Urban Soundscapes of the World

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Supported by HEAD GENIUS STIFTUNG United against pain
Content of presentation

• Introduction
• Site selection
• Audiovisual recordings
• Site classification
• Analysis and manipulation
Introduction

• To foster urban acoustic design in education & practice

• Rationale
  – Architects/designers work by example
  – Advent of affordable immersive AV recording / playback systems
    • valuable tool for participatory soundscape evaluation in urban planning/design
  – Auralization of outdoor spaces still very challenging
  – Availability of high quality spatial audio recordings in urban setting is sparse
Introduction

• Main goals
  – To set the scope for a standard on immersive recording/reproduction of urban acoustic environments with soundscape in mind
  – To collect a reference database of well-documented exemplars
    • recording locations systematically selected
    • professional-quality immersive audio-visual recordings (ambisonics / binaural / 360° video)
    • freely available to the research community: urban-soundscapes.org/soundscapes
  – To create a software toolbox for
    • AR audio/video manipulation (adding/suppressing sound) to assess acoustic design measures
    • calculation of novel binaural/spatial audio indicators
    • demonstrator: soundscape hackathon @ De Krook
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Site selection

• Soundscape evaluation studies
  – Sampling of urban sites often performed in ad hoc manner
  – Top-down selection
    • past/planned noise control or soundscape interventions
    • presence of particular sound sources, value for residents/visitors/tourists
  – Supportive for the study at hand, but selection bias likely

• This project
  – Representative coverage
  – Perception-based selection with local experts
  – Inspiration from circumplex model of affect

Site selection

• Online survey
Site selection

- Montreal, Canada – “full of life and exciting”

- 17% Place des Arts
- 17% Monument à Sir George-Étienne Cartier
- 11% Square Phillips

- 36 participants (a.o. students Université de Montréal, Sounds in the City project at McGill University, surround sound and BRAMS mailing lists)
  - 18 male, 17 female, 1 not specified
  - average age 38.9 ± 12.9 yr
Site selection

- Montreal, Canada – “chaotic and restless”

- 28% Rue Sainte Catherine
- 14% Place Émilie-Gamelin
- 11% Palais des congrès

- 36 participants (a.o. students Université de Montréal, Sounds in the City project at McGill University, surround sound and BRAMS mailing lists)
- 18 male, 17 female, 1 not specified
- average age $38.9 \pm 12.9$ yr
Site selection

- Montreal, Canada – “calm and tranquil”
  - 39% Parc Mont Royal
  - 14% Parc La Fontaine
  - 11% Mont Royal Cemetery

- 36 participants (a.o. students Université de Montréal, Sounds in the City project at McGill University, surround sound and BRAMS mailing lists)
  - 18 male, 17 female, 1 not specified
  - average age 38.9 ± 12.9 yr
Site selection

- Montreal, Canada – “lifeless and boring”

Spread out, little to no convergence (no single location reaches > 10% of votes)

- 36 participants (a.o. students Université de Montréal, Sounds in the City project at McGill University, surround sound and BRAMS mailing lists)
- 18 male, 17 female, 1 not specified
- average age 38.9 ± 12.9 yr
Site selection

• “full of life and exciting”
Site selection

- Conclusions
  - 4 quadrants not equally represented among urban locations
    - high fraction of “boring” places
    - makes agreement on prototypical “boring” locations difficult
  - Possible underlying mechanism
    - not all locations in a city are visited with the purpose of experiencing the soundscape
    - acoustic environment does not attract attention if sound is not the purpose of being there
    - the soundscape at these locations is not always memorable
  - Categorization of urban locations on soundscape perception
    - hierarchical representation might be more suitable
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Audiovisual recordings

- High quality spatial audio and video

Ambisonics: Core Sound TetraMic with Tascam DR-680 MKII

360° video: GoPro Omni (8K resolution)

Binaural: HEAD acoustics HSU III.2 with SQobold
Audiovisual recordings

• Wide range of urban public spaces

Raw recording data available at: urban-soundscapes.org/soundscapes
Audiovisual recordings

- Reproduction: head-mounted display with spatial audio
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Site classification

• Lab experiment setup
  – Oculus Rift with GoPro VR Player 3.0
  – Sennheiser HD650, LabP2 (level calibrated)
  – Questions projected in VR, answered verbally
Site classification

• Participants
  – 40 participants (11 female, 29 male), average age 29.6 yr (range 22–46 yr)
• Stimuli
  – 50 one-minute fragments (360° video, FOA audio track)
• Fragments rated in two ways
  – 11-point scale in terms of 4 core affect quadrants → 4 avg. scores for each location
  – Alternative hierarchical classification method based on activity interference

How much does the acoustic environment draw attention?
How well does the soundscape match expectations?
How much does the soundscape arouse the listener?
Site classification

- Hierarchical classification questionnaire → 4 avg. scores for each location

1. In general, how would you categorize the environment you just experienced?
   - Calming/tranquil
   - Neither calming/tranquil
   - Very calming/tranquil
   - Lively/active
   - or lively/active
   - Very lively/active

2. In general, what kind of activities would you imagine doing in the environment?
   - Read
   - Make a phone call
   - Have a chat
   - Drink/eat
   - Play
   - Work
   - On smartphone
   - Stay for a while
   - Smoke
   - Sports
   ×0.5

3. How much did the sound draw your attention?
   - Not at all
   - A little
   - Moderate
   - Highly
   - Extremely
   ×0.5

4. Would the sound environment prevent you from doing the activities mentioned above?
   - Not at all
   - A little
   - Moderate
   - Highly
   - Extremely
   ×1

5a. How much does the sound environment contribute to the calmness/tranquility of this place?
   - Not at all
   - A little
   - Moderate
   - Highly
   - Extremely
   ×0.5

5b. How much does the sound environment contribute to the liveliness/activeness of this place?
   - Not at all
   - A little
   - Moderate
   - Highly
   - Extremely
   ×0.5

Disruptive ×(1-S03)
Stimulating ×(1-S04)
Site classification

• Clustering
  – 70% of soundscapes clearly categorized into one class
  – fuzzy membership function much larger for this class than for others

• Relationship with overall perception

![Graph showing the relationship between overall perception and proportion within cluster. The graph includes labels for calming, background, disruptive, and stimulating categories. There is a note indicating a large number of environments with non-supportive soundscape.]
Site classification

• PCA analysis
  – Based on score in hierarchical model: 93% of variance explained
Site classification

- PCA analysis
  - Based on score in hierarchical model: 93% of variance explained
  - Based on score in 2D affect model: 86% of variance explained
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Analysis and manipulation

• Analysis of visual scene
  – Amount of greenery
  – Amount of buildings
  – Number of people
  – ...

• Analysis of spatial audio
  – Psychoacoustical parameters
  – Spatial auditory saliency
  – Detection of events
  – Spatial sound indicators
  – ...
Analysis and manipulation

• Soundscape hackathon
  – Demonstration of results
    • Friday 5 April, 14:30-16:30 @ De Krook