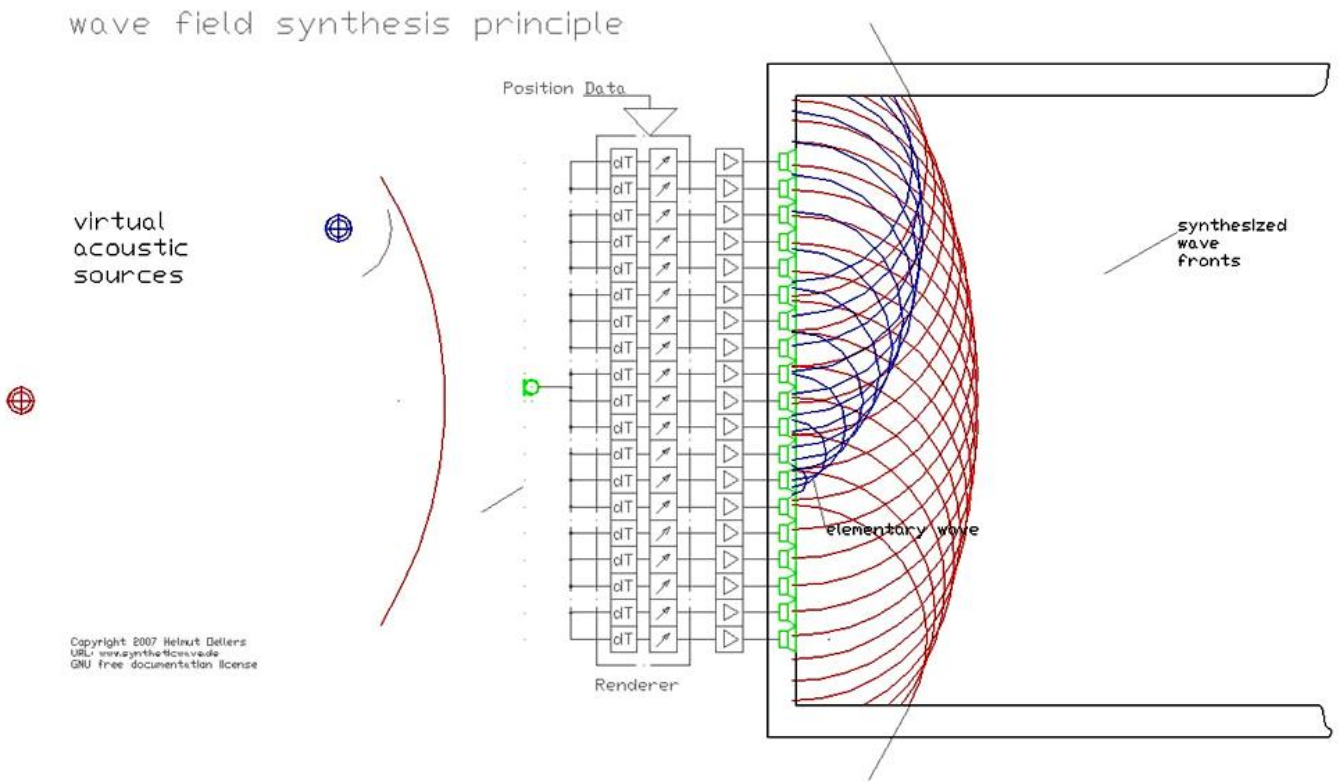
- Realtime-Rendering of TiME-Lab's 138 loudspeaker channels
- Object-based sound reproduction system
- Able to reproduce the acoustic character of environments such as churches or concert halls
- No 'sweet spot'





Methodology: Preliminary Study

TiME-Lab : Wave Field Synthesis



WFS Principle

© Helmut Oellers

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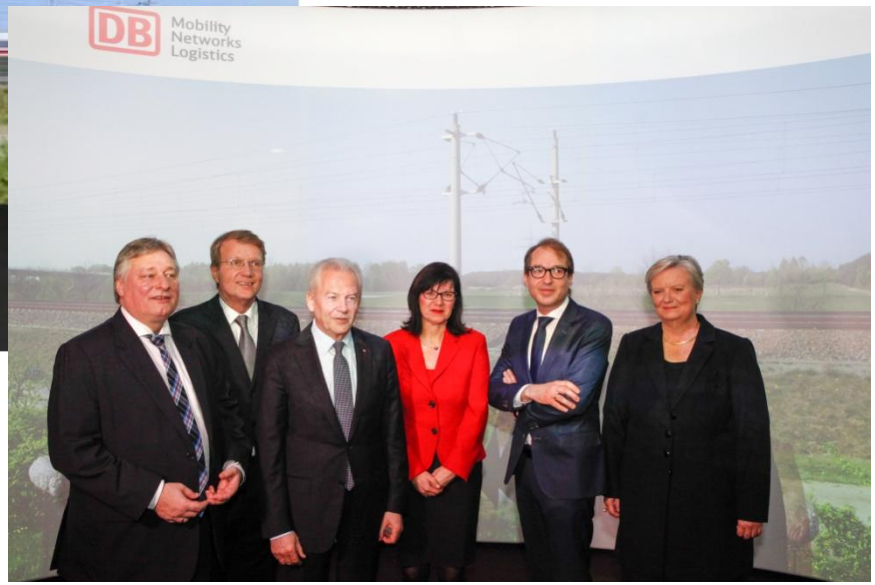

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Format: Lichtenrade

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4. Realisation
5. Presentation formats
6. Conclusion / Outlook

Conclusion / Outlook

Conclusion

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

Outlook:

- Possible extension of methods:
  - Predictive simulations
  - Interactive simulations
  - Perceptually based desgin of noise reduction technologies?
  - Possible tool for noise effect research?

Thank You!

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