2nd International Spatial Audio Workshop

Wednesday 23rd January 2008

Music Research Centre

Department of Music

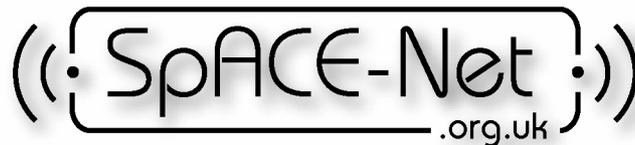**University of York**

SpACE-Net
.org.uk
Spatial Audio Creative Engineering Network

Welcome to the 2nd SpACE-Net Spatial Audio Workshop! For those of you who don't know, the Spatial Audio Creative Engineering Network (SpACE-Net) is a research network funded for two years by the UK's Engineering and Physical Science Research Council (EPSRC), as part of their Culture and Creativity Programme. It has been set up by spatial audio researchers based in the departments of Electronics and Music at the University of York, and in the Institute of Sound Recording at the University of Surrey. Also involved are colleagues at the University of Derby, the University of Kent and partners at Soundfield, Sony, and Creative. The purpose of the network is to bring together a community of spatial audio researchers, practitioners and artists, drawn from the fields of science, audio engineering and the arts.

There are many different approaches to spatial audio research - theoretical, experimental, creative – and, as is evident from recent AES conferences in surround-sound and intelligent audio environments, there is still a great deal of interest in this exciting and rapidly developing area, despite 5.1 having been defined as a 'standard' for us to work with since 1987. In particular, this last point has helped to influence the content of today's workshop – "5.1 Surround-sound: Opportunity or Constraint". So, even though you will hear about research, ideas, and even soundworks prepared using one or many different methods or technologies, they are all designed to be delivered using the industry standard 5.1 speaker layout – or one of the extensions to this format – 7.1 being the obvious example for some of our presentations today. Has this helped or hindered the work…? we will see.

One of the main goals of SpACE-Net is to commission new pieces from composers who make spatial audio a core component of their work. Our second call for works was announced in October 2007 and, from a high number of submissions, two have been selected for presentation at this event. They are diverse, interesting and stimulating in their content, make novel use of spatial audio techniques, presentation and arrangement and both are designed for 5.1. We welcome our artists to York today, both of whom are presenting their work in this particular format for the first time. Mathew Adkins is an award winning composer and performer of experimental electronic music based at the University of Huddersfield and will be presenting "Towards 'that beautiful land': Compositional strategies and influences in Five Panels (no.1)" – the first in a series of five experimental electronic compositions that take as their starting point the paintings of Mark Rothko. Daniel Jones is an artist and software engineer based in south London, who has worked on many independent projects and commissions, including scores for two short films, sound design for theatrical performance, site-specific audio/video performances, and web-based generative works. Today he presents "Atom Swarm" - a framework for musical improvisation based upon the swarming behaviours seen in large groups of social animals.

We are also delighted to welcome our internationally renowned guest speakers. Our keynote address is given by Jean-Marc Jot, Audio Research Fellow, at the Creative Advanced Technology Centre, Scotts Valley, California. Prior to leading Creative's 3D audio research and development activities Jean-Marc was part of the Room Acoustics team at IRCAM, Paris, where he developed the "Spat" software. Among notable publications and achievements he is the principal author of Creative's EAX API and has contributed to the environmental audio spatialization technology in the MPEG-4 standard. Aristotel Digenis is one of our own MSc Music Technology graduates, developer of freeware spatial audio processing tools and now Experienced Audio Programmer for Codemasters, working on advanced game audio engines. Praise and respect for Chris Watson's sound recording and compositional work is both long and significant. He has been nominated for Broadcast's Hot 100; the Guardian lists his album "Weather Report" as one of the 1000 you must hear before you die; the Radio Times describes some of his recent Radio 4 broadcasts as, "[his] wildlife recordings are beyond compare"; "…he is to radio wildlife programme making what David Attenborough is to television". He has worked on many of the BBC and Attenborough's recent television programmes and was awarded a BAFTA for "The Life of Birds" in 1998. He was also a founding member of the influential Sheffield-based experimental music group Cabaret Voltaire, and his work has been praised extensively by Bill Oddie on Richard and Judy's Channel 4 programme – it doesn't come much better that that…

We also have a number of technical research poster presentations to view over our lunch break, and are pleased to welcome Professor Lauri Savioja of the Telecommunications Software and Multimedia Laboratory, at Helsinki University of Technology who is visiting the Department of Electronics this week and contributing to this session. In addition, there are a number of tutorials and demos arranged throughout the day. HHB will be presenting the new Beyerdynamic Headzone 5.1 headphone monitoring system and the

http://space-net.org.uk

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PDR2000 Portadrive downstairs in the RVW Studio. Pete Harrison of Creative Labs Europe and Michael Kelly of Sony Computer Entertainment Europe will be running the ISACT tutorials in the Trevor Jones Studio for those who have already signed up for these sessions. After this workshop we will be announcing a new Creative sponsored call for works based on the use of the ISACT software, details of which will be available on the website, with which you are, by now, no doubt all intimately familiar! We will be listing other opportunities for funding here in the months to come, and so the networking sessions scheduled over lunchtime and this afternoon will provide an ideal opportunity to seek out new collaborations – there is more about these opportunities and our networking sessions on page ten.

We are sure you will agree that there is a high quality and varied programme ahead of us and hope you find the day interesting, stimulating and fun. Please complete your feedback form before you leave so that we can check that this is the case (or not)!

Finally we must thank all those who have helped in the preparation for today. Dr Jonathan Wainwright, Head of the Department of Music, and Dr Tony Myatt, Director of the Music Research Centre for hosting the event; Dave Malham, Matt Paradis, Alex Southern and Alastair Moore for technical support; Steve Fisher of Source Distribution together with Andrew Hingley of HHB for our additional Genelec 1038s to complete the MRC 7.1 diffusion rig.

<div align="right">

Damian, Jude, Tim and the SpACE-Net Team.

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SCHEDULE

	Foyer	Rymer Auditorium	Trevor Jones Studio	RVW Studio
10:00	From 9.45:	Introductions and welcome		
10:15	Registration and Coffee	KEYNOTE SPEAKER:		
10:30				
10:45		Jean-Marc Jot		
11:00				
11:15		COMMISSIONED WORK:		
11:30		Mathew Adkins		
11:45		*Five Panels: No.1*		
12:00	Buffet lunch and Posters			
12:15	Networking 1			HHB Demonstration
12:30			CREATIVE ISACT TUTORIAL A	
12:45				
13:00				
13:15				
13:30		INVITED SPEAKER:		
13:45				
14:00		Aristotel Digenis		
14:15		COMMISSIONED WORK:		
14:30		Daniel Jones		
14:45		*Atom Swarm*		
15:00	Tea		CREATIVE ISACT TUTORIAL B	HHB Demonstration
15:15	Networking 2			
15:30				
15:45		INVITED SPEAKER:		
16:00		Chris Watson		
16:15				
16:30				
16:45		Summary, questions, AOB		
17:00		END		

KEYNOTE AND INVITED SPEAKERS: Rymer Auditorium

10:15   **Jean-Marc Jot**
Audio Research Fellow, Creative Advanced Technology Center
http://www.atc.creative.com/

Prospects in format-agnostic spatial audio

The current practice in authoring, storing or transmitting spatial audio typically assumes selecting a multi-channel audio signal format. The most common spatial audio recording formats include 5.1 surround (3-2 stereo), the Ambisonic B format, and various two-channel stereo recording approaches (including binaural encoding and phase-amplitude matrix encoding). It is typically expected that the choice of a spatial audio format will inevitably imply limitations in fidelity for capturing and encoding spatial audio cues and in flexibility at the reproduction end. Ambisonic technology offers an elegant theoretical and practical framework for rational encoding and flexible reproduction of spatial audio scenes, with continuing development in the academic and audio engineering community. Recent developments in interactive spatial audio technology and in spatial audio analysis/synthesis techniques have the potential of offering viable alternative approaches to "format-agnostic" spatial audio recording and rendering, including the conversion, "up-mixing" or encoding/decoding of existing spatial audio formats. In this presentation, we attempt to review and illustrate these developments and demonstrate some of their possible applications to the creation, distribution and reproduction of music recordings, movie soundtracks, interactive audio and computer music works.

13:30   **Aristotel Digenis**
Experienced Audio Programmer, Codemasters
http://www.codemasters.co.uk/
http://www.digenis.co.uk/

Advanced audio in games

With the growing processing power of modern video game consoles - typically dedicating tens of GFLOPS to audio alone - and the rising popularity of home theatre systems, game developers are expanding the use of spatial audio. A live demonstration of "next-generation" game audio is given, along with a "behind the scenes" view of technologies like Ambisonics, HDMI, occlusion filtering and directional reverbs that make it possible. The distinct needs of spatial audio for films and games will be explored, and statistics detailing the way gamers listen to audio will be presented.

15:45   **Chris Watson**
Sound Recordist
http://www.chriswatson.net/

Ocean deep to desert sky

Chris Watson presents a selection of recent location surround recordings made using strategically placed microphones and hydrophones around the coniferous forests of Norway to the depths of the Pacific Ocean via the click and hum of alien insect voices filling the nocturnal air of the Kalahari desert.

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COMISSIONED SPATIAL AUDIO WORKS: Rymer Auditorium

11:45   MATHEW ADKINS
Music Department, University of Huddersfield,
http://www.mathewadkins.co.uk/

Towards 'that beautiful land': Compositional strategies and influences in Five Panels (no.1)

Five Panels (no.1) is the first of five experimental electronic compositions that take as their starting point the classic (post-1949) abstract paintings of Mark Rothko. As a result, and in contrast to my previous works, Five Panels is more minimal regarding its gestural content and makes less use of teleologically oriented structuring processes. The work focuses more on the details within each sound and on subtle shifts in timbre and acoustic space. This article will cover the influence of Rothko and abstract expressionism more broadly on the work. The spiritual quality of Rothko's paintings is also investigated. As essentially abstract works I am keen to understand how Rothko's works, and, as an extension to this, abstract music can communicate a sense of spirituality with specific reference to Five Panels. Finally, the immersive quality of Rothko's classic paintings, due both to their size and the painter's obsessive control over the conditions and placement of the paintings in galleries, is discussed in relation to the use of surround sound in Five Panels.

14:15   Daniel Jones:
http://www.erase.net/

Atom Swarm

AtomSwarm is a platform for musical performance and composition, which constitutes the outcome of a 12-month research program at Middlesex University's Lansdown Centre for Electronic Arts. This system simulates the swarming behaviours seen in large groups of insects or birds. Within these collectives, each individual operates under a set of very simple rules, but the swarm as a whole appears to exhibit astoundingly complex and adaptive behaviours, capable of responding rapidly to new environments.

Here, these behaviours are augmented by simulated genetic and metabolic interactions, and assigned to a spectrum of sonic characteristics, which are transformed as the population of the swarm develops through encounters between its agents. This development is manipulated by the human conductor, whose role is likewise limited by the parameters of the system; though he is able to manipulate the population's growth and interactions, this control is continually held in tension with the individual drives of its agents.

Through virtual sound-source positioning, this ecosystem is identified with the space surrounding the viewer, and spatialized from the perspective of a persistent agent termed the 'Listener'. This encourages the viewer to identify with an agent inside the space, shifting them from a position outside of the ecosystem to one immersed firmly within it.

Surround-sound product demonstrations: RVW Studio

12:15 and 15:00

BEYERDYNAMIC HEADZONE VIRTUAL 5.1 HEADPHONE MONITORING SYSTEM

BeyerDynamic's Headzone is the first professional mobile headphone system that provides virtual 5.1 reproduction. This innovative system is based on "Binaural Environment Modelling" technology and patented ultrasonic-headtracking. Headzone has proven popular for sound engineers faced with the problem of mixing surround sound projects in conventional stereo studio, for example mixing for live High Definition TV sports transmission and location surround sound music production.

http://www.beyerdynamic.co.uk/beyerpages/headzone.html

HHB PDR2000 PORTADRIVE

The HHB PortaDrive is a portable, battery powered eight-track audio recorder, capable of recording at resolutions up to 96kHz/24-bit. Primarily designed for Film and TV documentary location recording, PortaDrive is also popular for location surround sound recording. PortaDrive has extensive synchronisation and timecode features and produces project files that are compliant industry standard session formats, such as AES31, iXML and SDII, extensive metadata transferred with the audio data.

http://www.hhb.co.uk/

ADDITIONAL RYMER AUDITORIUM SPEAKER INSTALLATION COURTESY OF GENELEC:

http://www.genelec.com/

UK distribution, Source Distribution: **http://www.sourcedistribution.co.uk/**

Since its founding in 1978 Genelec, a Finnish company, has been dedicated to studio audio reproduction. Genelec has been the industry first to develop many of the key technologies in use today in studio monitor loudspeakers. The Directivity Control Waveguide™, the full implementation of the active loudspeaker with inbuilt power amplifiers and full loudspeaker element protection, integration of full room response tailoring.

Genelec manufactures active studio monitor loudspeakers. Genelec's world leading position in this very specialised field of audio engineering is a result of an unequalled commitment to following the scientific acoustic design principles in all our research and development work.

Genelec is dedicated to studio audio reproduction. There is a growing number of applications especially in the surround sound reproduction, where the design principles and products of Genelec have proven to work excellently. Producing a wide range of monitors distributed in over 70 countries around the world, Genelec pursues their continuous research work to maintain their world leading position.

[http://www.genelec.com/company/profile.php, Genelec, 2007]

12.15 POSTER PRESENTATIONS: Foyer

Interactive Auralization System Using High-Quality Impulse Responses
Becky Stewart
Queen Mary, University of London

In 1995, Andrew Reilly and David McGrath presented a series of papers at successive AES conferences describing an interactive, real-time auralization system over both headphones and loudspeakers. They found sufficient accuracy and decreased computation time when a room impulse response is split and only approximately the first 100 ms of the impulse response is updated according to source direction. The system ran on dedicated external hardware.

This approach has been updated, and with modern computing power, now runs on a PC. The subsection of the impulse response that updates with source or receiver movement is selected according to statistical parameters related to the mixing time of the room. A spatial average impulse response represents the reverberation tail for arbitrary source and receiver locations within the same space. This greatly decreases the computation time for convolution reverberation and provides a much more flexible system which employs multiple impulse responses to allow a source or receiver to move within a space. The system is blind to the source of the impulse responses, whether measured in an existing space or synthesised through software. High-quality impulse responses can then be calculated from modelling software in non-real-time and processed to allow real-time interactive auralization of virtual environments. The flexibility is further extended by using B-format impulse responses which allow for rendering the resulting sound field over multiple loudspeaker setups, or when combined with HRTFs, over headphones.

Methods for Second Order Spherical Harmonic Spatial Encoding in Digital Wave-Guide Mesh Virtual Acoustic Simulations.
Alex Southern
Audio Lab - Intelligent Systems Group, Department of Electronics, University of York

The Digital Waveguide Mesh (DWM) is a numerical simulation technique that has been shown to be suitable for modelling the acoustics of enclosed spaces. Previous work considered an approach using an array of spatially distributed receivers based on sound intensity probe theory to capture spatial room impulse responses (RIRs) from the DWM. A suitable process to facilitate spatial encoding of the DWM into second-order spherical harmonics has also been explored. The purpose of this work is to introduce a new alternative processing scheme based on the Blumlein Difference Technique. Both the previous and currently presented techniques are newly formulated with the main processing in the frequency domain. In addition the ability of the newly proposed technique for capturing the 2nd order components is confirmed and further processing of the receiver array is considered to extend the usable frequency range.

How Many Point Sources are Needed to Represent Strings in Auralization?

Lauri Savioja and Tapio Lokki
Helsinki University of Technology

Auralizations with different number of point sources per each string section were made and a listening test was organized to find out perceptual differences. The A/B comparison paradigm was applied and subjects compared differences in perceived number of musicians, spaciousness of auralization, and the overall preference. The results suggest that strings should be modelled with one point source for each musician, but one single recording can be applied in all positions for each section. However, the found differences are quite small and it seems that reasonable auralizations can also be made by representing all strings with only five carefully selected point sources, one for each section.

An In-Depth Study of the Mappings Between Head Shape and Localisation Cues for Efficient and Effective HRTF Individualisation

Jonathan Thorpe, Carl Hetherington and Tony Tew
Audio Lab - Intelligent Systems Group, Department of Electronics, University of York

Creating realistic 3D sound using binaural techniques requires knowledge of a listener's unique head-related transfer functions (HRTFs). These are expensive and time-consuming to determine acoustically. Attempts to deduce them from physical measurements have yielded disappointing results because of complex and intricate acoustic effects in the external ear. In order to more effectively investigate the way head shape variation affects localisation cues, we propose new methods for extracting these cues, identifying the areas of the head which are most involved in creating them and for modelling the shape of a human head focusing information on these areas. These methods will allow us to filter out irrelevant shape and HRTF data before applying a Principle Component Analysis (PCA) on both data-sets and investigating the effect of varying head shape PCA components on HRTF PCA components.

Headphone Transparification

Alastair Moore[1], Tony Tew[1] and Rozenn Nicol[2]
1)Audio Lab - Intelligent Systems Group, Department of Electronics, University of York
2)France Telecom R&D

The only way to be certain that binaurally rendered sounds are properly externalised is to compare them to real sound sources in a discrimination experiment. However, the presence of the headphones required for the binaural rendering interfere with the real sound source. A novel technique is presented which uses small compensating signals applied to the headphones at the same time as the real source is active, such that the signals reaching the ears are the same as if the headphones were not present.

Networking Events – Lunchtime and Afternoon Sessions

Unfortunately the official end of the SpACE-Net project looms large in July 2008 although we are currently looking at ways to further the aims of the organisation once the funding has run out. Watch this space for further announcements...

In the meantime we aim to continue to promote new projects in the area of spatial audio research, development and practice. Over the next six months we plan to organise and facilitate opportunities for our members to get together to talk about ideas and develop collaborative projects that might ultimately go forward to EPSRC for funding; this can be a tricky and involved process though, so we are here to help support and potentially fund any initiatives you have in the early stages leading up to a full proposal.

 To help promote such collaborations, we have time set aside during today's workshop to 'network', and to help you find potential collaborators. We would like to move this aspect of the day beyond the usual informal chatting and getting to know people (still very important of course!) to something a little bit more directed. The collaborations we have in mind are for academic research projects but there are all sorts of other reasons why talking to a specific person might help to further your work in spatial audio:

- academics might be seeking potential research assistants or PhD students or academic/industrial/private collaborators or project proposal referees;
- students might be seeking PhD supervisors, employers, or like-minded students with which to share results or information;
- industry members might be seeking employees, academics or students to conduct specialised research, or just an opportunity to help steer academic work;
- individuals might be seeking academics, students or industry members to help take forward their ideas.

To help with the networking component of the day, we will be collecting the following information at the beginning of the day:

- your area of work (max 6 words);
- your status (academic/student/industry/individual);
- which of the following would you be happy to be approached about becoming:
  PhD supervisor, PhD student, project referee, collaborator, employer, employee

Information from all delegates will then be distributed at lunchtime so that everyone can seek out the people they'd most like to talk with - without bothering anyone who isn't interested. We'll announce how we're going to manage this at the time.

Shortly after the event a *Call for Projects* will be announced to provide travel funding to help you get collaborative research projects underway and developed - if you already have some ideas or people in mind after the workshop then you'll be very well placed for this announcement when it's made.

Advance Notice

With support from the AHRC Methods Network and SpACE-Net:

Virtual Audio and Past Environments: Audio and Acoustics in Heritage Applications
National Centre for Early Music - http://www.ncem.co.uk/
Monday 17th March 2008

Virtual interactive environments, especially in online gaming and similar applications, are now a highly popular sector in the entertainment industry, and offer high quality graphical rendering of virtual worlds and user interaction and immersion. Such graphical virtualization techniques have long been used in the fields of archaeology, history, and heritage as a means to better understand, interact and experience past environments. However despite significant advances in desktop computer processing and associated graphics rendering, sound design and audio processing techniques are usually perfunctory at best in such applications and make little use of recent similar creative and technological developments in the field of acoustics and audio processing. Most people would also agree that good and considered use of high quality sound design can work with the imagination to evoke powerful images or memories, or provide important auditory cues to the nature of events in the virtual environment, either in support of or parallel to the visual stimulus. As a particular example, such techniques have long been used in film sound design and are now accepted as commonplace.

Additionally, architectural acoustic modelling and measurement techniques have more recently moved from purely lab-based research and analysis to include real-time walk through virtual environments - as used, for instance, by Arup Acoustics in their building design work - and the study of heritage sites. Of particular note in the latter case is the European CHARISMA project (Conservation of the Acoustical Heritage by the Revival and Identification of the Sinan's Mosques Acoustics – now finished). The main goal of this project was to introduce and develop the concept of "Hybrid Architectural Heritage" covering acoustic as well as more accepted visual features.

The proposed workshop aims to explore multi-disciplinary approaches to audio, acoustics, and sound design, and how techniques and current research might be applied to heritage and related applications. The day will consist of a series of presentations and discussion, leading to a unique evening programme of artistic events at a number of sites across York City Centre.

Speakers Confirmed to Date:

- Dr Damian Murphy, Audio Lab, University of York: *Archaeological Acoustic Space Measurement For Convolution Reverberation and Auralization Applications*
- Jude Brereton, Audio Lab, University of York: *The Voice, Singing and Performance in Acoustic Space.*
- Dr Peter Rutherford, School of the Built Environment, University of Nottingham: *Virtual Acoustic Reconstruction and the Role of Auditory and Visual Cues for Enabling Musical Performance*
- Dr Anthony Masinton, Department of Archaeology, University of York: *The Acoustics of Past Spaces: Understanding Sound in Ecclesiastic Heritage.*
- Dr Kenny McAlpine, Project Leader, Digital Audio Developments, University of Abertay Dundee.
- More to follow!

A website will be available shortly – but in the meantime for more information please Email Damian (dtm3@ohm.york.ac.uk) or Jude (jb64@ohm.york.ac.uk) or speak to us today!

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