Sound Design in Our Sound Environment: Soundscape Design, Auralisation and Evaluation in Environmental Acoustics

Damian Murphy

AudioLab, Department Of Electronic Engineering, University Of York.

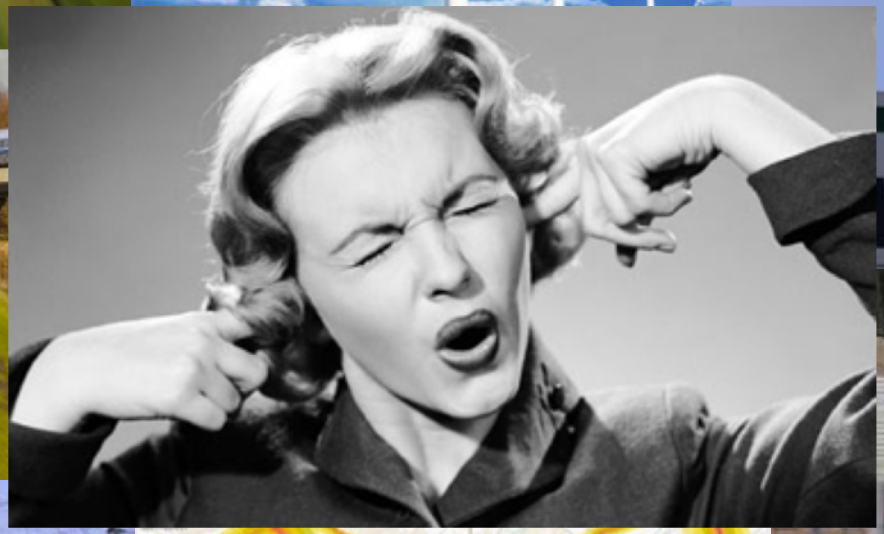
Seminars on the Occasion of Ludvig Elblaus' PhD Defence

Media Technology and Interaction Design, KTH, 24 May 2018

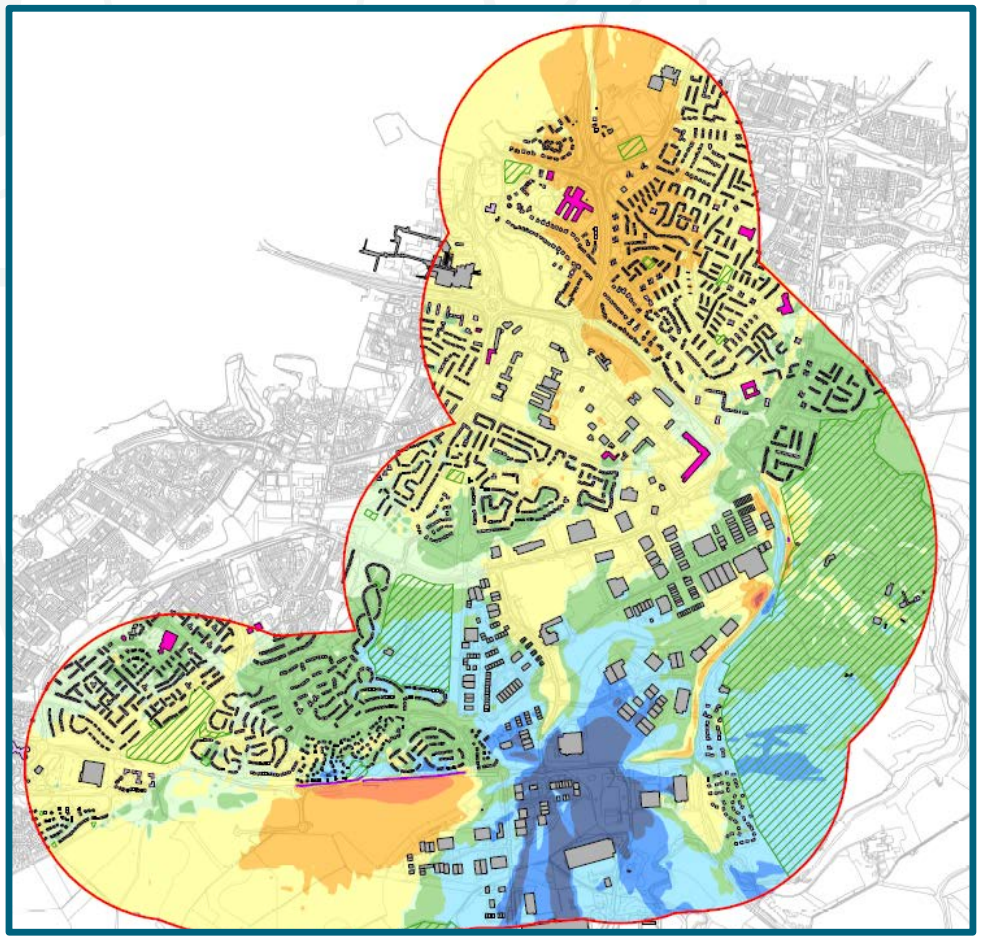

Heathrow


863


eathrow



Sound Mapping:
dB (A), Ldn, Lden, Lnight, LA10(18hour)…

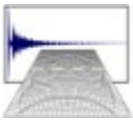


KEY:

- 600m buffer of Proposed Scheme and Affected Routes
- Proposed Noise Barriers
- Non-Sensitive Buildings
- Other Non-Residential Sensitive Receptors
- Residential Buildings
- Other Non-Residential Sensitive Open Spaces

Change in $L_{A10,18hr}$ dB (free field)

- >=5.0
- >=3.0 to <5.0
- >=1.0 to <3.0
- >0.0 to <1.0
- 0
- >-1.0 to <=-0.1
- >-3.0 to <=-0.1
- >-5.0 to <=-3.0
- <=5.0



Auralisation

- **Auralisation** is to sound what **3D visualisation** is to vision.
- Auralisations are **easier for us to interpret** - they involve **listening** rather than metrics.
- They help us to **understand** and **better design proposed changes** to an **acoustic environment** and the resulting perceived **soundscape**.

Auralisation Workflow

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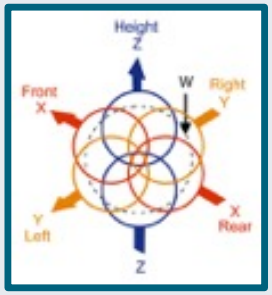
Sound Source Recordings



Auralisation Workflow

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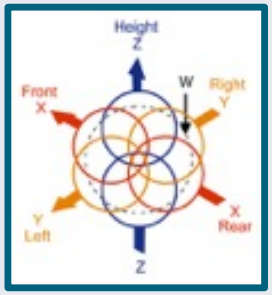
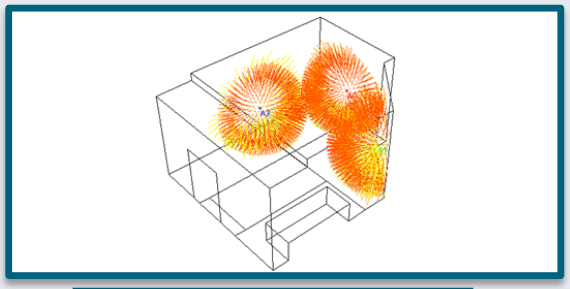
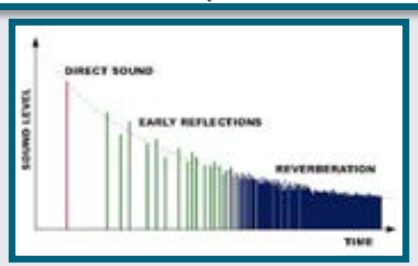
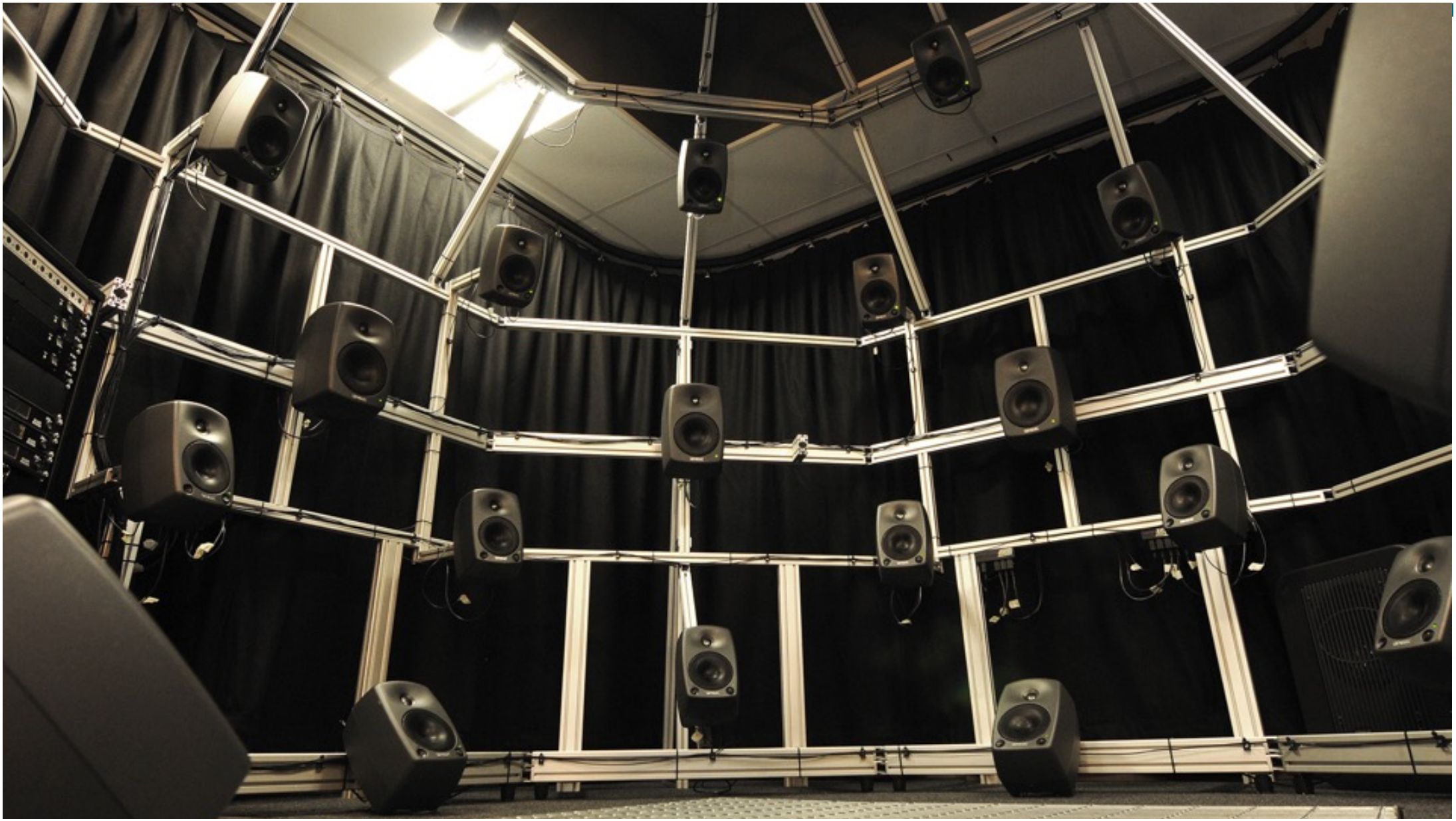


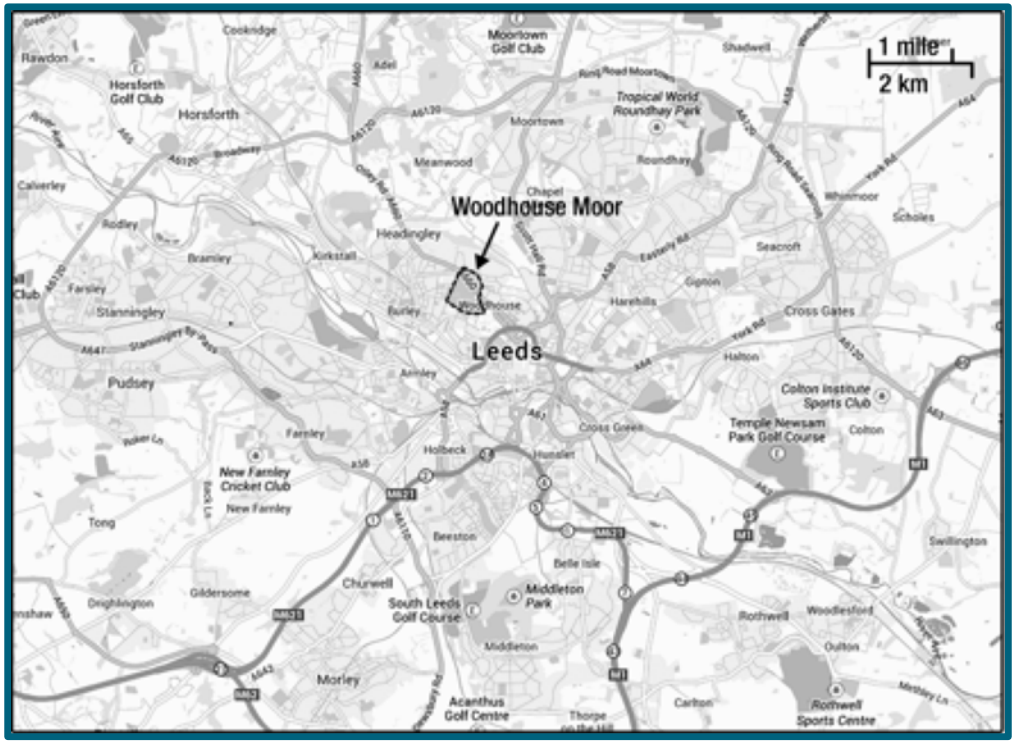
Representations of Sound Propagation



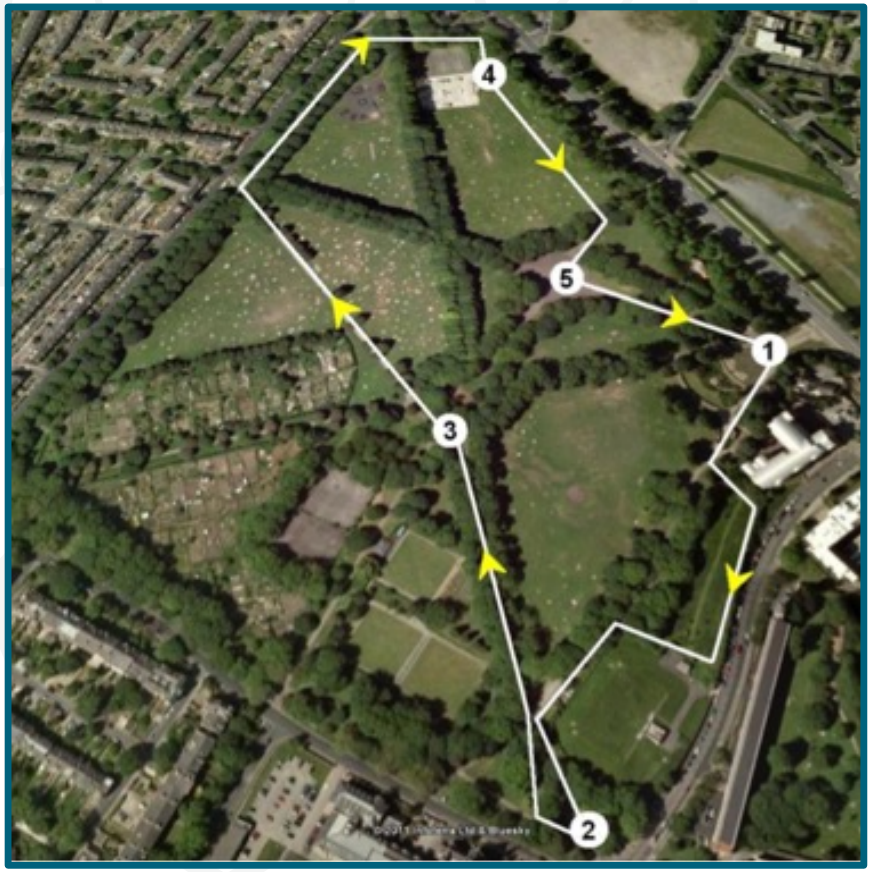


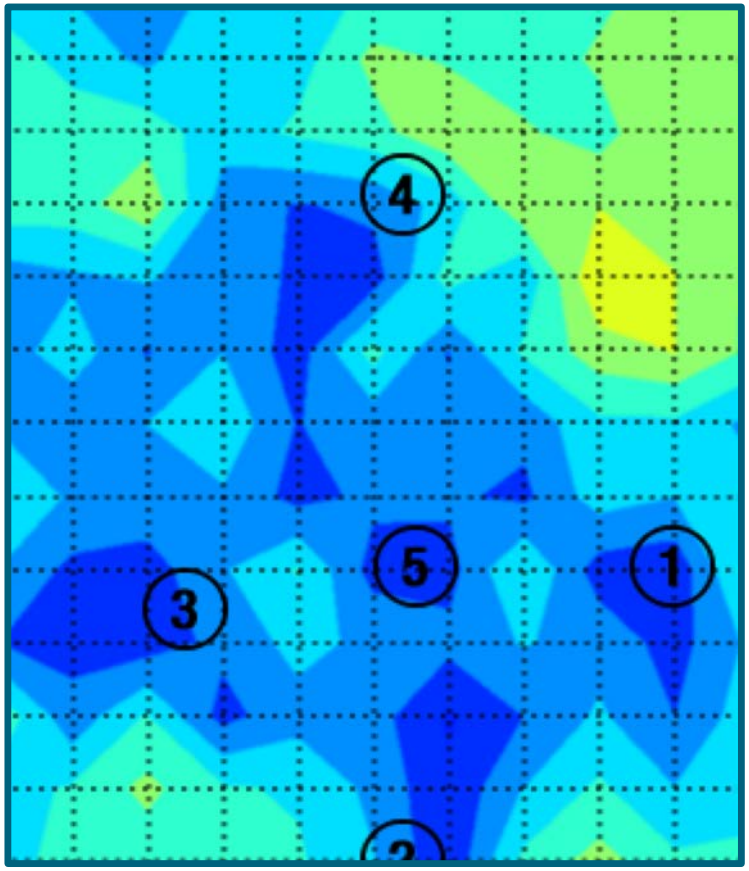


Soundscape Auralization: Subjective Evaluation



Soundscape Auralization: Site Survey and Soundwalk

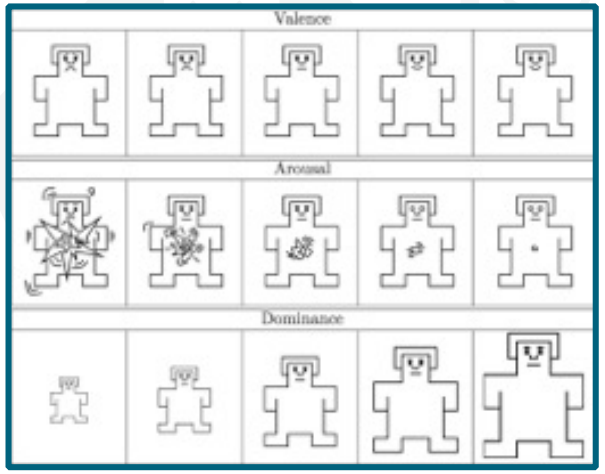




Soundscape Auralization: Virtual Soundwalk

- **Semantic Differential** pairs used to demonstrate **equivalence with actual soundwalk experience**: E.g., (Weak-strong); (Quiet-Noisy); (Static-Changing); (Rural-Urban).
- Can be time consuming to use and explain; unintuitive; inappropriate for non-experts.

Soundscape Auralization: Virtual Soundwalk



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- Can be time consuming to use and explain; unintuitive; inappropriate for non-experts.
- **Self Assessment Manikin (SAM)** derived from 18 SD pairs - three dimensions of emotion:
  - Valence – how pleasant
  - Arousal – how exciting
  - Dominance – how in control
- Intuitive, efficient, cross-cultural, equivalent to SD tests.

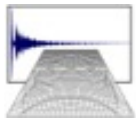
Self Assessment Manikin: Soundscape and Emotional Response



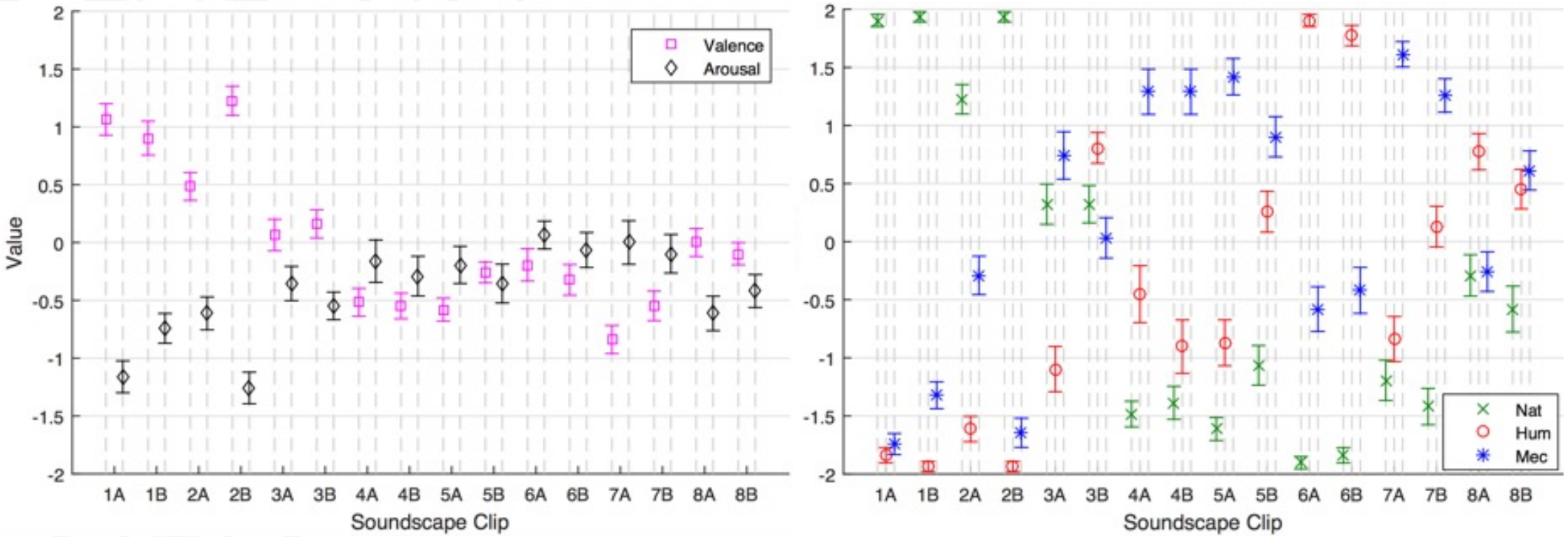





Location	Site	Clip A Sound Sources	Clip B Sound Sources
Dalby Forest (Rural/Natural)	1. Low Dalby Path	Birdsong, Owl Hoots, Wind	Birdsong and honking, Insects, Aeroplane flyby
	2. Staindale Lake	Birdsong, Wind, Insects, Single car	Insects, Birdsong, Water
North York Moors (Rural/Suburban)	3. Hole of Horcum	Birdsong, Traffic, Bleating	Birdsong, Traffic, Conversation
	4. Fox & Rabbit Inn	Traffic, Car door closing, Car starting	Traffic, Footsteps, Car starting
	5. Smiddy Hill, Pickering	Traffic, Car door starting, Conversation	Birdsong, Distant traffic
Leeds City Centre (Urban)	6. Albion Street	Busking, Footsteps, Conversation, Distant traffic	Workmen, Footsteps, Conversation, Distant traffic
	7. Park Row	Traffic, Buses, Wind, Busking	Busking, Footsteps, Conversation, Distant traffic
	8. Park Square	Birdsong, Traffic, Conversation, Shouting	Workmen, Traffic, Conversation, Birdsong

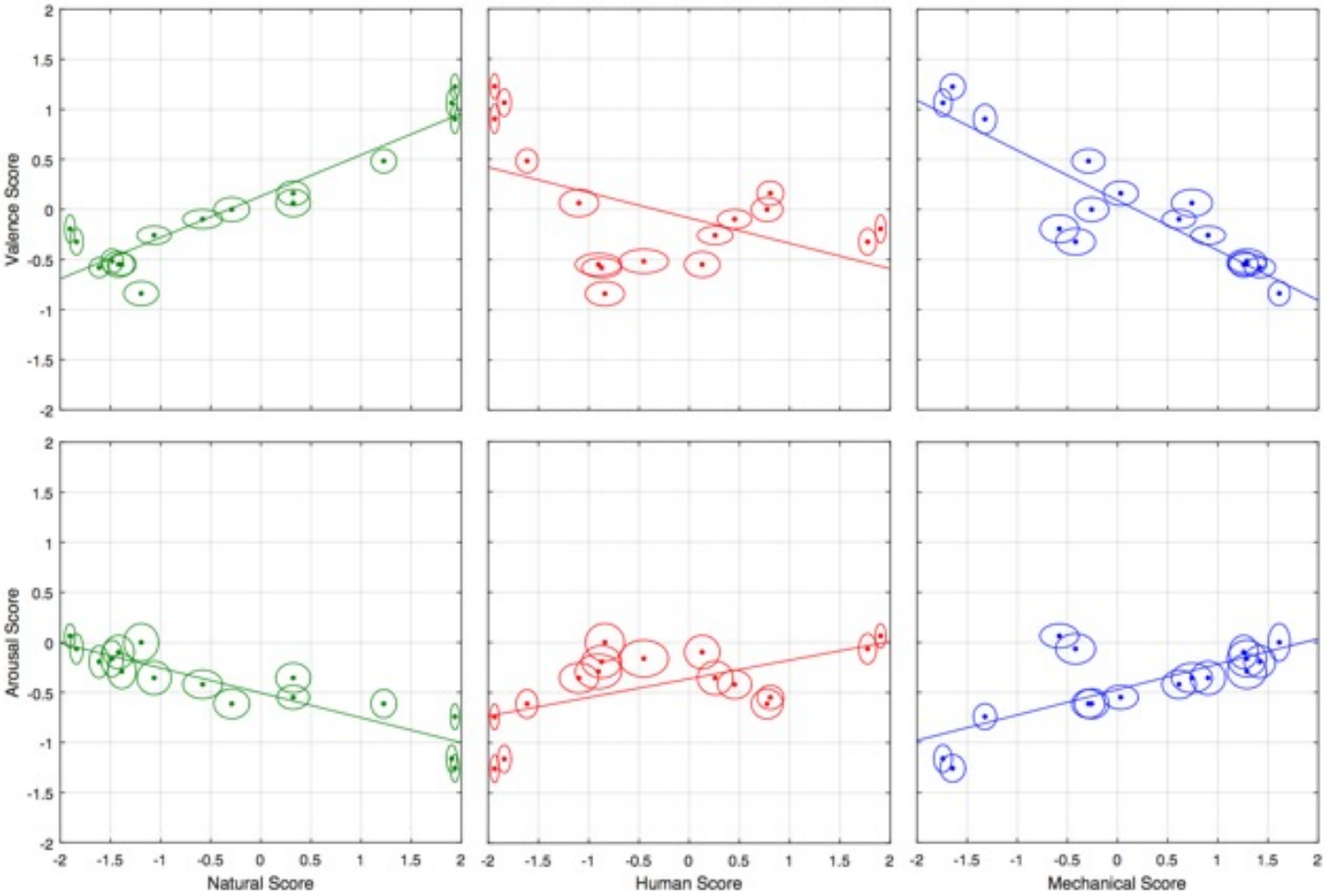


Self Assessment Manikin: Soundscape and Emotional Response

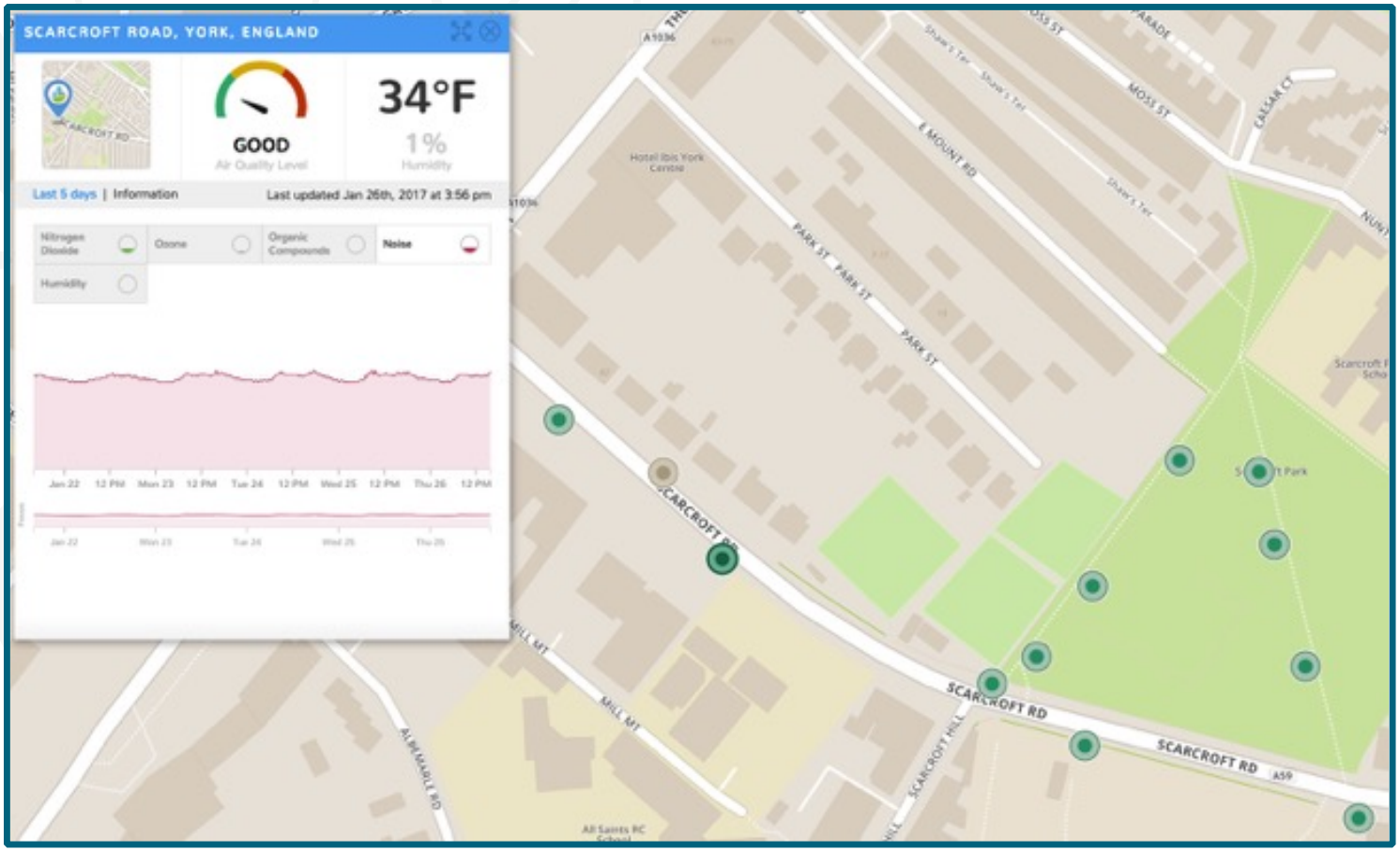


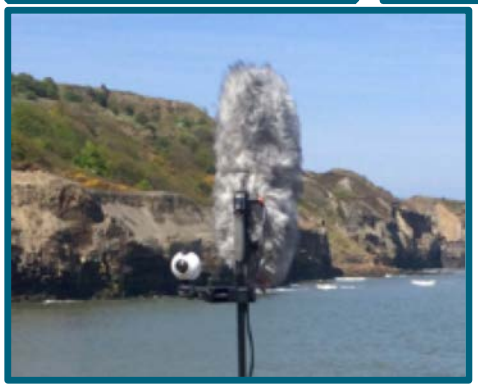
Stevens, F., Smith, S., and Murphy, D.T., "Soundscape Categorisation and the Self-Assessment Manikin", *Proc. of the 20th Int. Conf. on Digital Audio Effects (DAFx17)*, pp. 481-488, Edinburgh, UK, Sep. 5-9, 2017.

Self Assessment Manikin: Soundscape and Emotional Response



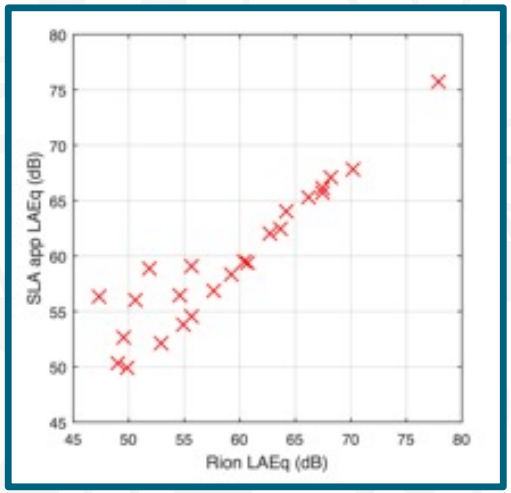
Real-Time Sound Level Monitoring: Scarcroft Road, York

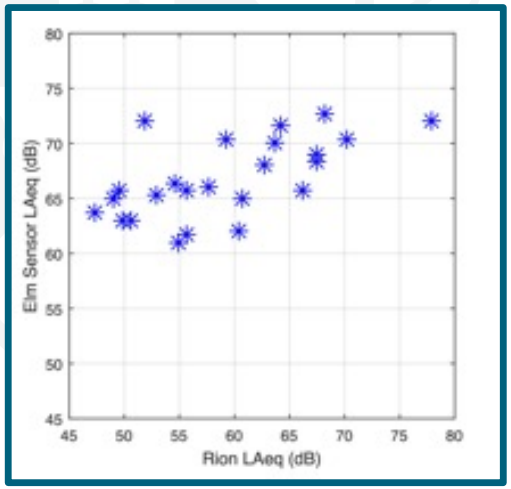


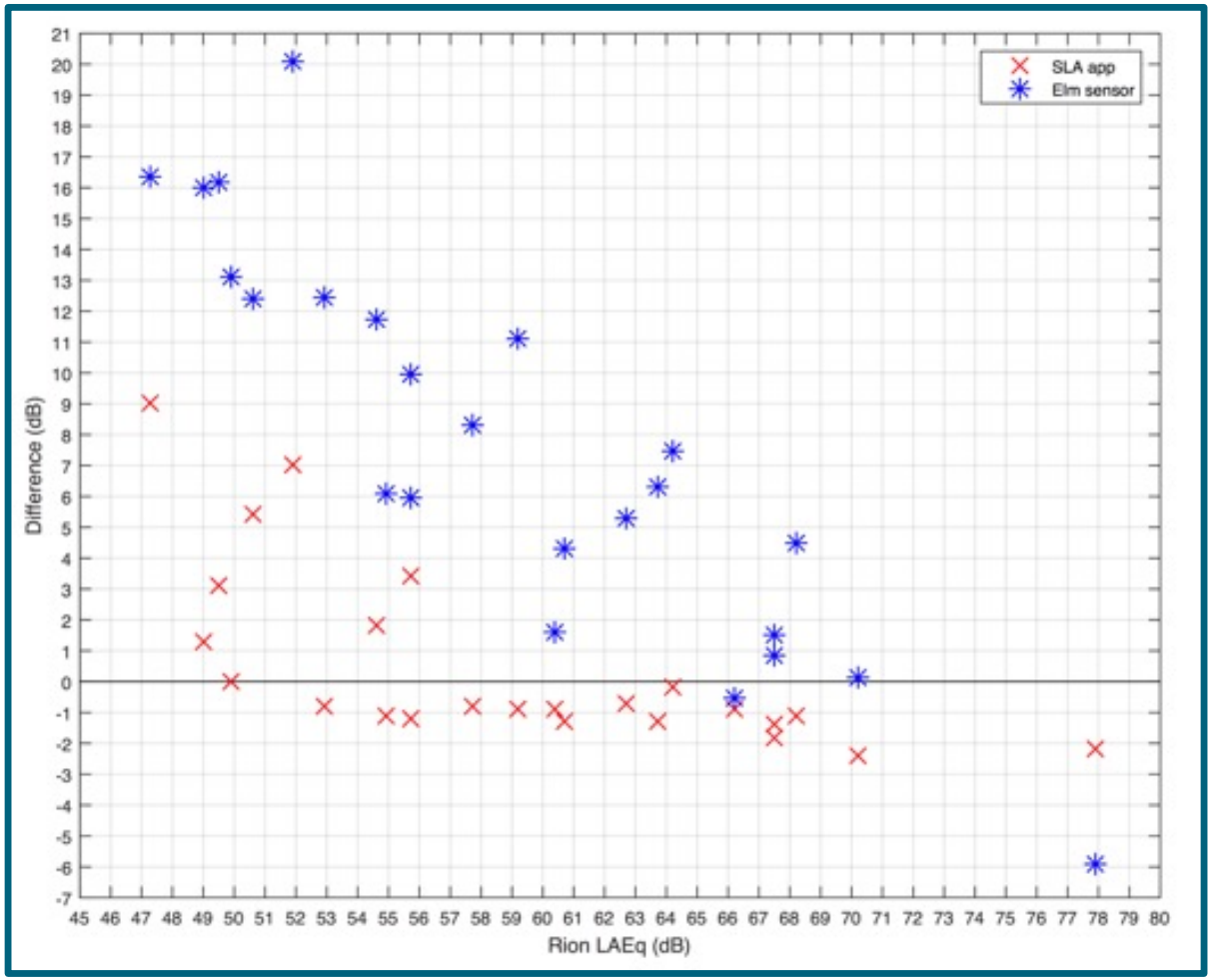


Real-Time Sound Level Monitoring: Scarcroft Road, York

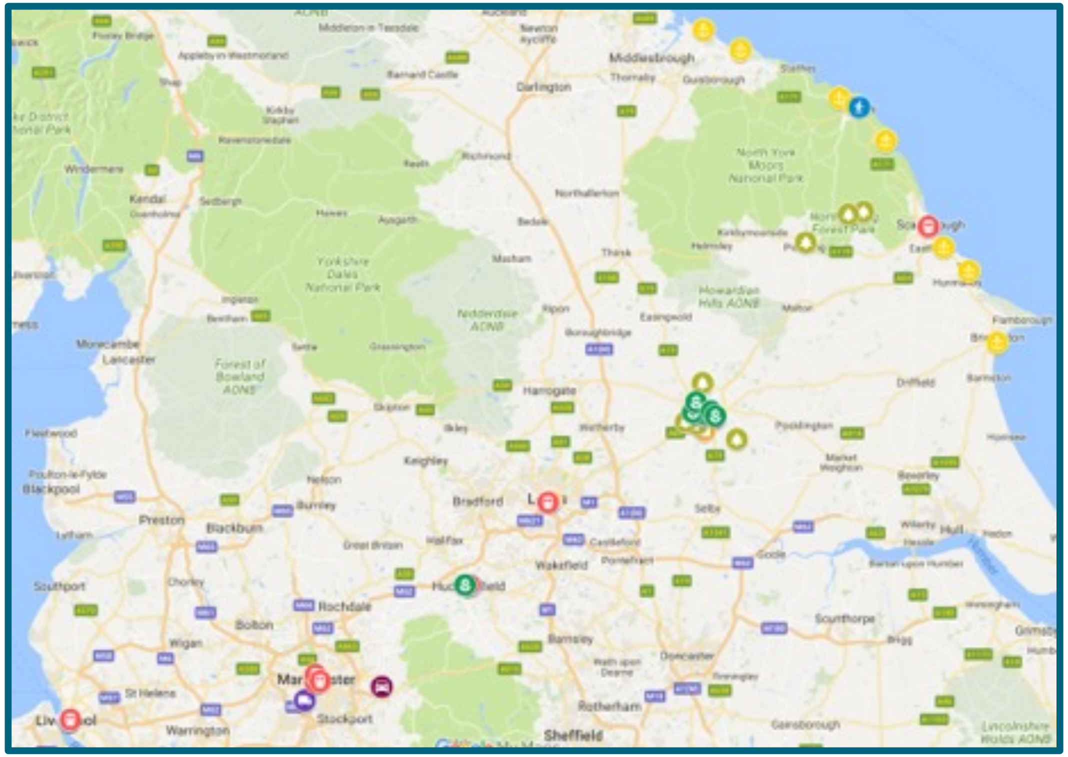
Real-Time Sound Level Monitoring: Calibration







EigenScape:
A Database of Acoustic Scene Recordings



Green, M. C., and Murphy, D. T., "EigenScape: A Database of Spatial Acoustic Scene Recordings", *Applied Sciences, Special Issue on Sound and Music Computing*, 7(11), 1204, 2017.

EigenScape:
A Database of Acoustic Scene Recordings

- Recordings made with MH Acoustics Eigenmike.
- 4th-Order Ambisonics – High spatial resolution
- 8 examples of 8 different scene classes:
- Beach, Busy Street, Park, Pedestrian Zone, Quiet Street, Shopping Centre, Train Station, Woodland.
- 10 minutes per scene, 24-bit / 48 kHz.
- https://zenodo.org/record/1012809

Green, M. C., and Murphy, D. T., "EigenScape: A Database of Spatial Acoustic Scene Recordings", *Applied Sciences, Special Issue on Sound and Music Computing*, 7(11), 1204, 2017.

EigenScape:
A Database of Acoustic Scene Recordings

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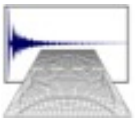
Feature Extraction

Classifier

PedestrianZone | Woodland | Beach | Busy Street | Train Station



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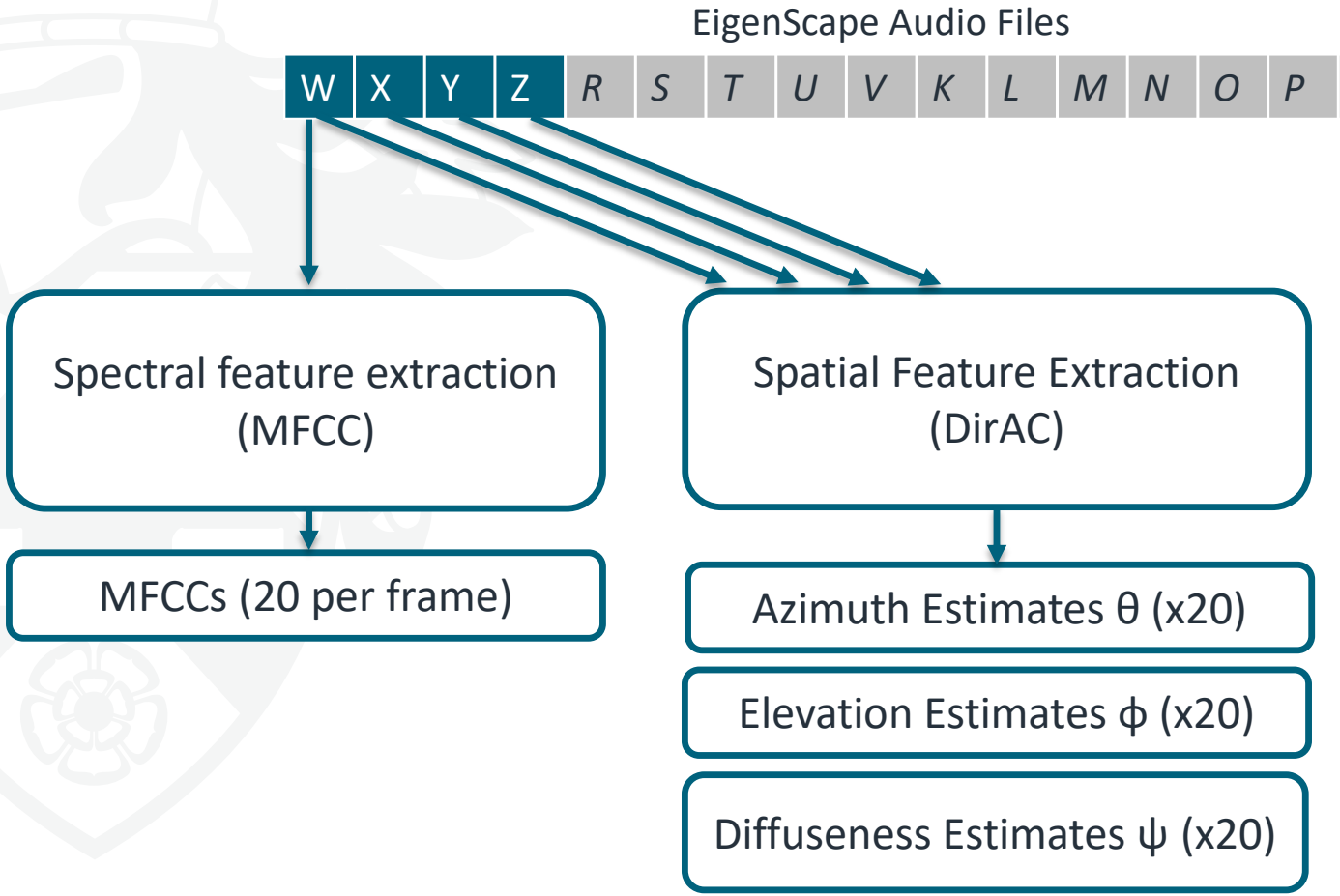

- 2048 sample frames, 50% overlap.
- Classifiers trained to identify scene class of 30s audio segments.
- Performance of classifiers trained using each feature set compared.

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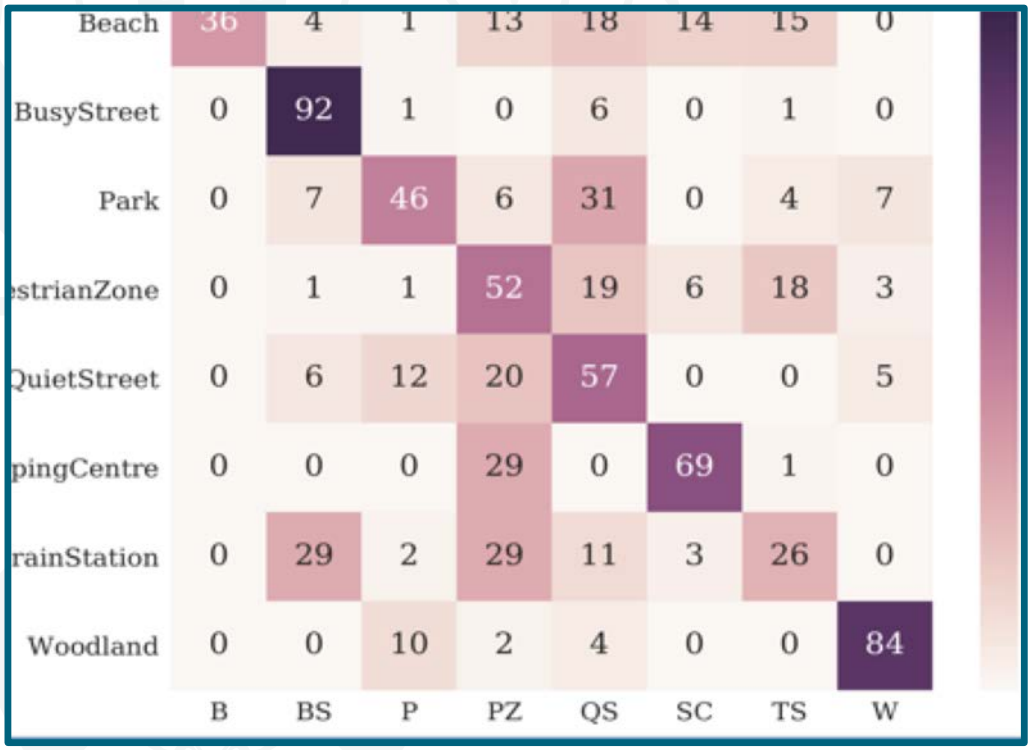

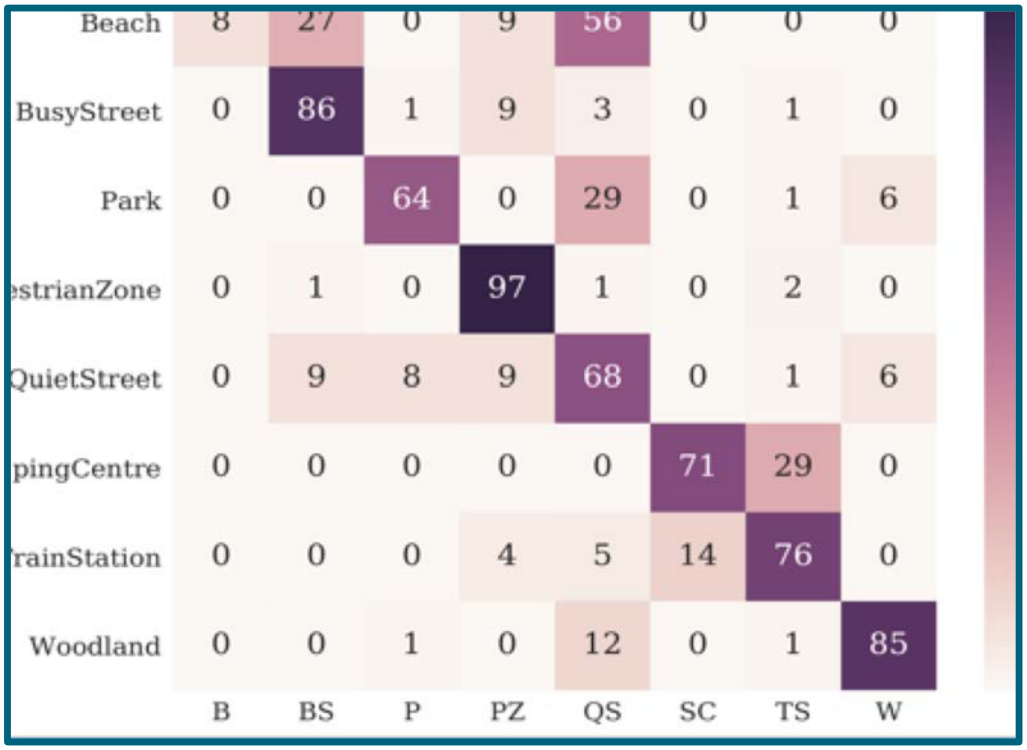

- Spatial features (Elevation/Diffuseness) outperform spectral (MFCC-GMM) in majority of scenes.
- Spectral similarity and spatial similarity not the same.
- Good, but not perfect, accuracy validates EigenScape.

Cochlea Unwound: A Sonic Crystal Listening Aid
http://liminal.org.uk/

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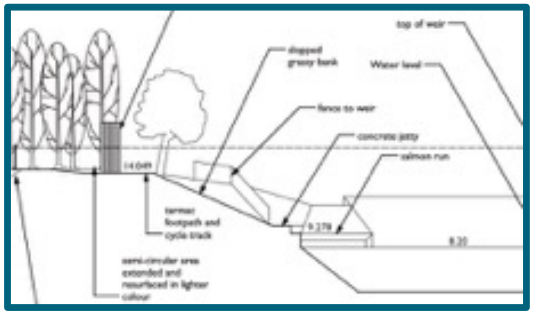
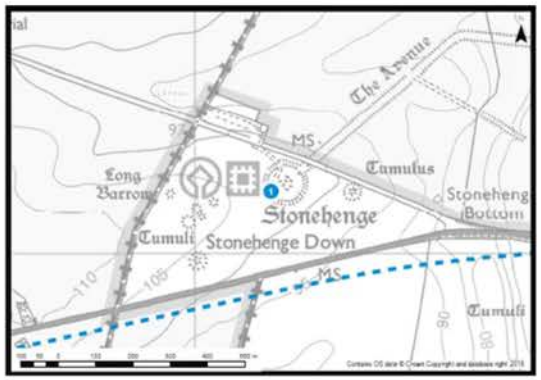


Redesigning the Landscape of Stonehenge

Redesigning the Landscape of Stonehenge

A303 Sound Demonstrations

Location 1 - Stonehenge



The following sound demonstration is for Stonehenge, looking towards the A303 before and after the scheme opens.

In this first video, "Without Scheme", you will hear road traffic flowing on the A303.

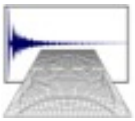
In the second video, "With Scheme", the road traffic uses the tunnel and vehicles can no longer be seen.

In the third video, "With Scheme and Tourists", visitors at Stonehenge can be heard close behind you talking and listening to the handheld electronic guides. These have been included to provide additional context.

highways england

Sound Design in Our Sound Environment: Summary

- Efforts to improve our sound environments should focus on **quality** rather **quantity**, and acoustic design should aim to reflect this.
- Auralisation can help us clearly **communicate design options**, and enable people to **understand what acoustic designs** mean for them.
- Auralisation enables us to **listen** to the many different sound environments we inhabit – and so better **understand the emotional affect** they have on us.
- Established soundwalk methodologies can be supplemented with more **controlled, quantitative and objective soundscape assessment** strategies.
- Auralisation enables **improved acoustic and soundscape design**.
- **Real-time soundscape data** helps to build a more complete understanding of our urban environment as part of this process.



Thank You!

Damian Murphy:

damian.murphy@york.ac.uk

http://www-users.york.ac.uk/~dtm3

http://www.openairlib.net/

Acknowledgements:

Marc Green, Yang Fu, Francis Stevens, Sorrel Harriet, Seb Jouan, Frances Crow, David Prior, Justin Abbott, Lu Yang, Iain Laird, and all AudioLab researchers.